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1976
THE CANADIAN MONEY SUPPLY UNDER FIXED
AND FLEXIBLE EXCHANGE RATES

Dissertation

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of the Ohio State University

By

William John Gasser, B.Sc. M.A.

* * * * *

The Ohio State University
1976

Reading Committee:
Professor Ernst Baltensperger, Chairman
Professor Edward Ray
Professor Thomas Wolf

Approved By

Adviser
Department of Economics
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A special acknowledgment is due my wife, Hannelore, without whose patience, encouragement, moral support, and income my preparatory studies and the work on this dissertation would not have been completed.
VITA

November 19, 1941 . . . . .  
Born - Youngstown, Ohio

1965. . . . . . . . . . . . . .  
B.Sc., The Ohio State University, 
Columbus, Ohio

1970. . . . . . . . . . . . . .  
M.A., The Ohio State University, 
Columbus, Ohio

1971 - 1976 . . . . . . . .  
Economist, Federal Reserve Bank 
of New York, New York

FIELDS OF STUDY

Major Field: Economics

  Studies in Economic Theory. Professor William Dewald
  Studies in International Trade. Professor Larry Wipf
  Studies in Public Finance. Professor John Weicher

Outside Field: Geography. Professor Emilio Cassetti
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<td>E/B</td>
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<td>B</td>
<td>Monetary base; currency in the hands of the non-bank public and chartered banks plus chartered bank deposits at the Bank of Canada</td>
<td>Cp+R</td>
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<td>B'</td>
<td>Extended sources definition of the monetary base</td>
<td>B'</td>
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<td>CA</td>
<td>Current account balance; three month moving average</td>
<td>T</td>
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<td>Cb</td>
<td>Chartered bank holdings of Bank of Canada notes (currency)</td>
<td>B403</td>
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<td>Cbt</td>
<td>Ratio of change in chartered bank holdings of Bank of Canada notes</td>
<td>Cbt_{t-1}/Cbt_t</td>
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<td>CM</td>
<td>Bank Credit Market</td>
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<td>Cp</td>
<td>Currency in the hands of the non-bank public</td>
<td>B102</td>
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<td>D</td>
<td>Total Canadian dollar deposit liabilities of chartered banks</td>
<td>B450</td>
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<td>Canadian dollar demand deposit liabilities of chartered banks (inclusive of float)</td>
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<td>Bank of Canada deposit liabilities to the Government of Canada</td>
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<td>Canadian dollar personal savings deposit liabilities of chartered banks</td>
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<td>Dt</td>
<td>Canadian dollar non-personal term and notice Deposit liabilities of chartered banks</td>
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<td>Dr</td>
<td>Ratio of change in total deposits</td>
<td>$D_{t-1}/D_t$</td>
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<td>E</td>
<td>Chartered bank domestic earning assets; the stock of domestic bank credit</td>
<td>$E = D - (R + F_b)$</td>
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<td>Chartered banks' demand for domestic earning assets; the supply of bank credit</td>
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<td>Public supply of earning assets to banks; the demand for bank credit</td>
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<td>E</td>
<td>Total elasticity operator; $E(x,b) = (\frac{dx}{dg}) \cdot \frac{(y/x)}{y}$</td>
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<td>e</td>
<td>Partial elasticity operator; $e(x,y)$ is the elasticity of $x$ with respect to $y$, $\frac{(\partial x/\partial y)}{(y/x)}$</td>
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<td>Foreign sources of the extended monetary base; official holdings of international reserve assets net of swaps and other borrowings</td>
<td>$FB + FG$</td>
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<td>Reserve asset target; desired level of official reserve assets by monetary authorities</td>
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<td>Government deposit ratio; ratio of Government of Canada deposits at chartered banks to chartered bank demand deposit liabilities</td>
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<td>Other Bank of Canada assets minus liabilities</td>
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<td>Vector of variables exogenous to the complete short-run hypothesis</td>
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<td>Rate of change in domestic prices; consumer price index, rate of change over preceding four quarters</td>
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<td>Chartered bank reserves; chartered bank deposits at the Bank of Canada plus currency</td>
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<td>Reserve ratio; ratio of chartered bank primary reserves to total deposit liabilities of chartered banks</td>
<td>R/D</td>
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<td>Excess reserves</td>
<td>re*D</td>
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<td>Excess reserve ratio; excess reserves to total chartered bank Canadian dollar deposit liabilities</td>
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<td>Statutory required reserves</td>
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<td>Required reserve ratio; required reserves to total chartered bank deposit liabilities</td>
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<td>Statutory reserve requirement ratio; (1954-1967 = .08)</td>
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<td>Statutory reserve requirement ratio for deposits subject to withdrawal on demand (Q3/67 = .09; Q4/67 = .105; Q1/68 = .1183; Q2/68 = .12)</td>
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<td>Desired savings deposit ratio</td>
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<td>Symbol</td>
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Symbol                        Source
xess  Exchange rate expectations proxy; Stein formulation unadjusted for serial correlation                       Appendix A
xew  Exchange rate expectations proxy; weighted average of past changes                                Appendix A
x1    One quarter lagged value of average quarterly exchange rate                                     x_{t-1}
x2    Two quarter lagged value of average quarterly exchange rate                                     x_{t-2}
YA    Long-run growth of domestic income; nominal GNP                                                   Appendix A
YAF   Long-run growth of foreign income; nominal U.S. GNP                                             Appendix A
YAR   Relative growth of domestic to foreign nominal income                                             YA-YFA
Y/Yp  Relative income; current income (NNP) relative to permanent income, a proxy for the cyclical state of real activity Appendix A
yd    Total net yield on Canadian dollar demand deposits, implicit benefits derived from deposits minus implicit and explicit costs
yf    Total yield on a financial asset denominated in a foreign currency
\hat{yf}  Ratio of change in domestic income to change in foreign income (GNP's) four quarter change
ys    Total net yield on savings deposits, proxied by is, isn.
yt    Total net yield on term and notice deposits; proxied by it
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<td>( \delta )</td>
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1 Source abbreviations refer to primary data sources or transformations of primary data. Primary data source symbols are: B- or D-, Dominion Bureau of Statistics, CANISM identification number (February 21, 1971 version); N- National Bureau of Economic Research, NBER identification number; Appendix, variables constructed specifically for this study or involving complex transformations as described in Appendix A. Simple transformations are described in the symbol column. All observed variables are measured by quarterly averages of Wednesdays' figures unless noted: (D) average of daily figures; (M) average of monthly figures; or (Q) a quarterly figure. Symbols listing no primary source or transformation are unobserved theoretic variables and operators.
CHAPTER I
INTRODUCTION

The short-run behavior of money in open economies has been a relatively underdeveloped area in the economic literature. Under perfectly fixed exchange rates, the issue is relatively uninteresting. The fixed rate commitment insures that the authorities will remove any excess demand for money through exchange rate pegging operations. If international capital markets are efficient, this adjustment will occur promptly so that the domestic money supply has no independent role to play in the determination of domestic prices and output. However, if the commitment to fixed exchange rates is not final, a short-run trade-off exists between changes in the money supply and the exchange rate. This thesis examines the nature of that trade-off in Canada.

The study reviews the short-run Canadian money supply process over the 1955-1970 period; a period that spans fixed and flexible exchange rates, monetary aggregates and credit market conditions as the domestic targets of policy, and a substantial revision to the Canadian Bank Act, which is a major determinant of the environment in which the money supply is generated. The primary objective of the study is to isolate the effects of policy instruments, predetermined domestic and foreign variables, and structural shifts on quarterly changes in various definitions of the Canadian money stock over this period. These
changes in the money stock are generated by a money supply process which depends on the financial asset markets' response to changes in the exogenous factors. In this process, domestic interest rates and foreign exchange rates are simultaneously determined. The study emphasises the effects of policy instruments and foreign sector variables, the instruments to evaluate potential control of the money supply and the foreign sector to determine the extent of constraint on this control imposed by fixing the exchange rate and level of international reserves. An important secondary objective is to determine how the short-run financial asset markets facilitate adjustment to international disequilibrium. This is of particular interest in Canada owing to the long-run stability of the exchange rate, whether a fixed or flexible rate system was formally in place.

The basic framework upon which this study is based is the Brunner-Meltzer non-linear money supply hypothesis. This hypothesis defines the short-run money supply as a product of a monetary base—monetary liabilities of the Government and Bank of Canada—and a

multiplier whose value is determined in the short-run by a financial asset market partial equilibrium.\(^1\) To meet the primary objective of the study, a policy exogenous formulation of the Brunner-Meltzer hypothesis is adapted to the Canadian institutional setting in order to explain the behavior of the Canadian money supply. Instruments of policy, variables directly under the control of the Bank of Canada, are assumed exogenous, as are real sector variables, which are predetermined relative to the short-run adjustment in financial asset markets, and foreign interest rates which are exogenous as a result of a "small country" assumption. The interaction of chartered banks and the non-bank public in financial asset markets determines the short-run money supply, along with domestic interest rates, the foreign exchange rate and the quantity of Canadian dollar bank credit extended. In addition to explaining the historic behavior of the money supply, this policy exogenous hypothesis provides information on the Bank of Canada's ability to control the money supply in the short-run. Institutional features that weaken this control are delineated as are the key exogenous variables that must be predicted in order to achieve monetary growth targets.

\(^1\) Over the longer run, the interaction of money supply and money demand proximately determines prices in a Walrasian money market as output and real assets respond in time to global disequilibrium. The money supply hypothesis thus forms a building block in a general equilibrium model. For this extension see Karl Brunner and Allan H. Meltzer, "A Monetarist Framework for Aggregative Analysis", in Proceedings of the First Konstanzer Seminar on Monetary Theory and Monetary Policy, ed. by K. Brunner, Supplement to Kredit and Kapital, I (1972), p. 1-88; and Brunner and Meltzer, "Money Debt and Economic Activity," Journal of Political Economy, LXXX (September/October, 1972), 951-77.
In extending the money supply hypothesis into the flexible rate environment, the exchange rate is made endogenous to the system. It is a potential target of monetary policy whose magnitude is determined in the short-run by the adjustment of financial asset portfolios across currencies in response to Canadian policy actions, to relative Canadian and foreign real sector variables, and to the conditions in foreign financial asset markets. While this endogeny of the short-run exchange rate is necessary for a flexible exchange rate model, it is also a useful property of the policy exogenous model under fixed exchange rates. A completely fixed rate is a limiting case of targeting while the ability of the rate to fluctuate within a one percent band around the IMF par value allowed some trade-off between this target and others even during the "fixed rate" portion of the period under study. This ability to trade-off between domestic and foreign monetary targets should be enhanced by sterilizing short-run effects of changes in foreign exchange reserves. Increases (reductions) in the supply of base money as a result of intervention in the foreign exchange market can be offset, for example, through open market operations that reduce (increase) the base and money supply. The policy exogenous hypothesis formulation allows for theoretic consideration of the existence and magnitude of this trade-off. The Canadian case is particularly interesting in this regard owing to the longer-run stability of the Canadian-U.S. dollar exchange rate under a wide variety of conditions; under fixed and flexible exchange rates, targeted floating exchange
rates, and constraints on the adjustment of reserve assets. If a short-run tradeoff exists and was utilized in Canada, it did not preclude the longer-run stability of the exchange rate.

Canada is also a useful case study owing to openness of its economy and the freedom from capital controls between it and the United States. The interplay of market forces can be observed in a relatively unfettered environment which greatly simplifies the testing of behavioral hypothesis. The dominant influence of the U.S. makes it a reasonable proxy for the rest of the world and the relative size of the two economies makes the "small country" assumption plausible. Moreover, statistical data on Canadian financial asset markets are also reasonably complete and easily accessible, and the Canadian tradition of economic thought and literature closely parallels that in the U.S. to provide a common base of past research on which to build the flexible exchange rate, open economy money supply hypothesis.

Prior to the mid-1960s, Canadian literature on the money supply process was largely institutional with the 1964 Report of the Royal Commission on Banking and Finance providing an encyclopedic

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1 The Government of Canada, Dominion Bureau of Statistics, and Bank of Canada maintain the Canadian Socio-Economic Information Management System (CANISM), a computer database containing almost all data collected by the Government and Bank. A tape copy of this data along with software to access it was made available for this study by the Bank of Canada.
account of these institutional features with remarkable insight, given past published work in Canada, and several original studies. This institutional literature and the Report itself provide many of the structural details upon which the hypothesis depends.¹ A 1965 study by Wonnacott contains a comprehensive, if disjointed, account of the relationship between the Canadian money stock and that of the U.S., while Macesich's early 1960s studies of the behavior of the currency ratio and other proximate determinants of the money supply and Weber's 1964 study of the money supply process using an early formulation of the Brunner-Meltzer hypothesis provides the theoretic starting points.²


Johnson; Winder and Macesich provide early studies of the relationship between money supply and money demand which suggest that money does indeed matter in Canada although the definition of money in the Canadian context has not been resolved. More recently, studies by Fand and Tower, using a free reserve model, Courchene and Kelly, with a demand for money model in which the proximate determinants are derived, have explicitly looked at some aspects of the money supply process. Studies completed since this thesis was begun by Dingle, Sparks and Walker, and Freedman provide useful theoretic and empirical support for the behavior of the reserve ratio and the banks' foreign asset position.2

Parallel with this literature on the money supply in Canada has been the development of a comprehensive theory on the determination of

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of short-term international financial capital flows as a result of portfolio adjustment in financial asset markets. This literature, based on the Markowitz-Tobin portfolio adjustment theory has, however, generally assumed either exchange rates or interest rates (or both) to be exogenously fixed policy variables. The Canadian case has been well represented in this literature, and several studies recognize the importance of these flows in the determination of the exchange rate. However, none consider their implication for the money supply in either the short or longer run.  

While these studies provide a basis upon which to build, none presents a comprehensive model of the interaction between domestic and foreign financial asset markets, most ignore the determination of

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the Canadian interest rate, and none provides a comprehensive explanation of the short-run determination of the exchange rate. The two major econometric models developed for Canada, the Bank of Canada's RDX-2 and University of Toronto's TRACE do not explicitly consider money although the former provides an insightful formulation of the financial asset and foreign exchange market.¹

Most of the recent general literature on money is an open economy follows Mundell and Johnson's formulation and deals with the longer-run adjustment period where absolute prices are assumed to be given in world markets and the domestic money supply simply determines domestic prices and the exchange rate. While this formulation provides considerable insight into longer-run problems, it results in the proposition that money does not matter in determining real income and employment, a proposition not consistent with the short-run impact money has on output in monetarist models.²


² See Harry G. Johnson, Further Essays in Monetary Economics (Cambridge: Harvard University Press) pp. 229-250 for an exposition of this approach. Johnson recognizes that the short-run adjustment link has yet to be developed in the Introduction to this work.
The Brunner-Meltzer hypothesis is, on the other hand, consistent with the monetarist proposition that money influences output in the intermediate run and prices over the longer run. It has been developed in great detail to account for the institutional structure in the U.S., where international factors play a relatively minor role, and has been adapted to fit a number of European economies operating under the constraint of a fixed exchange rate. However, the hypothesis requires considerable modification to account for the institutional structure in Canada, and the distinctive features of that country—its high degree of capital market integration with the U.S. as well as the different exchange rate regimes—which make it an interesting case, both as a test of the usefulness of the general money supply hypothesis approach and for an extension of the basic hypothesis.

This study develops the policy exogenous money supply equations in Chapter II and the bank credit and foreign exchange markets in Chapter III. The reduced form of this system has ambiguous signs on several key policy variables and estimates of the relative magnitude of parameters in the structural money supply and semi-reduced form asset market equations are necessary to determine the response of the different definitions of money to key policy variables.

The historic behavior of the authorities in setting policy instruments is examined in Chapter IV. Then, the direction causality in the hypothesis is reversed, with the foreign exchange rate and level of reserve assets made endogenous and the alternative policy instruments are made exogenous to assess the impact of setting the fixed exchange rate and fixed reserve asset targets on the still endogenous money supply. To complete the model for purposes of estimation and testing with the historic data, a simple reaction function is posited for the authorities in Chapter V. The estimation procedure followed is two stage least squares, with the first stage used to obtain instrumental variables for the now endogenized policy instruments as well as the alternative short-run targets. The first stage may be considered an implicit reduced form for the model which includes reaction functions. The instrumental variables generated are then used to test the hypothesized sign and order conditions in the
structural equations and to provide estimates of the critical parameters. The final section of Chapter V simulates the money supply from its structural components and tests the overall efficiency of the policy exogenous hypothesis. Finally, an evaluation of the effectiveness of policy instruments on the exchange rate and money supply and, in Chapter VI, the general conclusions of the study are presented along with an evaluation of particular problem areas and suggestions for future research.
CHAPTER II
THE MONEY STOCK AND MONEY SUPPLY

A. Introduction

This chapter develops structural equation for three alternative definitions of the Canadian money supply. These equations are postulated to be functions of policy parameters, variables given exogenously by the real and foreign sectors, and variables whose magnitude are determined by the short run equilibrium in the financial asset and foreign exchange markets. The three definitions of money considered in this study are defined in terms of their proximate determinants in Section B of this chapter. Section C examines the past behavior of the three definitions of money and the relative contribution of the individual determinants over the period under consideration. The definitions of the money stock thus formulated are converted into a money supply hypothesis in Section D where behavioral equations for the determinants are postulated. Section E examines the relationship between deposit yields and credit market interest rates within the Canadian institutional setting, while semi-reduced form equations for the money supply are used in Section F to derive the empirical conditions for expected response signs of the alternative definitions of money with respect to variables proximately exogenous to the money supply equations.
B. The Money Stock

The analytic framework for the money supply equations is based on the definitional equations (1) through (10) below. Algebraic manipulation of these equations results in the money stock defined in terms of its proximate determinants. The particular arrangement of the determinants utilized depends on three factors: (a) the Canadian institutional setting and reporting practices in the period under study, (b) a preliminary examination of the behavior of alternative constellations of the determinants, and (c) the desire to isolate policy variables from those determined by the decisions of the banks and nonbank public. The definitions of the money stock in terms of their proximate determinants are then expanded into money supply hypotheses by postulating behavioral relationships for those determinants not directly set by policy actions in equations (14) through (17) below.

The basic definitional equations are:

(1) \[ M_1 = C_p + D_d, \]
(2) \[ M_2 = C_p + D_d + D_s, \]
(3) \[ M_3 = C_p + D_d + D_s + D_t, \]
(4) \[ B = C_p + R, \]
(5) \[ D = D_d + D_s + D_t + D_g, \]
(6) \[ k = C_p / D_d, \]
(7) \[ s = D_s / D_d, \]
(8) \[ t = D_t / D_d, \]
(9) \[ g = D_g / D_d, \]
(10) \[ r = R / D. \]
Equations (1) through (3) define the alternative forms of money considered in this thesis as nonbank holdings of currency and coin (Cp), non-personal demand deposits at chartered banks (Dd), personal savings deposits (Ds), and non-personal term and notice deposits (Dt). Equations (1) and (3) correspond with the most commonly used definitions of money in the Canadian literature and conform with the general reporting practices of the Bank of Canada except for my inclusion of float (items in transit) in the money stock. Equation (2) defines transactions money, including personal savings deposits which by virtue of their check transfer option serve as a primary medium of exchange for most individuals.\footnote{The special personal savings deposits introduced in 1967 are included with other personal savings deposits in defining transactions money despite the fact that they are not subject to check transfer. An alternative formulation for the 1967-1970 period was also constructed, placing fixed term personal savings deposits (Dst) with non-personal term and notice deposits rather than retaining them in personal savings deposits. While this constellation is conceptually preferable for M2, the nonexistence of Dst over most of the period and an apparent lagged response to their introduction in 1967 resulted in too small a sample size to test propositions about the behavior of k, s, and t ratios so formulated.} Equation (4) defines monetary liabilities of the Government and Bank of Canada, the monetary base (B), by its uses, currency and coin in the hands of the nonbank public and reserves of the chartered banks (R). Equation (5) defines total chartered bank Canadian dollar deposits as the sum of the deposit classes reported, including Government of Canada deposits (Dg). Equations (6) through (10) define the currency, savings deposit, term deposit, government deposit and reserve ratios.
The proximate determinants of the money stock are derived by substituting equations (5) through (10) into equations (1) through (4) and rearranging terms:

(11) \[ M_1 = m_1 \cdot B, \]
(12) \[ M_2 = m_2 \cdot B, \]
(13) \[ M_3 = m_3 \cdot B; \text{ where} \]

\[ m_1 = \frac{(1 + k)}{z}, \]
\[ m_2 = \frac{(1 + k + s)}{z}, \]
\[ m_3 = \frac{(1 + k + s + t)}{z}, \]
\[ z = k + r(1 + s + t + g). \]

The money multipliers (\(m_1, m_2, \text{ and } m_3\)) are the factors by which the monetary base—high powered money—is expanded by the banking system into the quantity of publicly held money. The proximate determinants of the money stock consist of the monetary base and the ratios \(k, s, t, g, \text{ and } r\) which make up the multipliers.

The partial response of the money stock to a change in a proximate determinant can be expressed in elasticity form by differentiating equations (11) through (13) and rearranging terms:

\[ e(M_1, B) = e(M_2, B) = e(M_3, B) = 1, \]
\[ e(M_1, k) = \frac{k}{1 + k} - \frac{k}{z}, \]
\[ e(M_2, k) = \frac{k}{1 + k + s} - \frac{k}{z}, \]
\[ e(M_3, k) = \frac{k}{1 + k + s + t} - \frac{k}{z}, \]
\[ e(M_1, s) = \frac{-rs}{z}. \]
\[ e(M_2, s) = \frac{s}{1 + k + s} - \frac{rs}{z}, \]
\[ e(M_3, s) = \frac{s}{1 + k + s + t} - \frac{rs}{z}, \]
\[ e(M_1, t) = e(M_2, t) = \frac{t}{1 + k + s + t} - \frac{rt}{z}, \]
\[ e(M_3, t) = \frac{t}{1 + k + s + t} - \frac{rt}{z}, \]
\[ e(M_1, r) = e(M_2, r) = e(M_3, r) = \frac{-r(1 + s + t + g)}{z}, \]
\[ e(M_1, g) = e(M_2, g) = e(M_3, g) = \frac{-rg}{z}, \]
where
\[ z = k + r(1 + s + t + g) \] as before.\(^1\)

Since each ratio is positive by definition, the signs and orders of magnitude for most responses are unambiguous:\(^2\)

\(^1\) The elasticity of \( y \) with respect to \( x \), \( e(y, x) = (\partial y / \partial x) (x/y) \).
For the analysis of proximate determinants, the ratios are assumed independent so the partial response of \( M \) with respect to a determinant in equations (11) through (13) is equal to the total response. Using \( e(M_1, t) \) as an example, the elasticity is derived from equation (11) in the following manner:

\[ e(M_1, t) = \frac{dM_1}{dt} \frac{t}{M_1} \frac{d \log(M_1)}{dt} \text{, where} \]
\[ \log(M_1) = \log(1 + k) - \log(k + r(1 + s + t + g)) + \log(B), \]
\[ \frac{d \log(M_1)}{dt} = -\frac{1}{z} \frac{d(k + r(1 + s + t + g))}{dt} = -\frac{r}{z}, \]
so
\[ e(M_1, t) = -\frac{rt}{z}. \]

\(^2\) Consider for example the response of \( M_2 \) with respect to the savings deposit ratio:
\[ e(M_2, s) \geq 0 \text{ as } \frac{s}{1 + k + s} \geq \frac{rs}{k + r(1 + s + t + g)}, \]
which reduces to as \( rk \geq k + rt + rg \).

Since \( 0 < r < 1 \), \( rk < k < k + rt + rg \), and \( e(M_2, s) > 0 \).
\[ e(M_1, s) < 0 < e(M_3, s) < e(M_2, s), \]
\[ e(M_1, t) = e(M_2, t) < 0 < e(M_3, t), \]
\[ e(M_1, r) = e(M_2, r) = e(M_3, r) < 0, \text{ and} \]
\[ e(M_1, g) > e(M_2, g) = e(M_3, g) < 0, \]

The order of magnitude of the currency ratio response is also unambiguous,
\[ e(M_1, k) > e(M_2, k) > e(M_3, k), \]

but their sign depends on the ratio of reserves to demand deposits; \(^1\)
\[ e(M_1, k) \gtrless 0 \text{ as } 1 \lessgtr \frac{R}{Dd}, \]
\[ e(M_2, k) \gtrless 0 \text{ as } 1 + s \lessgtr \frac{R}{Dd}, \text{ and} \]
\[ e(M_3, k) \gtrless 0 \text{ as } 1 + s + t \lessgtr \frac{R}{Dd}. \]

In fact, \( R/Dd \) has ranged narrowly between 0.23 and 0.28 throughout the period so that:
\[ 0 > e(M_1, k) > e(M_2, k) > e(M_3, k). \]

\(^1\) \( e(M_1, k) \gtrless 0 \) as \( \frac{k}{1 + k} \lessgtr \frac{k}{k + r(1 + s + t + g)} \) which reduces to
\[ \text{as } 1 \lessgtr r(1 + s + t + g) \text{ where the term on the right side of the inequality is reducable to } R/Dd \text{ from equations (5) through (10) above.} \]
C. The Proximate Determinants of the Money Stock

This section briefly examines the historic behavior of the three definitions of money over the 1955-1970 period, and the relative influences of the proximate determinants on this behavior. This analysis brings out several important features of the Canadian money supply process that will be expanded in later sections.

The historic behavior of the three definitions of the Canadian money stock under consideration in this study are plotted in Figure 1. (As these definitions differ somewhat from those generally reported, their magnitudes are included in Appendix B.) In addition to an obvious seasonal coincidence of movement, until the early 1960's all three definitions showed a similar growth over time with M2 and M3 quite close, the result of the relatively low level of term and notice deposits early in the sample period. Through the mid- and late 1960's, however, differences in the behavior of the alternative definitions became more pronounced, particularly in the period since the 1967 Bank Act revision. This pattern is brought into sharper focus in Figure 2 which plots the annual percentage change in the three definitions of money, calculated over the same quarter one year earlier to remove the purely seasonal variation. This format also emphasizes the wide variation in the rate of monetary growth prior to 1961. The growth rate of M1, for example ranged from a high of 12.2 percent per annum in the last quarter of 1958 to as low as -5.1 percent in the fourth quarter of 1959. During the same period, M2 and M3 growth attained their
Figure 1

(millions of Canadian dollars)
Figure 2

Canadian Money Stock, 1955-1970
(percentage change*)
maxima of 11.8 percent per annum each in the fourth quarter of 1958, but did not reach their minima, -1.5 and -2.0 percent respectively, until the second quarter of 1960. This pattern of the decline in the growth of the more inclusive definitions of money lagging behind that of M1 also is evident in the contraction in 1950 and early 1957. From 1961 onward, the growth of the three monetary aggregates took on a more divergent behavior, with M3 growth increasing rapidly that year and again in 1965 when it topped 12 percent while M1 and M2 growth remained relatively steady at around 7 percent. Following the 1967 Bank Act revision — effective May 1 — the rate of change in M1 dropped sharply, to 2.1 percent per annum by the second quarter of 1968, while that of M3 remained above 12 percent and M2 climbed above 9 percent. Then in the 1969 contraction, M3 declined apace with M1 to below 1 percent while M2 growth bottomed at a rate above 5½ percent per annum. Over the period as a whole, M2 was most stable of the three definitions with a coefficient of variation of 53.7 as compared with 60.5 for M3 and 81.6 for M1. A similar pattern of relative variation between the three definitions of the Canadian money stock asserted itself in both the flexible and fixed exchange rate sub-periods.

As a first step in ascertaining the factors underlying this behavior of the Canadian money stock, the relative historic contribution of each of the proximate determinants isolated in
equations (11) through (13) were calculated. Since the results of the analysis of proximate determinants is broadly consistent with a number of prior studies, despite the somewhat different definitional decomposition of determinants, these results are presented.

This analysis of the money stock in terms of its proximate determinants follows along lines developed by J.E. Meade, "The Amount of Money and the Banking System", The Economic Journal, Vol. 44 (1934) pp. 77-83. The proximate determinant contributions are derived by differentiating the money stock identity,

\[ M = m(k, s, ...) \cdot B, \]

with the assumption of independence among the right side variables. This yields,

\[ \frac{dM}{M} = \left( \frac{\partial m}{\partial k} \cdot dk + \frac{\partial m}{\partial s} \cdot ds + \ldots \right) \cdot B + m \cdot dB. \]

Dividing by \( M \) yields

\[ \frac{dM}{M} = \left( \frac{\partial m}{\partial k} \cdot \frac{dk}{k} + \frac{\partial m}{\partial s} \cdot \frac{ds}{s} + \ldots \right) + \frac{dB}{B}, \]

or

\[ \frac{dM}{M} = e(m, k) \cdot \frac{dk}{k} + e(m, s) \cdot \frac{ds}{s} + \ldots + \frac{dB}{B}, \]

which is approximated by

\[ \frac{\Delta M}{M} = e(m, k) \cdot \frac{\Delta k}{k} + e(m, s) \cdot \frac{\Delta s}{s} + \ldots + \frac{\Delta B}{B}, \]

where \( \Delta M/M \) is the percentage change over four quarters and the elasticities are approximated by their four quarter average. The contribution of the currency ratio to the change in \( M \) is thus the product of the percentage change in \( k \) times its elasticity. The sum of the contributions equals the total change in the money stock.
equations (11) through (13) were calculated. Since the results of the analysis of proximate determinants is broadly consistent with a number of prior studies, despite the somewhat different definitional decomposition of determinants, these results are presented

1 This analysis of the money stock in terms of its proximate determinants follows along lines developed by J.E. Meade, "The Amount of Money and the Banking System", The Economic Journal, Vol. 44 (1934) pp. 77-83. The proximate determinant contributions are derived by differentiating the money stock identity,

\[ M = m(k, s, \ldots) B, \]

with the assumption of independence among the right side variables. This yields,

\[ \frac{dM}{M} = \left( \frac{\partial m}{\partial k} \frac{dk}{m} + \frac{\partial m}{\partial s} \frac{ds}{m} + \ldots \right) B + \frac{dB}{B}. \]

Dividing by M yields

\[ \frac{dM}{M} = \left( \frac{\partial m}{\partial k} \frac{dk}{m} + \frac{\partial m}{\partial s} \frac{ds}{m} + \ldots \right) + \frac{dB}{B}, \text{ or} \]

\[ \frac{dM}{M} = e(m, k) \frac{dk}{k} + e(m, s) \frac{ds}{s} + \ldots + \frac{dB}{B}, \text{ which is approximated by} \]

\[ \frac{\Delta M}{M} = e(m, k) \frac{\Delta k}{k} + e(m, s) \frac{\Delta s}{s} + \ldots + \frac{\Delta B}{B}, \text{ where } \Delta M/M \]

is the percentage change over four quarters and the elasticities are approximated by their four quarter average. The contribution of the currency ratio to the change in M is thus the product of the percentage change in k times its elasticity. The sum of the contributions equals the total change in the money stock.
in a graphical summary form. Furthermore, given the general tendency of the three definitions of money to move together, the analysis is centered on the behavior of transactions money (M2).

In the earlier studies both Gerald Weber and Alex Kelley found the monetary base to be the dominant source of change in the money stock over long periods of time with changes in the multiplier becoming a more important source of variation in quarter-to-quarter changes. Of the determinants which make up the multiplier, Weber found the currency and time deposit ratios to be most significant in the 1955-1961 sub-period — the portion of his study coincident with this thesis — although they tended to offset each other to some extent, while the reserve ratio remained a relatively stable factor. Kelly found the current ratio to be the major source of

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1 Earlier Canadian studies utilizing this approach include Joachim Ahrensdorf and S. Kanesthasan, "Variations in the Money Multiplier and their Implications for Central Banking", International Monetary Fund Staff Papers, VIII, No. 1 (November 1960) 126-149, Weber, Money Supply of Canada, Chapter 2, and Alex L. Kelley "Sources of Canadian Money Supply", Quarterly Review, Banca Nazionale Del Lavoro, XCI, (December 1969) 395-407, and Kelly, "The Money Multiplier", Chapter 3. Kelly's multipliers are most similar to those used in this thesis and the results of his study are for the most part consistent with that summarized here. The major difference between this formulation and those of Kelly and Weber is the treatment of government deposits. Weber included Dg in the definition of Dd while Kelley adjusted the monetary base to eliminate the government deposit ratio.

change in the multiplier, the savings deposit ratio and the reserve ratio made roughly equal contribution.¹

Figure 3 plots the approximate contributions of the monetary base and the sum of the determinants in the transactions money multiplier (M2) as derived from equations (1) - (13) above. As in the other studies, the monetary base, with a mean growth rate of 4.7 percent per annum dominated the growth in M2 over the period as a whole. The growth of the multiplier, averaging 1.3 percent, occurred almost entirely in the quarters following immediately after the 1954 and 1967 Bank Act changes. On a quarter by quarter basis, variation in the multiplier became a more significant source of instability in M2, the standard deviation of m2 (.0325) exceeds that of B (.0303) over the period as a whole, and even excepting the quarters following the Bank Act changes, remains nearly as large (.0272) for m2 versus .0294 for B).

In addition to these generally recognized features of the Canadian money supply process, this examination brings out a marked divergence in the relationship of the base to multiplier between the floating rate period and the fixed rate period. Movements in the multiplier tended to relate directly with those of the base in the floating rate period (1955 thru 1961) and inversely during the

¹ Kelly, "Sources of Canadian Money Supply", 401-03, does however get a much smaller influence for the reserve ratio when measured in a weighted regression of k, s, and t on m.
Figure 3
Contributions of Multiplier and Base
to M2 Growth, 1955-1970
subsequent fixed rate period. This pattern is particularly pro-
nounced if the adjustment to the '54 Bank Act revision (Q1/55 to
Q2/56) is dropped and the period of "managed float" (Q3/60 to Q1/62)
is included with the fixed rate. As a result of the positive rela-
tionship between the base and multiplier during the floating rate
period, the money stock itself showed a smoother growth pattern
under the fixed regime than with flexible rates.

Further information on the behavior of the multiplier is pro-
vided by decomposing it into its rational components. Figure 4 shows
the contribution of each component to the percentage change in the
multiplier. The reserve ratio dominated the movement in the multi-
plier only during the periods of adjustment following changes in the
Canadian Bank Act. While the 1954 Bank Act raised the level of re-
quired reserves from 5 to 8 percent, it lengthened the period over
which this ratio had to be calculated from a daily to a monthly
average and introduced a lagged reserve requirement. The banks, which
had been holding reserves equal to more than ten percent of total de-
posits prior to the Bank Act, reduced their reserves to nearly the
new requirement level and the money multiplier increased accordingly.
A similar reduction in bank reserves followed the 1967 Bank Act which
raised reserve requirements for demand deposit and lowered those for
notice deposits with the result that the ratio of required reserves
to total deposits fell to around 6 percent. The banks adjusted total
reserves accordingly. With the exception of these two periods,
changes in the currency and savings deposit ratio dominated the
Figure 4
Contribution of Multiplier Components
to Changes in Transactions Money
contribution of the multiplier with these two proximate determi-
nants partially offsetting each other in terms of direction of
change. Late in the period the term deposit ratio gained importance,
generally moving to reinforce the effects of the savings deposit
ratio.

While the contributions of the currency and savings deposits
tended to offset each other in the transactions money multiplier and
dampen the swings in M2, these movements reinforced each other in M1
and account for the greater variability in M1 than M2 observed over
most of the period. The term deposit ratio had a similar effect on
M3 where it contributed to movement in the opposite direction from
its effect on M2 and increased the variability of broadly defined
money, particularly late in the period.

The contribution of the government deposit ratio to changes
in transactions money exceeded one percent plus or minus in only nine
of the 64 quarters covered. Nevertheless, all six of these occur-
rences during the fixed rate period coincided with particularly heavy
official intervention in the foreign exchange market and in each of
these instances the direction of change in the level official re-
serves and the contribution of the government deposit ratio were
positively related.

The net effect on transactions money of the influence of
those proximate determinants whose behavior is subject to the control
of the Bank of Canada is plotted in Figure 5 along with the sum of
the contribution of the remaining determinants, those whose magnitude and changes are determined by the behavior of the banks and non-bank public.\(^1\) For the period as a whole, the policy controlled determinants account for nearly 93 percent of the change in transactions money as measured by the correlation coefficient, \(r_{M2,P}\). Even during the sub-period after the 1967 Bank Act change (Q3/67 - Q4/70) when the time and savings deposit ratios became more influential sources of change, the squared correlation coefficient between \(M2\) and the policy determinants remained above 70 percent. The changed relationship between the contribution of

\(^1\) These determinants are under policy control only to the extent that the decision to support the exchange rate is viewed as a policy decision of the Bank of Canada. This is not to imply that policy has been directed toward the control of these determinants but that their movement is the result of policy actions on the part of the Bank. The addition of the base and government deposit ratio is nearly equivalent to Courchene and Kelly's adjustment of the monetary base which subtracts out reserves required to support government deposits; Thomas J. Courchene and Alex K. Kelly, "Money Supply and Money Demand," Journal of Money, Banking and Credit, III, No. 2 (May 1971), 222. With our assumption, discussed below, of zero excess reserves, the addition of the reserve in reserve requirements; see Leonal C. Anderson and Jerry L. Jordan, "The Monetary Base — Explanation and Analytical Use," Federal Reserve Bank of St. Louis, Review (August 1968).
Controlled Contribution \((P) = \frac{AB}{B} + e(H2,s) \frac{\Delta H}{H} + e(H2, t) \frac{\Delta T}{T}\)

Noncontrolled Contribution \((P) = e(H2,k) \frac{\Delta K}{K} + e(H2,s) \frac{\Delta H}{H} + e(H2,t) \frac{\Delta T}{T}\)

Figure 5
Contributions of Controlled and Noncontrolled Determinants to M2
the base and multiplier from the floating to fixed exchange rate period noted above is amplified by the inclusion of the effects of other policy determined determinants along with that of the base. The correlation coefficient between the contributions of the policy and non-policy determinants went from +0.6415 in the Q1/55 – Q2/61 floating rate period to +.0018 for the Q2/62 – Q1/70 fixed rate period and dropped to -.8649 for the Q2/62 – Q2/67 period which excludes the effects of the 1967 Bank Act revision.

Thus, the behavior of the proximate determinants over the period under study generates a number of propositions that will be examined in detail below when the assumptions of independence between determinants are relaxed. First, differences between rates of growth in the three definitions of money are the result of changes in determinants which are not directly subject to control. Nonetheless, their movement shows a high degree of correlation with each other which tended to stabilize their effect on transactions money at the same time as it increased the variability of the more commonly used definitions of the Canadian money stock. This factor has led other researchers to place more emphasis on changes in the multiplier than may be warranted. Second, the reserve ratio contributes very little to quarterly changes in the multiplier except following changes in reserve requirements, but this contribution appears to have increased following the 1967 Bank Act change. The Bank Act may have also contributed to a change
in the relationship between the term and savings deposit ratios which increased the variability of M3 relative to that of M2 late in the period. The third is the fact that a large proportion of the change in the transactions money stock is attributable to changes in those determinants whose behavior is, at least in principle, subject to the direct control of the monetary authorities. While this control may have been circumscribed by policy decisions to maintain goals other than monetary aggregates, the result of these decisions accounted directly for nearly 70 percent of the observed quarterly changes in M2. The Canadian money stock would thus have been a controllable magnitude to the extent that the behavior of the remaining determinants could have predicted. Finally, the observed change in the relationship between the controlled and non-controlled determinants from the flexible to the fixed rate regime suggest polar possibilities. Either the decision to fix the exchange rate caused a structural shift in the behavior of the banks and nonbank public such that their reaction to changes in policy variables was altered, or the decision induced a course of policy that countered the movement in the private sector determinants. The latter pole is in keeping with the concept that fixed exchange rates constrain monetary policy. Unless evidence of a shift in behavioral equations for the noncontrolled determinants is found, the proximate determinant analysis indicates that the constraints on monetary policy imposed by the fixed exchange rate reduced the variability in the money stock from its earlier level.
D. The Money Supply

This definitional decomposition of the money stock into proximate determinants is converted into an hypothesized money supply function by specifying behavioral equations for the determinants. The monetary base is at this stage considered as an exogenously determined policy variable. Of the rational determinants in the multiplier, s, k and t are postulated to depend primarily on the behavior of the non-bank public in allocating their holdings of liquid financial assets. The reserve ratio is decomposed into a required and excess reserve ratio, the former a policy variable and the latter a behavioral variable depending on the allocation of assets by chartered banks. The government deposit ratio is a Bank of Canada policy variable. Public monetary asset allocation behavior is assumed to be linear homogenous in demand deposit and chartered bank behavior is assumed linear homogenous in total deposits. In general, the desired value of these ratios are

1 The U.S. studies using the non-linear money supply approach have generally assumed public behavior linear homogeneous in demand deposits, but for the United Kingdom, Brunner and Crouch, "Money Supply", have assumed linear homogeneity in liquid financial assets to examine particular problems of monetary control. The homogeneity assumption is in general an empirical question that, for Canada, has been explicitly considered by Weber, "Money Supply of Canada," 12-20 and 76-78. Weber's conclusion, that equations homogeneous in demand deposits (dd) "perform decisively better" in prediction than those homogeneous in total deposits, was reconfirmed in preliminary empirical work for this thesis for the period under consideration and with respect to other assumptions. The hypothesis was then structured around this assumption.
postulated to depend on the relative net yield and risk of the assets in the denominator to those in the numerator to the relevant decision making unit. While, in most cases, neither net yield nor risk is an observable magnitude, a number of proxies for and determinants of these magnitudes have been isolated in prior research and additional factors are tentatively posited here to account for the influence of the foreign sector and institutional peculiarities in Canada.

Because the foreign currency asset yield enters the hypothesized Canadian money supply process in a number of places, it is useful to introduce a definitional construct of this yield now. The yield of a financial asset, or cost of a financial liability, denominated in a foreign currency is comprised of two components. The first is the change in the foreign exchange rate over the period in which the asset is held. The second component is the yield on this asset in foreign units of account, the foreign interest rate. Ex post, this yield can be expressed as:

\[ y_f = [(x_1 - x_0)/x_0] + (x_1/x_0) \cdot if \]

where \( x_0 \) is the exchange rate when the foreign asset is purchased, \( x_1 \) is the exchange rate at its reconversion into domestic currency and \( if \) is the foreign interest rate expressed as a percentage per
the duration of the asset holding.\(^1\) Ex ante, the expected yield on
the foreign asset is determined by the expected value of the ex-
change rate at the anticipated conversion date \((x_e)\), the known cur-
rent exchange rate, and the foreign currency yield on the asset
which is assumed to be known with certainty.

\[ y_f = \frac{(x_e - x)}{x} + \frac{x_e}{x} \text{ if} \]

The expected cost of borrowing through the acquisition of foreign cur-
rency liabilities is similarly decomposable into an expected exchange
rate depreciation factor and the foreign currency cost, the foreign
interest rate.

Differentiation of the foreign yield (cost) equation in-
dicates that this yield is positively related to the foreign
interest rate, negatively related to the spot exchange rate and

\(^1\) The derivation of this relationship is as follows: At maturity,
the foreign currency value of a foreign asset initially costing \(F_0\),
is equal to one plus the foreign interest rate, \(F_1 = (1 + \text{if})F_0\), with
the interest rate expressed as a percent per unit of time of the asset
maturity. With the foreign exchange rate following the Canadian con-
vention and expressed as Canadian cents per unit of foreign currency,
the domestic cost of this foreign asset is equal to its foreign cur-
rency cost times the exchange rate, or \(F_0 = \frac{1}{x_0}D_0\). Similarly, the
Canadian dollar value of the matured asset is equal to the foreign ex-
change rate at the time of maturity times the matured asset value, or
\(F_1 = \frac{1}{x_1}D_1\). Substituting these foreign exchange relationships into
the foreign currency yield gives, \(D_1 = (1 + \text{if}) \frac{x_1}{x_0}D_0\), which re-
duces to:

\[ y_f = \frac{(D_1 - D_0)}{D_0} = (1 + \text{if})\frac{x_1}{x_0} - 1 = \frac{(x_1 - x_0)}{x_0} + (x_1/x_0) \text{ if} \]

Frequently in the literature, this relationship is approximated by,
\( y_f = \frac{(x_1 - x_0)}{x_1} + \text{if} \), wherein the foreign asset yield is the sum of
the foreign interest rate plus the rate of exchange rate appreciation
with \(x_1/x_0\) approximated at one. Since this study is particularly con-
cerned with cases where \(x_1\) diverges from \(x_0\) the precise definition of
the foreign asset is retained.
positively related to the expected future spot rate;

\[
\frac{\partial y_f}{\partial if} = \frac{x_e}{x} > 0, \\
\frac{\partial y_f}{\partial x} = -x_e(1 + if) < 0, \\
\frac{\partial y_f}{\partial x e} = \left(\frac{1}{x}\right)(1 + if) > 0.
\]

The small country assumption employed for the Canadian money supply hypothesis implies that the foreign interest rate is exogeneous to the overall model. The spot exchange rate is endogenously determined under the flexible rate alternative and exogenous under fixed rates. Its interaction with foreign and domestic interest rates will be considered in Chapter III. The expected future spot exchange rate, not an observable magnitude, is proxied under various assumptions of exogeneity as described below.

The public's and banks' financial asset allocation decisions are governed by standard price theoretic assumptions based on utility and profit maximization. Asset demand (liability supply) responds positively to changes in own yield and negatively to changes in the yield on substitute assets. In addition, the following order conditions are imposed on the public's monetary asset demand response to wealth \((W)\), the phase of the business cycle \((Y/Y_p)\), and credit market interest rates \((i)\) as part of the hypothesis:

\[
e(D_s, W) > e(C_p, W) > e(D_t, W) > e(D_d, W) > 0, \\
e(D_t, Y/Y_p) > e(D_d, Y/Y_p) > e(D_s, Y/Y_p) > e(C_p, Y/Y_p) > 0, \\
0 > e(C_p, i) > e(D_s, i) > e(D_s, i) > e(D_d, i) > e(D_t, i),
\]
These order conditions are predicated on two factors: (1) The operators holding demand and term and notice deposits (businesses) differ from those holding savings deposits (individuals) and, (2) The liquidity of the various forms of monetary assets differ. With an increase in wealth, financial asset demand increases, but firms are less likely to hold financial assets in the form of bank deposits than are individuals, $e(Ds, W) > e(Dt, W)$, and more likely to hold them in term than demand deposits, $e(Dt, W) > e(Dd, W)$. Individuals will want to hold a greater proportion of their incremental wealth in deposits than in currency, $e(Ds, W) > e(Cp, W)$. Increases in current income relative to permanent income increase business demand for transactions balance relative to individual demand due to the multiplicity of intermediate product transactions, $e(Dd, Y/Yp) > e(Ds, Y/Yp)$, while the increased savings from transitory income tend to increase asset demand for money relative to transactions demand, $e(Dt, Y/Yp) > e(Dd, Y/Yp)$ for firms and $e(Ds, Y/Yp) > e(Cp, Y/Yp)$ for individuals. The ordering of relative (negative) credit market interest rate responses is predicated on the assumption that firms are more responsive to interest rates in the aggregate than are individuals, $e(Ds, i) < e(Dd, i), e(Dt, i)$, while the response within each group

\[\text{(For expositional purposes, firms are assumed to utilize no currency. The removal of this assumption does not alter the order conditions.)}\]
is inversely related to the liquidity of each asset,
\( e(Cp,i) < e(Ds,i) \) and \( e(Dd,i) < e(Dt,i) \).

Given these order conditions and behavioral assumptions, the public's desired value of the currency ratio \((k^*)\) is specified to depend on the yield on demand deposits \((yd)\), domestic credit market rates \((i)\), the ratio of current to permanent income \((Y/Y_p)\), nominal wealth \((W)\), foreign interest rates \((if)\), the spot foreign exchange rate \((x)\), exchange rate expectations \((xe)\), and a vector of seasonal and trend variables \((Q_k)\):^1

\[
k^* = \kappa^*(yd, i, Y/Y_p, W, if, x, xe, Q_k)
\]

---

Assuming rapid adjustment in financial markets, the desired value of the currency ratio equals the measured value on a quarterly average basis and the behavioral equation for the observed currency ratio is equivalent to that for the desired currency ratio;

(14) \[ k = k(yd,i,Y/Yp,if,x,xe,Qk). \]

The direct response of the currency ratio to its domestic dependent variables is directly derivable in elasticity terms from the assumptions and order conditions above as:

\[ e(k,yd) < 0 < e(k,i), \quad e(k,Y/Yp) < 0 < e(k,W). \]

The foreign sector variables jointly determine the yield on foreign currency denominated financial assets which are substitutes for domestic currency and demand deposits in public asset portfolios. As with domestic earning assets, businesses are assumed to be more responsive to foreign asset yield changes than are individuals and, in addition, will in general be more informed on international financial matters, enabling them to shift into foreign currency assets — including foreign currency denominated deposits at Canadian banks — at lower cost than individuals. The response of the currency ratio to the foreign interest rate is therefore unambiguously positive,

\[ e(k,if) > 0. \]

The currency ratio response to the spot and expected future exchange rate is less certain. Their change gives rise to a change in the
expected yield on foreign assets and an unambiguous "asset substitution" effect on the currency ratio,

\[ e(k,x)_a < 0 < e(k,xe)_a. \]

But, superimposed on this "asset substitution" effect is a "transactions substitution" effect — denoted \( e(k,x)_t \) and \( e(k,xe)_t \) — arising from the widespread use of U.S. currency in domestic Canadian transactions. United States currency is a close substitute for Canadian currency in domestic transactions so long as the exchange rate is near parity. But this substitutibility diminishes as the rate moves away from parity and the transactions demand for Canadian currency will rise and, if there is no comparable substitution between U.S. dollar and Canadian dollar demand deposits, the desired currency ratio will rise.\(^1\) Formally, this transactions response is specified by:

\[ e(k,x)_t, e(k,xe)_t > 0 \text{ for } x, xe > 1, \text{ and } \]
\[ e(k,x)_t, e(k,xe)_t < 0 \text{ for } x, xe < 1, \]

Assuming that individuals do not generally anticipate changes in the exchange rate, the transactions effect for changes in the proxies will

\(^1\) Sydney A. Shepherd, Foreign Exchange in Canada: An Outline (Toronto: University of Toronto Press, 1961) 176-77, notes that U.S. currency tends to disappear from circulation in Canada when the U.S. dollar moves to an appreciable discount or premium. As the U.S. dollar moves to a discount (\( x < 1 \)), Canadian residents selling goods and services become unwilling to accept U.S. dollars on a one for one basis and the transaction costs to dealing in U.S. dollars rise owing to the calculation and agreement on a mutually acceptable rate of exchange. When the U.S. dollar moves to a premium (\( x > 1 \)), Canadian recipients of U.S. dollars tend either to turn them into a bank to obtain the premium or to save them in anticipation of expenditures in the United States.
be quite small and can be ignored. The asset effect, dominated by firms' expectations, will unambiguously determine the total response,

$$e(k,xe) = e(k,xe)a > 0.$$  

Changes in the current exchange rate are obvious to all, however, and the total response of the currency is unambiguous only for values of \(x\) below unity. As \(x\) increases above parity, the negative asset effect may at some point be offset by the positive transactions effect. To summarize this result:

$$e(k,x) = e(k,x)_a + e(k,x)_t \begin{cases} < 0 & \text{for } x < 1, \text{ or} \\ > 0 & \text{for } x > 1. \end{cases}$$

The seasonal factors will influence the currency ratio if the seasonal nature of economic activity is differentiated between currency and deposit users in some way that is not reflected in the seasonal pattern of independent variables already in equation 14. The trend variable is included to capture the net effect of changes in those long term factors noted above (footnote 1, page 39 above).

The behavioral equation for the savings deposit ratio, also assuming rapid adjustment of desired values, is postulated as:

$$s = s(ys,yd,i,Y/Y_p,W,if,x,xe,Qs),$$

where \(ys\) is the yield to the nonbank public on savings deposits, \(Qs\) is a vector of seasonal and trend factors and the remaining variables are defined as in the currency ratio equation. The response of the savings deposit ratio to its independent variables, summarized in
The signs of the domestic variable responses are again dependent on the public's behavior with respect to asset yields and order conditions postulated above. The yield on personal savings deposits (ys) consists of the explicit interest paid plus the implicit interest derived from other services provided by these deposits, the convenience in making check transfers minus the costs associated with acquiring and using savings deposits in transactions. Thus, the introduction of personal checking accounts in June of 1957 raised the yield on personal savings deposits through a reduction in the transactions costs of this subcategory just as did the 1967 introduction of "special" savings deposits which pay a higher explicit interest rate than ordinary savings deposits.

The foreign sector variables (if, x, and xe) entered the savings deposit ratio function as they effect the yield on alternative financial assets. Again, non-personal depositors are on balance postulated to be more responsive to alternative foreign asset yields than are individuals. Unlike the currency ratio, the savings deposit ratio is not subject to a transactions substitution effect so the signs for the response of if, x, and xe are all unambiguous.

The hypothesised behavioral equation for the term and notice deposit ratio is:
(16) \[ t = t(y_t, y_d, i, Y/Y_p, W, i_f, x, x_e, Q_t), \] with
\[ \begin{align*}
e(t, y_t) &> 0 > e(t, y_d), \\
e(t, i) &< 0 < e(t, Y/Y_p), \\
e(t, W) &> 0 > e(t, i_f), \text{ and } e(t, x) &> 0 > e(t, x_e).
\end{align*} \]

The domestic variable responses again follow from the order conditions
\[ e(D_t, i) > e(D_d, i), e(D_t, Y/Y_p) > e(D_d, Y/Y_p), \text{ and } e(D_t, W) > e(D_d, W) \]
while the foreign interest rate and exchange rates enter under the
same postulated as govern the yield on domestic financial assets.
In this case, the forward exchange rate itself rather than an expecta-
tions-proxy derived from the forward market may be the relevant future
exchange rate due to the option of holding foreign currency "swapped"
deposits open to term deposit owners. These foreign currency deposits
at Canadian chartered banks pay a return calculated explicitly as the
foreign interest plus the premium or discount on forward exchange.¹

¹ Extensive coverage of the evolution and use of these swapped de-
posits is given by Ronald A. Shearer, "The Foreign Currency Business of
Canadian Chartered Banks", The Canadian Journal of Economics and Politi-
cal Science, XIII, No. 3 (August 1965), pp. 328-357.
Total chartered bank primary reserves (R) consisting of deposits at the Bank of Canada (Db) plus Bank of Canada notes held as vault cash (Cb) are decomposed into that magnitude held to meet statutory reserve requirements (Rr) and the remainder held as excess reserves (Re). Similarly, the reserve ratio (r) is decomposable into a required reserve ratio (rr) plus an excess reserve ratio (re) in the definitional equation:

\[ r = rr + re, \]  
\[ rr = \frac{Rr}{D} \text{ and } re = \frac{Re}{D}. \]

Although the behavior of the required reserve ratio is primarily dependent on the statutory reserve requirement ratio (rs), a Bank of Canada policy variable, the lagging of reserve requirements and the 1967 change to differential requirements on demand and notice deposits has introduced an element of uncontrolled variability into this component of r. The statutory reserve requirements in effect from July 1, 1954 through July 1, 1967 can be described analytically by the equation:

\[ R_{rt} = rs \cdot D_{t-1} - Cb_{t-1}, \]

where \( R_{rt} \) is the average level of reserves required in the current

---

1 Prior to the 1954 Bank Act revision, reserve requirements on chartered banks were 5 percent of total Canadian dollar deposits calculated for the concurrent month on a daily average basis. Verbal descriptions of subsequent reserve requirement changes are found in most Canadian money and banking textbooks, e.g. Boreham, et al, *Money and Banking*, pp.238-42.
month, $D_{t-1}$ is total chartered bank deposits averaged over the four
Wednesdays ending with the second to last Wednesday of the preceding
month, and $Cb_{t-1}$ is lagged chartered bank vault cash holdings averaged
in the same way as deposits. Following the 1967 Bank Act, this re-
requirement became:

$$R_{rt} = rsd(Dd_{t-1} + Dg_{t-1}) + rst(Ds_{t-1} + Dt_{t-1}) - Cb_{t-1},$$

where $rsd$ and $rst$ are the statutory requirement ratios for demand and
term deposits respectively. In mid-1969, the requirements were altered
further such that $R_{rt}$ became an average to be met in each half of the
current month while the formula itself remains unaltered.

Dividing the statutory average level of required reserves
for the current month by concurrent average total deposits converts
this statutory reserve requirement to the actual required reserve
ratio.¹ In the 1967-70 case:

$$rr = rsd \cdot \delta \cdot D_t + rst(1-\delta)D_t - Cb \cdot v,$$

where

$$\delta = \frac{Dd+Dg}{D},$$

the ratio of deposits payable on demand to
total deposits,

¹ Except for the effects of the lagged vault cash aspect, this
analytic decomposition of the required reserve ratio is similar to
that for the U.S. institutional structure as presented in Burger, *The
Money Supply Process*, pp.50-53. An alternative formulation of the
Canadian lagged reserve requirements case has been constructed by
David Fand and J.E. Tower, "An Analysis of the Money Supply Process in
pp.380-99. Since borrowing from the Bank of Canada is minimal, Fand
and Tower's free reserves analysis is conceptually similar to excess
reserves defined in the rational formulation.
(1-\delta) = \frac{Ds+Dt}{D}, from the above definition and equation (5),

\[ D_t = \frac{Dt-1}{D_t}, \text{the ratio of change in total deposits,} \]

\[ Cb_t = \frac{Cb_t-1}{Cb_t}, \text{the ratio of change in vault cash, and} \]

\[ v = \frac{Cb_t}{D_t}, \text{the current ratio of vault cash to total deposits.} \]

For the period between Q2/54 and Q3/67, rsd = rst = rs, \( \delta \) drops out, and the required reserve ratio equation becomes:

\[ rr = rs \cdot D_t - Cb_t \cdot v. \]

Thus, the actual required reserve ratio is equal to the statutory ratio (rs) modified by the variables v, Cb, Dt, and \( \delta \), which themselves are functions of other exogenous elements in the nonlinear money supply hypothesis.\(^1\)

Having noted these sources of uncontrolled variation in required reserves, the required reserve ratio equations can be simplified by assuming that the changes in deposits and vault cash are small over

\(^1\) More specifically, the distribution factor \( \delta \)--and hence \( 1-\delta \)-- can be reformulated through definitions (5) through (9) above into:

\[ \delta = \frac{1+g}{1+g+s+t}, \]

while total deposits can be expressed as a multiple of the monetary base:

\[ D = \frac{1+k}{1+g+s+t} \cdot B. \]

Thus, their magnitude and change over time depends on the behavior of the currency, savings deposit, term deposit, and government deposit ratios as analysed above plus changes in the base. The behavior of the vault cash ratio and changes in vault cash over time will be considered explicitly below.
time when a quarterly averaging process is used, \( D_T = 1 \) and \( Cb_T = 1 \)
so the required reserve ratio for the 1954-67 period becomes;

\[
(18) \quad rr = rs - v.
\]

For the period covered by the 1967-70 regulations, is assumed to change relatively slowly over time and is taken as given in the short run so the required reserve equation is approximated by;

\[
(18a) \quad rr = rsd(\delta) + rst(1-\delta) - v.
\]

The excess reserve component (re) of the reserve ratio depends on the behavioral decisions of chartered banks in allocating a portion of their assets to defray the possible cost of meeting deposit withdrawals in excess of receipts at any particular time.\(^1\)

Thus, the banks' desired excess reserve ratio is positively related to: a) the variability of deposit flows for the individual deposit classes (\( \sigma_{Di} \)); b) the proportion of total deposits in the more volatile deposit classes (\( Di/D \)); and c) the cost of borrowing from the Bank of Canada, as measured by the discount rate (\( \rho \)). It is negatively related to the opportunity cost of holding excess reserves, the yield

\(^1\) The behavior of the excess reserve ratio in the U.S. has been analysed within the nonlinear money supply framework by Peter Frost, "Banks' Demand for Excess Reserves," (unpublished Ph.D. dissertation, University of California at Los Angeles, 1966) from whom this formulation is drawn.
on domestic and foreign bank earning assets (i and if);

\[(19) \quad r^e = r^e(\sigma_{Di}, Di/D, \rho, i, if), \text{ with} \]
\[
e(re, C_{Di}) > 0 < e(re, Di/D), \quad e(re, \rho) > 0 > e(re, i),
\]
\[
e(re, if) > 0 < e(re, x), \quad e(re, xe) < 0.
\]

Substituting (18) and (19) into the definition of the reserve ratio (17) and assuming relatively rapid adjustment to desired chartered bank positions results in the structural equation for the reserve ratio. In the simpler case of (18a):

\[r = rs^*Dt - C_b r^* + re(\sigma_{Di}, Di/D, \rho, i, if).\]

Further simplification is possible by noting that chartered banks can minimize the cost of holding excess reserves by retaining them in the form of vault cash rather than deposits at the Bank of Canada. Because of the lagged statutory computation procedure, the current period's vault cash reduces actual required reserves in the next period. Current reserve requirements can be met by shifting notes to the Bank of Canada with little cost in the event of an unexpected deposit drain near the end of an averaging period and the higher required reserves in the next month can be met through an orderly sale of securities or curtailment of loans. The limiting factor on the maintenance of excess reserves as vault cash is the transfer cost in moving from cash to Bank of Canada deposits. Assuming these costs are zero or a small constant, \(re^* = v\), the reserve ratio equation reduces to

\[r = rs^* Dr^+ (1 - C_b)r^e,\]
and combined with the unity approximations for \( D \) and \( C_b \), this reduces further to:

\[
(20a) \quad r = r_s, \text{ for the early period, and }
\]

\[
(20) \quad r = r_s d + r_s t(l-d),
\]

for the period since mid-1967. With the statutory reserve ratio \( (r_s) \) a policy variable and assumed exogenous, the reserve ratio enter the hypothesis as an exogenous policy parameter through most of the period.\(^1\)

The government deposit ratio \( (g) \) is a policy parameter. Under existing Canadian institutional relationships, the Bank of Canada is empowered to shift Government deposits between its own account and chartered banks' accounts on an ongoing basis giving the Bank direct control over this component of the multiplier. It can be varied within the overall constraints imposed by total Government deposit holdings.

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\(^1\)The postulated behavior of the reserve-ratio—its equality with the statutory reserve ratio under most circumstances—is at variance with several studies of the Canadian money supply process. Albert Breton, "The Behavior of the Aggregate Reserve Ratio of Canadian Chartered Banks", *Canadian Journal of Economics*, Volume 3, No. 2 (August, 1969) pp.435-42, suggests that the interest sensitivity of the reserve ratio is an important source of variability in the money supply process, while Fand and Tower, "The Money Supply Process", utilized what is essentially a "free reserves" model. To a large extent these differences are definitional, Breton defines reserves to include the net foreign asset position of chartered banks, which is by this hypothesis a function of interest rates while Fand and Tower utilize the statutory definition of reserves in their estimation equations rather than the actual reserves definition utilized. In fact, the Fand and Tower finding that 75-90% of the chartered bank adjustment to statutory reserve drains in the current quarters is broadly consistent with the assumption about the actual reserve ratio made here. A recent examination of the day-to-day adjustment of excess reserves within the adjustment period—J.F. Dingle, G.R. Sparks, and M.A. Walker, "Monetary Policy and the Adjustment of Chartered Bank Assets", *Canadian Journal of Economics*, Volume (November, 1972) pp. 495-514—implies a constant short-run excess reserve ratio even without the inclusion of the vault cash option and its associated (short-term constant) conversion cost.
(21) \[ g = g(Dg), \]

where the volume of government deposits at chartered banks \((Dg)\) is a policy variable having a directly proportionate relationship with the policy parameter:

\[ e(g, Dg) = 1. \]
E. The Determination of Deposit Yields

The yield on deposits to the public (yd, ys, and yt) consists of the explicit interest paid by banks minus service charges plus an implicit return in the form of services provided depositors by banks. In a competitive banking system, this yield would be highly correlated with the yield on other financial assets as banks adjusted the price they paid for deposits to equate the marginal cost of acquiring liabilities from their various sources -- borrowing from the central bank, borrowing abroad, and issuing non-deposit financial liabilities -- and competitive pressures from other banks and non-bank financial intermediaries equated the marginal cost of deposits to the marginal cost of funds from all sources to their marginal return on loans and securities in the bank credit market. In their adjustment of these yields, the Canadian banks, unlike their U.S. counterparts, are not constrained by the legal prohibition of explicit interest payments on demand deposits or limits on rates payable on other deposit classes. Nevertheless, chartered bank responsiveness in adjusting their deposit yields has been dampened by the oligopoly structure of Canadian banking, by a 6% legal limit on bank lending rates until 1967, and, intermittently, by various constraints on bank behavior placed on the chartered banks by the Bank of Canada in the form of moral suasion. The result of these constraints has been the introduction of specific non-linearities into the interest elasticities of the desired monetary asset ratio equations.¹

¹ Thomas J. Courchene, "Recent Canadian Monetary Policy", Journal of Money Credit and Banking, Vol. 3, No. 1 (February 1971) p. 36, suggests the analogy between regulation Q in the U.S. and the constraints on the assets of Canadian chartered banks.
In particular, the dominance of a few chartered banks has led to an absence of price competition between them for demand deposits and, until 1967, for personal savings deposits. The limit on lending rates and moral suasion constraints operate to alter the response of domestic term and notice deposit yields and, since 1967, the yield on special personal savings deposits. To parameterize these constraints we shall consider the elasticity of the deposit yields with respect to interest rates separately and then examine the overall domestic interest rate response of the desired k, s, and t ratios which includes the indirect effects of induced changes in deposit yields.

As noted above, e(yd,i) = 0 by assumption. In fact, the only available evidence of any change in demand deposit yields over the entire

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1 Although the number of chartered banks has varied between eight and ten over the study period, only five banks operate on a national scale. This market structure has led to the equivalent of a "kinked" demand curve for deposit classes where the competition from non-banks is not perceived as important. Studies of competition in Canadian financial markets by the Royal Commission, Report of the Royal Commission on Banking and Finance (Ottawa, 1964), and Vladimir Salyzyn, "The Competition for Personal Savings Deposits in Canada" Canadian Journal of Economic and Political Science, Vol. 32, No. 3 (August 1966) pp. 327-37, suggest that the chartered banks compete for deposits primarily through product differentiation. While this implies variability of the implicit interest yield, the most significant measure of this form of competition in both studies, number of branch offices, is not a variable in the short-run. Competition with near bank financial institutions has led to several discrete increases in savings deposit yields over the period, but these have been in response to the trend rise in interest rates rather than quarter to quarter variations. This behavior was formalized, except for a brief period after 1967 when the practice was illegal, by the Canadian Bankers Association setting deposit rates for all banks and frequently encouraged by the Bank of Canada in order to promote moral suasion guidelines.
Figure 6

Bank Deposit Interest Rates
sample period is the May, 1970 removal of the service charge on out-of-town checks.\footnote{Boreham, et al, Money and Banking pp. 104-107, notes the absence of measurable change in the deposit yield over most of the sample period. While the implicit yield may have changed, we are arguing that these changes, like the 1970 service charge reduction, were exogenous to the short-run model.}

The yield on personal savings deposits is complicated by the evolution of this deposit class into several sub-categories over the period under examination. Recall that aggregate savings deposits (Ds) includes "ordinary savings deposits" — subject to check transfer with an explicit interest yield — and, since 1957, "checkable savings deposits" on which no explicit interest is paid. In 1967, "Special savings deposits", a small denomination personal term deposit not subject to check transfer was introduced. The yield on personal savings deposits (ys) is thus an amalgam of the yields on these three deposit classes. The explicit interest yield on ordinary savings deposits changed only four times over the period, in each case, as can be seen in Figure 6, with considerable delay following increases in credit market yields depending on C.B.A. perception of the degree of non-bank competition. Checkable savings deposits pay no explicit interest, and the service charges on these deposits have not been altered except for the noted 1970 reduction on out-of-town clearing costs. Again, the assumption that implicit interest yields are not adjustable in the short-run, and $e(ys,i) = 0$ prior to the introduction of special savings deposits in 1967. Exogenous increases in the yield took place in 1956, 1962 and 1967 when the ordinary savings deposit rate was altered and in
1957 when checkable deposits were introduced. The special savings deposits were introduced by chartered banks in response to the 1967 Bank Act which reduced required reserves on notice deposits. This lowered the banks cost of acquiring additional reserves through term deposits, and combined with provisions in the Bank Act which prohibited collusive agreements to set deposit rates and the removal of the 6 percent lending rate ceiling provided an incentive for aggressive bidding to obtain these deposits. As a result, the explicit yield on special savings deposits became relatively responsive to credit market yields, and the aggregate yield \( e(y_s,i) > 0 \) since 1967.

The yield on non-personal term and notice deposits has become increasingly sensitive to credit market interest rates over the period of this study. While neither the precise explicit interest yield nor the implicit yield is available directly, an indicator of the explicit yield, the posted rate on 90 day deposit receipts is available on a

---

1 Widening the public's choice between interest opportunity and transactions cost is assumed to have increased the overall yield of the deposit class by permitting a more optional portfolio allocation.

2 See Thomas Courchene, "Recent Canadian Monetary Policy", *Journal of Money, Credit and Banking*, III, No. 1 (February 1971).

3 Two factors continued to dampen this response however, the Bank of Canada directly discouraged bank competition for non-personal notice deposits in late 1967 to protect near-banks, implicitly sanctioning a renewal of collusive rate firms, and the Prices and Incomes Commission in February, 1970 reached an agreement linking bank lending rates to personal savings deposit rates. The latter move appears to have encouraged banks to lag behind the governments securities yield proxy for credit market rates during the 1970 interest rate decline.
month end basis for much of the sample period.\(^1\) Prior to December 1955, the 90 day deposit rate was adjusted infrequently and did not reflect current movements in credit market rates. At that time, chartered banks, acting in concert, began adjusting this rate to levels just below the Treasury bill rate and from 1960, when price competition between banks for large denomination CD's became prevalent, the rate has frequently exceeded the Treasury bill rate.\(^2\) When the 1967 Bank Act prohibited collusion on all types of deposit rates and reserve requirements were lowered, this competition became more pronounced and the aggregate chartered bank volume of term and notice deposits increased markedly. While this action would also be expected to have increased \(e(yt,i)\), its effects were quickly circumvented by an agreement among chartered banks to limit price competition in an October 1967 move initiated by moral suasion from the Bank of Canada in order to protect non-bank intermediaries. Given this evidence, we postulate that \(e(yt,i) = 0\) prior to 1956 and \(e(yt,i) > 0\) since, but that this response became smaller for upward movement in credit market rates during periods of moral suasion when banks incentives to attract domestic term deposits are dammed.

\(^1\)The Bank of Canada, 1968 Statistical Supplement, p.82, notes the rate paid on the various types of term and notice deposits differs from this posted rate. While it is impossible to assess the variability of these actual rates, the emphasis placed on the competition for and growth of foreign currency deposits suggests that the remaining rates, also generally set collusively by the C.B.A. have not been adjusted differently from the 90 day posted rate.

\(^2\)Boreham, et. al, Money and Banking, p. 105, place this rise in deposit yields above the Treasury bill rate in 1960, while Neufeld, The Financial System of Canada, pp. 128-29 notes the introduction of intra-bank competition for bulk deposits in that year. The limited competition for these deposits prior to mid 1960 may be explained by increasingly stricter "moral suasion" limits on term lending imposed on chartered banks from 1957 onwards.
Since deposit yields are not in general available, the correlation between these yields and the credit market rates are impounded in the net elasticity of the desired monetary asset ratios with respect to interest rates. With \( e(y_d, i) = 0 \), the response of \( k \) with respect to interest rates in equation (14) is unaltered from that in Section D above, \( e(k, i) = e(C_p, i) - e(D_d, i) < 0 \). The savings and term deposit ratio responses, however, become,

\[
\begin{align*}
\hat{e}(s, i) &= e(D_s, i) + e(D_s, y_s)e(y_s, i) - e(D_d, i), \\
\hat{e}(t, i) &= e(D_t, i) + e(D_t, y)t)e(y_t, i) - e(D_d, i).
\end{align*}
\]

Given the posited response signs and relative orders of magnitude above—\( e(D_s, i) < 0 > e(D_d, i) \), \( |e(D_d, i)| > |e(D_s, i)| \), and \( e(D_s, y_s) > 0 < e(y_s, i) \)—\( \hat{e}(s, i) \) is still unambiguously positive and is positively related to the value of \( e(y_s, i) \). Thus,

\[
0 < \hat{e}(s, i) 67 < \hat{e}(s, i) 70 .
\]

The net response of the desired term deposit ratio with respect to interest rates is now ambiguous, depending on the magnitude of \( e(y_t, i) \) it may be positive or negative; \(^1\)

\[
\hat{e}(t, i) \hat{\leq} 0 \text{ as } |e(D_d, i)| + e(D_t, y_d)e(y_d, i) \hat{\leq} |e(D_t, i)| .
\]

\(^1\) Assuming own price elasticities exceed individual cross price elasticities, the stability condition for general equilibrium, this sign is unambiguously positive only when \( e(y_d, i) = 1 \) and unambiguously negative only when \( e(y_d, i) = 0 \).
With $e(yd,i) = 0$, the assumption made for the period up to 1956, the order condition $|e(Dt,i)| > |e(Dd,i)|$ is sufficient to insure a negative overall response as before. With $\bar{e}(t,i)$ directly related to $e(yt,i)$, the general increase in competition for term deposits through 1967 should have increased the value of $\bar{e}(t,i)$. While this elasticity may have become positive during periods of high $e(yt,i)$, we shall tentatively assume $e(t,i) < 0$ or $e(t,i) = 0$ for remaining a priori arguments, subject to empirical verification later in the study.
F. The Semi-reduced Form Money Supply Equations

Given the behavioral relationships underlying the money multipliers, the alternative definitions of the money stock in terms of their proximate determinants — equations (11), (12), and (13) — can be converted to money supply functions by substituting the behavioral equations (14) through (21) for the definitions of the proximate determinants. In semi-reduced form:

\[(22) \quad M_j = m_j(i;x;f,x_e,Y/Y_p,W,r,D_g,Q_m) \cdot B, \quad \text{for } j = 1,2,3.\]

The structural form for the response of the money supply under each definition to an independent change in each right side variable in equation (22) is derived in elasticity form by combining the partial elasticity of the money stock with respect to each proximate determinant and the elasticity response of the behavioral equation for the determinant with respect to their (proximately) independent variables. The elasticity of \(M_2\) with respect to domestic interest rates, for example, is given by:

\[e(M_2,i) = e(M_2,k)e(k,i) + e(M_2,s)e(s,i) + e(M_2,t)e(t,i).\]

The relative order conditions of the additive component elasticities necessary to determine the overall sign of the money supply responses are given in Table II-1 according to the sign and order conditions assumed as part of the hypothesis. While these overall signs are for the most part ambiguous on an a priori basis and will be evaluated following the empirical work in Chapter V, several points...
Table 1

Money Supply Functions: Response Sign Conditions

e(M1,i) ≤ 0 as e(m1,t)e(t,i) ≤ |e(m1,k)e(k,i) + e(m1,s)e(s,i)|
e(M2,i) ≤ 0 as e(m2,t)e(t,i) + e(m2,s)e(s,i) ≤ |e(m2,k)e(k,i)|
e(M3,i) ≤ 0 as e(m3,s)e(s,i) ≤ |e(m3,k)e(k,i) + e(m3,t)e(t,i)|
e(M1,if) ≤ 0 as e(m1,t)e(t,if) ≤ |e(m1,k)e(k,if) + e(m1,s)e(s,if)|
e(M2,if) ≤ 0 as e(m2,t)e(t,if) + e(m2,s)e(s,if) ≤ |e(m2,k)e(k,if)|
e(M3,if) ≤ 0 as e(m3,s)e(s,if) ≤ |e(m3,k)e(k,if) + e(m3,t)e(t,if)|
e(M1,x) ≤ 0 as e(m1,k)e(k,x) + e(m1,s)e(s,x) ≤ |e(m1,t)e(t,x)|
e(M2,x) ≤ 0 as e(m2,k)e(k,x) + e(m2,t)e(t,x) ≤ |e(m2,s)e(s,x) + e(m2,t)e(t,x)|
e(M3,x) ≤ 0 as e(m3,s)e(s,x) ≤ |e(m3,k)e(k,x) + e(m3,t)e(t,x)|
e(M1,Y/Yp) ≤ 0 as e(m1,k)e(k,Y/Yp) + e(m1,s)e(s,Y/Yp) ≤ |e(m1,t)e(t,Y/Yp)|
e(M2,Y/Yp) ≤ 0 as e(m2,k)e(k,Y/Yp) + e(m2,s)e(s,Y/Yp) ≤ |e(m2,t)e(t,Y/Yp)|
e(M3,Y/Yp) ≤ 0 as e(m3,k)e(k,Y/Yp) + e(m3,t)e(t,Y/Yp) ≤ |e(m3,s)e(s,Y/Yp)|
e(M1,W) < 0 since e(m1,k)e(k,W) + e(m1,s)e(s,W) + e(m1,t)e(t,W) < 0

e(M2,W) ≤ 0 as e(m2,s)e(s,W) ≤ |e(m2,k)e(k,W) + e(m2,t)e(t,W)|
e(M3,W) ≤ 0 as e(m3,s)e(s,W) + e(m3,t)e(t,W) ≤ |e(m3,k)e(k,W)|

e(M1,j) = e(M2,j) = e(M3,j) < 0, for j = r, Dg, B
can be made at this stage. First, the policy variables, B, Dg, and r, all have unique signs and influence the alternative definitions of money equiproportionately. Second, the trend increase in M3 relative to M2 relative to M1 is explained in the hypothesis by a trend growth in wealth over the sample period. Thus, interest rates, foreign sector yields, cyclic factors and structural changes should account for most of the differential behavior of the three definitions of money on a quarter-to-quarter basis. In fact, a close examination of the historic record indicates that the hypothesised relative domestic interest rate responses, inclusive of the non-linearities induced by moral suasion and changes in the Bank Act, are sufficient of themselves to account for most of the relative change in the three definitions of money noted in Section C. Finally, foreign interest rates and exchange rate expectations and (inversely) the spot exchange rate operate on the money supply through the same channels and in the same direction as do domestic interest rates. This coincidence, combined with the high degree of multicollinearity between the yields on foreign and domestic financial assets noted in most studies of international capital flows, may make the isolation of an independent effect of the foreign sector on the money supply process difficult to ascertain empirically.

1 An exception, the reduction in r through the lower reserve requirements on term deposits (rst) in 1967 should be noted. This increased M2 and M3 relative to M2 and altered the relative interest elasticities as noted above.
CHAPTER III

THE BANK CREDIT AND FOREIGN EXCHANGE MARKET

A. Introduction

This chapter develops the theoretic structure of the bank credit and foreign exchange markets in which the short-term equilibrium domestic interest rate and foreign exchange rate are proximately determined.

The bank credit market formulation employed in this study follows the standard Brunner-Meltzer hypothesis developed for the U.S. with two major exceptions. These exceptions involve dropping central bank advances to the banking system from the analysis and the recognition of foreign currency denominated assets and foreign currency liabilities as substitutes for Canadian dollar borrowing and deposits. On the supply side of the bank credit market this substitution involves the alternative to banks of holding foreign

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1 The standard Brunner-Meltzer bank credit market is presented in Brunner and Meltzer, "Liquidity Traps", and with more detail by Burger in The Money Supply. A further evolution of the credit market in a closed economy, differentiating between loan and investment sub-markets provides the step off point for an analysis of the effects of the secondary reserve requirements, but the introduction of this interesting feature of the Canadian money supply process significantly complicates the model without contributing significantly to the understanding of the foreign-domestic interaction. Both Manfred Willms, "Controlling Money in an Open Economy", and Michele Fratianni, "Bank Credit, Money Supply", have introduced the option of foreign asset holdings to the non-linear hypothesis under fixed exchange rate regimes in the German and Italian cases. Neither has allowed for interaction with the foreign exchange market.
currency assets (liabilities) rather than domestic earning assets (liabilities) when foreign yields are high (low) relative to those at home. On the demand side of the domestic bank credit market, this substitution involves the public's borrowing (lending) through foreign currency denominated liabilities (assets) when the foreign asset yield is low (high) relative to that on Canadian dollar denominated assets.

Domestic bank credit is defined as Canadian dollar denominated credit extended by chartered banks to the Canadian public and Government and measured by the Canadian dollar earning assets of the bank.¹ Foreign currency credit extended by the banks, whether to residents or non-residents, is explicitly excluded from this definition although it serves as an alternative asset for the banks and an alternative source of credit to the public and Government within the hypothesis.

The structural equation for domestic bank credit supplied by chartered banks — or the banks' demand for domestic earning assets — is, like the money supply equation, derived by postulating behavioral relationships for its proximate determinants as derived from the combination of the banks' consolidated balance sheet, the

¹Available data does not permit the separation of foreign currency denominated securities issued by Canadian residents from domestic bank credit. However, since chartered bank holdings of provincial, municipal and corporate securities, where foreign currency issues are most prevalent, amounted to only about 5 percent of their earning assets over the period, an assumption that these foreign currency assets are insignificant seems warranted.
definitions (4) through (10) in Chapter II, and the definition of the banks' net foreign asset ratio (f) as described below. The banks' demand for domestic earning assets is thus a multiple of the amount of base money supplied, with the multiplier dependent on the allocation of this base money between currency and bank reserves and on the level of total deposit liabilities supported by these reserves as determined by the interaction between the banks and public noted in the behavioral equations for the proximate determinants. In addition, banks may alter their supply of domestic earning assets by adjusting their net foreign currency asset position in response to changes in relative foreign and domestic currency asset yields and liability costs.

Unlike the case for the money supply function, however, the assumption of relatively rapid adjustment of desired values of the proximate determinants and their approximation by actual measured values will not serve to identify the bank credit supply function.¹

The demand for domestic bank credit by the public -- the supply of earning assets to banks -- consists of loan demand and a residual supply of private, municipal and provincial, and Government securities not taken into non-bank public and foreign portfolio. The supply of loans and private securities to banks is postulated

¹ This difference along with the underlying dynamic behavioral assumptions about underlying the non-linear money supply function are derived explicitly in Karl Brunner and Allen Meltzer "Some Further Investigations of Demand and Supply Functions for Money," Journal of Finance, IXX, No. 2 (May, 1964) pp. 248-56.
The foreign exchange market extension of the hypothesis retains the assumption of rapid adjustment in financial asset markets. This market replaces the balance of payments constraint in the fixed exchange rate versions of the hypothesis developed elsewhere and allows exchange rate adjustment to play a major role in the cross-currency financial asset allocation process even during so-called "fixed" exchange rate periods when changes in the exchange rate within the one percent range around IMF parity. The market is specified as a semi-reduced excess demand equation. In implicit form, excess demand is a function of the domestic and foreign interest rate, the current and expected exchange rate, official demand for foreign exchange and relative domestic and foreign real asset and output market variables. The interest and exchange rate variables determine the relative yield on domestic and foreign financial assets while official demand, measured by changes in net Canadian official foreign currency assets, is policy exogenous. Real section variables are summarized by the Canadian current account balance which combines the measures the aggregate relative price and output effects on the excess demand for foreign exchange emanating from the real sector and exogenous in the short-run.

See references cited in footnote 2 on page 1. for fixed exchange rate specification of the Brunner-Meltzer hypothesis. The short-run clearing of exchange markets through financial asset adjustment has been used for Canada by Rhomberg, "Canada's Foreign Exchange Market" and Helliwell and Maxwell, "Short-Term Capital Flows."
The foreign exchange market clears in the short-run as a result of the reallocation of financial asset portfolios across currencies following a change in the exchange rate induced by a change in excess demand that results from shifts in the other variables exogenous to this market. This financial asset reallocation takes place for two reasons. First, when the price of foreign exchange rises (falls) as a result of exogenous excess demand (supply) the nominal value of the Canadian dollar asset proportion of a multicurrency portfolio falls (rises). At given rates of return and risk on domestic and foreign currency assets, this induces a shift out of (into) foreign assets into (out of) those denominated in Canadian dollars in order to regain the optimal cross-currency portfolio diversification. The shift increases the supply of (demand for) foreign exchange to bring the market back into equilibrium.\(^1\) A second reallocation effect results from a change in the relative expected yield on foreign and domestic currency assets. Assuming static expectations, an increased (lower) exchange rate lowers (raises) the expected yield on foreign currency assets and results in an optimal cross-currency portfolio allocation containing more (less) domestic currency assets than before. So long as expectations are not destabilizing -- changes in the rate lead to expectations of further change in the same direction -- this expectations effect increases the

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supply of (demand for) foreign exchange to remove excess demand as well.¹

Short-run equilibrium in the bank credit and foreign exchange markets is simultaneous and allows for the allocative adjustment of domestic and foreign currency financial asset portfolios. The markets proximately determine the short-run domestic nominal interest rate vector and foreign exchange rate. This equilibrium does not, however, imply overall equilibrium between financial asset and real asset on output markets such that an excess supply of all financial assets would require adjustments in real output and prices over the longer run.

¹ Wonnacott, The Canadian Dollar, pp. 175-81, and Rhomberg, "Canada's Foreign Exchange Market", pp. 441-43, have applied the expectations explanation to the Canadian foreign exchange market.
B. The Bank Credit Market

The Canadian domestic bank credit market is described on its supply side by a structural equation derived from the proximate determinant definition of the bank credit stock and on its demand side by a single equation summarizing the non-bank public's behavior in supplying earning assets to banks. The equilibrium of supply and demand in the bank credit market proximately determines the credit market interest rate proxy vector. Because of the aggregate nature of the bank credit market, this vector is proxied by a single domestic interest rate (i).

The proximate determinant definition of bank credit is derived from definitions (4) through (10) in Chapter II along with the consolidated balance sheet of Canadian chartered banks and a definition for the banks' net foreign asset ratio (f). In simplified form, the consolidated balance sheet of the chartered banks can be written as the identity:

\[ R + E + F_b = D, \]

with reserves (R), domestic earning assets (E), and the banks' net foreign asset position (F_b) equal to total deposit liabilities (D).

---

1This identity conceptually ignores several components on the liability side of the combined balance sheet for purposes of analytic simplification. Advances from the Bank of Canada, chartered bank debentures and net worth are omitted due to their relatively small magnitude and/or variance over time. Computationally, the empirical portions of the study utilize earning assets as calculated from the right hand side of equation (23). This can be viewed as defining earning assets net of the omitted components in the same way as the standard Brunner-Meltzer hypothesis defines bank credit net of government deposits and net wealth. Burger examines this point in some detail in Chapter 3 of The Money Supply Process.
Domestic earning assets (bank credit) is defined to include secondary reserves -- Treasury bills and day-to-day loans -- as well as longer maturity government securities, private securities, and loans to private and local government sectors. Rearranging terms, the balance sheet identity for bank domestic earning assets is formed:

\[ E = D - (R + F_b). \]  

Substituting in the definition of the net foreign asset ratio,

\[ f = \frac{F_b}{D}, \]  

and equations (4) through (10) from Chapter II converts the right side of (23) to a multiple of the monetary base,

\[ E = a \cdot B, \]  

where

\[ a = \frac{(1 - (r + f))(1 + s + t + g)}{k + r(1 + s + t + g)}. \]

In elasticity terms, the partial response of the stock of bank credit to changes in the proximate determinants is given by:

\[ e(E, E) = 1 > 0, \]
\[ e(a, k) = e(E, k) = -\frac{k}{z} < 0, \]
\[ e(a, s) = e(E, s) = \frac{s}{1+s+t+g} - \frac{rs}{z} > 0, \]
\[ e(a, t) = e(E, t) = \frac{t}{1+s+t+g} - \frac{rt}{z} > 0, \]
\[ e(a, g) = e(E, g) = \frac{g}{1+s+t+g} - \frac{rg}{z} > 0, \]
$e(a, r) = e(E, r) = \frac{-r}{1-(r+f)} \cdot \frac{r(1+t+s+g)}{z} < 0$, and
$e(a, f) = e(E, f) = \frac{-f}{1-(r+f)} < 0$ as $f < 0.1$

Although the relationship between the overall magnitude of the bank credit multiplier relative to the three money multipliers is ambiguous on the basis of a priori considerations alone, the relative response of each multiplier to changes in most of the proximate determinants are certain. These orders of response and the conditions governing the ambiguous cases are as follows:

$e(M_1, B) = e(M_2, B) = e(M_3, B) = e(E, B) = 1,$
$0 > e(M_1, k) > e(M_2, k) > e(M_3, k) > e(E, k),$
$e(M_1, s) < 0 < e(E, s),$
$0 < e(M_3, s) \lesssim e(E, s)$ as $k \gtrless g,$
$e(M_3, s) < e(M_2, s) \lesssim e(E, s)$ as $k \gtrless g+t,$
$e(M_1, t) = e(M_2, t) < 0 < e(E, t),$
$0 < e(M_3, t) \lesssim e(E, t)$ as $k \gtrless g,$
$e(E, r) < e(M_1, r) = e(M_2, r) = e(M_3, r) < 0,$
$e(M_1, g) = e(M_2, g) = e(M_3, g) < 0 < e(E, g).$

¹ The numerator of $e(E, f)$ will always be positive so long as domestic earning assets exist in chartered bank portfolios by reason of the balance sheet equation, (23). The sign of the elasticity will vary inversely with the sign of $F_b/D$ as the net foreign asset position is positive or negative while the partial elasticity of domestic earning assets with respect to the foreign asset ratio is always negative:

$\frac{\partial E}{\partial f} = \frac{-(1+t+s+g)B}{k+r(1+t+s+g)} < 0.$
Ex post, the proximate determinants of bank credit define the short-term equilibrium stock. An examination of the behavior of the proximate determinants over the period under study reveals a similar pattern of influence as was noted for the money stock in the preceding chapter. Most of the quarter-to-quarter changes in bank credit have proximately resulted from changes in those determinants subject to policy control, B, r, and g as summarized by P in Figure 7. Again, the relative behavior of the policy and non-policy determinants changes markedly from the fixed to the flexible exchange rate period. Without having evaluated the interaction between the policy and non-policy determinants, however, it is impossible to ascertain at this point in the analysis whether this divergent behavior is due to greater freedom of policy action under flexible rates or to different public behavior under the alternative exchange rate regimes. The proximate determinants do, however, provide the structural form for the banks' supply of credit which explicitly includes the major policy variables available to the Bank of Canada and implicitly, through the term and savings deposit yields, the effect of moral suasion.

The definition of bank credit in terms of its proximate determinants is converted into a bank credit supply (bank earning asset demand) function, again with the substitution of behavioral equations for those determinants not posited to be under the direct
Figure 7

Contributions of Controlled and Noncontrolled Determinants of Domestic Bank Credit
control of the monetary authorities. In addition to the behavioral equations specified in Chapter XI for $k$, $s$, $t$, and $r$, the bank credit supply equation includes the ratio of chartered bank net foreign currency assets to total Canadian dollar deposits ($f$).

The behavior of the net foreign asset ratio is determined by the portfolio allocation decisions of chartered banks. As the banks adjust to their desired domestic reserve positions (zero excess reserves) they utilize excess Canadian dollar reserves in part to purchase foreign currency assets in excess of existing foreign currency liabilities or obtain additional Canadian dollar reserves by borrowing (accepting deposits) in foreign currency or selling foreign currency assets and converting the proceeds in the foreign exchange market.

In accordance with inherited portfolio selection theory, the chartered banks' desired net foreign asset position is postulated to depend on the relative expected yield on Canadian dollar denominated earning assets, foreign currency denominated earning assets, borrowing cost at home and abroad, a scale variable, and noninterest

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$^1$In the case, however, the desired value of the ratios will not be equal to their measured value as adjustment is slow relative to the time frame over which the bank credit supply function is defined. In addition, excess reserves may exist within this time frame and it is convenient to describe the adjustment process in terms of the banks' adjustment of reserve positions.
rate distribution variables. In keeping with the Brunner-Meltzer nonlinear hypothesis on bank behavior, total domestic deposits (D) is utilized rather than net worth for the scale variable. No attempt has been made to discriminate between borrowing and lending rates. The domestic asset yield and borrowing costs are given by the domestic bank credit market proxy (i) while the expected foreign asset yield is given by the foreign interest rate (if), the spot exchange rate (x) and the expected future exchange rate (xe) which as before comprise the foreign asset yield (yf). Non-interest distribution variables consist of a vector of proxy variables for the term structure of Canadian rates, seasonal variation and institutional constraints on banks' portfolio allocation (Qf);

\[ F_b = F_b(i, if, x, xe, D, Qf). \]

This relationship is assumed to be linear homogeneous in terms of the scale variable so that it provides the behavioral relationship for

---

1 The theory behind bank behavior is setting their foreign asset position has been developed by Charles Freedman, *The Foreign Currency Business of Canadian Chartered Banks*, (Bank of Canada: Ottawa, 1974). A summary of this theory and its extension to cover the determination of the foreign asset ratio is appended.
the net foreign asset ratio;

\begin{equation}
    f = f(i, x, if, xe, 0f).
\end{equation}

Since \( Fb \) can be either positive or negative, it is convenient to express the response of the desired value of the foreign asset ratio in partial derivative rather than elasticity terms at present;

\[ f'_{1} < 0, \quad f'_{2}, \quad f'_{3} > 0, \quad f'_{4}, \quad f'_{5} > 0. \]

The net foreign asset ratio is negatively related to the yield on domestic earning assets as banks reduce their foreign assets or increase liabilities to maximize profits as this yield rises, \( f'_{1} < 0. \) Increases in the yield (cost) of foreign assets (liabilities) has the opposite effect on the desired net foreign asset ratio; \( f'_{2} > 0, \)
\( f'_{3} > 0 < f' \). Finally, the equations contain a vector of variables to account for the effects of moral suasion requests of the chartered banks to limit either their domestic or foreign earning asset portfolios as well as the effects of seasonal window dressing and normal fluctuations in bank foreign asset positions reflecting changing trade finance requirements over the course of the year.

\[ \text{Specifically, qualitative limits on domestic loan expansion, as existed from 1956 through 1960 would encourage a larger net foreign asset position than relative yields would indicate while the October 1967 agreement to limit domestic term deposit competition is posited to have had the opposite effect.} \]
In elasticity terms, the response of the desired value of the foreign asset ratio with respect to the independent variables in equation (27) will again alternate in sign as the net foreign asset position of chartered banks is positive or negative, but this sign change is offset by that of the elasticity of the earning asset multiplier with respect to the foreign asset ratio \(-e(E,f) < 0\) as \(f > 0\) as discussed above -- so the effect of changes in these variables on the banks' earning asset demand is unambiguous in total.\(^1\)

The complete supply function for domestic bank credit is thus;

\[
(28) \quad Ed = a(i,x;\text{if},\text{x}e,\text{Yp},W,r,D_g,Q_e) \cdot B,
\]

where it should be recalled that the deposit yields are impounded in \(i\) and \(Q_e\) and the reserve requirements and shifts between demand and term deposits are included in the reserve ratio \((r)\).

\(^1\) For example, let \(e(Ed,i)\) stand for the partial response of banks' earning asset demand with respect to domestic interest rates through the channel of change in the desired net foreign asset ratio.

\[
e(Ed,i)_f = e(E,f)e(f,i) = \frac{\partial E}{\partial f} \frac{f}{E} \cdot \left[\frac{\partial f}{\partial i} i/f \right] = \frac{\partial E}{\partial f} \frac{\partial f}{\partial i} \frac{i}{E}.
\]

Since \(\partial E/\partial f < 0\) and \(\partial f/\partial i < 0\) unambiguously and \(i/E\) will always be positive, the overall response \(e(Ed,i)_f\) is unambiguously positive. Similarly;

\[
e(Ed,\text{if})_f < 0, \\
e(Ed,\text{x}e)_f < 0, \text{ and} \\
e(Ed,\text{x})_f > 0.
\]
The expected response of the banks demand for domestic earning assets to selected terms on the right hand side of (28), as found by working back through the structural form and given in Table 2 are quite ambiguous. Two points can however be made. In general we would expect the supply of bank credit to be positively related to domestic interest rates with \( \bar{e}(t,i) \) relatively small as \( e(t,yt) \) \( e(yt,i) \) offsets \( e(t,i) \) and \( e(a,f)e(f,i) \) is sufficiently large to dominate \( e(Ed,i) \). But during periods of limited competition for term deposits \( \bar{e}(t,i) \) takes on a large negative value and the imposition of moral suasion to limit the expansion of domestic credit expansion would also reduce the response of \( e(f,i) \) for upward movements in interest rates such that \( e(Ed,i) \) may become negative. Similarly, the response of the demand for bank credit with respect to the yield on the foreign asset ratio should generally be negative, with \( e(s,if) \) and \( e(s,x) \) small relative to \( e(t,if) \) and \( e(t,x) \) in the short period of time over which displacement from equilibrium in the bank credit market exists, but again the order conditions are of themselves insufficient to derive this response unambiguously. As the bank credit supply function is not identifiable empirically, no test of possible order conditions necessary to remove this ambiguity is possible and we shall posit less stringent conditions based on stability conditions for the overall credit market instead.

The non-bank public's behavior in the domestic bank credit is summarized by equation (29) which aggregates the public's supply
Table 2
Response Pattern of Bank Credit Supply

\[ e(Ed,i) = e(a,i) \leq 0 \text{ as } e(a,s) \bar{e}(s,i) + e(a,f)e(f,i) \leq |e(a,k)e(k,i) + \bar{e}(a,t) e(t,i)| \]

\[ e(Ed,if) = e(a,if) \leq 0 \text{ as } e(a,s)e(s,if) \leq |e(a,k)e(k,if) + e(a,t)e(t,if) + e(a,f)e(f,if)| \]

\[ e(Ed,x) = e(a,x) \leq 0 \text{ as } e(a,k)e(k,x) + e(a,t)e(t,x) + e(a,f)e(f,x) \leq |e(a,s)e(s,lf)| \]

\[ e(Ed,W) = e(a,W) \leq 0 \text{ as } e(a,s)e(S,\bar{W}) + e(a,t)e(t,\bar{W}) \leq |e(a,k)e(k,W)| \]

\[ e(Ed,Y/Y_p) = e(a,Y/Y_p) \leq 0 \text{ as } e(a,k)e(K,Y/Y_p) + e(a,t)e(t,Y/Y_p) \leq |e(a,s)e(S,Y/Y_p)| \]

\[ e(Ed,j) = e(a,j) < 0 \text{ as } e(a,r)e(r,j) < 0 \text{ for } j = rsd, rst, \delta, \text{ and } \rho. \]

\[ e(Ed,Dg) = e(a,Dg) < 0 \text{ as } e(a,g,\bar{g}) e(g,Dg) < 0 \]

\[ e(Ed,\bar{g}) = 1 > 0 \]
of earning assets to chartered banks (Es) into a function of bank
credit market interest rates (i), the three variables that determine
the expected yield (cost) of foreign currency denominated assets (liabilities) — (if), (x), and (xe) — expected domestic interest rates
(ie), expected inflation (pe), wealth (W), the index of transitory
income (Y/Yp), and the outstanding stock of Government of Canada direct
and guaranteed securities (S):¹

\[ Es = Es(i,x;if,xe,ie,pe,W,Y/Yp,S), \]

with

\[ e(Es,i) < 0 < e(Es,x), e(Es,if) < 0 < e(Es,xe), \]

\[ e(Es,ie) > 0 < e(Es,pe), e(Es,W) > 0 < e(Es,Y/Yp), e(Es,S) < 0. \]

The supply of earning assets to banks — public's demand for bank
credit — is negatively related to the cost of loans and yield on gov-
ernment securities, the own price, and positively related to the expected
cost of foreign currency loans and the yield on foreign securities as
these three variables influence the yield on the substitute foreign

¹A disaggregated bank credit market (see for example Brunner and
Meltzer, "A credit market Theory") would be useful in the Canadian
context to examine the effects of the more liquid asset ratio. This
disaggregation was undertaken in an earlier version of this model, but
showed no substantial differences from the implications of the aggregated
model in any respect other than that the MLA ratio biases the government
securities yield downward in direct proportion with its level. As the
MLA ratio was changed only twice during the study period, this modi-
fication was dropped to simplify. In addition, several variables hypo-
thesised to enter the earning asset supply function in versions of the
B-M hypothesis which include interaction with the real sector, the price
of existing assets and the real rate of return on real capital for ex-
ample, have been omitted due to measurement problems and the limited
range of issues in question in this thesis. The domestic deposit yields
are also omitted in symmetry with equation (28) above.
assets. Anticipated increases in the domestic interest rate raises the current demand for bank credit as expenditure plans are shifted forward and as the demand for securities declines in anticipation of capital losses. Price expectations enter with a positive sign as anticipated real asset prices raise the current demand for real assets and the demand for bank credit (loans) with which to finance real asset purchases. Wealth, defined in this study as permanent income, is positively related to the earning asset supply, on the assumption that the public's wealth elasticity of demand for securities is small relative to their elasticity of demand for loans. A similar assumption is made with respect to transitory income, which is also positively related to earning asset supply. The outstanding stock of government securities enters the asset supply function directly with a partial elasticity of unity and indirectly through an increase in wealth if not all the tax liability implicit in additional government securities is discounted.

Market clearing conditions, supply equals demand, are assumed to hold in the short-run.

\[ a(i,x;f;e,Y/yp,W,r,Dg,...) \cdot B = Es(i,x;f;e,ie,pe,W,Y/yp,S) \]

Given the exchange rate and the remaining policy variables and variables predetermined by longer run adjustments, the bank credit market solves for the bank credit interest rate and the structural bank credit supply equation can be used to solve for the equilibrium stock of bank credit.
It should be noted that the left hand side of (30) implicitly includes the equations for the desired values of the ratios \( k, s, t, r \) and \( f \), which are likewise determined given \( x \) and the variables exogenous to the overall hypothesis.

The market clearing condition can be rewritten as an excess demand equation for bank credit by recalling that the public's supply of earning assets to banks is the demand for bank credit,

\[
(31) \quad E_s(i, x; \ldots) - a(i, x; \ldots)B = 0,
\]

which is the semi-reduced form equation for interest rate determination in the hypothesis. Combining the signs posited for the supply of earning assets (equation 29) with those that are unambiguous in the earning asset multiplier and imposing stability conditions on the market enables the hypothesis to predict the signs of most of the elasticity coefficients in the bank credit market.¹ This response pattern along with the expected signs of the parameters in the semi-reduced form are given in Table 3.

¹The Walrasian stability conditions for partial equilibrium in the bank credit market requires that an increase in own price \( i \) result in excess supply, \( e(a, i) - e(E_s, i) > 0 \), while an increase in the price of foreign credit, a gross substitute results in excess demand for bank credit, \( e(E_s, if) - e(a, if) > 0, e(E_s, xe) - e(a, xe) > 0 \), and \( e(E_s, x) - e(a, x) < 0 \). These conditions are sufficient to determine unambiguous signs for \( e(i, x)_{cm} \), \( e(i, if)_{cm} \), and \( e(i, xe)_{cm} \) while the entry of \( i, p_e, S, D_g, \) and \( B \) with an unambiguous sign on one side of the market is sufficient to resolve their market responses. The imposition of these a priori conditions permits the ambiguous bank credit supply responses in Table 2 to take a positive or negative sign, but limits their magnitudes if the system is stable.
Table 3
Partial Response Pattern of Interest Rates in the Bank Credit Market

\[ e(i,x)_{cm} = \frac{e(a,x) - e(Es,x)}{e(Es,i) - e(a,i)} < 0 \]

\[ e(e,if)_{cm} = \frac{e(a,if) - e(Es,if)}{e(Es,i) - e(a,i)} > 0 \]

\[ e(i,pe)_{cm} = \frac{e(Es,pe)}{e(a,i) - e(Es,i)} > 0 \]

\[ e(i,ie)_{cm} = \frac{e(Ei,ie)}{e(a,i) - e(Es,i)} > 0 \]

\[ e(i,Y/Yp)_{cm} = \frac{e(a,Y/Y) - e(Es,Y/Yp)}{e(Es,i) - e(a,i)} > 0 \]

\[ e(i,W)_{cm} = \frac{e(a,W) - e(Es,W)}{e(Es,i) - e(a,i)} > 0 \]

\[ e(i,S)_{cm} = \frac{E/S}{e(Es,i) - e(a,i)} > 0 \]

\[ e(i,Dg)_{cm} = \frac{-e(a,g)}{e(Es,i) - e(a,i)} < 0 \]

\[ e(i,B)_{cm} = \frac{-1}{e(Es,i) - e(a,i)} < 0 \]
The foreign exchange market, defined as the institutional setting in which units of Canadian transactions money are exchanged for units of foreign transactions money, proximately determines the foreign exchange rate \((x)\) given the domestic and foreign interest rates, relative output, prices, wealth and real rates of return in Canada and abroad, and official behavior in the foreign exchange market.

In keeping with the adjustment speed assumptions employed in the bank credit market, it is assumed that the speed of adjustment in international financial markets is rapid relative to that in which real goods and services are traded internationally. Thus, while the transactions between Canadian residents and the rest of the world in real assets and services will change the net foreign asset component of Canadian financial asset portfolios,\(^1\) it is the adjustment of this portfolio over domestic and foreign currency denominated assets that determines the exchange rate in the short-run.\(^2\)

\(^1\)In this and the remaining discussions, non-residents are assumed not to hold Canadian dollar denominated financial assets. This assumption greatly simplifies the analysis without altering the conclusions.

Since the foreign exchange market reduces to a single implicit equation given the assumptions above, it is useful to first develop the underlying flow analysis explicitly before invoking the dynamic speed of adjustment assumption to convert the market to a single comparative statics stock equilibrium equation. This flow model is analytically equivalent to the structural form provided by supply and demand for earning assets in ascertaining response signs in the reduced firm bank credit market in Section B above.

Recent studies of international short-term capital flows have employed the Markowitz-Tobin stock-adjustment model of portfolio selection to explain these flows as the result of portfolio reallocation over domestic and foreign assets in response to shifts in interest rates, risk, and wealth. This short-term capital flow

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1Branson, Financial Capital Flows, provides perhaps the most complete exposition of this theory. Zoran Hodjera, "International Short-term Capital Movements: A Survey of Theory and Literature", IMF Staff Papers, (1973), provides a review of this literature.
hypothesis can be converted into an exchange market model by incorporating anticipated exchange rate change into the yield on foreign currency assets and viewing the capital flow as an excess demand for foreign exchange per unit of time. Foreign exchange supplied by net current account transactions, and those capital account items not sensitive to current interest rate differentials, is given exogeneous to the short-run model and portfolio reallocation over financial assets denominated in domestic and foreign currency proximately determines the short-run spot exchange rate.

In this formulation, the excess private sector demand for foreign exchange per unit of time \((X_p)\) is dependent on domestic and foreign interest rates, the exchange rate, exchange rate expectations, the balance on international transactions which are not sensitive to short-term interest or exchange rate fluctuations, and a vector of variables to account for exogeneous shifts:

\[
X_p = X_p(i,x,if,xe,T,Qx), \text { with }
\]

\[
X_p < 0 > X_{p_2}, X_{p_3} > 0 < X_{p_4}, X_{p_5} < 0 .
\]

It should be noted that this excess demand function is defined over all private operators in the Canadian foreign exchange market, banks and non-banks, residents and non-residents.
alike. Reflecting the assumption that the dominant source of (derived) demand for foreign exchange in the short-run is portfolio adjustment of financial assets, changes in the relative expected rate of return on Canadian and foreign currency denominated financial assets determine the demand for foreign exchange.

The entry of the balance on exchange in real assets and services (T) in equation 31 requires particular attention. In the specified pure flow model it measures the excess supply of foreign exchange arising from international trade, services, and those long-

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1 It is conceptually possible to isolate the excess demand for foreign currency assets by Canadian chartered banks (ΔFb), which in the short run is equivalent to changes in their desired net foreign asset position (Fb) as weekly data on Fb is available. Fb can be structured as a multiple of the domestic monetary base,

\[ Fb = f(i, x, \ldots, Dg)B, \]

in which case the semi-reduced form private excess demand function would include B, Dg, W and Y/Yp as well as those variables in (31). However, a preliminary examination of this bank excess demand equation via a proximate determinant analysis indicated that the allocative variables (i, x, if and xe) dominated the scale variable (B) over the period under study. The allocative variables are explicitly included in (31) while Y/Yp, W, and B are implicitly included in T as they affect the long-term trade flows.
term capital flows whose volume is not dependent on current nominal interest rates and may be assumed to be independent of the exchange rate in the short run. Although its value, measured by balance of payments accounting procedures, is dependent on the current exchange rate over any particular time span, this value determines not the excess quantity of foreign exchange supplied, but the rate at which financial claims and assets are being redistributed between residents and non-residents. Whether or not these transactions are cleared through the exchange market in the current period depends on relative expected yields (costs) of lending (borrowing) through the medium of financial assets denominated in Canadian and foreign units of account.

The remaining variable in the private demand for foreign exchange (QF) is a vector of seasonals, shift proxies and dummy variables to account for term structure, third currency devaluation and particular policy actions — primarily the U.S. balance of payments guidelines.

1. Recent studies of the determinants of various categories of transactions as measured in balance of payments accounts, particularly Richard E. Caves and Grant L. Reuber, Capital Transfers and Economic Policy: Canada, 1951-1962 (Cambridge, Massachusetts: Harvard University Press, 1971), suggest that the range of financial assets subject to short-term adjustment is larger than that usually assumed in balance of payments adjustment — short-term capital and errors and omissions. Consequently, we assumed that the short term exogeneous component of international private transactions consists solely of trade, services, and direct investment, those variables not found sensitive to current relative interest rate levels.
The excess demand of foreign exchange by the monetary authorities\(^1\) \((X_g)\) serves to identify the excess demand by the private sector in the flow balance through the market clearing condition,

\[
X_p + X_g = 0.
\]

The excess demand by the monetary authorities is measured by the change in the level of official reserves \((F)\) over the time frame in which demand is measured.

\[
X_g = F_t - F_{t-1}
\]

To account for differences between changes in official reserves as generally reported by Canadian authorities and official transactions in the foreign exchange market, several adjustments to reported official reserve figures are required. These adjustments reflect official reserve gains and losses through sales and redemptions of foreign currency denominated government securities, I.M.F. drawings and swaps with the Federal Reserve system.

The change in net official foreign currency assets are regarded as an exogeneous policy variable except in those cases

\(^1\) In principle, the monetary authorities would include not only the Bank of Canada and Government of Canada, but central banks elsewhere conducting foreign exchange market operations in Canadian dollars. In practice, all official operations in Canadian dollar foreign exchange markets are assumed to have been conducted by or on order of the Canadian authorities. Other transactions by governmental agencies in Canadian dollars are only included in official demand as they influence the foreign currency positions of the Bank and Government of Canada.
where the exchange rate has reached a (policy determined) intervention point, in which case the flow equilibrium condition

\[ X_p(i,x,if,xs,T,QX) + F_t - F_{t-1} = 0 \]

determines \( F_t \) with the foreign exchange rate \((x)\) policy enogenous and fixed. It should be noted that this switching of the dependent variable is not dependent on the declaration of an IMF par value. De facto intervention points may have existed for the exchange rate during the 1961-62 period of a floating exchange rate, while exchange rate was free to move within a 2 1/4 percent band around the 1962-1970 par value and only infrequently reached an intervention point.

With short-term foreign exchange market adjustment through financial asset flows, the excess demand for foreign exchange by the private sector per unit of time \((Xp)\) is equivalent to the change in Canadian resident foreign currency financial asset positions over an equivalent period of time,

\[ X_p = \Delta F_p. \]

The change in the private net foreign currency asset position can be viewed as an adjustment of the existing position \(F_p\) to the desired position \(F_p^*\) given by current and expected future value of the spot exchange rate, relative interest rates at home and abroad and relative prices income and wealth as summarized by \(T\).
To implement the assumption of rapid adjustment in international financial asset markets relative to the time frame in which the data is measured (daily at best for exchange rates and monthly for changes in official reserves), the excess demand (flow) analysis is converted to a comparative statics stock adjustment model without lags. The excess private sector demand for foreign exchange (Xp) becomes the stock demand for foreign currency denominated financial assets net of liabilities on the part of Canadian residents (Fp). The equilibrium condition for financial asset markets, that excess demand for foreign currency denominated financial assets equal zero when short-term portfolio adjustment is complete converts the market clearing flow equilibrium condition to the implicit function,

\[ F_p^* = F_p^*(i, if, x, xe, T, QX) \]

\[ F_p^*(i, if, x, xe, T, QX) = 0 \]

which describes the short-term Walrasian foreign exchange market. For periods in which the exchange rate constraint is not in place, this market proximately determines the foreign exchange rate given the domestic interest rate determined (simultaneously) in the bank credit market, the foreign interest rate, exogenously determined by the small country assumption, exogenous expectations about the future spot rate, the balance of trade, level of official reserves

1Non-resident supply is assumed perfectly elastic in keeping with the small country assumption.
and appropriate dummy variables. In those instances when the exchange rate has reached an intervention point, equation (33) approximately determines the net official foreign asset position when subject to exogenous shifts that would otherwise move the exchange rate.

The predicted signs of the response of the foreign exchange market to each variable in equation (33) is listed in Table 4. Like the bank credit market, these responses are not directly testable due to the assumption of rapid adjustment. Support for the hypothesis comes instead from their implications for the reduced form for the overall system. While these pure fixed and pure flexible rate cases define the limiting cases of exchange rate regime, over most of the period under study, neither case held in practice. Under fixed rates, the IMF intervention points were wide enough for the flexible rate model to hold whereas with floating rates, the Bank of Canada has maintained a presence in the market. To determine the exchange rate in these interim cases, a Bank of Canada reaction function will be specified in Chapter V and the assumption of exogenous intervention will be dropped in order to test the model empirically.
Table 4
Response Patterns in the Foreign Exchange Market

\[
e(x,i)_{fm} = \frac{-e(Fp,i)}{e(Fp,x)} < 0 \quad e(F,i)_{fm} = \frac{-e(Fp,i)}{e(Fp,F)} < 0
\]

\[
e(x,if)_{fm} = \frac{-e(Fp,if)}{e(Fp,x)} > 0 \quad e(F,if)_{fm} = \frac{-e(Fp,if)}{e(Fp,F)} < 0
\]

\[
e(x,xe)_{fm} = \frac{-e(Fp,xe)}{e(Fp,x)} > 0 \quad e(F,xe)_{fm} = \frac{-e(Fp,xe)}{e(Fp,F)} > 0
\]

\[
e(x,T)_{fm} = \frac{-e(Fp,T)}{e(Fp,x)} < 0 \quad e(F,T)_{fm} = \frac{-e(Fp,T)}{e(Fp,F)} > 0
\]

\[
e(x,F)_{fm} = \frac{-e(Fp,F)}{e(Fp,x)} > 0 \quad e(F,x)_{fm} = \frac{-e(Fp,x)}{e(Fp,F)} > 0
\]
CHAPTER IV

SOURCES OF THE MONETARY BASE

A. Introduction

This chapter examines the behavior of the monetary authorities in the money supply process, in particular, their behavior in adjusting the monetary base and constraints on their behavior imposed by fixed exchange rate and fixed reserve asset targets. While the basic hypothesis developed in this study considers policy instruments exogenous, past behavior of the authorities in attempting to attain particular policy targets must be considered in order to derive consistent and unbiased estimates of the effects of policy actions in testing the hypothesis and estimating structural parameters in the next chapter.

The monetary base is defined as the monetary liabilities of the Bank and Government of Canada. Its behavior is examined by defining its sources as the other assets and liabilities of these official entities which, through balance sheet and budget constraints, must reflect all changes in the base. The source base is first narrowly defined to include only the Bank of Canada balance sheet which is under their complete control. Then in order to account for all changes in international reserve assets, the source base definition is extended to include Government of Canada accounts as well. Of major interest is the extent to which changes in official reserve asset holdings result in changes in the overall base. A direct linkage, reductions in reserve assets...
leading to reductions in the base in the classical price-specie-flow adjustment mechanism, would do much to explain the stability of the Canadian dollar over the period. Sterilization of these reserve asset flows through offsetting changes in other source components would, on the other hand, imply another short-run adjustment mechanism is at work.

The final section of this chapter integrates the bank credit and foreign exchange markets with the constraint imposed by the source definition of the monetary base to develop a theoretic model of financial markets adjustment under flexible exchange rates and under the constraints imposed on policy instruments by fixed exchange rate and fixed reserve asset targets. Since we find no close relationship between the base and reserve asset changes either in the fixed or flexible rate periods, an alternative adjustment mechanism is posited for the short run. Under fixed exchange rate/fixed reserve asset targets, this adjustment mechanism operates through the bank credit market. Instead of buying reserve assets when their price (the foreign exchange rate) begins to fall below the target level, the authorities buy government securities in the bank credit market. This reduces the demand for bank credit, lowers domestic interest rates and reduces excess supply in the foreign exchange market by increasing the demand for foreign currency assets. It also increases the monetary base and thereby initiates a longer-run adjustment process whereby prices and output will rise in Canada relative to the rest of the world and the Canadian dollar price of foreign exchange will rise. This credit
market mechanism of adjustment implies no correlation between the base and reserve assets is to be expected and also recognizes that the growth or depletion of reserve asset stocks may be policy targets as well as the exchange rate. This mechanism also corresponds with Bank of Canada statements that policy is directed toward promoting and maintaining a level of interest rates in Canadian financial markets which would help in establishing a net current account deficit in the balance of international payments and rebuild depleted foreign exchange reserves.\footnote{Bank of Canada, Annual Report, 1962, p.6.}

B. Defining the Sources of the Base

The Canadian monetary base was defined in chapter II by its uses, currency in the hands of the public and chartered bank reserves. These monetary liabilities of the authorities can be defined in terms of their sources by aggregating over the balance sheet of the Bank of Canada shown in Table 5. Accounts are simplified into the aggregates of major interest in this study in Table 5, with symbols used in the remainder of this study in parenthesis. In equation form, this balance sheet can be rewritten as,

\[ C_p + C_b + D_b = S_B + F_B + O_B - D_G, \]

where the left-hand side is the uses definition and the right side defines the sources of the base:

(40) \[ B = S_B + F_B + O_B - D_G. \]
Table 5

Bank of Canada Balance Sheet
Fourth Quarter, 1962 a/
(millions of Canadian dollars)

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government securities (SB)</td>
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</tr>
<tr>
<td>Currency held by public (Cp)</td>
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</tr>
<tr>
<td>Foreign currency assets, net (FB)</td>
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</tr>
<tr>
<td>Currency held by banks (Cb)</td>
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</tr>
<tr>
<td>Other assets, net (OB) b/</td>
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</tr>
<tr>
<td>Chartered bank deposits (Db)</td>
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</tr>
<tr>
<td>Government deposits (DG)</td>
<td>34</td>
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</tbody>
</table>

a/ Quarterly average of Wednesday's figures.

b/ Other assets net includes bankers acceptances ($1.2 million), advances to the Government of Canada, chartered banks and savings banks ($0.3 million), investment in Industrial Development Bank $162 million), and other unidentified assets ($95 million), on the asset side, and other deposits ($30 million; includes deposit liabilities to foreign central banks), and other unidentified liabilities ($98 million).

The historic values of the sources of the base are listed in Table 6 and plotted on Figure 8. Net foreign currency assets and government securities holdings have been adjusted to account for Bank of Canada swaps with the Bank of England and Federal Reserve Bank of New York in 1962 and 1968. This adjustment was necessary because, under the conventional accounting procedure, Canada's drawing a swap initially results in an increase in foreign currency assets and a reduction in the Bank's holdings of government securities which are turned over to
<table>
<thead>
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<th>FB</th>
<th>OB</th>
<th>-DC</th>
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Figure 8

Sources of the Monetary Base
(millions of dollars)
the foreign central bank. If the foreign currency assets are used in exchange market intervention, recorded foreign currency assets return to their initial level, but government securities remain at the lower level as well. This exchange market intervention reduces the base, but on the sources side the reduction appears to have been the result of an open market operation. Such intervention also does not result in changes in reserve assets under the conventional definitions. To account for this discrepancy, the foreign currency liability to repay the swap is added to the Bank of Canada accounts when the swap is drawn and a domestic currency claim on the foreign central bank is added to the government securities account.\(^1\) With this adjustment, exchange rate support through the sale of swapped funds results in a reduction in the Bank's net foreign currency assets. The reduction in the base resulting from such transactions is now properly associated with the change in net international reserves.\(^2\)

\(^1\) For consistency, government securities held by the general public (S) are reduced by a like amount as there is no provision in available data for identifying foreign official holdings of government securities.

\(^2\) The reported (unadjusted) figures during swap periods (millions of dollars, average of Wednesdays) are:

<table>
<thead>
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<th>S</th>
<th>Swap</th>
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</table>
to changes in the base are listed in Table 7, with the contribution of government deposits (SB) and bank holdings of international reserves (FB) plotted on Figure 9.¹

By inspection, government securities dominate the base, both in levels and changes. This was most apparent during the pre-1962 floating rate period when the Bank's portfolio of foreign assets did not change significantly, but even during the fixed rate period, changes in the Bank's holdings of foreign reserves were generally more than offset by changes in its government securities portfolio such that foreign assets had little net effect on changes in the base. Correlation coefficients between changes in the base and its sources are listed in Table 8. The correlation between changes in government securities and the base is (0.83) for the period as a whole and (0.95) during the 1955-1962 floating rate period. While this correlation drops off somewhat (to 0.82) during the par value period, the large negative correlation between changes in Bank securities holdings and its holdings of foreign assets (-0.60) during the par value period indicates the use of government securities transactions to offset exchange market operations.

¹The contribution of sources of the domestic base to the total base is calculated as the four quarter change in the source component divided by the concurrent base, e.g.,

\[
\frac{\Delta SB}{B} = \frac{[SB(t) - SB(t-4)]}{B(t)}.
\]

This is equivalent to the percentage change in the source component multiplied by its proportion to the total base which is the analogous to the contribution of proximate determinants in the multiplier used in Chapter II above. The proximate contribution of each source of the base to changes in the money stock is thus equivalent to its contribution to changes in the base.
## Table 7
### Contribution of Sources to Changes in the Monetary Base
(four quarter differences)

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<th>2GB/B</th>
<th>2GB/S</th>
<th>2GB/D</th>
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<th>2GB/D</th>
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Figure 9

Contribution of Major Sources in The Monetary Base
(four quarter changes)
Table 8

Correlation Between Changes in the Money Base and Sources

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<th>Q1/55-Q1/62</th>
<th>Q1/62-Q1/70</th>
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<td>(0.8488)</td>
<td>(0.9728)</td>
<td>(0.7914)</td>
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<tr>
<td>Cor(ΔB,ΔFB)</td>
<td>-0.0209</td>
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<td>-0.0946</td>
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<tr>
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<td>(-0.0075)</td>
<td>(0.1805)</td>
<td>(0.0375)</td>
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<td>Cor(ΔB,ΔDG)</td>
<td>0.2248</td>
<td>0.4204</td>
<td>0.1390</td>
</tr>
<tr>
<td></td>
<td>(0.0796)</td>
<td>(0.0209)</td>
<td>(0.1066)</td>
</tr>
<tr>
<td>Cor(ΔB,ΔOB)</td>
<td>0.4615</td>
<td>0.4355</td>
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<td>(-0.3847)</td>
<td>(-0.6842)</td>
<td>(-0.3728)</td>
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<tr>
<td>Cor(ΔSB,ΔFB)</td>
<td>0.4649</td>
<td>0.1788</td>
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</tr>
<tr>
<td></td>
<td>(-0.3993)</td>
<td>(0.1285)</td>
<td>(-0.4605)</td>
</tr>
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</table>

Source: Table IV-1. The top coefficient in each cell is for four quarter differences, first quarter difference correlation coefficients are in parenthesis.
on the Bank's own account. In fact, the exchange market operations were more than offset for the fixed rate period as indicated by the negative (-0.09) correlation between changes in the foreign component and the total base.

C. The Extended Source Base

While Bank of Canada holdings of foreign exchange had little impact on the base, the Bank held at most only two percent of Canada's total reserve assets over the period of this study. The bulk of these reserves were held by the government in the Exchange Fund Account, Canada's stabilization fund. Most intervention is undertaken through this account which is managed (under government directive) by the Bank such that the bulk of the exchange market intervention does not have impact on the monetary base directly, but instead results in changes in government deposit levels and government borrowing. The presence of the Exchange Fund has led to some controversy in the literature regarding the impact of exchange intervention on the money supply.
In order to incorporate Exchange Fund holdings of international reserves into the sources of the base and evaluate the full impact of exchange market operations on base money, a consolidated financial account for the Government and Bank of Canada can be constructed and utilized to derive an extended source and definition of the base.

The government's balance sheet derived from its budget constraint, equation (41), which states that government Canadian dollar expenditures

\[ GD_t = \Delta SG_t - \Delta DGOV_t - \Delta FG_t \]

where \( \Delta X_t = X_t - X_{t-1} \),

\[ SG = SB + S \]

\[ DGOV = Dg + DG \]

in excess of receipts over a period of time \( GD \), must be financed by selling government securities \( SG \) to the public and chartered banks \( S \), or the Bank of Canada \( SB \), by reducing government deposits at the chartered banks \( Dg \), or at the Bank of Canada \( DG \), or by selling

---

1 The usual practice in the U.S. money supply literature has been to define the sources of the base over Federal Reserve accounts alone or in consolidation with Treasury "monetary" accounts, e.g., Burger, The Money Supply Process, pp. 18-21. With the different institutional structure and data availability, a parallel construction would not be possible for Canada in any event. A theoretical construction of the sources of the base utilizing the government budget constraint has been used to examine the interaction between monetary and fiscal policy in a closed economy in Brunner and Meltzer, "Money, Debt, and Economic Activity," p. 957, and to examine open economy aspects by Fratiani, "Bank Credit Formation ...... Italian Experience."
foreign currency assets (FG). The budget constraint, a flow equation, can be converted to a balance sheet at time n and stock equation by summing GD over time,

\[
SGD_n = SG_n - (DG_n + DC_n + FG_n),
\]

where \( SGD_n = \sum_t GD_t \)

the balance sheet equivalent of equation (41) is shown in Table IV-5.

While data for the cumulative government budget constraint is not available, the stocks of financial assets are, and equation (44) can be given empirical content by calculating SGD as a residual. Government foreign currency assets consist of exchange Fund Account holdings of gold and convertible foreign currency assets, Minister of Finance U.S. dollar working balances, and Canada's reserve position in the IMF. Government foreign currency liabilities, direct and guaranteed government securities payable in foreign currency, are netted out of the

1 Government holdings of currency and coin are assumed to be insignificant. Foreign currency assets are measured net of foreign currency liabilities such that the issuance of foreign currency denominated government assets and converting the proceed into Canadian dollars would reduce FG.

2 Data on outstanding government securities on a weekly basis is available from the 2nd quarter of 1954 from annual supplements of the Bank of Canada Statistical Supplement, table headed "Government of Canada Direct and Guaranteed Securities; V. Distribution of holdings." As this data does not distinguish between Canadian dollar and foreign currency issues, the latter are subtracted from general public holdings under the assumption that the Bank of Canada and chartered bank holdings are insignificant.
### Table 9

**Hypothetical Government of Canada Balance Sheet**

**Fourth Quarter, 1962 a/**

(millions of Canadian dollars)

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount (millions)</th>
</tr>
</thead>
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<tr>
<td>Deposit balances at Bank of Canada (DG)</td>
<td>34</td>
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<tr>
<td>Deposit balances at chartered banks (Dg)</td>
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<tr>
<td>Foreign currency and gold holdings, net (FG) b/</td>
<td>2,104</td>
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<tr>
<td>Accrued government cash deficit (SGD)</td>
<td>15,579</td>
</tr>
<tr>
<td>Government direct and guaranteed Canadian dollar securities held by:</td>
<td></td>
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<tr>
<td>Bank of Canada (SB)</td>
<td>2,872</td>
</tr>
<tr>
<td>Chartered banks and general public (S) b/</td>
<td>15,214</td>
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</table>

**a/** Quarterly average of Wednesday's figures except for foreign currency assets which are averages of month-end and the accrued deficit which is calculated as a residual.

**b/** Foreign currency denominated government securities are netted from both sides of the balance sheet with the assumption that the entire outstanding amount is held by the general public.
foreign currency assets to derive FG.¹

Consolidation of the balance sheets for the Bank of Canada and government yields the balance sheet identity:

\[ FB + OB + Dg + FG + SGD = Cp + Cb + Db + S \]

Chartered bank holdings of currency (Cb) and deposits at the Bank of Canada (Db) plus currency held by the non-bank public (Cp) again define the uses of the base such that rearrangement of the above yields the extended sources definition:

\[(45) \quad B = D + F,\]

where the sources are divided into a domestic and foreign component,

\[(45a) \quad D = SGD - S + Dg + DB \quad \text{and} \quad (45b) \quad F = FB + FG\]

Changes in domestic sources result from Bank purchases of government

¹Foreign currency assets and the IMF position are available only on an end of month basis. Outstanding foreign pay securities have been constructed on a weekly basis from dates of issue and retirement given in annual supplements of the Bank of Canada, Statistical Supplement table headed "Government of Canada Direct and Guaranteed Securities; VI. Details of Outstanding Issues." Statistical errors resulting from the aggregation of month end and averages of weekly data are included in the residual SGD.
securities, either new or outstanding issues, changes in government deposit balances in chartered banks and other bank accounts activity like advances to securities dealers or the banks. Changes in foreign sources of the base result from foreign exchange market operations by the Bank or the Exchange Fund Account.

The historic values of the individual extended source components are listed in Table 10. While the cumulative government deficit and private holdings of securities are large relative to other components on Table 10, they tend to offset each other both in levels and in changes. Similarly, changes in government deposits at chartered banks are large relative to changes in other sources, but their movement is generally offsetting changes in the cumulative government deficit such that the net impact of the domestic source component is considerably less than the movement of individual components.

The historic values of the aggregate domestic and foreign source components of the extended base are listed in Table 11 and plotted in Figure 10. Over the period as a whole, the base grew $2.5 billion, an amount roughly comparable to the $3.0 billion increase in foreign exchange reserves with domestic sources declining about $500 million. Surprisingly, the parallel behavior between the growth in international reserves and the base was most pronounced during the fixed rate period, while the large changes in reserve assets which took place during the fixed rate "crises" of 1962 and 1968 did not result in similar movements in the base as they were offset by movement
### Table 10

Sources of the Extended Base (millions of dollars)

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Table 11
Domestic and Foreign Sources Components of the Extended Monetary Base
(millions of dollars)

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Figure 10

Foreign Domestic Sources of the Extended Monetary Base
(millions of dollars)
in the domestic sources. During the 1966-1969 period, when Canadian reserve asset accumulation was limited by the agreement with the U.S. which exempted Canada from U.S. capital controls, the base continued to grow as a result of domestic source expansion. This constraint on aggregate reserves was lifted in the fourth quarter of 1969 when the Bank desired a tighter domestic monetary policy than could be achieved with the fixed rate and constraint on reserve asset accumulation.¹

A large reduction in the domestic source component followed (1.5 billion by the end of 1970), but this was more than offset by a (1.8 billion rise in the foreign source component, and the base continued to expand despite the freeing of the exchange rate in June 1970.

The contribution of changes in the extended domestic and foreign components to changes in the base are listed in Table 12 and plotted in Figure 11. As noted above, changes in both components exceeded those in the base, particularly during the par value period, with these changes largely offsetting. Correlation between changes in the base and its extended sources is shown in Table 13. For four quarter changes neither the domestic nor foreign source shows dominance over the period as a whole, but the correlation between the base and

¹ The agreement constraining Canadian reserve asset accumulation was initiated in 1963 and initially applied only to official U.S. dollar asset which could not exceed $2.7 billion. This agreement was later amended to include Canada’s IMF position in 1966, but some increase in the net reserve asset position as defined in this study was possible in 1967 by the early retirement of $200 million in U.S. dollar denominated government securities.
Table 12

Contribution of Extended Sources to Changes in the Monetary Base
(four quarter differences)

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Figure 11

Contribution of Domestic and Foreign Sources to Changes in the Extended Base
Table 13

Correlation Between Changes in Base and Extended Domestic and Foreign Sources

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* Coefficients significantly different from zero under the assumption that populations are bivariate normal with population coefficients not equal to zero.
domestic source components dropped sharply from 0.38 in the floating sub-period to 0.12 in the fixed rate sub-period. There is stronger evidence of a shift in dominance from the domestic source in the floating period to the foreign source in the par value period in the correlation of one quarter differences, but the relationship between the base and foreign component (0.24) is still weak during the fixed rate period. Moreover, the negative relationship between the domestic and foreign components increases substantially during the fixed rate period on both one and four quarter differences. Thus, while the foreign source played a more important role in the determination of the base during the fixed rate period when official foreign exchange market operations increased, in the short-run of a quarter or year, the changes in the foreign component were largely offset by changes in domestic sources. Even during periods of heavy foreign exchange market support for the Canadian dollar, the base did not consistently respond positively to changes in the extended foreign source. Between the fourth quarter of 1965 and second quarter of 1967 net international reserves fell $430 million while the base grew $380 million. While reserves rose nearly $300 million in the third and fourth quarters of 1967, the base grew only $60 million. Only during the exchange crisis early in 1968 did the base decline ($180 million in the first quarter as reserves dropped ($540 million) and in this instance, the reduction in reserve requirements that accompanied the 1967 Bank Act change led to a sharp
increase in the money multiplier and a reduction in the base would have been desirable in any event. In fact, the rate of change in the base had already begun to decline in the third quarter of 1967 and it turned positive again in the second quarter of 1968 although the loss of reserves continued.

The lack of correlation between the base and level of reserve assets, even during periods of heavy foreign exchange intervention, implies that there may be room for independent monetary policy with fixed rates in the short run, so long as reserve asset levels can be changed. In some cases, an initially expansive (contractionary) policy may have been in part offset by the reduction (increase) in the foreign component, but, so long as reserve assets can be changed, the domestic source change could be set large enough to obtain any desired change in the base. Of course, this independent policy cannot be maintained over the longer run as reserves are limited on the downside and the government cannot sell additional securities indefinitely—or raise taxes or shift government deposits. Moreover, the sterilization of reserve asset flows requires actions in the bank credit market that will intensify the pressure on the exchange rate, selling government securities to finance reserve asset purchases for example.

Nevertheless, the evidence above shows that even during the fixed rate period, the monetary base was not closely related to the level of international reserves in the short run and that an alternative to the standard fixed exchange rate assumption that the balance of payments determines the monetary base or money supply is necessary in the short run.
C. Effects of Constraints on the Base on the Money Supply Process

While the offset of changes in the domestic and foreign extended source components over the short run result in nearly complete sterilization of the monetary base, the nature of this offset has different implications for the money supply and adjustment of the economy to international disequilibria depending on whether it is conducted through changes in government deposits at chartered banks, through changes in public holdings of securities, or through changes in government expenditures net of receipts. Consider the simplified version of the money supply model which includes the government-Bank balance constraints:

\[ M = m(i,x,\ldots)B \]  \hspace{1cm} (46)

\[ CM(i,x,\ldots,B,S) = 0 \]  \hspace{1cm} (47)

\[ CM_L, CM_B, CM_x < 0; CM_I, CM_S > 0 \]

\[ FM(i,x,\ldots F) = 0 \]  \hspace{1cm} (48)

\[ FM_I, FM_x, FM_F < 0; FM_IF > 0 \]

\[ dB + dS = dF \]  \hspace{1cm} (49)

The bank credit and foreign exchange markets are excess demand equations with signs of the partials derived from the assumptions underlying the elasticity formulations in Chapter III. The budget-balance sheet constraint, equation (49) is derived by differentiating equation (45) with changes in SGD, DGOV, and OB assumed equal to zero for
expositional simplicity. The solution of this system for flexible, fixed rate and fixed reserve asset uses are given in the appendix with indications from model derived graphically in this section.

With flexible exchange rates, Case A, the monetary base and level of international reserves are both exogenous policy variables. Adjustment of the flexible rate system to exogenous disturbances is illustrated in Figure 12, with the bank credit and foreign exchange market curves plotted against the endogenous interest and exchange rates.

The slope of the credit market equilibrium curve CM is given by $-\frac{CM_1}{CM_x} < 0$ with excess supply above and to the right and excess demand below and to the left ($CM_1 < 0$).

The foreign exchange market equilibrium curve will also be downward sloping, $-\frac{FM_1}{FM_x} < 0$, with excess demand also above and to the left ($FM_x < 0$). Stability conditions require the slope of the FM curve to be less than the CM curve when measured against the interest

1 Note that the $dB = dSB$, all changes in the base are assumed to reflect open market operations while all exchange market purchases (sales) are financed through the issue (retirement of government securities).

2 A ceteris paribus increase in the domestic interest rate will increase banks supply of credit as they raise the yield on reserve conserving longer-term deposits and reduce their net foreign asset ratio. Demand for credit will fall as its cost increases to reinforce this excess supply situation.

3 A ceteris paribus increase in the exchange rate will raise the cost of foreign assets (lower their yield) and reduce domestic demand and at the same time raise the domestic currency value of foreign asset portfolios resulting in the desire to shift portfolios in favor of domestic currency assets.
Figure 12
Adjustment in Flexible Rate Case

A
Dynamic stability

B
Increase in base

C
Increase in foreign interest rate

D
Increase in demand for foreign exchange
The position of CM is determined by if, B, and F, while FM is dependent on if and F for its position. An increase in the base will increase the supply of bank credit ($CM_B > 0$) and, through the source constraint, reduce the stock of outstanding securities to reduce demand for bank credit ($CM_B > 0$). The net effect will shift CM to the left, create excess supply in the market at initial prices, reduce the equilibrium interest rate and raise the equilibrium exchange rate along the existing FM curve (Figure 12-B). Thus, the increase in the base results in an increase in the price of foreign exchange, (depreciation of the Canadian dollar) through the financial asset markets and, no relative price or purchasing power parity effects are necessary.

An increase in the foreign interest rate shifts both the CM curve and the FM curve to the right ($-CM_f > 0$; $-FM_f > 0$), resulting in an increase in both domestic interest rates and the exchange rate, providing the slope and shift coefficients meet the requirements $|CM_f| > |CM_f|$ as noted in the Appendix (Figure 12-C).

---

1 See Paul Samuelson, *Foundations of Economic Analysis*, pp. 269-272. In this case of two markets clearing in the relevant time frame, stability requires that the matrix

$$
\begin{bmatrix}
CM_f & CM_f' \\
FM_f & FM_f'
\end{bmatrix} > 0
$$

Given $CM_f$, $CM_f'$, $FM_f$, $FM_f'$ < 0, this necessitates,

$$
CM_f FM_f' > CM_f' FM_f
$$

which converts to $CM_f/CM_f' > FM_f'/FM_f'$ or $-CM_f/CM_f' > -FM_f'/FM_f'$. 

Finally an exogenous increase in the demand for foreign exchange\(^1\) will shift the FM curve outward, raising the exchange rate and lowering domestic interest rates with no effect on the base (Figure 12-D).

With the exchange rate fixed, Case B in the appendix, the level of official reserve assets becomes endogenous and the exchange rate exogenous.\(^2\) The solution can now be represented on an i, F graph (Figure 13).\(^3\)

The CM excess demand curve is downsloping, \((-\text{CM}_1/\text{CM}_2 < 0)\) while the FM curve is upsloping \((-\text{FM}_1/\text{FM}_2 > 0)\), with positive and negative excess demand on the left and right sides of the two curves. Stability is insured by the signs of the partials and no additional order conditions are necessary.

An increase in the base will again shift CM to the left and leave FM unchanged. This will lower the domestic interest rate and reduce the stock of foreign exchange reserves (Figure 13-B). It accounts for the negative short-run relationship between B and F in the historic data for Canada. Furthermore, it can be shown that \(dF/dB > -1\), implying

---

1 The model is augmented by adding a shift parameter to the foreign exchange market (48) and the column vector \(\{0, -1, 0\}\) to the righthand matrix of coefficients for case A in the Appendix.

2 More properly the exchange rate becomes a constant rather than a variable in the model, and the reaction of endogenous variables to x are not relevant.

3 From the budget constraint and an exogenous base, \(dS = dF\), so the CM equation can be plotted against F by substituting \(dF\) for \(dS\) in the differentiated form of equation (47).
Figure 13

Adjustment in Fixed Rate Case

A
Dynamic stability

B
Increase in Base

C
Increase in foreign interest rate

D
Increase in demand for foreign exchange
that a change in the base will not be completely offset by a change in reserve assets so long as the foreign exchange market response to official sales remains negative.\(^1\) This condition could of course be violated if market expectations become a function of the level of official reserves such that decreasing reserve levels lead to greater demand under an eventual devaluation.

An increase in the foreign interest rate will shift the CM curve to the right and the FM curve to the left with the result that domestic interest rates will rise and, under the order conditions necessary for market stability, increase the level of exchange reserves (Figure 13-C).

An exogenous shift in demand for foreign exchange will shift FM to the left reducing \(F\) and raising \(i\) as illustrated in Figure 13-D: This loss of foreign exchange reserves will be less the greater the slope of CM, which increases with the sensitivity of the domestic credit market to foreign interest rates. Thus the integration of Canadian and U.S. capital markets contributes significantly to the stability of the fixed exchange rate in that it reduces the amount of reserve asset change necessary for adjustment.

\[dF/dB = \frac{[FM'_1(CM'_1 - CM'_B)]/[CM'_1FM'_F] - (CM'_BFM'_1)]}{CM'_F} \leq -1\]

With the left side negative and right side positive, \(dF/dB \leq -1\) unless \(CM'_1\) or \(FM'_F\) becomes negative. The latter is a distinct possibility under fixed exchange rates.
Finally, in the case where reserve assets as well as the exchange rate are constraint—the limiting case for Canada during the 1963-1969 period—the monetary base becomes an endogenous variable and the model must be examined using the $i$, $B$ axis graph (Figure 14). This is the conventional fixed rate assumption found in the literature, with domestic monetary policy as endogenous variable. The CM curve is downslaping ($-\frac{CM'}{CM_B} < 0$), but the FM curve is horizontal, reflecting the determination of domestic interest rates in the foreign exchange market. This does not imply that Canada cannot influence its own domestic interest rate, but rather that such influence must be exercised through the exchange market (tariffs, exchange controls and similar policies), or through policies affecting aggregate demand without changing financial requirements (the government deficit).

An increase in the foreign interest rate will now shift the CM curve to the right as before and additionally shift the FM curve upward. The domestic interest rate will rise by the full amount of the foreign exchange market response and $di/dif$ will approach unity if the foreign exchange market reacts symmetrically to changes in domestic and foreign rates. The base may rise or fall as $\left| \frac{CM'_{if}}{FM'_{if}} \right| \geq \left| \frac{CM'_{if}FM'_{if}}{} \right|$. This term may well approach zero such that no change in the monetary base results from a rise in the foreign interest rate.

Changes in the exchange rate and foreign assets are irrelevant as both are fixed by assumption in this case, but an exogenous increase in the demand for foreign exchange will raise the domestic in-
Figure 14.

Adjustment in Fixed Rate/Fixed Reserve Rate Case

A
Dynamic stability

B
Increase in foreign interest rates

C
Increase in demand for foreign exchange

D
Increase in government deficit
Interest rate and reduce the monetary base as the FM curve shifts upward. This outcome is consistent with the monetary approach to the balance of payments where an excess demand for foreign exchange implies and excess supply of domestic money and adjustment requires a reduction in the money supply.

The model can also be expanded by reintroducing the government deficit in the extended source base (see Appendix). This allows the theoretic possibility of utilizing fiscal policy to maintain external equilibrium while retaining an exogenous domestic monetary policy. This alternative, generally considered the (Meade-Tinbergen-Mundell) "policy approach" to international adjustment is quite impractical given the lags in fiscal policy formulation in Canada (and in most countries) and will not be pursued further.

The implication of this formal model of the credit and exchange markets for the money supply process is that it was not so much the fixed exchange rate that constrained Canadian short-run monetary policy, but the constraint on reserve asset changes. The Canadian interest rate is closely related to the U.S. rate in all cases, but the monetary base remains exogenous under the fixed rate-free reserve asset movement case. However, the behavior of relative interest rates and the exchange rate may influence the money supply through the multiplier even though no relationship between the base and external disequilibrium exists. Furthermore, limits on reserve asset change may be reached over the longer-run unless such adjustment through the multiplier is present.
The inclusion of government deposits as a source of the extended base further relaxes constraints on the base imposed by fixing the exchange rate. As is shown in the Appendix, even the fixing of the exchange rate and reserve asset levels leaves some scope for an exogenous short-run monetary policy with respect to changes in the base and monetary aggregates. However, the complete sterilization of the base to changes in reserve assets through changes in government deposit levels will not result in a sterilization of the money supply as the government deposit ratio (g) enters the multiplier directly. Moreover, the ability to maintain an independent monetary policy over the longer run will be limited by initial government deposit levels for purchases of reserve assets. Once these deposits are drawn down, the level of government deposits becomes fixed at zero and the endogenous base, fixed rate-fixed reserve asset model may become applicable.

While the short-run financial assets model reverts to the more usual case of fixed exchange rates (with the monetary base an endogenous variable) under conditions where reserve assets and government deposits are fixed, it is important to note that neither condition was strictly met in the Canadian example over the study period. Government deposits did not fall to zero, nor were reserve assets completely constrained. Moreover, when quarterly average exchange rates are used, the rate itself was not strictly fixed over any quarter of the study period. Consequently, the pure fixed rate assumptions are not strictly applicable in this study and, instead, a reaction function for policy response
to approaching constraints will be utilized in the estimation and testing of the hypothesis in the following chapter. This approach allows the exchange rate, reserve asset level and government deposits to remain variable over the study period and also allows for short-term targets of exchange rates and reserve levels even during the flexible rate periods.
CHAPTER V
TESTS OF THE HYPOTHESIS AND ESTIMATION
OF STRUCTURAL PARAMETERS

A. Outline of the Estimation and Testing Procedure

The basic hypothesis to be tested is that the quarterly changes in the Canadian money stock over the period of the study resulted from;

1. changes in the quantity of base money supplied by the authorities;
2. policy controlled changes in the reserve ratio and government deposit ratio;
3. the posited behavior of the chartered banks and non-bank public in reaction to policy changes, foreign interest rates, real sector variables, and structural shifts that are exogenous to the short run hypothesis. To fully account for the effect of a change in the policy instruments on the money supply, their effect on the interest and exchange rates must first be evaluated. These rates are endogenous to the process. The full short-run impact of a change in policy is thus the combination of its direct effect in the base or multiplier and its indirect effect working through the bank credit and foreign exchange markets. Since the financial asset markets are themselves interdependent, a simultaneous equation estimation procedure must be used to obtain unbiased estimates of the structural parameters in the equations making up the money multiplier which depends on both interest and exchange rates. A further complication arises because the policy instruments themselves were reacting to targeted levels of the interest and exchange rate over
at least the fixed exchange rate/fixed reserve asset portion of the period under study and they were doubtlessly reacting to these and other variables in the hypothesis over the entire period. In order to obtain consistent and unbiased estimates of the response of these past policy targets to the policy instruments, the past reaction of the authorities must also be accounted for. This is done by specifying a reaction function for the authorities and including the targets thus identified with other variables exogenous to the hypothesis in the first stage regression equations to obtain consistent instrumental variables for the policy instruments, as well as the interest and exchange rate, for use in second stage estimation of structural and semi-reduced form equations.

The estimation problem and its resolution can be formally considered in the following simplified implicit version of the model.¹

\[ M = m(i,x;xe,if,...,r,g) \cdot B \]  
\[ i = i(x,B;if,xe,pe,...,r,g,SGD) \]  
\[ x = x(i,F;if,xe,T,...) \]  
\[ F = F(x,i;x*,F*,...) \]  
\[ B = B(i,x;x*,F*,...,r) \]

This system cannot be estimated directly by least squares since each equation contains at least one other current endogenous variable. Moreover, indirect least squares estimates derived from reduced

¹The starred variables, \( x^* \) and \( F^* \) are target levels as described below; \( r \) and \( g \) are assumed not to react in the short run as explained in section B below.
form equations will not assist because (at least) equations (51) and (52) are overidentified. A two-pass two stage least squares estimation procedure can however provide estimates of the critical parameters in the semi-reduced form equations for i and x.

As outlined in Table 14, this procedure is as follows:

First stage estimates of $\hat{B}$, $\hat{F}$, $\hat{x}$, and $\hat{i}$ are made using all exogenous variables in the system. The first stage estimates are used to estimate the semi-reduced form equations (52) and (53) for $\hat{i}$ and $\hat{x}$ along with the elasticities of response in each market. Finally, the behavioral equations for $k$, $s$, and $t$ in the multiplier are estimated using first stage values of $\hat{x}$ and $\hat{i}$ and the money supply equation is reconstructed in proximate determinant form using estimated values of $\hat{k}$, $\hat{s}$, and $\hat{t}$ and the actual values of $r$, $g$, and $B$.¹

Tests of the hypothesis consist of whether or not the coefficients of $\hat{x}$, $\hat{i}$, $\hat{k}$, $\hat{s}$, and $\hat{t}$ are of the expected sign and magnitude and overall explanation power of the hypothesis; whether $\hat{M}$ is a good estimate of $M$.

¹The hypothesis, in elasticity form, constrains the direct response of the base to one which is statistically equivalent to a structural equation for $m$ in which $B$ is excluded.
Table 14

Estimation Procedure

<table>
<thead>
<tr>
<th>Step</th>
<th>Equation</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>( \hat{F} = F ) (all exogenous variables)</td>
</tr>
<tr>
<td></td>
<td>( \hat{B} = B ) (all exogenous variables)</td>
</tr>
<tr>
<td></td>
<td>( \hat{x} = x ) (all exogenous variables)</td>
</tr>
<tr>
<td></td>
<td>( \hat{i} = i ) (all exogenous variables)</td>
</tr>
<tr>
<td>II</td>
<td>( \hat{i} = i ) (( \hat{x}, if, xe, pe, Y, \ldots, r, g, SGD, \hat{B} ))</td>
</tr>
<tr>
<td></td>
<td>( \hat{x} = x ) (( \hat{i}, if, xe, T, \ldots, \hat{F} ))</td>
</tr>
<tr>
<td>III</td>
<td>( \hat{k} = k ) (( \hat{i}, \hat{x}, if, xe, \ldots ))</td>
</tr>
<tr>
<td></td>
<td>( \hat{s} = s ) (( \hat{i}, \hat{x}, if, xe, \ldots ))</td>
</tr>
<tr>
<td></td>
<td>( \hat{t} = t ) (( \hat{i}, \hat{x}, if, xe, \ldots ))</td>
</tr>
<tr>
<td>IV</td>
<td>( \hat{m} = (1 + \hat{k} + \hat{s} + \hat{t})/ \hat{k} + r (1 + \hat{s} + \hat{t} + g) )</td>
</tr>
<tr>
<td>V</td>
<td>( \hat{M} = mB )</td>
</tr>
</tbody>
</table>
B. The Reaction Functions

The reaction functions describing the historic behavior of the policy instruments are not part of the policy exogenous money supply hypothesis being tested, but are necessary in order to obtain unbiased estimates of critical parameters in the foreign exchange and bank credit market. Since the complete specification of such functions for a period as long and varied as the one under study would be an exceedingly complex task well beyond the scope of this study, the following simplifications are made: 1 (1) The foreign exchange and foreign reserve asset targets utilized in previous studies of the Canadian foreign exchange markets are collected and combined to form an equation describing the authorities' desired level of reserve assets; (2) Policy behavior setting in the monetary base is posited to have depended on these foreign exchange rate and reserve asset targets as well as the state of the domestic economy--domestic interest rates, the rate of unemployment, the state of the business cycle, the inflation rate, the size of the government deficit--and to the relationship between the Canadian economy and the rest of the world as measured by the Canadian current account deficit and relative interest and inflation rates.

---

rates; (3) The required reserve ratio is assumed to be independently set as it was changed only following the Bank Act Changes of 1954 and 1967; and (4) The government deposit ratio is assumed to be independently set as a result of decisions implicit in the adjustment of the base and random fluctuations in government balances. The reaction functions will not be used in their structural form, but the variables upon which they depend are entered in the first stage regression equations to derive unbiased instrumental variables for second stage regression testing and estimation.

Past empirical work on the Canadian reaction function has found policy behavior with respect to domestic objectives to be quite unstable. On the other hand, foreign targets have tended to dominate monetary policy behavior and are reasonably well defined by the IMF rules regarding the fixed exchange rate, policy pronouncements and intergovernmental agreements. For this reason, we formulate a rather specific reaction function for the behavior of the foreign exchange reserve instrument, with the variables in this function, along with others, included in the reaction function for the monetary base. Since both reaction functions are used only in the reduced form where

1 The reaction functions in RDX-2, for example consists of an interest rate equation which sets the Government bond rate in response to foreign rates, the growth in bank loans, the rate of domestic inflation, foreign interest rates and other balance of payments variables (The Structure of RDX-2, Part 1, pp. 177-78 and Part 2, p. 106), and an equation specifying official behavior in the foreign exchange market. (Ibid, Part 1, pp. 231-33 and Part 2, p. 126).
they implicitly depend on all exogenous variables, this distinction between the two is simply an expositional convenience.

Official behavior in the foreign exchange market is summarized by changes in the level of foreign exchange Reserves (F) which has been adjusted for valuation changes and to net out borrowed reserves that arise from central bank swaps or issues of foreign currency denominated government securities in order to remove changes which do not directly impact on the foreign exchange market. Official behavior in setting this instrument is specified as:

\[ F = a(F^*-F_{-1}) + b(x-x^*), \]

where a positive difference between the desired reserve level \((F^*)\) and the last period's reserve level \((F_{-1})\) will lead to increased reserve asset purchases and the exchange rate moving above its desired level \((x^*)\) will result in reductions in reserve assets. The stock demand for \(F\) is given by:

\[ F = aF^* + (1-a)F_{-1} + bx - bx^*, \quad 0 < a, b < 1, \text{ with} \]

\[ F^* = \$2.3 \text{ billion from Q3/63 to Q4/68}^1 \]

---

1From the third quarter of 1963 through the fourth quarter of 1968, the reserve agreement with the U.S. limited Canadian reserves of U.S. dollars to $US 2.6 billion—later revised to $US 2.5 billion and to include Canada's IMF position which had been negative—which converts to about $CDN 2.3 billion under the definition of net reserve assets used in this study. Given that the reserve agreement pertained only to an upper limit on U.S. dollar reserve assets and, after 1964, their IMF position, it did not impose a binding constraint. Canada could and did draw down reserves at times and repayed official foreign currency liabilities so that their net reserve position showed considerable variability.
\[ F^* = \text{Trend growth in annual imports otherwise} \]
\[ x^* = x_1 \text{ during floating rate periods (Q1/55 - Q2/61 and Q2/70 - Q4/70)} \]
\[ x^* = 1.0299 \text{ in Q3/61} \]
\[ x^* = 1.0526 \text{ from Q4/61 to Q2/62} \]
\[ x^* = 1.0811 \text{ par value from Q3/62 to Q1/67} \]

As the current and lagged exchange rate are already variables in the model, \( F \) becomes dependent on the entire system and the introduction of a reaction function simply serves to introduce the remaining targets as exogenous variables to the system. Except for the lagged rate, these targets are constant and enter much like dummy variables. In general form, the foreign exchange market intervention function becomes:

\[ F = F(x, x^*, F^*, F^*_{-1}) \]
\[ F_x < 0, F_{x^*} < 0, F^*_{-1} < 0. \]

The theoretic model developed in Chapter IV indicates that over part of the period under study the monetary base was endogenous.

1 This was not an explicit target, however, at the end of the reserve agreement, Canada stated that reserve assets were below "normal". As Canadian reserves subsequently leveled off a level roughly equivalent to a year's imports (their 1950s and early 60s level) this ratio is assumed to have been an implicit target in the absence of the agreement with the U.S.

2 In June 1962, Canada announced a policy shift to raise the price of foreign exchange and was prepared to intervene to force this move. However, the exchange rate rose without substantial intervention purchases and by July, the Bank was intervening to hold the rate down. Paul Wonnacott, The Canadian Dollar, 1948-1962 (Toronto: University of Toronto Press) pp. 240-245, found that the authorities appeared to have been pegging the rate at $1.0299 from July-September and at $1.0526 thereafter.
to the short-run money supply process as a consequence of the reserve asset constraint. Moreover, it is likely that the base was also responsive to reserve asset and exchange rate changes even during the parts of the period when explicit constraints were not in place. In addition, past studies have found that the authorities have reacted to the rate of domestic inflation, the rate of unemployment, the stage of the business cycle and current account balance. As these variables are already included in other structural equations in model policy reaction to their change will be implicitly accounted for in the reduced form first-stage estimation procedure used to calculate instrumental variables. It is also evident from the data that the Bank reacted to the 1967 reduction in reserve requirements by reducing the base (see Figure 3 and 4 in Chapter II, pp. 14 and 16 above) and past studies suggest a distinct shift in policy following the resignation of Governor Cogne in June 1961.

\[(56) \quad B = B(x, x*, F_{-1}, F^*, i, p, Y/Y_p, u, r, QB), \quad \text{with}\]

\[
B_x, B_{F^*}, B_p, B_{Y/Y_p}, B_r \leq 0 \\
B_{x^*}, B_4, B_u > 0; \quad B_{F-1} \geq 0
\]

Except for the exchange rate, reserve asset targets the unemployment rate \(u\) and the 1961 shift parameter \(QB\), the dependent variables in the reaction function are already included in other
structural equations in the model. Consequently, policy reaction to their change will be implicitly accounted for the reduced form first-stage estimation procedure used to calculate instrumental variables. The addition of the foreign sector target, the unemployment rate and shift parameter will serve to identify the base reaction function equation for purposes of calculating the instrumental variable. Since it is possible that the monetary base was guided to attain the foreign targets even in the absence of the fixed exchange rate/fixed reserve asset targets, the first stage estimation of the base will be first run over the entire period and then over the fixed and flexible rate sub-periods and fixed reserve asset sub-period to determine if a significant shift took place. If the reaction function was stable over the entire period or over the major sub-periods, the instrumental variable base should result in a more significant coefficient in the second stage estimation of the interest rate than would the actual values of the base. If it does not, we assumed that the reaction function was unstable and does not bias this coefficient when the actual value of the base is entered. The base variable entered in the interest rate equation may thus be a composite of actual and estimated, depending on the period involved.
C. **First Stage Estimation**

The complete system to be estimated in the first stage (reduced form) is presented in Table 15. The implicit semi-reduced form bank credit market equilibrium (57) is equation (31) in Chapter II without the linear homogeneity constraint on the base. The foreign exchange market equilibrium condition is equation (33) in Chapter II. The definition of the extended source base is equation (45) in Chapter IV, while the policy reaction equations, (55) and (56) were as derived in Section 3 of this Chapter. The hypothesized signs of the partial derivatives are given according to the analysis presented above.¹

Differentiating the system, using the definition of the extended base to substitute for dS in (57), and converting the log-linear form yields the estimation equations.² The reduced form coefficients cannot be given a priori signs by the hypothesis once the reaction functions are introduced although the determinant of the dependent variables coefficients will be negative and the system stable so long as the Bank does not pursue an overly aggressive policy of increasing the base

¹As noted in Chapter III, the presence of monopoly power, moral suasion and legal constraints in the banking system make the response of bank credit supply ambiguous in sign. These ambiguities are removed in the first stage by tentatively assuming the system is stable and that demand responses dominate.

²The linear base constraint converts to a percentage change constraint \( B = \frac{\text{SGD}}{B} - \frac{S}{B} S + \frac{Dg}{B} B + \frac{F}{BF} \) wherein the ratios SGD/B, etc., are implicitly assumed constant coefficients when estimation is made in log-linear form. The bias introduced by this assumption cannot be assessed, but it may not be particularly damaging if the authorities make an attempt to maintain a "normal" relationship between these aggregates.
Table 15
System Estimated in First Stage

\[(57)\]
\[CM(i, x, B, S; if, xe, Y/Y_p, W, pe, ST, x, D_g, = 0\]
\[CM_x', CM_{x'}, CM_{B',} < 0; CM_{if',} CM_{xe',} CM_{W'}, CM_{Y/Y_p'}, CM_{x'}, CM_{D_g'}, CM_{p'}, > 0\]

\[(33)\]
\[FM(i, x, F; if, xe, T, Y/Y_f, P, pf) = 0\]
\[FM_{x'}, FM_{T'}, FM_{T'}, FM_{p'}, FM_{T'} < 0; FM_{if'}, FM_{xe'}, FM_{x'/Y_f'}, FM_{pf'}) > 0\]

\[(45)\]
\[B = SGD - S + D_g + F\]

\[(55)\]
\[F = F(x, x^*, F_{-1}, F^*)\]
\[F_{x^*}, F_{F_{-1}} < 0; F_{F^*}, F_{x^*} > 0\]

\[(52)\]
\[B = B(x, x^*, F_{-1}, F^*, i, p, Y/Y_p, r, ST)\]
\[B_{x^*}, B_{F^*}, B_{i}, B_{p}, B_{Y/Y_p}, B_{r} < 0; B_{x^*}, B_{F_{-1'}}, B_{ST} > 0\]
in an effort to control domestic interest rates (See Appendix). This is a useful property of the hypothesis since it implies that necessary conditions for short-run financial markets stability coincide with those for long run stability when prices also adjust. Beyond this stability condition, the hypothesis cannot be used to derive response signs as all reduced form terms require order constraints on the reaction function, the justification for which are beyond the scope of the present study.

The estimation equations take the log linear form:

\[ \log y = \beta_0 + \beta_1 \log x_1 + \beta_2 \log x_2 + \ldots + \mu \]

with the vector \( i, x, B, S \) and \( F \) of current endogenous and the \( x \)'s predetermined current and lagged variables. Exceptions to the log form were made when the variable can take a positive or negative value (the current account balance) and for price variables where the effect of prices works mainly through price expectations which are formed over longer run changes.\(^1\) In these cases the dependent variables are in percentage change terms so that the coefficient may be interpreted as an elasticity.

A summary of the first stage estimation is given in Table 16. All equations have high correlation coefficients and are significant according to the F statistic. The Durban Watson statistics are low, however, and particularly in the case of \( B \), much of the explained

\(^1\) The current account balance (\( T \)) is the unweighted average of the current and two preceding quarters.
Table 16
First Stage Estimates of Endogenous Variable Coefficients\(^a\)/
(Q1/55 to Q2/70)

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>(x)</th>
<th>(i)</th>
<th>(B)</th>
<th>(F)</th>
<th>(S)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(W)</td>
<td>-.0556**</td>
<td>-.526**</td>
<td>0.780**</td>
<td>1.69*</td>
<td>0.13**</td>
</tr>
<tr>
<td>(Y/Yp)</td>
<td>-.0782</td>
<td>-.251</td>
<td>0.318**</td>
<td>-.872</td>
<td>-.23*</td>
</tr>
<tr>
<td>(SGD)</td>
<td>0.141**</td>
<td>-.403</td>
<td>-.124</td>
<td>2.17**</td>
<td>0.72**</td>
</tr>
<tr>
<td>(Y/Yf)</td>
<td>0.00564</td>
<td>-.0118</td>
<td>0.129**</td>
<td>-.253</td>
<td>-.081**</td>
</tr>
<tr>
<td>(pf)</td>
<td>0.0644</td>
<td>5.50*</td>
<td>0.262</td>
<td>-5.56</td>
<td>-.79</td>
</tr>
<tr>
<td>(p)</td>
<td>0.442**</td>
<td>5.64</td>
<td>.603*</td>
<td>-5.42**</td>
<td>-.86**</td>
</tr>
<tr>
<td>(T)</td>
<td>-.000817</td>
<td>-.000825</td>
<td>-0.00410</td>
<td>0.0114*</td>
<td>0.00090</td>
</tr>
<tr>
<td>(ST)</td>
<td>-.0242**</td>
<td>0.563**</td>
<td>0.0357*</td>
<td>0.0891</td>
<td>-.014</td>
</tr>
<tr>
<td>(il)</td>
<td>0.00511</td>
<td>0.600**</td>
<td>1.0131</td>
<td>-.0752</td>
<td>-.010</td>
</tr>
<tr>
<td>(i2)</td>
<td>-.0164**</td>
<td>-.0690</td>
<td>-.0214*</td>
<td>0.141*</td>
<td>0.023</td>
</tr>
<tr>
<td>(if)</td>
<td>0.00414</td>
<td>0.628**</td>
<td>0.00122</td>
<td>-.00391</td>
<td>-.00042</td>
</tr>
<tr>
<td>(x1)</td>
<td>0.846**</td>
<td>1.58</td>
<td>0.0558</td>
<td>-2.12*</td>
<td>-.47**</td>
</tr>
<tr>
<td>(x2)</td>
<td>-0.280**</td>
<td>0.915</td>
<td>-1.134</td>
<td>3.48**</td>
<td>0.65**</td>
</tr>
<tr>
<td>(r)</td>
<td>0.0479*</td>
<td>-.975**</td>
<td>0.114**</td>
<td>0.559*</td>
<td>0.085</td>
</tr>
<tr>
<td>(Dg)</td>
<td>0.00837**</td>
<td>-.0377</td>
<td>0.00222</td>
<td>-.0951**</td>
<td>0.015**</td>
</tr>
<tr>
<td>(F^*)</td>
<td>-.00379</td>
<td>-.133*</td>
<td>0.00719</td>
<td>0.302**</td>
<td>0.036**</td>
</tr>
<tr>
<td>(x^*)</td>
<td>0.00602**</td>
<td>0.00264</td>
<td>-.00145</td>
<td>0.00281</td>
<td>0.0013</td>
</tr>
<tr>
<td>(xes)</td>
<td>0.00328</td>
<td>0.257**</td>
<td>0.00345</td>
<td>-.00636</td>
<td>-.0038</td>
</tr>
<tr>
<td>(xed)</td>
<td>0.00280</td>
<td>0.00236</td>
<td>0.00289</td>
<td>-.00419</td>
<td>-.0015</td>
</tr>
</tbody>
</table>

Summary Statistics

\[
\begin{align*}
& F^2 & .9877 & .9773 & .9976 & .9350 & .9960 \\
& R^2 & .9809 & 9676 & .9966 & .9069 & .9940 \\
& F(19,42) & 171.31 & 99.93 & 959.8 & 33.32 & 547.64 \\
& D.W. & 1.9007 & 1.6458 & 1.5235 & 1.3310 & 1.1748
\end{align*}
\]

\(^a/\) Coefficients significantly different from zero at the 95 percent (*) and 97.5 percent (**) confidence levels indicate the relative importance of exogenous components in each equation although the tests themselves are biased.
variation is the result of trend growth rates. As noted above, the hypothesis does not predict signs for the coefficients, but in general the coefficients have "reasonable" signs; the exchange rate and interest rate is positively related to the U.S. rate, reserves are positively related to their target level and the exchange rate relates positively to its target and negatively to the reserve target. The strong significant of the reserve ratio and government deposits is somewhat disconcerting in view of the hypothesis assumption that the government deposit level is an exogenous control variable of little significance while changes in the reserve ratio reflect long-term decisions whose effects should be anticipated and offset by changes in other components of the base.

Reviewing the first stage base equation over the fixed and flexible rate sub-periods, Table 17 reveals some indications of a structural shift. In the flexible rate period only the coefficients of wealth picking up trend growth, the ratio domestic to foreign income, and domestic prices are significant at the 90 percent confidence level (t-statistics of 2.09, 1.42, and 1.39 as composed with a critical value of 1.37 even with the high Durban-Watson statistic (3.08) which suggests serial correlation of error terms and an upward bias in the t-statistics. The negative relationship between the base and current prices is reasonable given the Bank of Canada's heavy emphasis on price stability in their monetary policy.
Table 17

Selected First Stage Estimates of Base Coefficients by Sub-Period

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Flexible Rates (Q1/55-Q2/62)</th>
<th>Fixed Rates (Q3/62-Q2/70)</th>
<th>Managed Rates (Q3/61-Q2/70)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>.660*</td>
<td>.960*</td>
<td>.771*</td>
</tr>
<tr>
<td>Y/Yp</td>
<td>.135</td>
<td>-.030</td>
<td>.250</td>
</tr>
<tr>
<td>SGD</td>
<td>-.083</td>
<td>-.432</td>
<td>-.049</td>
</tr>
<tr>
<td>Y/Yf</td>
<td>.107</td>
<td>.121*</td>
<td>.121*</td>
</tr>
<tr>
<td>pf</td>
<td>.986</td>
<td>1.52</td>
<td>-.222</td>
</tr>
<tr>
<td>p</td>
<td>-1.251*</td>
<td>-.251</td>
<td>1.05</td>
</tr>
<tr>
<td>ST</td>
<td>.066</td>
<td>.088</td>
<td>-.022</td>
</tr>
<tr>
<td>if</td>
<td>.008</td>
<td>-.093</td>
<td>-.063</td>
</tr>
<tr>
<td>r</td>
<td>.283</td>
<td>.146</td>
<td>.227*</td>
</tr>
<tr>
<td>F*</td>
<td>-.051</td>
<td>.032</td>
<td>.035*</td>
</tr>
<tr>
<td>x*</td>
<td>.002</td>
<td>5.99*</td>
<td>-1.462</td>
</tr>
</tbody>
</table>

Summary Statistics

| R²        | .9909                     | .9973                     | .9968                     |
| R²*       | .9737                     | .9931                     | .9930                     |
| F         | (19,10) 57.4             | (19,12) 237.1            | (19,16) 261.81            |
| D.W.      | 3.0799                    | 2.0907                    | 1.8105                    |

a/ Coefficients significantly different from zero at the 95 percent (*) and 97.5 percent (**) confidence levels indicate the relative importance of exogenous components in each equation; the tests themselves are biased.
formulation. 1 During the fixed rate period, the fit of the equation improves significantly and the relationship between the base and wealth remains significant and positive, but domestic inflation has an insignificant coefficient while the U.S. interest rate and foreign exchange markets target coefficients become significant and have the signs that would be expected from the reaction function alone. This indicates that fixing the exchange rate did in fact result in a different policy behavior, that the Bank of Canada shifted its policy instrument direction to the exchange rate target and systematically began to alter the base to offset exchange rate movements. As there was little correlation between reserve asset charges and the base (Chapter IV, Tables 8 and 13, pp. 104 and 117), it appears that much of this reaction took place in the bank credit market.

Extending the sub-period to contain the "managed float" during 1961 reduces the overall explanatory power of the equation somewhat, and results in incorrect coefficients on the foreign exchange market targets although the significance of the exchange rate target is low. This marked shift with the inclusion of only four additional observations suggests that the reaction function, as specified, is highly unstable. But this also implies that treating the base as exogenous over this period will not seriously bias the estimation of the structural equations. The first stage equation for the outstanding stock of government securities has the second best fit over the period as a

1The resignation of Governor Coyne in June 1961 followed heavy pressure to alter this monetary policy which was felt to be hindering growth and causing unemployment. See H. Scott Gordon, The Economist Versus the Bank of Canada, The Pyerson Press (Toronto: 1961).
whole in terms of $R^2$, but its Durbin-Watson statistic is quite low, and government securities show strong signs of a structural shift between the fixed and floating rate period. As most changes in the base result from shifts in the Bank's portfolio of government securities, the coincidence of a shift in both equations is not unexpected.

The remaining first stage equations fit as well or better over the period as a whole as during either the fixed or floating rate sub-periods, with the small sample sizes and high standard error terms on coefficients generally making it impossible to reject the hypotheses that these coefficients came from different populations during the sub-periods.
D. Estimation of Semi-Reduced Form Bank Credit and Foreign Exchange Markets

The semi-reduced form bank credit market in Chapter III yielded the interest rate determination equation

\[ Es(i,x,if,xe,ie,pe,W,Y/Y_p,S) - a(i,x,if,xe,Y/Y_p,W,r,D,...)*B \]

For estimation purposes, interest rate expectations are assumed to depend on recent interest rate changes, while a lagged exchange rate to capture expectations is included along with the other exchange rate expectations proxies discussed in Chapter III-C. More formally, the expected interest rate in time \( t \) is assumed to depend on last periods interest rate times the change in the rate during the last quarter raised to the \( \alpha \)th power, where \( \alpha \) is between zero and plus one for stabilizing expectations:

\[ ie_t = il (i1/i2)^\alpha \quad 0 < \alpha < 1 \]

In this case, taking the natural log of \( ie \) yields,

\[ \log ie_t = (1 + \alpha) \log il - \alpha \log i2, \]

which is substituted into the log linear estimation equation such that the estimated coefficients on \( il \) and \( i2 \) consist of the elasticity of the interest rate with respect to expectations \( B \) plus the \( \alpha \) terms.

Similarly, exchange rate expectations can be formulated as log linear functions of past rate changes for consideration along with other expectations proxies.

\[ \log xe_t = (1 + \gamma) \log xl - \gamma \log x2, \]

with \( 0 < \gamma < 1 \)

for expectations to be stabilizing. Thus, with the domestic interest postulated to depend positively on interest exchange rate expectations,
the expected credit market elasticities become:

\[ e(i, i) > 0, \quad e(i, 12) < 0 \]
\[ e(i, x) > 0, \quad e(i, x2) < 0. \]

and the empirical counterpart of equation (31) is the estimation equation:

\[ \log i = \beta_0 + \sum_j \beta_j \log n_j + \sum_k \beta_k \log q_k + \mu \]

\[ n = i-1, i-2, x-1, x-2, xess, xed, ius, Y/Y_p, W, r, Dg \]

\[ q = x, S, B. \]

In this notation, \( n \) is the vector of the \( n \) variables in the credit market that are predetermined relative to the complete hypothesis (including lagged values of jointly determined variables \( i \) and \( x \)) and \( q \) is the vector of jointly dependent variables estimated in the first stage regressions.

Fitting equation (58) provides estimates of the reaction of domestic interest rates to changes in the base and provides tests of the money supply hypothesis in that the signs of most of the elasticities to estimated have been predicted in the theoretic derivation of equation (31) in Chapter III above.

Summary results of the estimation of (58) with different

\[ ^1 \text{Note that (58) is identifiable as the four jointly determined variables in the equation (} 1, x, B, \text{ and } S) \text{ is at least equal to the number of pre-determined variables in the model excluded (} T, SGD, \text{ } \tilde{p}, \text{ } Y/Y_f). \text{ See Carl F. Christ, Econometric Methods and Models, John Wiley and Sons (New York: 1966) pp. 326-327 for this formulation of identifiability conditions.} \]
exchange rate expectations proxies and different assumptions about the
endogeneity of the monetary base are given in Table 18. The signs
the credit market elasticities predicted by the hypothesis (see Table
3, Chapter III, p. 83) are noted below each predetermined variable.

In general, the hypothesis is confirmed, although the
relatively low significance levels for several key variables is dis­
appointing. While the presence of a lagged dependent variable on the
right-hand sign makes the normal Durbin-Watson test inappropriate, and
biases the OLS estimates, this bias can be ascertained and the
presence of significant autocorrelation among residuals can be tested
by the large sample test for serial correlation. The hypothesis of
serially correlated residuals is rejected at the 90 percent confidence
level for equations (58e) – (58i). Thus, the coefficients in these
equations will be biased, but this bias is quite small (about 3%)
for the 64 observation sample. Equations (58a) – (58c) show the
results of step-wise estimation with the critical F value for the
covariance of entering variables set at 2.0. Equations (58f) –
(58i) result from forcing (omitting) variables that were not (were)

---

1 J. Johnston, Econometric Methods, 2nd ed., McGraw Hill (New
York: 1972, pp. 311-313).

2 The "t" statistics for e_{t-1} regressed on e_t and all other
endogenous variables were between 1.08 and 1.55 for these equations.

3 Using Johnson's formula E(β̂) = β + 2β/n, op. cit., p. 306.
<table>
<thead>
<tr>
<th>Predetermined Variables</th>
<th>Log Stage Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>5.844 (0.030)</td>
<td>.5158 (0.045)</td>
</tr>
<tr>
<td>5.844 (0.030)</td>
<td>.5158 (0.045)</td>
</tr>
<tr>
<td>5.844 (0.030)</td>
<td>.5158 (0.045)</td>
</tr>
<tr>
<td>5.844 (0.030)</td>
<td>.5158 (0.045)</td>
</tr>
<tr>
<td>5.844 (0.030)</td>
<td>.5158 (0.045)</td>
</tr>
<tr>
<td>5.844 (0.030)</td>
<td>.5158 (0.045)</td>
</tr>
</tbody>
</table>

**Table 10**

Second Stage Estimates of the Bank Credit Market Interest Rate - S/

- Numbers in parentheses represent standard errors.
- Coefficients significantly different from zero are marked with an asterisk (*).
- Ninety-five percent confidence level is denoted with a double asterisk (**).
selected in the step-wise estimation. The U.S. interest rate is the
most important single variable, with an elasticity estimate ranging
from 0.9 when it enters alone (58a) to 0.5 when entered with only lagged
values of the Canadian rate (58c). The latter equation biases the over­
all effect of U.S. rates downward, however, as lagged values of the
Canadian rate were themselves heavily dependent on U.S. rates. With
lagged values of U.S. rates in place of the lagged Canadian rates (58i),
e(i,f) returns to 0.85 although the overall fit of the equation is
reduced considerably.

In addition to the U.S. interest rate, the one quarter lagged
value of the Canadian rate, the term structure of government debt (ST),
and the required reserve ratio (r) are significant with the expected
signs in all equations. The outstanding stock of government securities
(S) and government deposit variables (Dg) are significant in most
equations and have the expected sign in all cases. The second quarter
interest rate lag is not significantly different from zero when other
explanatory variables are added (58f) - (58i), but has the correct sign
and a low standard error of estimate such that it contributes signif­
icantly to the overall fit of the equation in all cases. Furthermore,
it is close to 1-e(i, il), but less than this magnitude such that in­
terest expectations are stabilizing.

The elasticities of interest rates with respect to wealth and
the ratio of current to permanent income are not significantly different
from zero, but the cyclical variable shows a consistently negative coefficient. This is a somewhat puzzling outcome, but probably reflects bank credit supply constraints (the earning asset demand equation had a negative sign) and may result from the banks' use of Canadian Treasury securities to meet secondary reserve requirements which should rise during cyclical upturns.

The interest rate expectations proxies proved to be highly collinear. When entered without expectations proxies derived from the forward market, the lagged exchange rates have the correct sign (58f) and this conclusion holds when the Stein expectations proxy (unadjusted for serial correlation) is entered (58h) although their standard errors rise sharply. The entry of the Stein expectations proxy adjusted for serial correlation causes problems however. While this expectations proxy is highly significant, it reserves the signs of coefficients for $x_1, x_2, x_{ed}, \rho_e, W$, and $\hat{b}$ and reduces the D.W. statistic. While the test for serial correlation with lagged dependent variables still rejects their presence, the lagged error turns sharply from a negative insignificant value to a positive value and the statistical properties of the regression equation become questionable. Since it cannot be conclusively demonstrated that the assumptions necessary for OLS unbiased and consistent estimation are met with this term included, equations (58h) and (58j) are not given more weight in the parameter estimation than the others as would be suggested by their adjusted $R^2$ and F tests.
Figure 15

Second Stage Interest Rate Estimates
The predetermined current exchange rate (x) has the correct sign in all cases and is highly significant when lagged exchange rates are dropped (58k) and (58l). The coefficient on this variable varies considerably, depending on the expectations proxy considered. Given no clear-cut solution as to which proxy is most appropriate, an average is used for the point estimate.

A similar problem exists with the base (B). While it is low and negative in most cases, the high standard error of the base coefficient results in all but (58k) and (58l) being well within the sampling errors of each other. Adding the base as an exogenous variable during the pre-1961 and pre-1962 periods resulted in a significant positive relationship between the base and interest rates and negative relationship between government securities and interest rates. This theoretically (for a short-run hypothesis) unappealing result suggests that, despite the evidence of a first stage shift, the Bank's monetary policy was geared to interest stabilization during the early period and that the endogenous base assumption is necessary for testing. The result also shows the advantages gained by even a simplistic first-stage formulation of Bank behavior. Doubtlessly, a more complex reaction function would remove more of the ambiguity surrounding the base, government securities and exchange rate coefficients.

The minimum, maximum, mean, and a rounded average "best guess" point elasticity for bank credit market responses are listed in Table 18. The rounding to derive point elasticities include a correction (-3%) for the bias introduced by the lagged dependent variable.
Table 19

Summary of Credit Market Interest Elasticity Estimates

<table>
<thead>
<tr>
<th></th>
<th>Maximum</th>
<th>Minimum</th>
<th>Average</th>
<th>Point Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e(i,lf)$</td>
<td>.669</td>
<td>.615</td>
<td>.640</td>
<td>.65</td>
</tr>
<tr>
<td>$e(i,ST)$</td>
<td>-.547</td>
<td>-.649</td>
<td>-.606</td>
<td>-.60</td>
</tr>
<tr>
<td>$e(i,S)$</td>
<td>2.29</td>
<td>1.41</td>
<td>1.84</td>
<td>1.80</td>
</tr>
<tr>
<td>$e(i,r)$</td>
<td>1.06</td>
<td>.938</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>$e(i,Dg)$</td>
<td>-.002</td>
<td>-.103</td>
<td>-.059</td>
<td>-.05</td>
</tr>
<tr>
<td>$e(i,x)$</td>
<td>-1.74</td>
<td>-3.47</td>
<td>-2.34</td>
<td>-2.50</td>
</tr>
<tr>
<td>$e(i,B)$</td>
<td>.913</td>
<td>-1.15</td>
<td>-.224</td>
<td>0</td>
</tr>
<tr>
<td>$e(i,Y/Y_p)$</td>
<td>-.436</td>
<td>-1.95</td>
<td>-1.34</td>
<td>-1.00</td>
</tr>
<tr>
<td>$E(i,p)$</td>
<td>.699</td>
<td>-.739</td>
<td>-.05</td>
<td>0</td>
</tr>
<tr>
<td>$e(i,p)$</td>
<td>.255</td>
<td>-1.53</td>
<td>-.916</td>
<td>0</td>
</tr>
<tr>
<td>$e(i,il)$</td>
<td>.656</td>
<td>.612</td>
<td>.633</td>
<td>.60</td>
</tr>
<tr>
<td>$e(i,i2)$</td>
<td>-.026</td>
<td>-.175</td>
<td>-.111</td>
<td>-.10</td>
</tr>
<tr>
<td>$\beta = e(i,ie)$</td>
<td>.586</td>
<td>.462</td>
<td>.520</td>
<td>.50</td>
</tr>
<tr>
<td>$\alpha = e(ie,il/i2)$</td>
<td>.364</td>
<td>.044</td>
<td>.226</td>
<td>.25</td>
</tr>
<tr>
<td>$e(i,x1)$</td>
<td>2.80</td>
<td>-.638</td>
<td>2.12</td>
<td>0</td>
</tr>
<tr>
<td>$e(i,x2)$</td>
<td>2.16</td>
<td>-.683</td>
<td>-.239</td>
<td>0</td>
</tr>
<tr>
<td>$e(i,xes)$</td>
<td>-.259</td>
<td>-.233</td>
<td>-.246</td>
<td>-.25</td>
</tr>
<tr>
<td>$e(i,xess)$</td>
<td>-.033</td>
<td>-.037</td>
<td>-.035</td>
<td>-.03</td>
</tr>
<tr>
<td>$e(i,xed)$</td>
<td>.009</td>
<td>-.005</td>
<td>-.002</td>
<td>0</td>
</tr>
</tbody>
</table>
The foreign exchange market excess demand equation of Chapter III (33) is converted directly to the log-linear reduced form estimation equation:

\[ \log x = \beta_0 + \sum_{i}^{n} \beta_i \log p_i + \beta_{n+1} x + \beta_{n+2} F + \mu \]

\[ p_i = \text{if, xe, T, Y/Yf, pe, pf} \]

Again, several formulations of exchange rate expectations are used in the variables xes, xess, xed, xl and x2. \(^1\) The estimates from this equation under alternative expectations proxies are listed in Table 20 along with the coefficient signs expected from the hypothesis.

Most of the explanation of exchange rates is provided by the lagged rate itself. Entered alone the lagged rate accounts for 93 percent of the change in the rate, while the current account balance (CA), the exchange rate dummy (xed), foreign interest rates (if) and the jointly determined domestic interest rate (i) and official reserves (\(\hat{F}\)) enter with correct signs but high standard errors but bring the explained variation (\(R^2\)) to nearly 98 percent. Other variables in the hypothetized foreign exchange market equation enter with the expected signs, but are not significant. Somewhat disturbing is the sign and

\(^1\)Note xes and xess, which were calculated as residuals from the forward rate parity equation, take the opposite signs from the others. Positive expectations are negative numbers for these variables and vice-versa.
Table 20

Second Stage Estimate of the Exchange Rate

<p>| | | | | | | | | | | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
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<td>t-2</td>
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significance of the domestic cyclical variable current over permanent income. This is the only real sector variable to have significance and is strongly negative. The negative sign indicates that foreign demand for Canadian assets increase during cyclical high periods sufficiently to offset an increased rate of Canadian savings and diversification out of Canadian assets. However, the relative stage of the business cycle in Canada and the United States \((Y/Y_f)\) is statistically not significant, and a better measure of the relative cyclical position is needed.

On the basis of these preliminary equations, the point estimates of the critical exchange rate elasticities are reported in Table 21.

\begin{table}
\centering
\begin{tabular}{lcc}
\hline
\textbf{Summary of Exchange Market Exchange Rate Elasticity Estimates} \\
\hline
\textbf{e(x,1f)} & .02 \\
\textbf{e(x,i)} & -.02 \\
\textbf{e(x,F)} & +.03 \\
\textbf{e(x,CA)} & -.002 \\
\textbf{e(x,x_1)} & 1.0 \\
\hline
\end{tabular}
\end{table}
Figure 16
Second State Exchange Rate Estimation
(Canadian cents per U.S. dollar)
E. Estimation of the Behavioral Determinants of the Multiplier

The important publicly determined proximate determinants of the money stock, k, s, and t were hypothesized to be dependent on the domestic interest rate and foreign exchange rate in Chapter II, along with foreign interest rates, exchange rate, wealth, income and other variables. With the domestic interest rate and the exchange rate endogenous to the overall hypothesis, consistent estimators for these jointly determined variables are obtained from the first stage estimation procedure in part B of this chapter. 1

The behavioral equation for the currency ratio was posited in Chapter II, equation (14) as:

\[(14) \quad k = k(yd, i, Y/Yp, W, if, x, xe, Qk).\]

To test the assumptions and order conditions underlying this relationship as well as provide estimates of the magnitude of the responses, equation fourteen is assumed to be linear in logs to form the regression model:

\[(60) \quad \ln k = \beta_0 + \beta_1 \ln i + \beta_2 \ln(Y/Y_p) + \ldots + \beta_n Q_{kn} + u.\]

The deposit yield was dropped from the regression model as no data on changes in the yield on demand deposits is directly available. This

---
1Alternatively, estimators \( \hat{i} \) and \( \hat{x} \) derived from second stage estimation of the bank credit and foreign exchange markets in part C could be used. Preliminary runs using these estimators found them to be slightly less efficient (producing lower R^2s and higher standard errors on the coefficients) than those taken from the first stage.
yield, comprised of the convenience of using check transfer plus other services made available by banks to depositors minus service charges is in principle subject to bank discretion. In practice, prior to 1967, there is no evidence available that banks attempted to adjust this yield and, while the 1967 Bank Act attempted to increase price competition between banks by prohibiting collusion in the setting of changes, data to indicate a change in bank behavior is still unavai-

1Competitive banks would be expected to raise the deposit yield when the yield on their earning assets increase. In Canada no explicit interest was paid on non-personal demand deposits to other than governmental units over the period, however, service charges are officially subject to the agreement of the depositor and could be altered to reflect their profitability.

2The reduction in the total response of the currency ratio to changes in the interest rate is derived from differentiation of the log form of the currency ratio definition, equation (6);

\[ \log k = \log Cp - \log Dd, \]

where currency and deposits are functions of the interest rate and the deposit yield is a function of interest rates. In elasticity form:

\[ \bar{e}(k,i) = e(Cp,i) + e(Cp,\text{yd})\cdot e(\text{yd},i) - e(Dd,i) + e(Dd,\text{yd})\cdot e(\text{yd},i), \]

where \( \bar{e} \) denotes the total elasticity and the price theoretic sign of each term is indicated below. Whatever the overall sign of \( e(k,i) \), increases in \( e(\text{yd},i) \) serve to reduce the (positive) first bracketed term and increase the (negative) second bracketed term, to reduce the total elasticity.
quite insignificant in all tests, indicating that no effective increase in competition for demand deposits resulted from the Bank Act change.

The three month Treasury bill tender yield (i) is used to summarize the level of bank credit interest rates, while the average term to maturity of Government of Canada direct and guaranteed securities (ST) serves to summarize the term structure of interest rates in the bank credit market. The longer the term to maturity of government debt, the higher will be long-term yields relative to short-term yields and the short-term Treasury bill rate will be downward biased proxy of domestic credit market rates. Thus the average term to maturity variable should have the opposite sign to that of the interest rate proxy in behavioral equations dependent on the credit market interest rate sector. The average term to maturity is an exogenous Government policy variable.

The three-month U.S. Treasury bill yield serves as a proxy for foreign interest rates. The exchange rate is expressed as Canadian cents per U.S. dollar. The exchange rate expectations proxies are the lagged values of the exchange rates (x1) and (x2), proxies derived from the relationship between the forward and spot exchange markets (xes, and xess), and a dummy variable (xed: -1, 0, +1) for periods

1 The average term to maturity measure has been successfully utilized in a number of studies of the Canadian credit market to account for the term structure of Canadian interest rates, eg. Courchene and Kelly, "Money Supply," p. 232; Officer, An Econometric Model of Canada, pp. 88-89. This is necessitated primarily by the 1958 Conversion Loan in which a massive refunding of Canadian debt increased the average term to maturity from 6 1/4 years to over 10 years in less than six months.
when reports of anticipated rate changes were found in the literature. It should be noted that an insignificant response for any or all of the particular expectations proxies does not logically disconfirm either the postulated behavioral response or discriminate between the alternative proxies. However, repeated significant response of one particular proxy in different behavioral equations is confirming evidence for both.

The results of the alternative specifications of the regression equation (60) used to estimate the elasticities of the currency ratio response are summarized in Table 22, along with the signs predicted by the hypothesis. Except for the quarterly dummies, all variables are in natural logs so the regression coefficients are the elasticity estimates. The percentage of variation explained (R^2) adjusted for degrees of freedom and Durbin-Watson statistic (D.W.) are indicated in the last columns. The standard errors of the regression coefficient is reported in parentheses.

Stepwise regression selected the domestic interest rate (i) as the most significant single explanatory variable, and this variable along with the term structure proxy (ST) the ratio of current to permanent income (Y/Y_p), and the exchange rate (x) explain about 70 percent of the variation in the currency ratio while reducing serial correlation of the residuals sufficiently to bring the Durbin-Watson statistic into the high indeterminate range (60a), (60b).

---

1 Details of the derivations and construction of these expectations proxies are given in Appendix A.
Table 22

Second Stage Estimates of the Currency Ratio

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<th>Q3</th>
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\* Standard errors of coefficients in parenthesis; coefficients significantly different from zero at the 95 percent confidence level denoted by *. 

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These variables all have the expected signs and remain significant and stable in other specifications of the equation. No test of the hypothesis that $e(k,x)$ falls or becomes positive during periods when the rate moves above 1.0 was possible owing to constraints data manipulation. Forcing the entry of other variables in the hypothesis generally resulted in a worse fit. The U.S. interest rate, for example, has the wrong sign, its coefficient is not significantly different from zero, and it increases the coefficient and the standard error of the coefficient on the domestic interest rate (60c) - (60g). This indicates that multicollinearity between the interest rates are biasing both upward in absolute terms, that $e(k,if)$ is zero and $e(k,i)$ about 0.08. Alternatively, the U.S. rate may be picking up an additional bias in the domestic credit market proxy. In this case, $e(k,if)$ would still be zero, but $e(k,i)$ about 0.10. In the remaining empirical estimates a 0.9 compromise is used.

None of the exchange rate expectations variables is significant and xed and xess (60f) have the incorrect sign. The lagged exchange rate (xl) picks up part of the effect of the current rate and results in a positive but insignificant coefficient on the latter (60d). This suggests that there may be some delays in the adjustment of the desired currency ratio to the exchange rate, but when entered alone (xl) was less important than $\hat{\alpha}$.

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1Other Canadian interest rates are more closely correlated with U.S. rates than is the Canadian Treasury bill rate over the portions of the study period for which both are available.
Quarterly dummies resulted in a better $R^2$, but lowered the D.W. statistic (60g and 60h). Despite the potential of bias resulting from serial correlation among error terms, the coefficients remain within their 95 percent confidence on the acceptable regressions and the quarterly dummies are retained in the "best" estimates equation (60h) for further work.

The currency ratio estimates from (60h) are plotted on Figure 17. In general, the estimated ratio tracks the major swings in the actual ratio well although it underestimates the troughs and peaks. As these swings in the currency ratio coincide quite closely with interest rate cycles (See Figure 15, p. above), there is some evidence that the interest rate response is being underestimated in (60h).
Figure 17

Currency Ratio Estimates
The desired volume of the savings deposit ratio was specified in Chapter II above as:

\[ s = s(ys, yd, i, Y/Y_p, W, if, xe, Qs) \] where
\[ s_1 > 0 > s_2, s_3 > 0 > s_4, s_5 > 0 > s_6, s_7 > 0. \]

This function was also assumed to take the log-linear form for estimation purposes:

\[ s = \beta_0 \cdot is^\beta_1 \cdot (isn)^\beta_2 \cdot i^{\beta_3} \cdot Y/Y_p^{\beta_4} \cdots Qs, \]

which was transformed into the test equation:

\[ \ln(s) = \beta_0 + \beta_1 \ln(is) + \beta_2 \ln(isn) + \cdots + \beta_n Qs. \]

With \( yd \) totally without an empirical counterpart and \( ys \) only observable in part, the hypothesized response of \( s \) to domestic and foreign interest rates is quite complex. Recall from Chapter II

\[ \tilde{e}(s, i) = e(D_s, i) + e(D_s, ys)e(ys, i) - e(D_d, i) \] with \( e(D_s, ys)e(ys, i) \) approaching 0 prior to 1967 such that \( \tilde{e}(s, i) = e(D_s, i) - e(D_d, i) \). With both terms on the right negative, the overall sign is governed by the order condition,

\[ |e(D_d, i)| > |e(D_s, i)|, \]

such that the savings deposit ratio is expected to be positively related to domestic interest rates prior to 1967. With \( e(ys, i) \) increasing after the 1967 Bank Act Change, this positive response should increase after
1967 as the term $e(Ds,ys).e(ys,i)$ is also positive.

Similarly, we expect demand deposits to be more sensitive to foreign interest rates, exchange rates and exchange rate expectations such that:

$$e(s,if), e(s,xe) > 0 > e(s,x)$$

Again, we expect these elasticities to have increased following the 1967 Bank Act change, although the increase may be relatively minor.

With the savings deposit ratio positively related to domestic credit market rates, it should be negatively related to the term structure which captures the bias in the Treasury bill rate as a proxy for all credit market rates.

Regression results of alternative specifications of the savings deposit ratio equation for the entire period are presented in Table 23. Again, all variables except the quarterly and expectations dummies are in logarithmic form. The domestic interest rate ($i$), the term structure ($ST$), the ratio of current to permanent income, ($Y/Y_p$) and wealth ($W$) are significant at the 95 percent level, in all test equations and have the expected signs. These variables alone explain over 90 percent of the variation in $s$ (61a). The Durbin-Watson test for autocorrelation of residuals places this equation in the lower end of the indeterminate range at a 5 percent significance level, but rejects the hypothesis of serial correlation at the 10 percent significance level.

Given the high degree of correlation between $s$ and wealth, the problem inherent in the construction of the wealth proxy (permanent income), and the growth over time in both wealth and the savings
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<td>(.292)</td>
<td>(.073)</td>
<td>(.013)</td>
<td>(.031)</td>
<td>(.034)</td>
<td>(.137)</td>
<td>(.110)</td>
<td>(.088)</td>
<td>(.199)</td>
<td>(.042)</td>
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<tr>
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<td>-.144*</td>
<td>.236*</td>
<td>.003</td>
<td>.013</td>
<td>-.006</td>
<td>-.222*</td>
<td>.017*</td>
<td>.033</td>
<td>.161</td>
<td>-.138</td>
<td>.073*</td>
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<td>(.038)</td>
<td>(.238)</td>
<td>(.060)</td>
<td>(.011)</td>
<td>(.042)</td>
<td>(.027)</td>
<td>(.111)</td>
<td>(.003)</td>
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<td>(.071)</td>
<td>(.161)</td>
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<td>-.136*</td>
<td>.204*</td>
<td></td>
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<td>.280</td>
<td>.183*</td>
<td>.078*</td>
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<td>(.041)</td>
<td>(.247)</td>
<td>(.028)</td>
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<td>(.112)</td>
<td>(.069)</td>
<td>(.020)</td>
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</table>

*Standard error of estimates in parenthesis; coefficients significantly different from zero at .95 percent confidence level marked *. 

deposit ratio, a trend dummy variable was substituted for wealth in equation 61a. Although the time trend was significantly positive, it was inferior to wealth by itself and, when entered together with wealth, the trend variable was insignificant. Thus, the wealth proxy captures a factor other than time operating to increase savings deposits relative to demand deposits, and is a significant explanatory variable in its own right despite the rather crude measurement technique.

The foreign exchange rate ($\bar{x}$) was insignificant at the 95 percent confidence level in all cases and has the incorrect sign unless entered with the savings deposit yield proxies. The only significant expectations proxies were $x_{ek}$ and $x_{ess}$, differences between the market forward exchange rate and the interest parity exchange rate. This response was positive and (barely) significant at the 95 percent confidence level in equation (61b) but significantly positive in the remaining cases. The entry of $\bar{x}$ and $x_e$ do, however, improve the overall explanatory power of the equation—as measured by an F test on the adjusted correlation coefficient—and result in a sharp reduction in autocorrelation among residuals suggesting that they are at least capturing the effects of a significant missing explanatory variable.

The U.S. interest rate was insignificant in all cases and has the incorrect sign most of the time.

The interest rate on ordinary savings deposit (is) was positively related to the savings deposit ratio but insignificant. The rate on special (non-checkable) savings deposits, available only after mid-1967, was also positively related, but its elasticity not significantly different from zero unless entered in conjunction with the 1967 shift dummy when it becomes significant above the 90 percent confidence level. With the yield on savings deposits also in the equation, the coefficient on the domestic interest rate becomes the partial elasticity $e(s,i)$ rather than the total $\hat{e}(s,i)$, but the drop in its magnitude—from .088 in (61a) to .078 in (61b) for example—is not significant. This result is not surprising given the relatively low response of the savings deposit ratio to the savings deposit yield (at most 0.18) and a lack of correlation between the savings deposit yield and current domestic interest rates.\footnote{Regression of isn on the Treasury bill rate, the business cycle variable, the term structure and foreign interest rates produced no significant coefficients. A two quarter lag of the Treasury bill rate was however significant. It thus appears that chartered banks did not seek these deposits actively by offering currently competitive rates even after the Bank Act reform. This behavior may be reasonable given the low estimated response of savings deposits to own yield, but without a more fully specified model of bank behavior it remains a tentative explanation.}

Equation (61a) was run over three sub-periods to test the hypothesis that $\hat{e}(s,i)$ increased over time. The equation deteriorated

<table>
<thead>
<tr>
<th>Period</th>
<th>$\hat{e}(s,i)$</th>
<th>$e(s,Yr)$</th>
<th>$e(s,W)$</th>
<th>$R^2$</th>
<th>D.W.</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1/55 - Q2/60</td>
<td>.046*</td>
<td>-.44</td>
<td>.392*</td>
<td>.756</td>
<td>2.05</td>
<td>20.60</td>
</tr>
<tr>
<td>Q2/60 - Q3/65</td>
<td>.040</td>
<td>-1.74</td>
<td>.154</td>
<td>.1596</td>
<td>2.67</td>
<td>2.09</td>
</tr>
<tr>
<td>Q4/65 - Q4/70</td>
<td>.049*</td>
<td>-26</td>
<td>.441</td>
<td>.9117</td>
<td>1.85</td>
<td>50.02</td>
</tr>
</tbody>
</table>
in the middle sub-period when the only significant variable accounting for changes in s was a seasonal factor. However, the equation was significant in both the beginning and end period and showed no significant increase in \( \bar{e}(s,i) \). We thus reject the hypothesis that this response rose over time. While savings deposits may have become more sensitive to interest rates, so it would appear did demand deposits. As a result, no shift in the savings deposit ratio response is discernible over time.

The quarterly dummies again resulted in a sharp increase in serial correlation of residuals with only the fourth quarter dummy showing a "t statistic" greater than 2.0. Thus, although the inclusion of Q4 invalidates confidence tests for coefficients by increasing sampling error, the relatively minor changes in the other coefficients that were significant in previous equations results in the "best filling" equation being (61g) which "explains" over 95 percent of the variation in s (the unadjusted \( R^2 \) is .9678).

The actual and estimated (61g) values of the savings deposit ratio are plotted on Figure 18 with residuals from the estimation equation on Figure 19. The former clearly shows the highly seasonal pattern of s, with a sharp drop in the fourth quarter, doubtlessly a result of savings rundowns and demand deposit buildup owing to the holiday season which is not fully reflected in interest rate or real activity changes. A substantial over-estimation of the savings deposit ratio from Q3/66 through Q4/67 is also shown on this chart and in
Figure 18

Savings Deposit Ratio Estimates
Figure 19

Savings Deposit Residuals
(actual minus estimates)
Figure 19. As this period coincides with the 6 percent ceiling on the banks' Canadian dollar loans, it appears not to have been in the banks' interest to compete aggressively for savings deposits. Thus, when the 1967 Bank Act became effective in July 1967, the banks responded by introducing "special" savings deposits (non-checkable) in order to reduce their overall reserve requirements by shifting depositors out of checkable savings deposits, but did not attempt to build up aggregate savings deposits until their lending rate ceiling was raised in 1968. This pattern of residuals suggests a lower response of the savings deposit ratio to interest rates during the lending rate ceiling period, but the proposition cannot be tested directly owing to the lack of data on deposit yields.

In summary, the estimation of (61) generally supports the hypothesis developed in Chapter II with regard to the sign of the domestic interest rate, wealth and current income. Foreign interest rates, the exchange rate, and exchange rate expectations have the expected signs, but are not significantly different from zero. Contrary to the hypothesis, however, no evidence of an increase in the response of the savings deposit ratio was found over time. And, while residual plots of the estimation equation shows signs of a reduction in $\delta(s,i)$ during high interest rate periods when bank lending rates are constrained, no estimation of the magnitude of this non-linearity was possible.
The time deposit ratio was specified in Chapter II as:

\[ t = (y_t, y_d, i, Y/Y_p, W, i_f, x, x_e, Q_t). \]

The yield on demand deposits is not observable, assumed to be constant and not considered in the empirical section. The posted yield on term deposits \((i_t)\) is available as a proxy for \(y_t\) from Q1/1960 on, but does not fully account for actual rates paid.

The presence of a non-linear relationship between \(y_t\) and domestic credit market rates \((i)\) in the hypothesis presents a problem for linear estimation techniques. It was posited that early in the period and during periods when "moral suasion" was used to reduce interest rates, this relationship would not be strong such that

\[ \hat{e}(t,i) = e(t,i) + e(t,y_t) e(y_t,i) \]

would be dominated by the first term and negative. Following the 1967 Bank Act changes the second term are expected to dominate and the overall response of the term deposit ratio to domestic interest rates would be positive. Short of building a structural model of the Canadian banking industry, there is no way to identify a consistent linear or log-linear relationship here and one test of the hypothesis is that the residual errors show up where expected and that dummy shift variables are significant. A second test of the hypothesis is that the coefficients on variables

\[ 1 \] This need not arise from collusion among banks on deposit rates, but would result from non-competitive lending rates as well as banks would attempt to increase the proportion of foreign currency assets and liabilities when Canadian rates are held below market levels by paying less for deposits.
expected to be related to "it" through banks' behavior should shift in a predictable way when "it" enters the estimation equation; e(t,i), e(t,if), e(t,xe) should decline while e(t,St) and e(t,x) should rise. Finally, an instrument variable it can be constructed using the two stage estimation. While the model was not specifically constructed to explain all aspects of banking behavior, the exogenous variable set includes most terms that would reasonably enter the banks' behavioral decisions and will provide an unbiased instrument with regards to other variables in the equation. The estimation equation for t again is log linear:

(62) \[ \log t = \beta_0 + \beta_1 \log \text{ST} + \ldots, \ldots, \]

with the expected signs and estimated coefficients reported in Table 24.

Estimation results for the term deposit ratio were not particularly satisfactory owing to autocorrelation among residuals. For the period as a whole (62a) and 62b), Y/Yp,W, \( \hat{\beta} \) and \( \hat{x} \) were significant and had the expected signs but the extremely low D.W. statistic indicates that the standard errors of the coefficients may be underestimated. Adding the dummy variables for structural shifts in 1957 and 1967 improves the situation somewhat and both have the expected sign although only D67 is significant. Re-estimating this equation over the 1961-1971 sub-period results in a marked reduction in the estimate of \( \bar{e}(t,i) \) as expected with the new coefficient lying outside the standard error of the
Table 24
Second Stage Estimates of Term Deposit Ratio

<table>
<thead>
<tr>
<th>Period</th>
<th>ST</th>
<th>Y/Yp</th>
<th>W</th>
<th>xe</th>
<th>1f</th>
<th>1t</th>
<th>D57</th>
<th>D67</th>
<th>*</th>
<th>*</th>
<th>*</th>
<th>D.W.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q1/55-04/70</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>62a</td>
<td>-.064</td>
<td>2.37*</td>
<td>1.76*</td>
<td>-.041</td>
<td>.026</td>
<td>-.281*</td>
<td>.226*</td>
<td>.9882</td>
<td>.6414</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>(.119)</td>
<td>(.943)</td>
<td>(.553)</td>
<td>(.037)</td>
<td>(.152)</td>
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<td>(.943)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>62b</td>
<td>.133</td>
<td>2.76*</td>
<td>1.53*</td>
<td>.040</td>
<td>.038</td>
<td>.001</td>
<td>.217*</td>
<td>-.295*</td>
<td>2.87*</td>
<td>.9618</td>
<td>.7819</td>
<td></td>
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<tr>
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<td>(.953)</td>
<td>(.215)</td>
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<td>(.161)</td>
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<td>(.086)</td>
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<td>Q1/61-04/70</td>
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<tr>
<td>62c</td>
<td>.920*</td>
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<td>1.89*</td>
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<td>.241*</td>
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<td>1.79*</td>
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<td>.041</td>
<td>513*</td>
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<tr>
<td>62f</td>
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<td>4.51*</td>
<td>1.42*</td>
<td>933*</td>
<td>.091</td>
<td>-.169*</td>
<td>1.79*</td>
<td>-.481*</td>
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<td>(.44)</td>
<td>(4.18)</td>
<td>(.424)</td>
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<td>.639</td>
<td>.191*</td>
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<td>-.037</td>
<td>-.122</td>
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<td>(.412)</td>
<td>(.063)</td>
<td>(.130)</td>
<td>(.064)</td>
<td>(.131)</td>
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</table>
old (but not outside the range of the joint standard error and this range may be understated in any event). This reduction in the negative response $e(t,i)$ was expected (See page 46, Chapter II).

Adding the notice deposit interest rate, (62d) improves the equation modestly, it has the expected sign, $e(t,it) > 0$, and the domestic rate, now the partial elasticity $e(t,i)$, rises and becomes significant.

Dropping the exchange rate variables, whose coefficients are insignificant, reduces autocorrelation further and raises the coefficients on the term deposit rate and lowers that on domestic interest rates (62e). Equation (62f) decomposes the term deposit rate into its difference from the domestic and foreign rate. Since we expect multicollinearity between the notice deposit rate and other interest rates, this should not improve the fit on the equation. The larger (and significant) coefficient on the foreign rate difference suggest foreign currency deposits (or other assets whose yields are more closely related to foreign rates) are closer substitutes for Canadian notice deposits than are Canadian Treasury Bills, but with the rise in the term structure variable coefficient indicates that these alternatives extend into the domestic credit market.

The attempt to account for the joint dependence of "it" and
by using the first stage regressor \( \hat{t} \), equation (62g) was not particularly successful as the instrument \( \hat{t} \) became insignificant and autocorrelation increased. Nevertheless, the coefficients are similar in sign and magnitude to those estimated directly.

In addition to the direct estimates of \( \tilde{e}(t,i) \) in equations (62a), (62b) and (62c), this response can be calculated indirectly by utilizing estimates for the partial elasticities derived from independent estimation of the equation;

\[
(63) \quad \bar{t} = f(i, i, ST, Y/Y_p, D67),
\]

for \( e(it,i) \) and from the first stage estimates for \( e(it,ius), e(it,ST), \) and \( (it,Y/Y_p) \). Estimation of (63) yielded:

\[
(63a) \quad \ln(\bar{t}) = 5.61 + 0.61 \ln(\hat{i}) -0.22 \ln(ius) + 1.06 \ln(Y/Y_p) \\
(3.1) \quad (.096) \quad (.151) \quad (.909) R^2 \quad .9447 \\
-10.57 \ln(ST) -0.76 \ln(\hat{x}) + 0.13 D67 \\
(.244) \quad (.130) \quad DW \quad 1.5426
\]

The statistically significant coefficients:

\[
e(it,\hat{i}) = .60 \\
e(it,ius) = -.20 \\
e(it,ST) = -.57
\]

are combined with the partials \( e(t,i) \) and \( e(t,it) \) estimated from (62d - (62a) in the form,

\[
\bar{e}(t,i) = e(t,i) + e(t,it) e(it,i),
\]
to give alternative estimates for the total response of the term deposit ratio to those in (62a), (62b) and (62c).

Total elasticities calculated in this manner yield:

<table>
<thead>
<tr>
<th></th>
<th>$\bar{e}(t,i)$</th>
<th>$e(t,if)$</th>
<th>$e(t,ST)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>62d</td>
<td>-.12</td>
<td>-.059</td>
<td>.87</td>
</tr>
<tr>
<td>62e</td>
<td>-.10</td>
<td>-.431</td>
<td>.83</td>
</tr>
<tr>
<td>62f</td>
<td>-.12</td>
<td>-.021</td>
<td>.87</td>
</tr>
</tbody>
</table>

While the response for $\bar{e}(t,i)$ and $\bar{e}(t,ST)$ are consistent with those calculated directly, those for $e(t,ius)$ are quite variable indicating that the coefficient is not identifiably different from zero on average although it has the expected sign.

No attempt to estimate (62) for the 1955 - 1960 period was successful, as seen by (62h). Nearly all coefficients have the wrong sign and only 40 percent of the variation is explained. In part, the lack of any available term deposit yield in this period may account for this poor fit. Thus, while the larger negative coefficient on interest rates for the estimation of (62) over the entire period (62a and 62b) than over the 1961 - 1970 sub-period suggests an increased sensitivity of deposit yields to credit market rates over time in support of the hypothesis, it appears more reasonable to assume that the average elasticity was not different from its later value during the early period.
The average estimated response of the term deposit ratio are approximated as:

\[
\begin{align*}
\bar{e}(t, i) &= -0.10 \\
\bar{e}(t, if) &= 0 \\
e(t, ST) &= 0.85 \\
e(t, Y/Y_p) &= 4.50 \\
e(t, W) &= 2.00 \\
e(t, x) &= 0 \\
e(t, xe) &= 0 \\
e(t, it) &= 0.6
\end{align*}
\]

These average estimates would, however, be modified, if the chartered reaction to a change in domestic or foreign interest rates were known. If banks would match a percentage increase in domestic rates with a percentage change in term deposit rates:

\[
\bar{e}(t, i) = e(t, i) + e(t, it) \approx 0.2
\]

If on the other hand, chartered banks did not respond at all, the response of \( t \) to changes in those rates, would be given by the partial responses:

\[
\bar{e}(t, i) = e(t, i) \approx -0.5
\]

Thus, the estimations put limits on the magnitude of the response of \( t \) to domestic interest rates, but to evaluate this response within these ranges more information is needed on the price setting behavior of the banks:

\[-0.5 < \bar{e}(t, i) < 0.2\]

\(^1\text{The use of moral suasion by the Bank of Canada may make this response a policy variable under ideal conditions.}\)
For simulation in the next section, the average response (62e) was used so that the error term is larger than would be the case with this additional information.

Comparison of the estimated and actual term deposit ratio, Figure 20, and the estimation residuals, Figure 21, reveals several instances of this non-linear response in the term of deposit ratio. The overestimation in Q1 and Q2 1966 came as credit market rates rose, but banks did not respond by raising deposit rates owing to a 6 percent limit on their lending rates imposed by the Bank of Canada. ¹ This ceiling was retained through 1967 and banks' response to the Bank Act revisions at mid-year were delayed so that t was overestimated again in late 1967. When the lending rate limit was dropped, banks began competing more aggressively for term funds and deposit yields rose more than usual in response to the early 1968 interest rate rise. Similarly, the deposit yield appears not to have been reduced during the 1968 credit market interest rate declines in late 1968 as the estimation equation continues to underpredict through the year.

Most striking, however, is the over-prediction of the equation in late 1969 and 1970 following the Bank of Canada's "request" that the chartered banks "compete less aggressively for large blocks of

¹ The earlier underestimation (Q2-Q3/66) resulted from the failure of the Atlantic Acceptance Corporation in June of that year and a shift in the supply of deposits to banks as a result of increased risk perceived at non-bank financial intermediaries.
Figure 20

Term Deposit Ratio Estimates
Figure 21
Term Deposit Residuals
(actual minus estimate)
Canadian dollar short-term deposits.\textsuperscript{1} This over-prediction holds over both the Q3 and Q4 rise in interest rates as banks did not respond to the upswing, $e(y_{t,i}) \to 1$, in complying with the Bank of Canada's request.

The reserve ratio was specified in Chapter II as

\begin{equation}
    r = rr + re,
\end{equation}

with the assumptions that \( re = 0 \) with rapid adjustment and further simplifying assumptions that:

\begin{equation}
    rr = rs \text{ prior to Q3/67 and}
\end{equation}

\begin{equation}
    rr = rsd \delta + rst(1-\delta) \text{ thereafter},
\end{equation}

where \( rs \) is the eight percent statutory reserve requirement on total deposits prior to Q3/67, \( rsd \) the twelve percent requirement on demand deposits, and \( rst \) the four percent requirement on term and notice deposits. \( \delta \) is the proportion of total deposits subject to each requirement.

\[
\delta = \frac{Dd + Dg}{D} = \frac{1 + g}{1 + s + t}
\]

To derive the linear approximation of the hypothesis' estimates for the reserve ratio, \( \hat{\delta} \) is calculated using estimated values of \( \hat{s} \) and \( \hat{t} \) from (61) and (62) above, then \( \hat{rr} \) is calculated using \( \hat{\delta} \) in (20) and (20a), and finally a linear regression equation,

\begin{equation}
    \hat{r} = \beta + \beta_1 \hat{rr} + \mu,
\end{equation}

is used to test the propositions that \( re \) is random with a mean zero.
by checking the overall fit of the equation and testing for $\beta_0 = 0$ and $\beta_1 = 1$. Estimation of (63) yielded:

\[(63a) \quad \hat{r} = .003 + .978 \hat{rr} \quad \hat{R}^2 = .9240 \quad F(1, 62) = 766.44 \quad D.W. = 1.1718\]

Despite the high $R^2$, this is not an impressive fit as the low D.W. statistic indicates missing explanatory variables. A review of the residuals revealed a particular deterioration after 1967 and indeed estimating (63) over the Q3/67 - Q4/70 period resulted in:

\[(63b) \quad \hat{r} = -.133 + .993 \hat{rr} \quad \hat{R}^2 = .4341 \quad F(1, 13) = 11.74 \quad D.W. = 0.9828\]

This suggests a problem with $\delta$, and indeed, a comparison of the actual statutory reserve ratio $rr$ and that calculated from $\hat{\delta}$ times the reserve requirements show a similar lack of correlation ($R^2 = .5109$). A major source of this error is a mis-specification of $\delta$. In fact, the lower reserve requirements apply to non-checkable savings deposits as well as term deposits. Subsequent to the 1967 Bank Act revision, chartered banks made a strong and successful effort to switch depositors to the non-checkable deposits. As a result, while $s$, the ratio of total savings deposits to demand deposits, showed little change, the proportion of $s$ reservable at the lower rate rose. As the hypothesis in its present form marks no provision for independent estimation of the non-checkable component, an accurate formulation of $\delta$ is not testable.
Estimating (63) with the actual reserve ratio yields:

\[
\hat{r} = -0.001 + 1.04 \text{ rr} \\
(0.002) \quad (0.020) \\
\hat{R}^2 = 0.9764 \\
F(1, 62) = 2606.9 \\
\text{D.W.} = 1.3082
\]

While this equation still retains a D.W. statistic in the indeterminant range, the residuals show the problem lies in the early part of the period while banks were learning to deal with lagged reserve requirements. As a result of the mis-specification of \( \delta \) in the hypothesis, \text{rr} will be used as the estimated \( \hat{r} \) in remaining empirical work. The estimated values of \( \hat{r} \) using \( \hat{r} \) and \text{rr} along with the actual values of \( r \) are plotted in Figure 22.
Figure 22

Reserve Ratio Estimates
F. Estimation of the Money Supply Equations

The total response of the money multipliers to the variables determining the short-run equilibrium values of the ratios \( k, s, \) and \( t \) is given by the product of the response of the multiplier to the determinant and the response of the determinant to the predetermined variable:

\[
e(m_j, n) = e(m_j, k)e(k, n) + e(m_j, s)e(s, n) + e(m_j, t)e(t, n)
\]

where \( j = 1 \) to \( 3 \), the three definitions of money, and \( n = i, Y/Y_p, W, if, x, \ldots, \) the predetermined (relative to the money supply equations) variables upon which \( k, s, \) and \( t \) depend.

Since the savings and term deposit ratios enter \( m_1, m_2, \) and \( m_3 \) with different signs, the response of the three definitions of money to the \( n \) predetermined variables will vary depending on the signs and relative magnitude of the component elasticities. In addition to having different signs, the responses of the multipliers to the proximate determinants change over time as the proportions of the three deposit classes, currency, and reserves to total deposits change. As a consequence, the supply equations are non-linear both because of non-linearities in the response of the ratios to the \( n \) predetermined variables, and because of changes in the response of money to these proximate determinants. The latter non-linearities are relatively important, with the standard deviations of the responses \( e(m_j, k), e(m_j, s) \) and \( e(m_j, t) \) over time generally well above the standard errors.
of the residuals in the estimation equations for \( \hat{k} \), \( \hat{s} \), and \( \hat{t} \) as shown in Table 25.

Table 25

<table>
<thead>
<tr>
<th></th>
<th>( k )</th>
<th>( s )</th>
<th>( t )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( m_1 )</td>
<td>.795</td>
<td>.023</td>
<td>.257</td>
</tr>
<tr>
<td>( m_2 )</td>
<td>.795</td>
<td>1.183</td>
<td>.257</td>
</tr>
<tr>
<td>( m_3 )</td>
<td>.840</td>
<td>.457</td>
<td>.369</td>
</tr>
</tbody>
</table>

\( a/ \) Ratios of standard deviation of \( e(m_j,k) \), \( e(m_j,s) \) and \( e(m_j,t) \) over time to stand errors of residuals in regression equations 60d, 61g and 62g.

To account for these non-linearities over time, the estimated responses for the multipliers of the three definitions of money to the predetermined variables are given in Table 26, for 1955, 1962 and 1970 and plotted in Figure 23. The responses of all three multipliers to the domestic interest rate remained nearly constant over time when estimated at the average elasticity of the term and savings deposit ratios. The multipliers \( m_1 \) and \( m_3 \) respond negatively to an increase in domestic interest rates while \( m_2 \) reacts positively after 1962, but the latter response is small. However, when the non-linearity of the term deposit ratio is allowed for, the maximum and minimum response, depending on the response of term deposit rates to the domestic credit market rate, widens sharply over

\( 1 \) Quarterly estimates of all responses are appended.
Table 26

Summary Estimated Response Pattern for the Money Multipliers

<table>
<thead>
<tr>
<th></th>
<th>m1</th>
<th>m2</th>
<th>m3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( e(m_j, i) )</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. ( e(it, i) = 1 )</td>
<td>-.05</td>
<td>-.04</td>
<td>-.04</td>
</tr>
<tr>
<td>b. ( e(it, i) = 0 )</td>
<td>-.05</td>
<td>-.05</td>
<td>-.06</td>
</tr>
<tr>
<td>( e(m_j, Y/Y_p) )</td>
<td>.62</td>
<td>.57</td>
<td>.44</td>
</tr>
<tr>
<td>( e(m_j, W) )</td>
<td>-.10</td>
<td>-.11</td>
<td>-.17</td>
</tr>
<tr>
<td>( e(m_j, x) )</td>
<td>.05</td>
<td>.05</td>
<td>.05</td>
</tr>
</tbody>
</table>
Figure 23

Estimated Responses of the Money Multiplier with respect to Predetermined Variables over Time

A
E(m₃, l)

B
E(m₁, l), E(m₂, l)

C
E(mⱼ, Y/Y_p)

D
E(mⱼ, W)
time. Thus, with term deposits relatively unimportant in 1955 it made little difference in the short-run how banks adjusted this yield. But, by 1960, the responsiveness of the term deposit yield is important enough to completely change the signs of \( e(m2,i) \).\(^1\) With banks actively competing for term deposits, \( e(it,i) \Rightarrow 1 \), a one percent increase in domestic rates will reduce \( m2 \) by about .01 percent and \( m3 \) by about .01 percent, whereas if banks do not match other credit market rates, \( m3 \) will decline by about .06 percent and \( m2 \) will rise about .03 percent. Even \( m1 \) is quite sensitive to this non-linearity; by 1970, the elasticity of \( e(m1,i) \) varies between \(-.06\) and \(-.02\) as \( e(it,t) \) goes from one to zero. These estimates tend to understate the non-linearity in \( m1 \) and \( m3 \) and overstate that in \( m2 \) to the extent that no estimate of the bias in \( e(s,i) \) during periods of constraints on deposit yields was possible. With \( e(m1,s) < 0 < e(m2,s), e(m3,s) \), this bias would offset the reductions in \( e(t,i) \) during periods of constraint in \( e(m1,i) \) and \( e(m3,i) \), while reinforcing this reduction in \( e(m2,i) \).

The estimated elasticities also show considerable algebraic decline in the responsiveness of \( m1 \) to the cyclical variable \((Y/Y_p)\) over time, from .62 percent to .44 percent, and in \( m2 \) from a -.09 percent to -.38. These declines are countered by an increase in the response of \( m3 \) to the cyclical term, from an elasticity of .37 in 1955 to over .6 by 1970.

\(^1\)Term deposits ("Other Notice Deposits") were less than 5 percent of total deposits at year-end 1955 as compared with more than 15 percent by end-1970 (Non-personal Term and Notice Deposits").
The overall response of the money supply to a change in the base can now be evaluated by combining the direct effect of a change in the base—a unitary elasticity in the multiplicative money supply equations—with the indirect effect working through the multiplier as the change in the base alters the short-run equilibrium values of the domestic interest and foreign exchange rates in the bank credit and foreign exchange markets. This indirect effect will not be independent of the source of the change in the base. An increase in the base brought about by a pure open market purchase of government securities, for instance, will have a greater impact on interest rates than one brought about by a shift in government deposits simply because the former reduces the outstanding stock of securities and shifts the demand for bank credit as well as its supply.

From the extended source definition of the monetary base in Chapter IV:

\[ B = \text{SGD} - S + Dg + OB + F, \]

four cases for changes in the base can be defined. The response of the interest and exchange rate to a percentage change in the base in each of these cases is given by the response in the foreign exchange and bank credit markets, with estimated responses derived from equations (58) and (59) in Section C above.¹

¹ Estimated responses are summarized in Table V-6, p. 100, and Table V-8, page 100 above.
Case A: $dB = dOB, dSGD$; a change in the base resulting from other Bank accounts—advances to securities dealers, for example—or from the purchase of newly issued government securities to "monetize" a government deficit. The total response of interest and exchange rates to a percentage change in the base in this case is given by the credit market response to a change in the base, as neither OB nor SGD enter these markets directly.

$$E(i,B)_A = e(i,B)_{CM} \approx 0$$
$$E(x,B)_A = e(x,i)_{FM}[E(i,B)_A] \approx 0$$

Case B: $dB = dDg$; a shift in government deposits. Since the level of government deposits at chartered banks enters the bank credit market supply, the total response of interest rates consists of two terms:

$$E(i,B)_B = e(i,B)_{CM} + e(i,Dg)_{CM}[Dg/B] \approx -.5[Dg/B] < 0$$
$$E(x,B)_B = e(x,i)_{FM}[E(i,B)_B] \approx 0.01[Dg/B] > 0$$

Case C: $dB = -dS$; a pure open market operation.

$$E(i,B)_C = e(i,B)_{CM} - e(i,S)_{CM}[S/B] \approx 1.8[S/B] < 0$$
$$E(x,B)_C = e(x,i)_{FM}[E(i,B)_C] \approx 0.036[S/B] > 0$$

Case D: $dB = dF$; a change in the base resulting from foreign exchange market intervention.\(^2\) Since changes in official reserves

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1 According to the theory $E(i,B)_{CM} < 0$, but in estimation the coefficient was not significantly different from zero.

2 For intervention conducted through the Exchange Fund Account, this case is equivalent to an advance by the Bank to the Fund or to the Bank's purchase (sale) of new government securities to fund intervention within government accounts.
impact directly on the foreign exchange market and indirectly—through \(dx\)—on the bank credit market, the total response of interest rates contains the exchange market elasticity as well.

\[
E(i,B)_D = e(i,B)_{CM} + [e(i,x)_{CM} e(x,F)_{FM}] \cdot \frac{[F/B]}{0.75 [F/B]} < 0 \\
E(x,B)_D = e(x,i)_{FM} e(i,B)_{CM} + e(x,F)_{FM} [F/B] \approx 0.03 [F/B] > 0
\]

Variation in the ratios \(Dg/B\), \(S/B\), and \(F/B\) over the study period results in different point estimates for \(E(i,B)\) and \(E(x,B)\) in the different cases, but their variation is small compared with the standard errors of the coefficients calculated for \(e(i,B)_{CM}\), \(E(x,F)_{FM}\). Furthermore, these ratios do not change consistently over time and as a consequence, there is nothing to be gained by attempting to account for their changes. Table 27, which summarizes the estimated response pattern uses values of \(F/B\), \(Dg/B\) and \(S/B\).

\begin{table}[h]
\centering
\begin{tabular}{c c c}
\hline
\textbf{Case A:} & \text{dB} = dOB, dSCD & \text{Case B:} \\
\hline
\(E(i,B)_A \approx 0\) & \(E(i,B)_B \approx -0.048\) & \(E(i,B)_B \approx 0.001\) \\
\(E(x,B)_A \approx 0\) & \(E(x,B)_B \approx 0.001\) & \\
\text{Case C:} & \(dB = -ds\) & \text{Case D:} \\
\hline
\(E(i,B)_C \approx -9.45\) & \(E(i,B)_D \approx -0.051\) & \(E(i,B)_D \approx 0.020\) \\
\(E(x,B)_D \approx 0.189\) & \(E(x,B)_D \approx 0.189\) & \\
\end{tabular}
\caption{Estimated Response of Interest and Exchange Rates with respect to Changes in the Monetary Base (elasticities)}
\end{table}

Source: Tables V-6 and V-8, Chapter V, Section C, p. 100 above and mean values of \(Dg/B = 0.16, S/B = 4.85\), and \(F/B = 0.68\).
Note that the Bank has more impact on the foreign exchange rate per unit of change in the base when operating in the domestic securities market than when operating in the foreign exchange market itself, according to the elasticities estimated in this study. This somewhat surprising result follows from the relatively higher response of the credit market to changes in government securities than the response of the foreign exchange market to changes in official reserve holdings. While this result is dependent on the estimation parameters and, hence, the somewhat simplistic specification of the Bank's reaction function which may bias both elasticities downward, it does have a reasonable economic interpretation. The Bank's holdings of government securities relative to total assets in the Canadian bank credit market is significantly greater than its holdings of foreign exchange relative to total foreign currency denominated short-term financial assets relevant to the foreign exchange market. Similarly, the Bank of Canada is a much bigger actor in the bank credit market than in the foreign exchange market such that it has a greater impact in the former. By operating in the government securities market, the Bank induces private transactors in the foreign exchange market to make portfolio switches that have a far greater impact on the exchange rate than does its own activities in the exchange market which do not significantly alter cross-currency asset portfolios. This differential response also results in a greater short-run effect of exchange intervention financed through the public
purchase and sale of government securities rather than through changes 
monetizing in the monetary base. It thus accounts for the stability of 
the Canadian exchange rate despite the sterilization of the base ob-
erved over most of the period under study.

Combining the response of interest and exchange rates to 
changes in the base (Table 27), with the response of the multiplier 
in the interest and exchange rates (Table 26) plus the unitary base 
elasticity gives the total response of the money supply to the policy 
controlled monetary base.

For changes in the base that result from OB, SGD, S or F 
(cases A, C, and D), this combination takes the form:

\[ E(M_j, B) = e(m_j, i)E(i, B) + e(m_j, x)E(x, B) + 1. \]

For a shift in government deposits, an additional term is added to re-
fect the effect of the government deposit ratio change on the multi-
plier and the total response of the money supply becomes ¹

\[ E(M_j, B) = E(m_j, i)E(i, B) + e(m_j, x)E(x, B) + e(m_j, g)Dg/B + 1 \]

While the responses of the multipliers to interest and ex-
change rate changes over time as noted in Table 26 above, these dif-
ferences are not significant when multiplied by the relatively small

¹With the government deposit ratio defined \( g = Dg/D \), the response 
of the multiplier to a percentage change in government deposits is 
\( 1 \times e(m_j, g) \) which is \( Dg/B \) times a percentage change in the base for 
\( dB = dDg \). With \( e(m_j, g) = .0129 \) and \( F/B = .16 \) at mean values, this term 
is equal to .0024.
effect changes in the base have on interest rates except in Case C, a pure open market operation.\(^1\) Thus, changes in the base resulting from financing a government deficit (Case A), from shifts in government deposits between the Bank of Canada and chartered banks (Case B), from Bank intervention in the foreign exchange market on its own account (Case D), or from changes in other Bank of Canada accounts (Case A) all elicit an equi-percentage response in all definitions of money over the study period. The responses of the various definitions of money to a percentage change in the base resulting from a pure open market operation are listed in Table 28. In this case, the change in the supply of base money is augmented by an opposite change in the demand for bank credit and the interest elasticity of a change in the base is greatly increased such that the non-linearities in the multipliers' response to interest rates become significant. For M2, whose estimated response to a change in the base declined about 20 percentage points over the 16-year study period, differences in the responsiveness of the term deposit ratio result in a range of response from 0.73 to 1.11 by the end of the period. M1 and M3, which are more sensitive to interest rates, show a similar variability, with the non-linear behavior of the term deposit response more important than their change over time.

\(^1\)For Case B, a shift in government deposits, \(E(M1,B) = 1.000605\) in 1970 with \(e(it,i) = 1\) and M1 its most responsive to interest rates. With \(e(it,i) = 0\), M1 responds least to interest rate changes and \(E(M1,B) = 0.998685\). This difference, 0.0028, compares with a standard error of the M1 estimation equation of about 0.013 as shown in Table 29 below.
Table 28
Responses of Money Supply to Pure Open Market Operations

<table>
<thead>
<tr>
<th></th>
<th>M1</th>
<th>M2</th>
<th>M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$E(M_j,B)_c^{1955}$</td>
<td>1.48</td>
<td>1.10</td>
<td>1.20</td>
</tr>
<tr>
<td>$E(M_j,B)_c^{1962}$</td>
<td>1.39</td>
<td>1.01</td>
<td>1.20</td>
</tr>
<tr>
<td>$E(M_j,B)_c^{1970}$</td>
<td>1.39</td>
<td>0.92</td>
<td>1.30</td>
</tr>
<tr>
<td>a. $e(it,i) = 1$</td>
<td>1.58</td>
<td>1.11</td>
<td>1.11</td>
</tr>
<tr>
<td>b. $e(it,i) = 0$</td>
<td>1.20</td>
<td>0.73</td>
<td>1.58</td>
</tr>
</tbody>
</table>

\(^a/\) From the formula:

$$E(M_j,B)_c = e(m_j, i)E(i,B)_c + e(m_j, x)E(x,B)_c + 1,$$

with $E(i,B)_c$, $E(x,B)_c$ given by Table 27, and $e(m_j, i)$, $e(m_j, x)$ given by Table 26.
The overall fit of the money supply equation is examined by combining the estimated values of \( \hat{k}, \hat{s}, \hat{t} \) and \( \hat{r} \) with the policy determined \( B \) and \( g \) in proximate determinant form.\(^1\)

\[
\hat{M}_2 = \frac{(1 + \hat{k} + \hat{s})}{(\hat{k} + \hat{r} + (1 + \hat{s} + \hat{t} + g))} \cdot B
\]

This estimation procedure allows for part of the non-linearity in the money supply hypothesis in that the response of the multiplier to interest rates, income, etc. can vary over time as the elasticities of the multiplier to the proximate determinants change over time. It does not, however, capture the full implications of the hypothesis in that the response of the determinants to these predetermined variables change in a predictable way, but they are approximated at their average values in estimating \( \hat{s}, \hat{t}, \hat{k} \) and \( \hat{r} \). Thus, comparing \( M \) with the actual value of \( M \) is not a test of the overall hypothesis, but simply an indication of its ability to explain the data under limiting assumptions. The test of the overall hypothesis must of necessity be a nonrigorous examination of the residuals to see if they fall where predicted by non-linearities in the response of the determinants to variables predetermined or exogenous to the supply equations themselves.

The overall ability of the hypothesis to "explain" the behavior of the three definitions of money is evaluated by treating the in-sample estimates as a forecast. A statistical summary of this forecast of levels of the money supply is shown in Table 29 along

---

\(^1\) The alternative of simulating \( M_j \) with estimated values of the base was rejected because it involves mainly testing the reaction functions which are assumed stable only for purposes of deriving unbiased instrument variables for \( i \) and \( x \) in second-stage equations.
Table 29
Summary Statistics for Estimated Money Supply
(ratios of error to average levels of M)

<table>
<thead>
<tr>
<th></th>
<th>M₁</th>
<th>M₂</th>
<th>M₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Non-linear Model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Absolute Error</td>
<td>.009</td>
<td>.006</td>
<td>.008</td>
</tr>
<tr>
<td>Root Mean Square Error</td>
<td>.013</td>
<td>.008</td>
<td>.013</td>
</tr>
<tr>
<td>Maximum Positive Error</td>
<td>.044</td>
<td>.024</td>
<td>.040</td>
</tr>
<tr>
<td>Maximum Negative Error</td>
<td>.032</td>
<td>.029</td>
<td>.049</td>
</tr>
<tr>
<td>B. Naive Model</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Absolute Error</td>
<td>.013</td>
<td>.008</td>
<td>.012</td>
</tr>
<tr>
<td>Root Mean Square Error</td>
<td>.018</td>
<td>.011</td>
<td>.017</td>
</tr>
<tr>
<td>Maximum Positive Error</td>
<td>.058</td>
<td>.040</td>
<td>.053</td>
</tr>
<tr>
<td>Maximum Negative Error</td>
<td>.054</td>
<td>.037</td>
<td>.046</td>
</tr>
<tr>
<td>C. Relative (B/A)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean Absolute Error</td>
<td>1.44</td>
<td>1.33</td>
<td>1.50</td>
</tr>
<tr>
<td>Root Mean Square Error</td>
<td>1.38</td>
<td>1.38</td>
<td>1.31</td>
</tr>
<tr>
<td>Maximum Positive Error</td>
<td>1.32</td>
<td>1.67</td>
<td>1.33</td>
</tr>
<tr>
<td>Maximum Negative Error</td>
<td>1.68</td>
<td>1.28</td>
<td>0.94</td>
</tr>
</tbody>
</table>
with summary statistics from a naive forecast, estimates generated for comparison purposes from a model estimating the money supply as a linear function of its lagged value, a time trend, and quarterly dummies. By all but one test, the non-linear model has lower errors, with most about a third those of the naive model. Both the non-linear hypothesis and the naive model do best on M2, transactions money, but the non-linear model has its greatest relative advantage in estimating M1. The non-linear model also has a much better root mean square error statistic on all definitions of money, indicating fewer large errors.

Comparing the errors of these in-sample forecasts with those generated by the Bank of Canada's RDX2 econometric model for variables similar to my definitions of the money stock provides another indication of the power of the non-linear approach. The RMSE (as a percent of mean) reported for RDX2's in-sample estimate (Q4/63 to Q4/68) of chartered bank total assets is 3.21.\(^1\) Chartered bank total assets \((R + E + F_b)\) is similar to my definition of M3 -- more specifically, it is M3 minus currency in the hands of the public plus foreign currency liabilities of chartered banks -- which has an RMSE of 1.3 percent as reported in Table 29. Similarly, RDX2's variable "currency outside chartered banks held by non-financial public plus demand deposits of chartered banks (ex float)" has an in-sample RMSE of 3.93 percent.\(^2\) This variable is similar to my M1 which has an in-sample RMSE of 1.3 percent. While RDX2 has not

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1 Helliwell, and others, The Structure of RDX2, Part 1, p. 257.

2 Ibid.
been designed specifically to estimate the money supply relationships such that the comparison is not a fair test of competing models, the comparison does provide an indication of the power of the non-linear hypothesis. Moreover, the RDX2 model endogenizes policy reaction which has not been the case in this study. On the other hand, this study considers a far wider sample period with greater room for structural shifts than is the case with RDX2.

Errors resulting from one and four quarter percentage changes in M2 from the non-linear and naive models are compared in Table 30.

Table 30
Summary Statistics for Errors in Estimated Changes in M2
(error as a percentage change in M2)

<table>
<thead>
<tr>
<th>M2 (one quarter)</th>
<th>RMSE</th>
<th>MPE</th>
<th>MNE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Non-linear model</td>
<td>0.006</td>
<td>0.012</td>
<td>0.017</td>
</tr>
<tr>
<td>B. Naive model</td>
<td>0.012</td>
<td>0.033</td>
<td>0.033</td>
</tr>
<tr>
<td>C. Relative (A/B)</td>
<td>2.000</td>
<td>2.750</td>
<td>1.940</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>M2 (four quarter)</th>
<th>RMSE</th>
<th>MPE</th>
<th>MNE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Non-linear model</td>
<td>0.012</td>
<td>0.025</td>
<td>0.029</td>
</tr>
<tr>
<td>B. Naive model</td>
<td>0.017</td>
<td>0.047</td>
<td>0.039</td>
</tr>
<tr>
<td>C. Relative (A/B)</td>
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<td>1.880</td>
<td>1.334</td>
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Again the non-linear model outperforms the naive, by a factor of over two in the first difference estimation. A comparison of four quarter
percentage change estimates and the actual changes is provided in Figure 24, with the errors in this estimate and the contribution of errors in estimating k, s, t, and r shown in Figure 25.¹

Errors in the estimate of M2 are serially correlated and dominated by the contribution of errors in the estimated savings deposit ratio. The contributions of errors in the currency and term deposit ratios tend to offset that for s such that the error in M2 is considerably less than the contributions of errors in the individual ratios. This offset results from the opposite signs of e(M2,s) > 0 > e(M2,k), e(M2,t) which results in any error in all three estimated ratios of the same direction in past cancelling in the estimation of M2. One type of error with this effect is any unaccounted factor which influences desired demand deposits, the denominator of all three ratios. A second type of error, accounted for in the hypothesis but, not in the estimation model are errors in the estimated term and savings deposit ratios resulting from the non-linear response of bank deposit rates to domestic and foreign interest rates and the cyclical variable. These non-linearities could only partially be accounted for in the estimation of the term deposit ratio and not at all in the estimation of the savings deposit ratio, owing to the lack of data on

¹The contribution of errors in k̂ for example, are determined by taking the product of the error in k̂(k−k̂) and the elasticity of M2 with respect to k at time t.
Figure 24

Estimated Four Quarter Changes in M2
(percentage change)
Figure 25

Sources of Errors in Changes in M2 Estimates
deposit yields. These errors tend to cumulate rather than offset in the estimation of $M_1$: $e(M_1, k), e(M_1, s), e(M_1, t) < 0$—and only offset in $M_3$ through the currency ratio: $e(M_3, k) < 0 < e(M_3, s), e(M_3, t)$. 
CHAPTER VI

CONCLUSIONS, PROBLEMS AND AREAS FOR FURTHER RESEARCH

The primary conclusions of this study can be encompassed in two major themes. First, the various assumptions and order constraints placed on financial asset market behavior in the policy exogenous money supply hypothesis for Canada are generally supported in the testing of the structural equations. The addition of parameter estimates from the structural equations are sufficient to explain the behavior of the Canadian monetary aggregates over the study period, including an explanation for the sometimes divergent behavior of the different definitions of money. The policy instruments play a very important role in this process, making aggregates a potentially controllable policy target in Canada. This conclusion holds in particular for transactions money, here defined as M2.

Second, the reduced form and semi-reduced form financial asset market equilibrium model, with policy instruments endogenized by the inclusion of an implicit reaction function, is somewhat less satisfactory but nonetheless provides some insight into the stability of the Canadian dollar over this period. No evidence of the classical price-speci- flow adjustment mechanism was found in the short-run. Changes in reserve assets are not closely related to changes in the monetary base or other policy instruments. Moreover, the non-controlled components of the money multipliers are not strongly dependent on the exchange rate.
While it was found theoretically possible for a stable short-run adjustment mechanism to exist with exchange market induced changes in the base being offset by open market operations in the government securities market, the conditions necessary for financial asset market stability with this type of sterilization were not met, according to parameters estimated in this study. As a consequence, I tentatively conclude that the historic stability of the foreign exchange rate resulted from the use of open market operations to meet exchange rate targets directly. These operations guide the exchange rate through their influence on incipient interest rate differentials. This conclusion is appealing because such operations will lead to long-run stability in a monetary balance of payments adjustment model as well. It remains tentative, however, pending further research into the adjustment process over shorter time frames than used in this study. The remainder of this Chapter details factors underlying these two themes, secondary conclusions, problems, and suggested directions for further study.

The structural shift in the money supply process as a result of the 1967 Bank Act change and the non-linearities in the banks' behavior that results from limited inter-bank competition for Canadian dollar deposits create some problems in testing and estimating the structural equations in the money supply process, but estimation errors derived from the complete policy-exogenous model were about half those of the naive model and one-third those of the best alternative econometric model available for comparison.¹

¹See Chapter V, pp. 207-210 for these results.
These strong results derive from several distinct attributes of the Canadian money supply process and financial asset markets that are well accounted for in the non-linear hypothesis. First, the policy instruments, as defined in this study, directly accounted for more than ninety percent of the quarterly changes in transactions money (M2) according to the purely arithmetic proximate determinate analysis.\(^1\) Second, the proximate determinants whose behavior is dependent on the actions of the bank and non-bank public tend to be relatively independent with respect to factors endogenous in the short run. As a result, the proximate effect of a policy controlled determinate change tends to be its total effect and errors that result from difficulties in specifying certain non-linearities in the public's response are of minimal importance. The interdependence that does exist between the determinants tends to be self-cancelling within the overall money supply multiplier so that the overall fit of the money supply is better than that of the individual structural equations.\(^2\) Third, the absence of a large indirect response of the money supply to exogenous policy changes stems in part from the fact that domestic interest rates are largely determined by the exogenous foreign interest rates owing to the openness of Canadian financial asset markets. Thus, the policy actions by the Bank of Canada have a large and direct impact on the money supply and foreign exchange rate but lesser influence on the domestic interest rate. This suggests that any Canadian attempt to operate an independent mone-

\(^1\) See Chapter II, p. 30 for these results.

\(^2\) The RMSE of the M2 levels over the period was only 0.008 (0.013 for M1 and M2) as compared with residual standard errors of 0.023, 0.030, and 0.053 for levels of k, s, and t respectively.
tary policy by targeting domestic interest rates instead of monetary aggregates would lead to wide variation in both the exchange rate and in the money supply. Finally, the ability of the hypothesis to explain past changes in the money supply is overstated to some extent owing to the improper specification of the desired reserve ratio in the post-1967 period. While the proper estimated reserve ratio can easily be formulated, additional data would have to be assembled to extend the sample. The size of this overstatement is quite small and does not seriously bias the results. Furthermore, the tested hypothesis does include and support the postulate that quarterly changes in excess reserves are insignificant in the Canadian system.¹

The major postulates concerning the behavior of the banks and non-bank public with respect to the currency, savings deposit and term deposit ratio were either supported or the evidence was inconclusive.² In particular, the order conditions posited for the public's monetary asset response to wealth, the phase of the business cycle, and interest rates were well supported by the equations testing the behavior of these ratios. The domestic interest rate, the ratio of

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¹ A one percent error in the estimate of the proportion of deposits in each deposit class would result in a 0.08 percent error in the statutory reserve ratio and about a 0.03 percent error in the multiplier and money estimates (all calculations at mean values; = 0.56, e(M2,r) = -0.4, rsd - 0.12, rst - 0.04).

² See Chapter II, Sections D and E, pp. 33-68, for the postulated behavior of these ratios and Chapter V, Section E, pp. 163-94, for their tests.
current to permanent income (a business cycle proxy), and wealth had
the correct sign in all cases and were significantly different from zero
in most. As a result of the institutional feature in Canada which
distinguishes between personal and non-personal depositors, and of our
assumption that monetary asset allocation behavior is homogenous of
degree one in demand deposits (held by non-persons), the Canadian cur-
rency ratio is quite sensitive to interest rates. This differs from
findings in the U.S. where the currency ratio depends primarily on long-
term factors and is not particularly important in the money supply
process.

The expected non-linearity in banks' response to credit
market interest rates in setting deposit yields also came through
strongly in tests of the savings and term deposit ratios. The use of
moral suasion by the Bank of Canada to hold bank lending rates down
resulted in lower deposit yields and a shift out of interest sensitive
term and savings deposits, particularly during the 1966-1968 period.
While the lack of good data on deposit yields limit the econometric
model's ability to pick up all these shifts, some show up quite clearly
in the residual pattern on term and savings deposit estimation equa-
tions.¹

The foreign sector on the other hand, did not play as large
a role in the behavior of the multiplier as had been anticipated. It
largely enters the money supply process through the domestic bank

¹ See Chapter V, Section E, Figures 19 and 20.
credit market and through its effect on policy behavior. The current exchange rate was significant and had the predicted sign only in the current ratio equation, while the significance tests for other variables determining the yield on foreign currency assets were inconclusive except in the savings deposit ratio. It was posited businesses would be more sensitive to foreign currency yields than demand deposits and that the term deposit ratio would be negatively related to foreign interest rates. In fact, both of these coefficients were insignificant, a result which would logically hold only in the unlikely event that the foreign interest elasticity for all three, currency, demand, and term deposits, were equal or quite small. Since the evidence for a high degree of substitution between Canadian dollar term and notice deposits and "swapped" U.S. dollar term deposits is quite strong, it appears that the problem lies with the term deposit ratio. Indeed, evidence provided by an examination of the residuals from the term deposit ratio equation suggests that the empirical specification of the non-linear response of bank deposit yields to domestic and foreign currency assets yields is inadequate. Thus, the term deposit estimation equation is understating the negative elasticity with respect to foreign interest rates and the estimated money supply equations are biased against the influence of the foreign sector in the money supply process.

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1 Canadian banks offer U.S. dollar deposits, at U.S. market yields, to Canadian residents on a "swapped" basis by converting Canadian dollars spot, investing in U.S. currency denominated assets and placing a forward exchange contract to coincide with deposit maturity. To the depositor, these deposits are effectively a Canadian dollar term deposit paying a higher yield. These deposits became popular during the 1966-68 period when Canadian lending rates were held down by moral suasion.
The close correlation between Canadian and U.S. interest rates owing to the integration of financial asset markets makes it difficult to pick up an independent effect for each interest rate in quarterly data. The lack of suitable data on deposit yields compounds this problem. This same problem may be resulting in the poor fit on the exchange rate expectations in the behavioral equations. In general, a residual from the forward market provides the best fit, along with the expectations dummy, but this variable is only significant in the savings deposit ratio equation.

Despite these problems, which indicate the need for further research and better data, the non-linear hypothesis is successful in its Canadian application. It should be noted, however, that this ability to explain the money supply with a high degree of precision ex-post does not mean that the Canadian authorities could achieve a similar degree of precision ex-ante. The exogenous long-term variables and foreign interest rate would also have to be predicted on a current basis in order to offset their influence with appropriate policy actions. Still, the hypothesis fits better in ex-post simulation than available alternatives and provides a sound starting point for the ex-ante forecasting process because it requires only a limited number of exogenous variable forecasts.

Tests and estimation of the foreign exchange and bank credit market specifications were less successful. The interest rate appears
to be largely determined by foreign interest rates and interest rate expectations that are based on the past behavior of the Canadian interest rate. Changes in outstanding government securities are also an important variable with the anticipated sign, but the monetary base did not have a coefficient significantly different from zero. The insignificance of the base is somewhat puzzling, but several explanations are possible. First, owing to the rapid adjustment assumption, data constraints, and computer software limitations, the non-linear bank credit supply equation and linear homogeneity constraint on the base had to be approximated with a log-linear reduced form estimation equation that ignored the constraint on the base coefficient. While the non-linearities were not overly important in the short-run equilibrium money supply equations, they may play a greater role in the adjustment of the credit market toward with equilibrium. Changes in the data over a shorter period of time would assist in resolving this problem, but such data is not available for all variables in the model. A second possible source of error is that the Government securities variable is picking up the effects of the base. Since most changes in the base resulted from open market operations, there is a potential multicollinearity problem here. This problem would be aggravated by the use of instrumental variables which remove some of the random differences between the two. Most likely, however, is the possibility that the first stage estimation does not completely purge out the policy reaction. This two-stage procedure

1 See Chapter III, Section B and Chapter V, Section D, in particular Table 18, p. 153.
depends on an unstable reaction function to identify exogenous shifts in the base and create a useful instrumental variable. If the base were consistently being adjusted, the reaction function would not be identified in the reduced form and the second stage estimation coefficient would be picking up both cause and effect. A possible solution to this dilemma is the use of the government deficit instead of the outstanding stock of government securities in the credit market equation on the assumption that all base changes came about through open market operations. This alternative assumption was considered originally, but rejected in order to test an alternative assumption that the base is a homogeneous variable which can be used to proxy all instruments contained therein. It is not however, an unreasonable assumption given the relative importance of the open market operations in changes in the sources of the base and is a suggested area of future investigation.

The behavior of the foreign exchange rate was largely as expected. The domestic and foreign interest rates, current account, and official intervention have the expected signs. The exchange rate expectations, however, are best proxied by lagged rates, a situation unappealing from a theoretic standpoint and one that makes it difficult to interpret the significance of other coefficients. Here again, adjustment is most likely quite rapid relative to the quarterly time frame of the data such that considerable improvement is possible in future research with more complete data.
Despite the somewhat shaky coefficients estimated in the bank credit and foreign exchange markets, their magnitudes support some tentative conclusions about the relative efficiency of the exchange market support conducted indirectly in the government securities market and suggest limits for the independence of monetary aggregate and exchange rate targets. A one percent increase in the monetary base (\$22 million at 1962 levels) as the result of an open market operation will raise the Canadian dollar price of one US dollar 0.2 percent (or 0.002, since the rate is near 1.1) whereas the same increase in the base brought about by a foreign exchange market purchase will only increase the exchange rate about 0.02 percent.\(^1\) This greater impact of the base on the exchange rate when open market operations are utilized, by a factor of ten, has as its correlate the conclusion that a foreign exchange market purchase that is financed through the sale of a government security will tend to increase domestic interest rates enough to more than offset the initial exchange market purchase. Thus, the sterilization of reserve asset changes through the Exchange Fund's sale of overnight securities is inherently destabilizing and it must be the behavior of the domestic component of the base that has given rise to

\(^1\) See Chapter V, Section F, Table 27, p. 202.
the stability of the Canadian exchange rate over the period under
review. On the other hand, the sterilization of reserve asset flows
through the Exchange Fund's drawing down Government balances at the
chartered banks is inherently stable and would permit Canada to main­
tain independent short-run money supply and foreign exchange rate
targets so long as deposits or reserve assets are available.  

1 This sterilization can be seen as an increase in the foreign
asset component of the base offset by a decrease in the government secur­
ities component in Table 27, p.201. The Stability conditions specified
in Chapter IV, Section C, p.123, are not met according to the estimates
-generated from quarterly data.

2 \( E(x,B) - E(x,B) = 0.019 \) while \( E(i,B) - E(i,B) = -.003 \) in
Table 27 so that base sterilization is possible and the reaction of the
multiplier is quite small so that a one percent change in the exchange
rate requires only a 0.0014 percent change in M3 under the most
extreme conditions in Table 26.
BIBLIOGRAPHY


APPENDIX A

Construction of Variables Unique to this Study
FB; Net foreign currency assets of the Bank of Canada

Bank of Canada foreign currency assets, (B11) minus foreign currency liabilities (B57) adjusted to remove foreign government securities acquired through "swaps" with the Bank of England and Federal Reserve Bank of New York in 1962 and 1968. A tabulation for the effects of these adjustments is given in Chapter III, p. 106 f.

FG; Net international reserve assets held by the Government of Canada

Canadian dollar value of official holdings of gold, U.S. dollars, and other convertible foreign currencies by the Exchange Fund Account and Minister of Finance and Canada's position in the IMF (net gold tranche position) taken at their U.S. dollar equivalents from Annual Supplements to the Bank of Canada Statistical Summary or the IMF Statistical Summary for years in which comparable data was not published by the Bank of Canada. These U.S. dollar magnitudes were converted to Canadian dollar equivalents by initialing the series in 1955 at the end-1954 U.S./Canadian exchange rate and multiplying the quarterly change in the U.S. dollar magnitude by the average quarterly exchange rate for the current quarter. This procedure was necessary because changes in the domestic currency value of official foreign currency assets do not themselves alter the budget constraint and should not alter the behavior of private participants in the foreign exchange and bank credit market. Changes in the outstanding stock of Government Securities denominated in foreign currencies was netted out
of the Canadian dollar equivalent series to account for the acquisition (disposition) of international reserves by borrowing foreign exchange. The data on changes in foreign currency Securities were taken from various Annual Supplements to the Bank of Canada's Statistical Review, Tables "Government of Canada Direct and Guaranteed Securities," "VI. Details of Unmatured Outstanding Issues," and "VII. New Issues and Retirements."

S; Government of Canada, Canadian dollar direct and guaranteed securities outside government and Bank of Canada accounts

Government of Canada direct and guaranteed securities held by the general public (B2475) and chartered banks (B2472) minus foreign currency denominated securities (calculated for FB above) minus foreign official reserve agency holdings of Government securities as a result of Central bank "swaps" (calculated for SB below).

SB; Bank of Canada holdings of Government of Canada direct and guaranteed securities

This variable is measured by quarterly averages of Wednesdays holdings by the Bank of Canada (B2) at par (Treasury Bills) or amortized value (other bonds), adjusted to omit the decline in holdings in 1962 and 1968 that resulted from "swap" drawings with the Bank of England and Federal Reserve Bank of New York. These swaps resulted in
the foreign central banks acquiring custody of Government of Canada securities from the Bank's portfolio, but did not increase the stock of securities in the hands of the chartered banks or general public (resident or non-resident). A tabulation of the effects of these adjustments is given in Chapter IV, page 100f, above.

SGD; Cumulative government deficit

The government deficit (GD) is calculated as a residual from the government budget constraint:

\[ GD = \Delta SG + \Delta DGOV - \Delta FG, \]

where SG, DGOV, and FG are defined elsewhere in this appendix. SGD is the cumulative sum of GD, as measured above for each quarter of the study after initializing it at the outstanding levels of SG, DGOV, and FG in the first quarter of 1954.

W; wealth

The wealth variable used in estimating the behavioral relationships of the non-bank public is permanent net national product.  

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1 See M Friedman, A Theory of the Consumption Function, NBER General Series No. 63, Princeton University Press (Princeton, 1957), pp 9 and 142-47. This variable is conceptually the same as that used in the Brookings model and has the advantage over the alternative of an aggregate net worth variable as it includes human capital. For Canada it has a further advantage in being relatively easy to quantify.
Construction of the wealth variable follows a procedure developed by Darby\(^1\) for estimating permanent income on the basis of a time trend and adaptive expectations formed on the basis of current and past income. Current income is measured by net national product, the gross product of Canadian assets in a quarter minus asset depreciation of the tangible capital stock. Quarterly net national product current prices, seasonally adjusted and at annual rates (CANSIM D40248) was used in these calculations.

The time trend for the growth of permanent was estimated by the second order regression:

\[
\ln(Y_{pt}) = \beta_1 + \beta_2 t + \beta_3 t^2 + \nu,
\]

where the OLS estimates of the \(\beta\)'s were found to be:

\[
\begin{align*}
\ln(Y_{pt}) &= 9.8789 + 0.01120 t + 0.00010 t^2, \\
(0.0117) & \quad (0.00079) \quad (0.00001) \\
(839.7) & \quad (4.35) \quad (9.1860)
\end{align*}
\]

where the first term in parenthesis is the standard error and the second is the student's \(t\).


\(^2\) Tests of higher orders of \(t\) were found efficient on the basis of the \(t\) statistics of the additional terms. The quadratic estimator was used instead of a linear trend due to the significance of the quadratic term coefficient indicating a possible change in the permanent interest rate over the period. See Darby, op cit, p.22.
Adaptive expectations were included by using a coefficient of 0.1 on current income in order to determine the effect of its difference from expected permanent income in that period:

\[(A1) \quad Y_{pt} = 0.1 Y_t + 0.9 Y_{pt}^e.\]

Expected permanent income is derived from the trend value of income and last quarter's permanent income:

\[(A2) \quad Y_{pt}^e = (1 + b_2 + 2b_3 t) Y_{pt-1},\]

where $b_2$ and $b_3$ are the coefficient estimates for $\beta_2$ and $\beta_3$ above.

Combining equations (A1) and (A2) yields the estimate of wealth derived for this thesis:

\[Y_{pt} = 0.1 Y_t + 0.9(1 + 0.01125346 + 0.00020304 t)Y_{pt-1},\]

where $Y_{p0}$, the initial value of permanent income is derived from the intercept term in the OLS trend estimation,

\[Y_{p0} = e^{9.87894732} = 19515.11\]
Three classes of exchange rate expectations proxies are considered in this study: (1) those derived from the relationship between the spot and forward exchange rates, \((x_{ek})\), \((x_{es})\), and \((x_{ess})\); (2) those derived from past values of the exchange rate \((x_{ew})\), \((x_{l})\), and \((x_{2})\); and (3) dummy variables to account for diverse exogenous shocks which cannot otherwise be accounted for by the model \((x_{ed})\).

\(x_{ek}\): covered interest arbitrage margin

Given the level of the spot exchange rate determined in the spot market for foreign exchange, covered interest arbitrage should insure that the forward rate deviates from the spot rate only to the extent of the interest differential on financial assets of comparable risk denominated in the two currencies. A deviation from this interest parity should occur only (a) if the domestic currency risk of the two assets change, (b) if arbitragers expectations of exchange rate change are sufficiently strong that their expected gain from uncovered arbitrage exceeds their sure gain from covered arbitrage, or (c) if arbitragers face an upward sloping cost of funds such that they cannot supply all forward exchange demanded by speculators at the covered equilibrium rate. Given the relative political stability in the U.S. and Canada, as well as the close interaction between the private sectors of the two countries, it seems reasonable to assume that the domestic currency risk assigned to Government securities and private
financial assets in the two countries has not varied considerably relative to one another over the period under study. As a consequence, the difference between the forward premium and the differential on government securities yields in the U.S. and Canada should reflect the higher expected gains from uncovered interest arbitrage or the cost of obtaining more than the usual amount of funds for arbitrage purposes when expectations of a change in the rate are widely held. The proxy \( xek \) is thus derived from the relationship,

\[
xek = \{(x_f - x)/x\} \cdot 400 - \{(x_f - x)if - i\},
\]

where \( x \) and \( x_f \) are the spot and forward exchange rate (B40001 and B40004), \( if \) is the U.S. three month Treasury bill rate (N-FYGN3) and \( i \) is the Canadian 91-day Treasury bill rate (B14001).

\( xes; \) covered interest arbitrage residual

To account for the increasing opportunity cost of funds to arbitragers, Jerome Stein has proposed regressing the actual forward premium, \( \{(x_f - x)/x\} \cdot 400 \), on the interest differential, \( (i - if) \), and treating the residual as a measure of expectations. In Stein's original study, he transformed the regression to remove serial correlation among residuals and to provide for an unbiased estimator of the slope.

---

coefficient, the marginal opportunity cost of arbitrage funds. Following Stein, the expectations proxy is derived from the relationship

\[ xes = 400 \left( \frac{xf-x}{x} \right)_t - 0.034 - 0.652(i-if)_t \]
\[ + 0.485(i-if)_{t-1} - 298 \left( \frac{xf-x}{x} \right)_{t-1}, \]

where the coefficients and lagged terms are from the Hildreth-Lu transformed regression of the equation:

\[ 400 \left( \frac{xf-x}{x} \right) = \beta_0 + \beta_1(i-if) + \mu. \]

\textit{xes}; Covered arbitrage residual

While consistent estimations of \( \beta_0 \) and \( \beta_1 \) in were necessary for Stein's conclusions about their interpretation, it is not at all clear that the absence of serial correlation is a desirable property of exchange rate expectations proxies. Consequently, a second covered arbitrage residual proxy was constructed from the untransformed equation:

\[ xess = 400 \left( \frac{xf-x}{x} \right) - 0.110 - 0.841(i-if). \]

\textit{xew}; Past changes in the exchange rate

Expectations generated from past movements in the exchange rate are proxied first by constructing a lagged rate dummy and second, by entering the lagged values of the rate itself (\( x_1 \) and \( x_2 \)) in the behavioral equations. The former method is viewed as capturing a pure
expectation effect, while the latter contains other effects that introduce lags in the adjustment process as well. The Romberg lag proxy, \( x_{ew} \) is formed from estimation of the second order difference equation,

\[
x_{ew} = 1.2548 - 0.2544x_2,
\]

where the coefficients are taken from the regression of \( x \) on its two quarter lagged values.

\textit{xed; Dummy expectations}

During variables \((1,0-1)\) were constructed to capture exchange rate expectations by reviewing both the financial literature of the period and other studies in which dummy variables were utilized. This dummy variable is used in conjunction with past rate movements, but should properly be a substitute for \( x_{ed}, x_{es}, \) and \( x_{ess} \). The values of this dummy, reasons for its value and the source of this reason are listed in Table A-1.

\textit{Y/Yp; relative income}

To measure cyclical activity in Canada, the relative income variable was constructed by dividing current nominal net national product \((\text{CANISM D40248})\) by permanent income \((Y_p\text{ or }W\text{ as constructed above})\). In addition, real income \((\text{D40239 GNE at constant prices})\) divided by wealth and by permanent real income was tested in the behavioral equations and found less satisfactory in all cases.
APPENDIX B

Constructed Data and Estimates
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<td>-0.05</td>
<td>-0.54</td>
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<td>-0.38</td>
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APPENDIX C

Derivation of the Behavior of the Foreign Currency Ratio
Appendix C

This appendix provides the basic price theoretic hypothesis underlying the foreign currency ratio equation. The behavior of net foreign assets (NFA) is part of the banks profit maximization procedure along with their setting of interest rates on deposit liabilities, management of reserve assets, and allocation of earning assets into loans and securities.

Consider a bank with foreign and domestic currency denominated earning assets (Af and Ad) and deposits denominated in foreign and domestic currencies (Df and Dd). Assume that asset markets are competitive so that asset yields (raf and rad) are given, but that the bank can attract more deposits by increasing its deposit rates (rdf and rdd). The bank's balance sheet results in the identity,

(C1) \( Ad + Af = Dd + Df \),

with net foreign assets defined as

(C2) \( NFA = Af - Df \). 

Bank profits are the difference between the total return on assets and

\[ \text{This exposition is a simplification and extension of the theory developed by Charles Freedman, The Foreign Currency Business of the Canadian Chartered Banks, Ottawa, the Bank of Canada, Chapter 4.} \]
the total cost of deposits

\[(C3) \quad \pi = (A_d \cdot r_{ad}) + (A_f \cdot r_{af}) - (D_d \cdot r_{d} - D_f \cdot r_{df}).\]

If net foreign assets are constrained to zero, \(A_d = D_d\) and \(A_f = D_f\), and \(C3\) can be rewritten,

\[(C4) \quad \pi = D_d(r_{ad} - r_{dd}) + D_f(r_{af} - r_{df}),\]

and the first order conditions for profit maximization,

\[(C5) \quad r_{ad}(\partial D_d/\partial r_{dd}) = r_{dd}(\partial D_d/\partial r_{dd}) + D_d\]
\[(C6) \quad r_{af}(\partial D_f/\partial r_{df}) = r_{df}(\partial D_f/\partial r_{dd}) + D_f\]

give the result that the bank adjusts its deposit rates until the marginal yield of each class of deposit (the left sides of \(C5\) and \(C6\)) equals its marginal cost.

If the bank is able to arbitrage between the two asset classes, \(NFA \neq 0\) and by substitution of the definition of \(NFA\) \((C2)\) into the balance sheet equation \((C1)\),

\[(C7) \quad NFA = D_d - A_d,\]

is equal to the excess of banks domestic currency deposits over domestic currency assets.

The profit equation can be reformulated to account for these arbitrage profits by substituting \(C7\) and \(C2\) into \(C3\),
\[ (C8) \quad \pi = Dd(rad - rdd) + Df(raf - rdf) + NFA(raf - rad) \]

To avoid a corner solution and all assets arbitraged into NFA = \((\frac{a}{b}) Dd + Df\), this profit equation can be written in the form:

\[ (C9) \quad \pi = Dd(rad - rdd) + Df(raf - rdf) + aNFA(raf - rad) - bNFA^2. \]

The last term limits the extent to which the profit maximizing bank will extend its foreign asset position in correspondence with banks' normal reluctance to depend too heavily on one source or outlet for funds and in accord with the Canadian Bank Act's directive that banks maintain "adequate and appropriate" assets against foreign currency deposits.\(^1\)

The first order conditions for maximization with respect to deposit rates remain as before, \((C5\) and \(C6)\) while the maximization condition for NFA is,

\[ a(raf - rad) - 2b NFA = 0, \]

at which point the bank's marginal return on net foreign assets, \(a(raf - rad)\), equals its marginal (implicit) cost of an imbalanced position, \(-2b NFA\).

It should be noted that this net foreign asset position is not necessarily a foreign exchange position. The foreign asset yield

\(^1\) Section 72, sub-section 7 of the Canadian Bank Act, 1967 revision.
(raf) may be considered as net of exchange risk by adjusting for the forward exchange discount or premium with the banks covering this position in the forward exchange market.

Assuming that the size of the net foreign asset position a bank is willing to take is related to its size in the domestic market, the desired level of net foreign assets will be related to total domestic deposit liabilities,

\[ b = b(D, \ldots) \quad \frac{\partial b}{\partial D} < 0, \]

such that the implicit form demand equation for NFA can be written

\[ \text{NFA} = \text{NFA}(\text{rad}, \text{raf}, D, \ldots). \]

with NFA linear homogenous in the scale variable,

\[ f = \frac{\text{NFA}}{D} = f(\text{rad}, \text{raf}, \ldots), \]

consistent with the other variable in the non-linear money supply hypothesis.
APPENDIX D

Solution to the Condensed Model in Chapter IV
Solution to the Condensed Model in IV-C

The model consists of four equations,

\[(46)\] \[M = m(i, x, if, \ldots) B\]

\[(47)\] \[CM(i, x, if, \ldots, B, S) = 0\]

\[(48)\] \[FM(i, x, if, \ldots, F) = 0\]

\[(49)\] \[dB + dS = dF,\]

which can be decomposed into the first equation and the three equation system (47-49). Differentiating (47) and (48) and rearranging in determinant form yields, for fixed exchange rates with the base exogenous, Case A:

\[
\begin{bmatrix}
CM' & CM' & CM'
\end{bmatrix}
\begin{bmatrix}
di
\end{bmatrix}
= 
\begin{bmatrix}
-CM'_f & CM'_B & 0
\end{bmatrix}
\begin{bmatrix}
dif
\end{bmatrix}
\]

\[
\begin{bmatrix}
FM' & FM' & 0
\end{bmatrix}
\begin{bmatrix}
dx
\end{bmatrix}
= 
\begin{bmatrix}
-FM'_f & 0 & -FM'_F
\end{bmatrix}
\begin{bmatrix}
dB
\end{bmatrix}
\]

\[
\begin{bmatrix}
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
dS
\end{bmatrix}
= 
\begin{bmatrix}
0 & -1 & 1
\end{bmatrix}
\begin{bmatrix}
dF
\end{bmatrix}
\]

with signs given by the assumptions in Chapter IV as;

\[
\begin{bmatrix}
(-) & (-) & (+)
\end{bmatrix}
\begin{bmatrix}
di
\end{bmatrix}
= 
\begin{bmatrix}
(-+) & (-) & 0
\end{bmatrix}
\begin{bmatrix}
dif
\end{bmatrix}
\]

\[
\begin{bmatrix}
(-) & (-) & 0
\end{bmatrix}
\begin{bmatrix}
dx
\end{bmatrix}
= 
\begin{bmatrix}
(-+) & 0 & -(-)
\end{bmatrix}
\begin{bmatrix}
dB
\end{bmatrix}
\]

\[
\begin{bmatrix}
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
dS
\end{bmatrix}
= 
\begin{bmatrix}
0 & -1 & 1
\end{bmatrix}
\begin{bmatrix}
dF
\end{bmatrix}
\]

Let \(\Delta A\) = the determinate of the endogenous variables = \([CM'_f FM'_x - FM'_x CM'_1]\)

which is assumed to be positive as a result of necessary conditions for stability; i.e., \(CM'_1 FM'_x > CM'_x FM'_1\). The derivatives of the endogenous
terms with respect to exogenous terms is given by;

\[
\begin{array}{ccc}
\frac{di}{dx} & \frac{dx}{dS} & \frac{dS}{dF} \\
\frac{CM'_xFM'_f - CM'_xFM'_x}{\Delta A} & \frac{CM'_fFM'_x - CM'_fFM'_f}{\Delta A} & 0 \\
\frac{CM'_SFM'_x - CM'_BMFM'_x}{\Delta A} & \frac{CM'_SFM'_F - CM'_SMFM'_F}{\Delta A} & -1 \\
\frac{CM'_xFM'_F - CM'_SFM'_x}{\Delta A} & \frac{CM'_SFM'_F - CM'_SMFM'_F}{\Delta A} & 1 \\
\end{array}
\]

where the column heading is the numerator and the row heading the denominator. The signs of these responses are given by,

\[
\begin{array}{ccc}
\frac{di}{dx} & \frac{dx}{dS} & \frac{dS}{dF} \\
(+?) & (+?) & 0 \\
(-?) & (+?) & -1 \\
(+?) & (-?) & 1 \\
\end{array}
\]

di/dif > 0 as \(|CM'_xFM'_f| \sim |CM'_xFM'_x|\); with FM' > FM'_f, a stability condition for the foreign exchange market, di/dif will be positive if CM'_if > CM'_i. Given the high degree of capital mobility in Canada and uncertainty of expectations about the exchange rate, this is a reasonable assumption.

\[
dx/dif \leq 0 as \ |CM'_xFM'_if| \leq |FM'_i CM'_if|
\]

With CM'_i > CM'_if as a stability condition in the credit market, and FM'_if = FM'_i as a reasonable assumption for the foreign exchange market,
dx/dif > 0 is the expected sign. The remaining signs are determined from the standard price theoretic assumptions employed to determine market responses.

Case B: Fixed exchange rate, stock of government securities endogenous. The exchange rate becomes exogenous, international reserves endogenous and the determinant becomes:

\[
\begin{bmatrix}
CM_{i}' & 0 & CM_{s}' \\
FM_{i}' & FM_{f}' & 0
\end{bmatrix}
\begin{bmatrix}
di \\
dF \\
dS
\end{bmatrix}
= \begin{bmatrix}
-CM_{i}' & -CM_{s}' & CM_{B}' \\
-FM_{i}' & -FM_{f}' & 0
\end{bmatrix}
\begin{bmatrix}
df \\
dx \\
deB
\end{bmatrix}

\text{With } AB = [CM_{i}'FM_{f}' - FM_{i}'CM_{s}'] > 0 \text{ unambiguously, the responses;}

\[
\begin{bmatrix}
di \\
dF \\
dS
\end{bmatrix}
= \begin{bmatrix}
CM_{s}'FM_{i}' - CM_{i}'FM_{f}' & CM_{i}'FM_{i}' - CM_{i}'FM_{f}' & CM_{i}'FM_{f}' - CM_{i}'FM_{i}' \\
CM_{s}FM_{i}' - CM_{i}FM_{f}' & CM_{i}FM_{i}' - CM_{i}FM_{f}' & CM_{i}FM_{f}' - CM_{i}FM_{i}' \\
CM_{s}FM_{i}' - CM_{i}FM_{f}' & CM_{i}FM_{i}' - CM_{i}FM_{f}' & CM_{i}FM_{f}' - CM_{i}FM_{i}'
\end{bmatrix}
\begin{bmatrix}
df \\
dx \\
deB
\end{bmatrix}

\text{have the following signs;}

\[
\begin{bmatrix}
di \\
dF \\
dS
\end{bmatrix}
= \begin{bmatrix}
(+) & (+) & (+) \\
(-) & (-) & (-) \\
(-) & (+) & ?
\end{bmatrix}
\begin{bmatrix}
df \\
dx \\
deB
\end{bmatrix}

\text{1 In fact, several studies have found a greater international capital flow response to foreign interest rates than to domestic rates. While this probably reflects biased estimates results from assumptions about this independence of interest rates, it would imply a greater exchange market response to the foreign rate as well. See Kouri and Porter, (1974) for a discussion of this bias.}
With \( \frac{dF}{df} > 0 \) and \( \frac{dS}{df} > 0 \) as \( |CM_{1}FM_{1f}| > |CM_{1}FM_{1}| \) under the stability condition noted for \( \frac{dx}{df} \) above; \( \frac{dF}{dx} < 0 \) and \( \frac{dS}{dx} < 0 \) as \( |CM_{1}FM_{1x}| > |CM_{1}FM_{1}| \) under the stability condition for the determinant \( \Delta A \) above. The sign \( \frac{dS}{dB} \) is ambiguous on a priori grounds, depends on the response of the credit market with respect to open market operations relative to the response of the foreign exchange market to foreign exchange operations.

**Case C:** Fixed exchange rates, constraint on reserve.

The determinant form becomes:

\[
\begin{bmatrix}
CM'_{1} & CM'_{S} & CM'_{B} \\
FM'_{1} & 0 & 0 \\
0 & 1 & 1
\end{bmatrix}
\begin{bmatrix}
di \\
ds \\
\frac{dB}{df}
\end{bmatrix}
= \begin{bmatrix}
-CM'_{1f} - CM'_{X} & 0 \\
-FM'_{1f} - FM'_{X} & -FM'_{F} \\
0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
df \\
dx \\
\frac{dF}{df}
\end{bmatrix}
\]

with \( \Delta C = FM'_{1f}[CM'_{B} - CM'_{S}] > 0 \), and solutions:

\[
\begin{array}{c|c|c|c|}
\frac{di}{df} & \frac{ds}{dx} & \frac{dB}{dF} \\
\hline
\frac{FM'_{1f}[CM'_{S} - CM'_{B}]}{\Delta C} & \frac{CM'_{1f}FM'_{1} - CM'_{1}FM'_{1f}}{\Delta C} & \frac{CM'_{1}FM'_{1} - CM'_{1}FM'_{1f}}{\Delta C} \\
\frac{FM'_{1f}[CM'_{B} - CM'_{S}]}{\Delta C} & \frac{CM'_{1f}FM'_{1} - CM'_{1}FM'_{1f}}{\Delta C} & \frac{CM'_{1}FM'_{1} - CM'_{1}FM'_{1f}}{\Delta C} \\
\frac{FM'_{1f}[CM'_{S} - CM'_{B}]}{\Delta C} & \frac{CM'_{1}FM'_{1} - CM'_{1}FM'_{1f}}{\Delta C} & \frac{CM'_{1}FM'_{1} - CM'_{1}FM'_{1f}}{\Delta C}
\end{array}
\]

and signs,

\[
\begin{array}{c|c|c|}
di & ds & dB \\
\hline
(+) & (+) & (?) \\
? & (-) & (+) \\
(+) & (-) & (+)
\end{array}
\]

\( \Delta C \)
The addition of an exogenous fiscal policy to the model is simplified by retaining the fixed rate fixed reserves assumptions such that the base constraint (43) can be rewritten:

\[(43a) \quad dB + dS = GD.\]

substituting for \(dS = GD - dB\) in the difference form of the credit market for Case C and solving;

\[
\begin{bmatrix}
CM_1' (CM_S' - CM_B') \\
FM_1 \\
0
\end{bmatrix}
\cdot
\begin{bmatrix}
di \\
dB
\end{bmatrix}
=
\begin{bmatrix}
CM_{Ie}' \\
FM_{Ie}' \\
0
\end{bmatrix}
\cdot
\begin{bmatrix}
dif \\
GD
\end{bmatrix}.
\]

\(di/GD = 0 \text{ and } dB/GD = \frac{CM_1'}{CM_S' - CM_B'} > 0\)

Alternatively, the base may be exogenous, in which case

\(di/dB = 0 \text{ and } GD/DB = \frac{CM_1' - CM_B'}{CM_S'} > 0.\)
While sterilization of the base appears to have been the normal practice in Canada over the period under study, it should be noted that this does not imply an offset of the money supply itself. Indeed, an increase in the foreign component of the base which is offset by a reduction in government deposits at the chartered banks will still result in some reduction of the money supply. The derivation of this point is made by adding $D_g$ the simplified system above to form:

\begin{align}
(46)' & \quad M = m(i, x, \ldots, D_g)B \\
(47)' & \quad CM(i, x, \ldots, D_g, B, S) = 0 \\
(48) & \quad FM(i, x, \ldots, F) = 0 \\
(49)' & \quad dB = dS = dF + D_g
\end{align}

Note $CM_{D_g} < 0$, as an increase in government deposits at chartered banks raises $g$ and reduces the domestic bank credit multiplier by $rg$. (Additional reserves held against increased government deposits reduce banks ability to extend credit.)

For the flexible rate case, if all intervention is financed

---

1D. Roper, "Macroeconomic Policies and the Distribution of the World Money Supply," *Quarterly Journal of Economics*, Vol. LXXXV (February, 1971) p. 120, suggests that Canadian sterilization is automatic due to government deposit shifts offsetting. This study finds not only that government deposit shifts are not the major source of base sterilization, but that this would not sterilize the money supply in any event.
through government deposit level changes,

\[ dF = -dG \quad \text{and} \quad dB = -dS \]

such that \((47')\) and \((48')\) form the system:

\[
\begin{bmatrix}
CM_1 & CM'_x \\
FM_1 & FM'_x
\end{bmatrix}
\begin{bmatrix}
di \\
dx
\end{bmatrix}
=
\begin{bmatrix}
-CM_{if} & (CM'_i-CM'_S) & CM'_D \\
-FM_{if} & 0 & -FM'_F
\end{bmatrix}
\begin{bmatrix}
dF \\
DB
\end{bmatrix}
\]

Whose solutions

\[
\frac{di}{dF} = \frac{CM'_iFM'_F + CM'_D FM'_x}{\Delta A} \quad \text{and} \quad \frac{dx}{dF} = \frac{CM'_iFM'_F + CM'_D FM'_x}{\Delta A}
\]

differ from those in Case A only by the substitution of \(CM'_D\) for \(CM'_S\), such that

\[
\left| \frac{di}{dF} \right| \quad \text{securities financing} \quad \text{as} \quad \left| \frac{di}{dF} \right| \quad \text{deposits financing}
\]

It is reasonable to assume \(CM'_S > |CM'_D|\) such that the response of the interest and exchange rate to intervention is greater under conditions in which exchange rate intervention is financed through the securities market. However, government deposits will effect the money multiplier directly \((46')\) such that the net effect on the money supply will be greater when deposits are run down to finance exchange market purchases.
The results of adding government deposits changes to Case B, fixed exchange rates variable reserve levels are similar; e.g.

\[
\left| \frac{di}{dB} \right| = - \left[ \frac{CM_I^I}{Dg} \frac{FM_I^I}{B} \frac{CM_I^I}{B} \right] < \left| \frac{di}{dB} \right| \text{ fixed exchange rates securities financing} \]

with \( CM^I_B > |CM^I_Dg| \).

But \( dM/dB \) deposits financing < \( dM/db \) securities financing.

A major change is wrought in Case C (fixed exchange rates - fixed reserves) however, as government deposit shifts between the Bank of Canada and chartered banks add an additional degree of freedom such that the base may remain exogenous to the system. Consider the differentiated form of (47') and (48) and (49)' with \( dF = dx = 0 \):

\[
CM_I^i di + CM_I^i dI + CM_I^i dDg + CM_B^i dB + CM_S^i dS = 0
\]

\[
FM_I^i di = FM_I^i dI = 0
\]

\[
dB + dS = dDg
\]

substituting \( dB + dS \) for \( dDg \) from the base constraint and rearranging terms yields:

\[
\begin{bmatrix}
CM_I^i & \left( CM_I^i + CM_S^i \right) \\
FM_I^i & 0
\end{bmatrix}
\begin{bmatrix}
di \\
dS
\end{bmatrix}
= \begin{bmatrix}
-CM_I^f - (DM_B^i + CM_Dg^i) \\
-FM_I^f
\end{bmatrix}
\begin{bmatrix}
dif \\
DB
\end{bmatrix}
\]

With \(-FM_I^f (CM_Dg^i + CM_S^i) = \Delta C > 0\), assuming \( CM_S^i > CM_Dg^i \), the responses of endogenous terms to exogenous are given by:
Note that if the exchange market responds equally to changes in the domestic and foreign interest rate, \( \frac{dS}{dif} \) and \( \frac{dS}{dif} = 1 \), changes in the base have no effect on the domestic interest rate, but the response of the money supply, given by

\[
\frac{dM}{dB} = \frac{\partial m}{\partial Dg} + 1 > 0 \text{ so long as } \frac{\partial m}{\partial Dg} < 1.
\]