THE NEW CAMBRIDGE AGGREGATE PRIVATE EXPENDITURE FUNCTION: A THEORETICAL MODIFICATION AND EMPIRICAL TESTING FOR CANADA

by

Abu Nasar Md. Wahid

A thesis
presented to the University of Manitoba
in fulfillment of the
thesis requirement for the degree of
Doctor of Philosophy
in
Department of Economics

Winnipeg, Manitoba

ISBN 0-315-54822-3

THE NEW CAMBRIDGE AGGREGATE PRIVATE EXPENDITURE FUNCTION: A THEORETICAL MODIFICATION AND EMPIRICAL TESTING FOR CANADA

BY

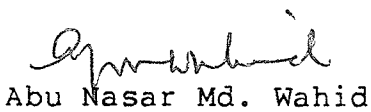
ABU NASAR MD. WAHID

A thesis submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements of the degree of

DOCTOR OF PHILOSOPHY

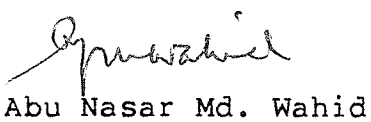
I hereby declare that I am the sole author of this thesis.

I authorize the University of Manitoba to lend this thesis to other institutions or individuals for the purpose of scholarly research.



Abu Nasar Md. Wahid

I further authorize the University of Manitoba to reproduce this thesis by photocopying or by other means, in total or in part, at the request of other institutions or individuals for the purpose of scholarly research.



Abu Nasar Md. Wahid

ABSTRACT

The most distinguishing feature of the Cambridge Economic Policy Group (CEPG) model is that the government budget deficit and the current account deficit are directly related. In the national income accounting framework, this proposition holds under the hypothesis that the private sector spends almost the entire amount of its disposable income with a short lag.

In testing this hypothesis, the CEPG constructed a unique aggregate private expenditure (PX) function, and estimated it jointly with a private sector disposable income (PDI) function, using the maximum likelihood (ML) method with annual British data, initially for 1954-72 and later for 1954-74. The estimated results were consistent with the hypothesis.

Since then
no other study could corroborate the CEPG hypothesis, rather, critics identified some specification errors with the PDI function and pointed out that the method of estimation adopted by the CEPG was at fault. They estimated the model with some other methods using more recent (1962-80) data and found that the results were inconsistent with the CEPG proposition.

This thesis examines the New Cambridge model and discovers that in addition to the faulty estimation method and misspecified PDI function, the PX function suffers from some serious macroeconomic and econometric problems as well.

In order to resolve the problems already identified and to test the model for the Canadian economy, this thesis proposes a modification to the CEPG model and offers an alternative estimation technique.

Findings, based on quarterly Canadian data in real terms for the periods of 1972-86 and 1962-86 suggest that the proposed model estimated with the alternative technique yields an overall good fit. Furthermore, the findings support the original CEPG hypothesis that the private sector expenditure is adjusted to its disposable income with a short lag.

A simulation experiment has further validated the conclusions drawn from the regression analyses.

This study has both academic and policy implications. As far as the academic interest is concerned, the outcome of this study indicates that the CEPG theory is worthy of further consideration, even though it was about to be abandoned in the early 1980's. With regard to policy, the empirical validity of the CEPG hypothesis for Canada suggests that the private sector is in balance, which automatically implies that the government budget deficit and the current account deficit are interdependent.

ACKNOWLEDGEMENTS

This study would have not been possible to undertake and complete without the direct and indirect support of several mentors and friends of mine.

Among them, the most noteworthy is my thesis advisor professor Costas Nicolaou to whom my debt is immeasurable and invaluable. The idea of this research, its progress and findings owe to a great deal to him. In the first instance, I must express my profound gratitude and thankfulness to him for his relentless and sincerest advice and assistance to make this study a success.

I am also thankful to professors Wayne Simpson, Richard Lobdell and Sivalingappa Halli for their comments and suggestions on earlier drafts of this thesis.

I am specially grateful to Professor Henry Rempel who encouraged me to join the Ph.D. program at this university in 1983.

The Graduate Studies Committee of the department of Economics and the Faculty of Graduate Studies of this university also deserve my thanks and gratitude for providing me with financial assistance in the form of Teaching Assistantship and The University of Manitoba Graduate Fellowship respectively.

I also feel obliged to convey my gratefulness to professors Cy Gonic, John Loxley, and Wayne Simpson who gave me the opportunity to teach in the department as a Sessional Lecturer. This has not only been a means of my survival but also a source of gaining teaching experience.

I am also thankful to some of my friends who helped me in many ways during the course of this research. They are: Tilak Abeysinghe, John Baffoe, Khorshed Chowdhry, Saud Chowdhry, Gobind Ganga, Fidelis Ezeala-Harrison, Chowdhury Haque, Hafiz Rahman and Zelealem Yiheyis.

I am also grateful to my parents and elder brother whose guidance and genuine concern for my future brought me to this stage.

Finally, I must express my heartfelt gratitude to my beloved wife-Bithi, son-Asaad and daughters-Najla and Naila who missed me on several important occasions of family affairs due to this research. They went through a painful period of loneliness and agony for this study.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Chapter I

INTRODUCTION

1.1 STATEMENT OF THE PROBLEM

There has been great concern among economists and policy-makers about mounting government budget deficits[1] almost all over the world. The reason for this concern lies in the fact that rising government budget deficits are held to cause many economic evils, such as inflation, public debt, crowding out of private investment and deterioration in the balance of payments on the current account.

In recent years, however, special emphasis has been put on a direct link between the government budget deficit and the balance of payments current account deficit.

The theoretical basis of such a link stems from the accounting identity that the sum of the deficits of the private,[2] public[3] and foreign[4] sectors taken together is

---

[1] Among different concepts of government budget, this study will refer to the 'national accounts budget' which includes all government expenditures and revenues affecting the flow of income.

[2] Private sector is comprised of the personal sector and the company sector.

[3] Public sector includes federal, state/provincial and local governments, and public corporations (or Crown corporations in the Canadian context).

nil. However, this identity does not automatically give rise to a direct link between the government budget deficit and the current account deficit. Rather it crucially depends on the deficit of the private sector. More specifically, if and only if the private sector deficit is zero or constant, then the change in government budget deficit has to be directly reflected on the change in current account deficit and vice versa.

The implication of a zero private sector deficit is that the private sector fully adjusts its expenditures to disposable income with a very short lag. This hypothesis was first proposed and examined by the Cambridge Economic Policy Group (CEPG),[5] popularly known as the New Cambridge (NC) school, for the U.K. economy.[6]

In testing this hypothesis, the group constructed a unique aggregate private expenditure (PX) function. In this function, private expenditure was expressed as a function of private sector current disposable income (PDI) and that of

---

[4] This includes foreign nationals, companies and governments at all levels.

[5] The CEPG is a group of economic forecasters in the Department of Applied Economics at the University of Cambridge, England. Nicholas Kaldor was a senior patron of this group until his death. Among the members of the group, Wynne Godley, Fransis Cripps, Martin Fetherston, Robert Neild and Christopher Taylor are most noteworthy.

[6] T.F. Cripps, W.A.H. Godley, and M.J. Fetherston, (1974), "Memorandum to the Expenditure Committee", Ninth Report from the Expenditure Committee: Public Expenditure, Inflation and Balance of Payments, London, Her Majesty's Stationery Office.

lagged disposable income (PDI_{-1}) and certain other non-income variables such as change in bank loans outstanding to the personal sector (BAP), change in hire purchase debt outstanding to the personal sector (HP), and change in inventories (stockbuilding) in the private sector including inventory valuation adjustment (stock appreciation) (ST).[7]

In terms of this PX function, the NC hypothesis proposes, that the sum of the co-efficients of PDI and PDI_{-1} is unity. In order to check the empirical validity of this, the PX function needs to be estimated. But since PX is not only determined by PDI but also determines PDI, another equation has to be added to take care of the simultaneity between PX and PDI. Accordingly, the CEPG specified an extra equation in which PDI was expressed as a function of PX and other exogenous determinants of income (XN). They expressed all variables in real terms and estimated PX jointly with that of PDI using maximum likelihood (ML) method. This method is known as the feedback adjusted maximum likelihood (FAML) method in the NC literature.

Initially, the empirical evidence produced by the NC model, with annual British data (1954-72), showed that the sum of the co-efficients of PDI and PDI_{-1} was slightly over 0.95, implying that over 95 percent of the PDI is spent within two years. (Cripps, Godley and Fetherston: 1974).

---

[7] For definition, see R. Maurice (et. al.) (1968), "National Accounts Statistics: Sources and Methods", London, Her Majesty's Stationery Office, Chapter 13, pp. 390-407.

Thus the initial British experience supported the NC hypothesis, though not in its strict sense.

But soon afterwards, the model was found to have grossly overpredicted private expenditure during 1973-74.[8] In response, the NC school revised its model.[9] This time, they dropped the variable BAP, incorporated a constant term on the right hand side of the PX function and expressed all the variables in nominal rather than real terms and re-established with new evidence, extending the time period from 1954-72 to 1954-74, that their theory was still consistent with the data.[10]

But Chrystal[11] was not satisfied with the revised model and its evidence. He criticised the NC model with reference to its specification of the PDI equation and the estimation method. According to him, the PDI equation is ad hoc, with improper specification and the method of estimation adopted by the CEPG was based on convenience rather than on standard statistical criteria.

---

[8] J.A. Bispham, (1975), "The 'New Cambridge' and Monetarist Criticisms of "Conventional" Policy Making", National Institute Economic Review, November, Vol. 74, pp. 39-55.

[9] The rationale and implications of these changes will be critically evaluated in the next chapter.

[10] T.F. Cripps, W.A.H. Godley, and M.J. Fetherston, (1976), What is Left of New Cambridge? Cambridge Economic Policy Review, No. 2, pp. 46-49.

[11] K.A. Chrystal (1981-a), "The New Cambridge Aggregate Expenditure Function: The Emperor's Old Clothes?", Journal of Monetary Economics, Vol. 7, No. 3, pp.395-402.

Chrystal,[12] and later Chrystal and Darnell,[13] estimated the revised NC aggregate private expenditure function using other techniques such as ordinary least squares (OLS) and indirect least squares (ILS) with more recent British data. Their findings with annual data, both in real and in nominal terms, for the period 1962-80, contradicted the initial results obtained by the CEPG for 1954-72 and 1954-74. Accordingly, they rejected the NC aggregate private expenditure function on both theoretical and empirical grounds. Since then, no one has attempted to correct the model and examine its empirical validity.[14]

---

[12] K.A. Chrystal (1981-b), "The New Cambridge Aggregate Expenditure Function: Correction and Confirmation", Discussion Paper, No. 189, University of Essex,

[13] K.A. Chrystal and A.C. Darnell (n.d.), "The Aggregate Private Expenditure Function Again", Working Paper, University of Essex and University of Durham, unpublished.

[14] Anyadike-Danes reformulated the model in non-linear form and found a very good prediction results with less than one percent error for the period 1965-80. But the problem with the Anyadike-Danes formulation is that it imputed fixed values to each of the parameters on a priori basis. Therefore, whatever be the predictability of the model, it serves hardly any purpose in policy matters. For details, see M. Ayadike-Danes (1982), "The New Cambridge Hypothesis and Fiscal Planning", Cambridge Economic Policy Review, Vol. 8, No. 1, April, pp. 33-38.

1.2 GENERAL OVERVIEW OF THE STUDY

In this theoretical and empirical context, the present thesis examines the revised NC model more closely and discovers that in addition to the PDI equation, the PX function suffers from some macroeconomic and econometric problems. It also confirms that the estimation technique adopted by the CEPG is not appropriate.

The present study surmises that these problems are the probable cause of the apparent breakdown of the NC model, as claimed by Chrystal and Darnell. Accordingly, it attempts to modify the equations of the model to resolve these problems and to adapt the model to the Canadian economy. Furthermore, it offers an alternative estimation technique based on standard statistical criteria and thus corrects the ad hoc method adopted by the CEPG.

Once the modification of the model is completed and an alternative method of estimation is chosen, this study estimates the modified model with the alternative estimation technique using Canadian data to determine; first, whether the modified model and the alternative estimation technique yield an overall good fit; second, whether the modified model estimated with the alternative method confirms the central hypothesis of the NC school for Canada that the private sector expenditure adjusts to its disposable income with a short lag; and finally, if the model is stable in terms of its estimated results.

1.3 SPECIFIC WORK PLAN AND SCOPE OF THE STUDY

The detailed work plan of the present study is as follows. First, the literature on the theory and empirical evidence of the NC aggregate private expenditure function will be critically evaluated. Second, the macroeconomic and econometric problems of the original NC model will be identified by examining the rationale of the variables included in the model. In this context, it will also examine some important variables which have been erroneously excluded from the model. Third, based on the problems already identified, a theoretical modification to the model will be proposed and an alternative method of estimation will be offered. Fourth, the modified model will be estimated with the alternative method using Canadian data to ascertain whether it produces an overall good fit and confirms the NC hypothesis that the private sector is virtually in balance. Fifth, a simulation experiment will be carried out to examine the closeness of the historical movements of the simulated values vis-a-vis the actual values of the dependent variable (PX).

1.4 PURPOSE OF THE STUDY

The primary purpose of this research is to investigate the interdependence of the government budget deficit and the current account deficit for Canada.

Apart from its implications for policy, the present study would serve the purpose of an academic exercise addressing some theoretical and empirical issues which are unanswered in the NC literature.

1.5 ORGANIZATION OF THE STUDY.

Including this introduction, the thesis has been divided into six chapters.

The second chapter provides a description, interpretation and critical evaluation of the theory, empirical evidence and policy implications of the NC aggregate private expenditure function. The purpose of this chapter is to identify and discuss the specific problems of the model in detail.

The third chapter attempts to modify the NC model and its estimation technique in order to free the model from the already identified problems in general, and to adapt the model to the Canadian economy in particular. This chapter constitutes the basic theoretical contribution of the present study.

Chapter four examines whether the proposed modification of the model and its estimation technique produce an overall good statistical fit. It also tests whether the central hypothesis of the NC school, that the expenditure of the private sector adjusts to its disposable income with a short lag, is valid for Canada.

The fifth chapter performs an historical simulation experiment in order to validate the estimated results of the model.

The final chapter presents a summary of this study. It also concludes the thesis with some policy recommendations and directions for further research in this field.

SUMMARY

The New Cambridge model suggests the existence of an interdependence between the government budget deficit and the current account deficit, implying that the private sector of the economy is in balance. The evidence for the earlier periods, i.e., 1954-72 and 1954-74 appears to be consistent with the NC hypothesis, as evaluated by the initial methodology. But the data for later periods do not support the NC view of the connection between the budget and the current account deficits. Rather, the model is found to have some serious theoretical and econometric flaws. This thesis aims at modifying the NC model and examining its empirical validity for Canada.

Chapter II

REVIEW OF LITERATURE.

This chapter deals with the development of different versions of the model[15] originated by the Cambridge Economic Policy Group (CEPG), also known as the New Cambridge (NC) school. It covers the empirical testing of the model as well.

The purpose of this chapter is to provide a survey of the NC literature and to give direction to the main theme of this research.

The chapter has been divided into five sections. The first section discusses the methodological developments of the early NC model and its initial findings; the second section focuses on the testing and criticisms of the early model; section three analyses the revised NC model; the fourth section critically evaluates the main features of the revised model; the last section focuses on the empirical testing of the revised model.

---

[15] This model refers to the New Cambridge aggregate private expenditure function which is inextricably related to their theory of balance of payments.

2.1 DEVELOPMENT OF THE EARLY MODEL

Initially, the New Cambridge approach to balance of payments analysis appeared in an informal manner in the form of newspaper columns.[16] The originality and novelty of the early NC ideas were unclear to a commentator like Smith,[17] for two reasons. First, the CEPG changed their positions several times in the process of arguments and counter-arguments; and second, they were more concerned with forecasting and policy implications than with theoretical issues.[18] However, the views of the Cambridge Economic Policy Group became clear when they presented their formal model and empirical evidence in the form of a memorandum to the British House of Commons Select Committee on Public Expenditure in June of 1974.

2.1.1 Origin of the Model

During the early 1970s, Godley and Cripps[19] observed that the British current account had reached a zero balance in early 1972 from a record surplus of 100 million pounds in 1971. In the second half of 1972, the deficit increased to 300 million pounds per annum, although sterling was devalued

---

[16] For details, see the columns published in The Times. For references, see the bibliography.

[17] R.P. Smith (1976), "Demand Management and the New School", Applied Economics, Vol. 8, No. 3, pp. 193-05.

[18] Ibid.

[19] W.A.H. Godley and T.F. Cripps (1973), "Balance of Payments and Demand Management", The Times Jan. 8, p. 17.

by 20 percent in the same year. In the third quarter of 1973, it further increased to 3,000 million pounds per annum.

The main reason for this poor performance, according to Godley and Cripps[20]

> ".....was the astonishing increase of almost 10 percent between 1971 and 1972 in the volume of imports of goods and services, at a time when output apparently rose by under 3 percent and stockbuilding did not rise at all".

In this empirical context, Godley and Cripps,[21] with a view to tackling the British balance of payments problem, recommended that personal consumption should grow at a rate slower than that of national output, and that government should not enter into any new expenditure commitment beyond 1972. But the government removed all quantitative controls over credit, cut tax rates and expanded its own expenditures through deficit financing. The reason for such an action, Godley and Cripps surmised, was the assumption dominating the policy decisions for several years that ".....the balance of payments is determined as much by events abroad, domestic costs and the exchange rate as by fiscal and monetary decisions at home."[22] They unequivocally denounced this proposition and presented their own theory about the

---

[20] Ibid.

[21] W.A.H. Godley and T.F. Cripps (1974), "London and Cambridge Economic Bulletin Part I: Why Britain Needs a Fresh Set of Principles to Manage Economy?" The Times, Jan. 22, p. 19.

[22] Ibid.

budget and current account deficits.

2.1.2 New Cambridge Theory of Balance of Payments

Although Godley and Cripps[23] were well aware of the problems of inflation and unemployment in the U.K., initially their prime concern was the rapidly deteriorating balance of payments.

The NC theory of balance of payments is based on a direct link between the government budget deficit and the current account deficit. This link was proposed by Robert Neild,[24] a member of the CEPG. According to him, an open economy can be divided into three sectors: private sector, public sector and foreign sector. Any single sector of the economy, at a particular point in time may demonstrate financial surplus [net acquisition of financial assets (NAFA)] or deficit [net acquisition of financial liabilities (NAFL)], depending on the relative size of disposable income and expenditure of the sector in question. But all sectors taken together can never be in surplus nor in deficit. This is essentially derived from the identity:

$$(S - I) + (T - G) + (M - X) = 0 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2.1)$$

where:

S is domestic private sector savings;

---

[23] Ibid.

[24] R. Neild (1973), "London and Cambridge Economic Bulletin Part I: The Seeds of a Classic Inflation", The Times, Jul. 19, p. 27.

I is domestic private sector investment including changes in inventories;

T is government tax revenue;

G is government purchase of domestic goods and services;

M is imports of goods and services;

X is exports of goods and services.

From identity (2.1), it automatically follows that if the private sector surplus (S - I) is zero or constant then government budget deficit would determine the balance of payments current account deficit and vice versa.

2.1.3 Early New Cambridge Model and Its Empirical Findings

The implication of a 'zero private sector balance' to the behavior of the private sector is that it spends virtually the entire amount of its disposable income with a short lag. In order to test this, the CEPG initially constructed an aggregate private expenditure function as follows:

$$PX = bPDI + dPDI_{-1} + gHP + hBAP + qST + U; \quad \ldots\ldots\ldots\ldots (2.2)$$

$$b, d, g, h, q > 0.$$

where:

PX is aggregate private expenditure (composed of consumption, investment including change in inventories, (stockbuilding) but excluding expenditure on housing);

PDI is private sector disposable income (composed of personal disposable income and undistributed corporation profits);

PDI_{-1} is previous period's PDI;

HP is change in hire purchase debt outstanding (consumer loans from non-bank financial institutions, instalment finance companies and department stores.);

BAP is change in bank loans outstanding to the personal sector(excluding loans for house purchase);

ST is stockbuilding including stock appreciation (i.e. physical change in inventories and inventory valuation adjustment);

U is the disturbance term.

In relation to this specific function, the NC hypothesis proposes that the sum of the parameter estimates of 'b' and 'd' is less than but close to unity and that it is stable. For its verification, the PX function needs to be estimated.

But in estimating the function, the CEPG found that it was not the appropriate formulation because PX is not only determined by PDI but also determines PDI. Thus the PX function alone is not capable of capturing the feedback effect of PX onto PDI. Therefore, in order to take care of the simultaneity between PX and PDI, they specified another equation, i.e.:

PDI = nPX + XN ....(2.3)

where:

'n' is a co-efficient that represents the extent to which private expenditure influences the magnitude of private income in the current year. Through an iterative process, the CEPG estimated the PX function, with 'n' ranging from 0.0 to 1.0, and found that the value 0.42 for 'n' yields the best fit of the PX function. Thus, they select 'n' to be 0.42, implying that on the average, during the period under consideration, an additional 100 pounds of private expenditure would generate 42 pounds of private disposable income in the same year. Thus, 0.42 can be considered as a crude estimate of 'n'.

XN is a variable representing other exogenous determinants of income on which no observation was taken. This is, therefore, merely an error term.

The NC school encountered another problem with the disturbance term of the PX function:

> "...with income and expenditure growing over time it cannot realistically be assumed that the disturbances in the above formulation will have constant variance, so that some normalization is necessary." (Cripps, Godley and Fetherston: 1974)

Accordingly, they took a logarithmic transformation of the PX function. Thus the early NC model takes the following form:

$$LogPX = Log[bPDI + dPDI_{-1} + gHP + hBAP + qST] + U; \quad ...(2.4)$$

$$PDI = nPX + XN \quad .....(2.5)$$

The NC school expressed all the variables in real terms. Given 'n' to be 0.42 and taking no observation on XN,[25] the CEPG jointly estimated the equations with annual British data for the period 1954-72, using maximum likelihood (ML) method under the assumption that the disturbance term is normally and independently distributed; and that the disturbance term follows first order autoregressive scheme.

The estimated results as reported by the NC school are as follows,[26] with 't' statistics in parentheses.

---

[25] The CEPG-justification for the replacement of 'n' by 0.42 and having no observation on XN, in relation to the CEPG estimation method is discussed later in this chapter under the method of estimation.

[26] T.F. Cripps, W.A.H. Godley and M.J. Fetherston (1974), "Public Expenditure and the Management of the Economy: A Memorandum to the Expenditure Committee", Ninth Report to the Expenditure Committee: Public Expenditure, Inflation and Balance of Payments, Jul. London, Her Majesty's Stationery Office.

$$PX = 0.533PDI + 0.416PDI_{-1} + 0.899HP + 0.970BAP + 0.962ST \quad (2.6)$$
$$(10.08) \quad (07.81) \quad (03.13) \quad (03.68) \quad (13.08)$$

> "The official figures for personal bank advances increase rapidly in 1971 and 1972 following the implementation of competition and credit decontrol in September 1971. The above equation was therefore first estimated for the period 1954-70 only; since the bank advances appear to be playing the role of a proxy monetary variable, the observed values of this series for 1971 and 1972 (which would obviously be misleading) were replaced by those obtained from a regression of bank advances on HP for 1954-70" (Cripps, Godley and Fetherston: 1974)

The CEPG did not report the R^2 of this fit in any source. As a result, it is not possible to ascertain the goodness of fit of this model. From 't' statistics, it is clear that all the variables are significant[27] in explaining the variation in the dependent variable PX. Although, the Durbin-Watson 'd' statistic is not reported, the CEPG observed that there was no significant autocorrelation in the model.

The estimated co-efficients of PDI and PDI_{-1} are calculated to be 0.533 and 0.415 respectively. The implication is that an increase in private sector disposable income by 100 pounds in the current period will cause an increase in the current and subsequent periods' expenditures by about 53 and 42 pounds respectively. That is, about 95 percent of private sector disposable income is spent within two years, implying that the private sector is more or less

---

[27] 5 percent level of significance will be consistently used in testing hypotheses throughout this research.

in balance, which in turn leads to the conclusion that the deficit (or surplus) of the public sector would be more or less reflected on the deficit (or surplus) of the foreign sector and vice versa.

This conclusion based on the sum of the co-efficients of PDI and PDI_1 is not unambiguous altogether. Because the correlation coefficient between PDI and PDI_1 for 1954-72 is 0.987, as found by Chrystal (1981-b).[28] This high correlation between PDI and PDI_{-1} makes the 't' tests inappropriate for the individual significance of these variables. In this case, an 'F' test for the joint significance of PDI and PDI_{-1} is necessary which the CEPG is not known to have performed.

2.2 CONFIRMATION AND CRITICISM OF THE EARLY MODEL

Soon after the submission of the NC evidence to the House of Commons Expenditure Committee (June, 1974), the British Treasury, as discussed in Mowl,[29] using the same CEPG method, verified the empirical findings of the CEPG with regard to the sensitivity and stability of the parameter estimates over time and the justification for the exclusion of the constant term from the PX function. In these tests,

---

[28] K.A. Chrystal (1981-b), "The New Cambridge Aggregate Expenditure Function: Correction and Confirmation", Discussion Paper, No. 189, University of Essex.

[29] C. Mowl (1974), "Godley's Evidence to the Select Committee on Expenditure Regarding Demand Management: The "Basic Proposition" and the Associated Econometrics", Unpublished.

the empirical evidence suggested that the NC theory was unshakable. Based on these preliminary findings, the Treasury forwarded the CEPG memorandum to the House of Commons Expenditure Committee for hearing in June of 1974.

During the time when the CEPG evidence was being heard in the House of Commons Expenditure Committee, and immediately afterwards, Stamler and Grice, as discussed in Stamler,[30] had applied certain tests to the CEPG model to examine the validity and robustness of the PX function. They carried out the tests by introducing more lags on the income terms, inserting a constant term on the right hand side of the function and varying the crude estimate of 'n', i.e. 0.42. These findings suggest that under different circumstances, neither the sum of the estimated co-efficients of the income terms nor the lag in adjustment were substantially different from what the CEPG had postulated.

In order to test the consistency of the NC results, Stamler (1975) estimated the PX function with annual data in three different ways: first, ignoring simultaneity between PX and PDI and recognizing heteroscedastic error, he estimated the logarithmic form of the function as a single equation; second, he ignored both the simultaneity and heteroscedastic error and thus estimated the non-logarithmic form of the private expenditure function as a single equation with a constant term on the right hand side; and

---

[30] H. Stamler,(1975), "Some Further Investigation into New Cambridge Expenditure Functions", unpublished.

third, the same equation as in the second case, but without a constant term. In all the cases he used OLS. The results are reported in Table 1.

Based on these results, the only conclusion that can be drawn is that the sum of the co-efficients of the income terms is less than but fairly close to unity in all cases. This supports the NC hypothesis that the private sector is more or less in balance. However, R^2s, Durbin-Watson 'd' statistic and Student's 't' statistics are not available in any source for these models. Due to the absence of R^2, it is unknown how well the models fit the data. Since 't' statistics are not reported, it is difficult to ascertain whether the independent variables are statistically significant in explaining the variation in dependent variable. The absence of 'd' statistics makes it impossible to judge if the models suffer from autocorrelation. Due to the missing summary statistics, R^2, 'd' and 't', it is difficult to ascertain the quality and reliability of the estimates.[31]

Smith (1976) examined whether the PX function was sensitive to estimation techniques. For this purpose, he estimated it with two different methods other than the CEPG

---

[31] H. Stamler (1975) also estimated the PX function with quarterly data both ignoring and recognizing the simultaneity between PDI and PDI_{-1}, using a lag of 9 quarters. But the quarterly data displays somewhat different results; i.e. the sum of the co-efficients of the income terms ranges from 0.77 to 0.87 in various cases.

TABLE 1

Stamler's Single Equation OLS Estimates of the Aggregate Private Expenditure Function 1954-72

Regressors:	Parameter Estimates		
	Logarithmic form with constant term	Non-logarithmic form without constant term	Non-logarithmic form with constant term
Private Sector Disposable Income(PDI)	0.562	0.560	0.566
Lagged Private Sector Disposable Income(PDI_{-1})	0.388	0.389	0.387
Change in Bank Loans Outstanding to the Personal Sector (BAP)	0.737	0.750	0.755
Change in Hire Purchase Debt Outstanding (HP)	0.869	0.860	0.872
Stockbuilding (ST)	0.944	0.970	0.959

Variables are expressed in constant prices;

All data are annual.

Source: H. Stamler (1975), "Some Further Investigation into New Cambridge Expenditure Functions", (Unpublished)

method.[32] They are the indirect least squares (ILS) method considering the simultaneity between PX and PDI assuming 'n' =0.42; and ordinary least squares (OLS) method assuming 'n' = 0, which amounts to ignoring the simultaneity between PX and PDI. Smith's results have been compared with those of the original FAML results obtained by the CEPG in Table 2.

Smith did not provide any summary statistics of his estimates. However, from appropriate significance tests, he observed that parameter estimates obtained by ILS and OLS are not significantly different from those obtained by the original FAML method. He also observed that the NC aggregate private expenditure function does not suffer from simultaneity bias, because the relevant residual sum of squares was observed to be small. From the heteroscedasticity test he found that the model was free from this problem. He also found that the sum of the coefficients of PDI and PDI_{-1} was close to 0.95. Smith did not report the Durbin-Watson 'd' statistic, nor did he claim to have found the model free from autocorrelation.

On the basis of Smith's findings, apart from the possibility of autocorrelation, two conclusions can be drawn: first, the New Cambridge PX function is stable regardless of whether it is estimated with FAML, ILS or OLS methods; and second, it supports the main NC hypothesis that the private sector spends virtually all of its disposable

---

[32] In doing so, he used the same set of data that the CEPG had originally used.

TABLE 2

Smith's Comparative Estimates of the Aggregate Private Expenditure Function 1954-72

Regressors:	Parameter Estimates		
	Maximum Likelihood Method(ML)	Indirect Least Squares Method(ILS)	Ordinary Least Squares Method(OLS)
Private Sector Disposable Income(PDI)	0.533	0.545	0.573
Lagged Private Sector Disposable Income(PDI_{-1})	0.416	0.404	0.375
Change in Bank Loans Outstanding to the Personal Sector (BAP)	0.790	0.719	0.674
Change in Hire Purchase Debt Outstanding (HP)	0.899	0.992	0.924
Stockbuilding (ST)	0.962	0.971	0.958

All the variables are expressed in constant price;

All data are annual;

Source: R. P. Smith (1976), "Demand Management and the New School", Applied Economics, Vol. 8, No. 3, pp. 193-205.

income with a short lag, thus supporting the NC theory of balance of payments.

The NC theory of balance of payments was strongly criticised by Bispham.[33] Based on the facts presented by the CEPG, Bispham observed that the variable bank advances to the personal sector (BAP) rose rapidly in 1971 and 1972 following the introduction of competition and credit decontrol policies. As such, the actual observations of the variable BAP for the period 1971-72 were replaced by the calculated values based on a regression of BAP on HP for the period 1954-70. This, according to Bispham, is equivalent to an admission that the initial specification of the NC aggregate private expenditure function did not fit the data well with the changed monetary situation. This raises doubt about the usefulness of the model, should monetary conditions change again.

In addition, from the British Blue Book[34] data (constant price), according to the CEPG method, Bispham showed how the CEPG model predicted the aggregate expenditure of the private sector for the period 1972-74 in Table 3 which suggested that the NC equation overpredicted the private expenditure by more than 10 percent during 1973-74.

---

[33] J.A. Bispham (1975), The 'New Cambridge' and Monetarists Criticisms of 'Conventional' Policy Making", National Institute Economic Review, Vol. 74, pp. 39-55.

[34] The United Kingdom National Accounts books are popularly known as Blue Books.

TABLE 3

Bispham's Prediction Results Based on the Aggregate Private Expenditure Function 1972-74

Variables	Observed Values			Predicted Values		Residuals	
	1972	1973	1974	1973	1974	1973	1974
Aggregate Private Expenditure (PX)	40249	43151	42937	44914	46761	-1763	-4824
Private Sector Disposable Income(PDI)	42406	44989	45136				
Change in Bank Loans Outstanding to the Personal Sector (BAP)	239	163	-63				
Change in Hire Purchase Debt Outstanding (HP)	218	144	-45				
Stockbuilding (ST)	1094	3156	4239				

All variables are expressed in constant price;

All data are annual;

Data for 1972, 1973 and 1974 have been deflated by the deflators 1.1597, 1.2715 and 1.4689 respectively.

Source: J. A. Bispham (1975), "The 'New Cambridge' and Monetarist Criticisms of "Conventional" Policy Making", National Institute Economic Review, Nov. Vol. 74, pp. 39-55.

Based on this evidence, he concluded that the NC aggregate private expenditure function "has broken down massively" (Bispham: 1975). Bispham, however, did not provide any explanation as to why the NC model broke down in 1973-74.

Cripps, Godley and Fetherston[35] accepted Bispham's conclusion and commented as follows.

> "The fact that companies did not continue to borrow pretty nearly one-for-one to finance stocks in the year of greatly accelerated inflation, 1974, a possibility explicitly foreseen when the equation was first presented, cannot properly be adduced to discredit it." p. 48.

From this quotation, it appears that Cripps, Godley and Fetherston knew that their model was not full-proof against high rate of inflation. Henec, Bispham's (1975) findings could not surprise them.

2.3 REVISED NEW CAMBRIDGE MODEL

The empirical breakdown of the NC model during the post 1972 period prompted Cripps, Godley and Fetherston (1976) to revise their model. In doing so, they dropped the variable BAP, incorporated a constant term on the right hand side of the equation and expressed all the variables in nominal rather than in real terms.[36] Other assumptions remained the

---

[35] T.F. Cripps, W.A.H. Godley, and M.J. Fetherston, (1976), "What is Left of New Cambridge?" Cambridge Economic Policy Review, No. 2, pp. 46-49.

[36] For a more detailed rationale, see sub-subsection 2.4.1.3.

same. Thus the revised two-equation model becomes:

$$LogPX = Log[\ a + bPDI + dPDI_{-1} + gHP + qST] + U \quad .....(2.7)$$

$$PDI = nPX + XN \quad .....(2.8)$$

where:

a is the intercept;

all other variables and constants are defined as before;

With these changes in the model, they estimated the revised private expenditure function with their FAML method for the original period (1954-72) and for an extended period (1954-74) separately, in order to test whether their model did in fact break down during the post 1972 period as claimed by Bispham in 1975. The results with 't' statistics in parentheses, are as follows:

$$\underset{\text{(t-ratios)}}{1954\text{-}72{:}PX = \underset{(-2.70)}{-208.6.} + \underset{(13.18)}{.624PDI} + \underset{(6.74)}{.345PDI_{-1}} + \underset{(3.70)}{1.062HP} + \underset{(10.61)}{.874ST}} \quad .....(2.9)$$

$$\underset{\text{(t-ratios)}}{1954\text{-}74{:}PX = \underset{(-1.14)}{-156.5.} + \underset{(7.60)}{.616PDI} + \underset{(4.09)}{.360PDI_{-1}} + \underset{(2.26)}{1.173HP} + \underset{(4.99)}{.472ST}} \quad .....(2.10)$$

Again, R^2s are not reported anywhere for these models, and so it is not known how well the models fitted the data. The 't' statistics suggest that all the explanatory variables are statistically significant. The intercept in the case of extended data period is not significant. Due to the absence of Durbin-Watson 'd' statistics, it is hard to know whether or not there is autocorrelation in the model.

However, it is observed that the co-efficients of disposable incomes (PDI and PDI_{-1}) and changes in hire purchase debt outstanding (HP) have been altered slightly when the period is extended up to 1974 but at the 5 percent level, their statistical significance did not change at all. The sum of the co-efficients of the income terms remains stable at less than but close to unity, i.e. 0.96 and 0.97 for the original and extended periods respectively, implying that the private sector maintains a small and stable surplus. Thus the overall estimated results remain quite consistent with the original NC hypothesis and therefore, the new version of the NC aggregate private expenditure function has survived this empirical test.[37]

2.4 MAIN FEATURES OF THE REVISED MODEL

The CEPG revised their aggregate private expenditure function when it was found to be inconsistent with data (Bispham: 1975). This section critically evaluates the main features of the revised NC model as it exists now, with reference to the specification of the model and the estimation technique adopted by the CEPG.

---

[37] It should however be noted that, again the CEPG did not perform an 'F' test to verify whether or not the sum of the co-efficients of PDI and PDI_{-1} is jointly significantly different from zero and unity. For the rationale of the 'F' test, see subsection 2.1.

2.4.1 Specification of the Model

As it has already been mentioned, the major focus of the NC model is on its aggregate private expenditure (PX) function. In order to avoid the problem of simultaneity bias from the parameter estimates of the PX function, the CEPG justified the formulation of an added equation for PDI. This subsection critically evaluates the specification of these two equations separately.

2.4.1.1 The Aggregate Private Expenditure Function

The New Cambridge PX function integrates consumption and investment into a single equation, rather than specifying them separately as is done in the Keynesian tradition. Cuthberston[38] rationalized this integration by saying that:

> ".....the interaction between the personal sector and the company sector in determining their expenditure decisions is a complex one and therefore, a better prediction of consumption plus investment expenditure may be obtained using a single expenditure equation for the whole of the private sector (i.e. companies plus persons) rather than two separate equations." (pp. 57-58).

The CEPG's aggregated private expenditure function is quite uncommon and new in macroeconomic literature. Although initially critics objected in principle to the aggregation of personal consumption and corporate investment, during the recent past, applied economists have been increasingly

---

[38] K. Cuthberston (1979), Macroeconomic Policy: The New Cambridge, Keynesian and Monetarist Controversies, London, Macmillan Press Ltd., Chapter 3, pp. 53-89.

accepting it for the purpose of forecasting and public policy analysis of government deficit and balance of payments deficit.[39]

In the Keynesian macroeconomic literature, it is an established hypothesis that investment is volatile, while consumption is stable. Since consumption constitutes a larger segment of the private expenditure, therefore, a PX function is expected to be more stable than an investment function separately. However, this proposition is subject to empirical testing.

In response to the model presented by Fetherson and Godley[40] at the Carnegie-Rochester conference in 1978, Blinder[41] said that since the aggregate private expenditure function was so central to the NC theory, it would need a more careful examination. In doing so, Blinder (1978) expressed the NC aggregate private expenditure function in a

---

[39] M. Anyadike-Danes (1982), "The New Cambridge Hypothesis and Fiscal Planning", Cambridge Economic Policy Review, April, Vol. 8, No. 1, pp. 33-38.

[40] M.J. Fetherston and W.A.H. Godley (1978), "New Cambridge Macroeconomics and Global Monetarism: Some Issues in the Conduct of U.K. Economic Policy", in K. Brunner and A. Meltzer (et.al.), Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economies, North Holland, Vol. 9, pp. 33-65.

[41] A.S. Blinder (1978), "What's New and What's Keynesian in the New Cambridge Keynesianism?", in K. Brunner and A. Meltzer (et. al.) Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economies, North Holland, Vol. 9, pp. 67-85.

more Keynesian fashion as follows:[42]

$(C + I) = u_1 (PRDI + UCP) + u_2 A_{-1}$, ...(2.11)

$0 > u_1, u_2 < 1$;

where:

PRDI is personal disposable income;

UCP is undistributed corporation profits

A_{-1} is real net worth at the close of the previous period.

u_1 and u_2 are constants;

C and I are defined as before.

If equation (2.11) is considered to be equivalent to a truncated version of the NC aggregate private expenditure function, then according to Blinder, this can be conceptualised as the sum of an Ando-Modigliani[43] type of consumption function:

$C = v_1 PRDI + v_2 A_{-1}$, $0 < v_1 < v_2 < 1$.....(2.12)

and an investment function that depends only on retained earnings. But still Blinder does not understand how coefficients of PRDI and UCP are equal in (2.11).

Another characteristic of the CEPG aggregate private expenditure function is its ad hoc modelling.

---

[42] This equation is not directly available in the Fetherston-Godley paper (1978), but it definitionally follows from two equations that can be found there.

[43] A. Ando and F. Modigliani (1963), "The Life Cycle Hypothesis of Savings: Aggregate Implications and Tests", American Economic Review, Vol. 53, pp 55-84.

[44] R. Russell and L.M. Wakeman (1978), "New Cambridge

Russell and Wakeman,[44] in their comment pointed out that although Fetherston and Godley formulated their hypothesis as:

H_1: DSFA = (1-w)DPDI .....(2.13)

where:

D is for change;

SFA is the stock of financial assets held by the private sector;

PDI is private sector disposable income;

w is a constant;

they instead tested:

H_2: PX = wPDI + (1-w) PDI_{-1} .....(2.14)

where:

PX, PDI, and PDI_{-1} are defined as before.

Given the unsatisfactory empirical performance of their PX function, they added some non-income variables and finally tested:

H_3: PX = wPDI + (1-w)PDI_{-1} + gHP + hBAP + qST.....(2.15)

where:

all the variables in this function are defined as before;

Equation (2.15) also did not survive empirical testing (Bispham: 1975, Chrystal: 1981-a, 1981-b, and Chrystal and Darnell: n.d.).

Economics Without Markets: A Comment", in K. Brunner and A. Meltzer (et. al.) Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economies, North Holland, Vol. 9, pp. 95-101.

From the very beginning, the CEPG manipulates variables to get a better fit. The CEPG school confessed that they replaced BAP by regressing it on HP to get a better fit in their first attempt to estimate the model for 1954-72. This might have caused a systematic bias in the estimates of the parameter co-efficients. Over and above, they dropped the same variable from the revised model (Cripps, Godley and Fetherston: 1976), with a plea that it was not consistent with the data. Thus both the inclusion and exclusion of this variable were done on an ad hoc basis, just to get a better fit rather than on any theoretical grounds.

ST is another ad hoc variable. About its inclusion as an explanatory variable, Cripps, Godley and Fetherston (1974) have argued that ".....firms treat stocks as liquid liabilities and tend automatically to borrow additional sums from banks to finance them." Thus, basically they have used it as a proxy variable for change in bank advances to the company sector (BAB).

But the problem of using ST as a proxy variable for BAB is three-fold: first, since the data on the original variable BAB are available, there is no valid reason to use a proxy variable for it; second, if the changes in stockbuilding are planned then it can be considered liquid liabilities as claimed by the CEPG. But if they are unplanned, then the CEPG assumption would not be valid; third, and more important, a part of ST [i.e., the value of

physical change in stocks (inventories)] is a component part of the dependent variable (PX), making PX a linear combination of ST. Therefore, the presence of ST as an explanatory variable is not econometrically justifiable.

The revised model inserted a constant term on the right hand side of the equation without any theoretical explanation. Inclusion of a constant term implies that the average and marginal propensities to spend out of disposable income are different. According to Chrystal and Darnell:[45]

> "On the question of constant term, it is better included than excluded in such an equation, for not only does it aid the linear approximation, but its erroneous exclusion could seriously bias the estimates".

The CEPG used the logarithmic transformation of their private expenditure function on the assumption that the error term displays heteroscedasticity. They are not known to have performed any statistical test for the presence of heteroscedasticity. However, prior to the application of the NC model to the Canadian economy, this thesis will conduct a test for heteroscedasticity and the logarithmic formulation will be adopted or abandoned depending on the conclusion of the test.

---

[45] K.A. Chrystal and A.C. Darnell (n.d.), "The Aggregate Private Expenditure Function Again", Working Paper, University of Essex and University of Durham, U.K., unpublished.

2.4.1.2 Feedback Equation

The feedback equation in the NC model can be considered as an auxiliary equation for the purpose of facilitating the estimation process of the function.

In the feedback equation, the variable private sector disposable income (PDI), is expressed as a function of PX and XN where PX represents aggregate private expenditure and XN represents all exogenous determinants of income other than PX. In estimating the model, the CEPG replaced 'n' by its crude estimate (0.42) which was obtained through an iterative process discussed earlier. The selection of the value for 'n' was not done on any standard statistical basis. They also did not take any observation on the variable XN, hence it is clearly vague and undefined and does not add any new information to the model.[46]

2.4.1.3 Common Characteristics of the Revised PX and PDI Equations

The New Cambridge school, in their revised model, expressed both the aggregate private expenditure function and the feedback equation in nominal rather than in real variables. In favor of this alteration, Cripps, Godley and Fetherston (1976) attempted to provide a theoretical explanation. According to them:

---

[46] The econometric flaws pertaining to this equation are critically evaluated later in this chapter under the method of estimation.

> "A constant price expenditure function implies, since the equation involves lags, that a given level of money disposable income in the current period will generate the same amount of real expenditure in the following period, regardless of the rate of inflation between the two periods. However, since this period's expenditure is being financed by the money disposable income of the current and preceding periods, the real expenditure of the current period is more likely to be financed by current and lagged money income, both deflated by the prices prevailing in the current period. But this is the same as denominating the whole thing in money terms."

This is the only rationale, Cripps, Godley and Fetherston (1976), presented in favor of expressing the variables in nominal instead of real terms. It is however, hard to follow the argument contained in this quotation.

Chrystal and Darnell are not convinced with the CEPG-justification for current price formulation of the model. They counter-argued that the current and lagged PDI expressed in nominal terms are likely to be very highly correlated giving rise to multicollinearity in the model. The present research, in verifying the validity of the NC model for Canada will use both current and constant price data for two reasons: first, best linear unbiased estimates can be obtained even in the presence of multicollinearity; and second, it cannot be ruled out that a high correlation does not exist between the same variables in real terms.[47]

---

[47] In fact Chrystal (1981-b) found the correlation coefficient between PDI and PDI_{-1} in real terms for 1962-80 to be as high as 0.970; in nominal terms, for the same period, it was even higher i.e. 0.999.

But the main issue here is whether or not expenditure behavior of the private sector is based on real or nominal values. The CEPG did not make any direct comment on this question; they first estimated the PX function with real variables, and then on the wake of its empirical breakdown, they reformulated it in nominal terms without any apparent theoretical reason. However, the present study would rely more on the function expressed in real variables because in nominal terms, the price variable not only causes spurious correlation but is also likely to distort the relationship. The possibility of a distortion is especially high in the case of accelerated rate of inflation during the mid 1970s on the wake of the international oil crisis.

2.4.2 Method of Estimation

The only source that explains the CEPG method of estimation to a considerable detail is Fetherston's mimeograph[48] of 1975. He termed this technique as a feedback adjusted maximum likelihood (FAML) method.

The primary objective of this method was to endogenise current disposable income, in order to take care of the simultaneity between PX and PDI. In doing so, the CEPG specified an extra equation representing the feedback effect of expenditure into income. The two equations are then

---

[48] M.J. Fetherston (1975), "Estimation of Simultaneous Relationships: A U.K. Private Expenditure Function", Department of Applied Economics, University of Cambridge, England, Unpublished.

jointly estimated with the help of a maximum likelihood method. Chrystal[49] raised a question as to the status of the feedback equation because according to him, PDI is neither a behavioral equation nor a reduced form. He argued that if the feedback equation were considered as an equation and 'n' were set to zero, then the CEPG technique being correctly applied could produce the same parameter estimates as 2SLS. But in reality, the NC school used the feedback equation as an identity rather than an equation. The NC method of estimation has been criticised on two major points: the undefined nature of the variable XN and the use of the crude estimate of 'n'. They are discussed separately as follows.

2.4.2.1 Undefined Nature of XN

Fetherston tried to justify this point in the following manner. In his own words:

> "The procedure to be described here, which will be denoted FAML (feedback adjusted maximum likelihood) attempts to allow for this feedback effect in a way which, unlike 2SLS, does not require specifications of any additional predetermined variables, but merely requires an a-priori value for the magnitude of the feedback effect (i.e. a value for n). This eliminates the danger of misspecifying predetermined variables of the system, but of course, introduces the possibility of misspecifying the value of n. However as long as the feedback parameters are correctly specified, then the estimates obtained will be valid and so compatible with a great

[49] K.A. Chrystal(1981-a), "The New Cambridge Aggregate Expenditure Function: The Emperor's Old Clothes?", Journal of Monetary Economics, Vol. 8, No. 3, pp. 395-402.

> number of possible alternative specifications of other equations." (Fetherston: 1975)

Since no observation has been taken on XN, therefore, the feedback equation does not represent a complete behavioral relationship; hence its inclusion is in fact not taking care of simultaneity between PX and PDI as was originally intended. Chrystal (1981-a) criticised the addition of this equation as making the parameter co-efficients of PDIs biased downward.

2.4.2.2 The Crude Estimate of n

The NC school estimated the private expenditure function given the value of 'n'. Through an iterative method, the NC school found that if 'n' takes the value 0.42, the aggregate private expenditure function yields the best fit. Thus, they take 'n' to be 0.42, in the application of their FAML estimation method. Thus, the NC school considered 0.42 to be a crude estimate of 'n'.

Imputation of 0.42 to the parameter 'n', as done by the NC school was quite an ad hoc phenomenon, not found in any established statistical procedure. Apart from this, the parameter estimates of the PX function are found to be quite sensitive to the value of 'n'. Putting the value of 'n' from 0.0 to 1.0, Mowl (1974) found that the estimated co-efficients of PDI, PDI_{-1}, HP, BAP and ST varies from 0.562 to 0.445, 0.388 to 0.505, 0.869 to 1.045, 0.737 to 0.936 and 0.944 to 0.014 respectively.

Chrystal (1981-a) was most critical about the crude estimate of 'n'. He accused the NC school of simply trying various values, and settling on the value they liked the best. In their estimation method, as Fetherston (1975) has explained after trying different values for 'n' they have settled down at 0.42, which produces the best fit. But Chrystal did not accept this trial and error method. He claimed that the results obtained by the CEPG were manipulative and hence not reliable. The NC school never responded to this fundamental criticism of their model.

2.5 EMPIRICAL TESTING OF THE REVISED MODEL

At the Carnegie-Rochester conference on Public Polices, Fetherston and Godley (1978) presented a paper. In this paper, they constructed a simple open economy macro model for U.K. At the heart of this model, there lies an aggregate private expenditure function and a direct relationship between the government budget deficit and current account deficit. In this paper, they did not present any updated estimates of their private expenditure function; instead, in order to further corroborate their proposed relationship between the twin deficits, they carried out a policy simulation experiment by increasing public sector expenditure. The simulation results supported the NC conclusion that ".....ex post public sector deficits are, in the long run, fully reflected in the external surplus on current account." (Fetherston and Godley: 1978).

Chrystal and Darnell (n.d.), the main critics of the NC school, were not satisfied with the policy simulation results. They made some further verification of the New Cambridge aggregate private expenditure function. However, they estimated the PX function with OLS and ILS methods rather than the FAML method which they had discarded on econometric grounds.

With a view to testing the goodness of fit of the NC aggregate private expenditure function, Chrystal (1981-b) ran a regression on the revised private expenditure function with more recent British data (1962-80). In this estimation process, he ignored simultaneity between PX and PDI and possible heteroscedasticity with the error term of the PX function. Thus he estimated the non-logarithmic form of the single equation PX function using OLS. In his estimation process, he suspected that there was no lag in the adjustment between income and expenditure. Thus in order to test this, he estimated the PX function both with and without PDI_{-1} . The results are shown in Table 4.

R^2s in this Table indicate that all the equations have a very high goodness of fit. For the current price formulation of the equation with PDI_{-1} , the 't' tests suggest that all the variables are statistically significant. However, when PDI_{-1} is dropped, then HP becomes statistically insignificant. In the case of constant price formulation of PX function with PDI_{-1} , the 't' test demonstrates that all

TABLE 4

Chrystal's OLS Estimates of the Revised Aggregate Private Expenditure Function 1962-80

Regressors:	Parameter Estimates			
	Nominal		Real	
Private Sector Disposable Income(PDI)	0.40 (4.5)	0.92 (74.0)	1.1 (5.4)	0.96 (76.0)
Lagged Private Sector Disposable Income(PDI_{-1})	0.59 (5.8)	....	-0.21 (-0.97	....
Change in Hire Purchase Debt Outstanding (HP)	4.9 (3.2)	3.8 (1.4)	-1.8 (-0.64)	-0.38 (-0.16)
Stockbuilding (ST)	0.38 (4.0)	0.46 (2.8)	0.31 (1.4)	0.26 (1.2)
R^2	0.999	0.999	0.999	0.999
Durbin-Watson 'd' Statistics	1.40	0.73	1.00	0.75

Current price data are deflated by the retail price index;

Values in parentheses represent 't' statistics;

Source: K. A. Chrystal (1981-b), "The New Cambridge Aggregate Expenditure Function: Correction and Confirmation", Discussion Paper, No. 189, University of Essex.

the variables except PDI are statistically insignificant. The results of the 't' test basically remain the same when it is performed on the same function without PDI_{-1} . Thus the overall fit in real terms is worse than what is obtained in nominal terms.

The sum of the co-efficients of the income terms are stable and less than but close to unity in all cases. But Chrystal and Darnell (n.d.) did not test the joint significance of the variables PDI and PDI_{-1} using an 'F' test.[50]

The problem with the models is autocorrelation. Both in nominal and in real terms, for the PX function with PDI_{-1} , the Durbin-Watson 'd' statistics are in the inconclusive range, implying that the presence of first order autocorrelation cannot be rejected conclusively. With PDI_{-1} dropped from the PX function, 'd' indicates conclusive evidence of autocorrelation, making the parameter estimates inefficient and significance tests imprecise.

Chrystal (1981-b) also argued that the NC model exhibited structural instability during the mid-1970s. In order to examine this, he conducted a test for the constancy of regression relationships over time, by using a moving regression method advanced by Brown, Durbin and Evans, as discussed in Chrystal (1981-b).

---

[50] For the rationale, see the last paragraph of subsection 2.1.3.

According to this method, he estimated the revised NC private expenditure function as a single equation, first with 10 observations and moved the regression through the data (1962-80) by successively dropping the first and adding the next observation. He carried out this test in both real and nominal terms, and his findings suggest that the estimation results in real terms are highly unstable. The estimated co-efficients of PDI vary from 0.42 to 2.40, and that of PDI_{-1} from -1.50 to 0.54, and that of HP from -10.90 to 10.10. Chrystal (1981-b) has not reported the range of the parameter estimate of ST but mentioned that it had not demonstrated the slightest hint of stability.

Again the results of the moving regressions using current price data were found to be more consistent with the NC hypothesis than those obtained from the constant price data. The range of the co-efficients in nominal and real terms are in Table 5.

Based on these estimated results, it has been observed that the co-efficient of the variable HP is extremely sensitive. The variation of the co-efficients of other variables are also relatively large. Therefore, Chrystal(1981-b) again concluded that the NC aggregate private expenditure function did not seem to be stable at all.

TABLE 5

Chrystal's Constancy Test for the Parameters of the Aggregate Private Expenditure Function 1962-80

Regressors:	Range of Parameter Estimates in current price	Range of Parameter Estimates in constant price
Private Sector Disposable Income(PDI)	0.81 to 0.36	0.42 to 2.40
Lagged Private Sector Disposable Income(PDI_{-1})	0.13 to 0.65	-1.50 to 0.54
Change in Hire Purchase Debt Outstanding (HP)	-0.85 to 5.59	-10.90 to 10.10
Stockbuilding (ST)	1.10 to 0.27	.....

Source: K. A. Chrystal (1981-b), "The New Cambridge Aggregate Expenditure Function: Correction and Confirmation", Discussion Paper, No. 189, University of Essex.

In support of Chrystal's conclusion, Chrystal and Darnell again estimated the aggregate private expenditure function for the period of 1960-82 with the help of the ILS method, taking into account the simultaneity between PX and PDI both with and without a constant term in both real and nominal terms.

The results, contained in Table 6, suggest that the NC model does not conform with the data in real terms regardless of whether it contains a constant term or not. Both with and without the constant terms, R^2s are 0.030 and 0.037 respectively. Such poor RS'2s imply that the PX function does not fit the data well.

In nominal terms, however, the R^2s are 0.999 for the PX function both with and without the constant term. This suggests that the model fitted the data very well. The parameter estimate of the intercept is found to be negative but highly statistically significant. But all other variables except HP, have been found statistically insignificant when a constant term is included in the model. When the constant term is excluded in nominal terms, none of the explanatory variables are found to be statistically significant. Moreover, the sum of the parameter coefficients of the income terms exceeds unity which is against the NC proposition.

TABLE 6

Chrystal and Darnell's ILS Estimates of the Aggregate Private Expenditure Function 1960-82

Regressors:	Parameter Estimates			
	Nominal		Real	
Constant term	.....	-1078.870	.....	548.028
	.....	(-693.628)	.....	(939.737)
Private Sector Disposable Income(PDI)	0.200	0.071	5.532	-4.460
	(0.118)	(0.170)	(6.256)	(-10.006
Lagged Private Sector Disposable Income(PDI_{-1})	0.817	0.989	-4.614	4.544
	(0.135)	(0.204)	(6.295)	(8.675)
Change in Hire Purchase Debt Outstanding (HP)	5.642	3.788	-34.091	47.624
	(1.830)	(2.253)	(47.858	(87.559)
Stockbuilding (ST)	0.356	0.362	1.186	0.884
	(0.109)	(0.117)	(1.714)	(1.575)
R^2	0.999	0.999	0.0375	0.0309
Durbin-Watson 'd' Statistics	1.532	1.971	1.889	1.984

Values in parentheses represent 't' ratios;

Source: K. A. Chrystal and A. C. Darnell (n.d.). "The Aggregate Private Expenditure Function Function Again" Working Paper, University of Essex and University of Durham, (Unpublished).

Thus, according to the findings of Chrystal and Darnell, the NC hypothesis cannot be unambiguously supported either in nominal or in real terms. The evidence presented by Chrystal and Darnell raises a basic question as to the validity of the revised NC aggregate private expenditure function. Therefore the NC theory of balance of payments cannot be taken for granted without further re-examination and verification of the aggregate private expenditure function.

SUMMARY

The New Cambridge approach in explaining the interdependence between the government budget and current account deficits has been derived from the income accounting identity together with the hypothesis that the private sector maintains a small and stable balance. In order to test this hypothesis, the NC school constructed an aggregate private expenditure function and using British data for the period 1954-72 and 1954-74, they empirically supported this hypothesis. Initially, this function was found to be quite stable. However, since 1974, no subsequent study has been able to support the NC hypothesis. Critics pointed out serious theoretical problems with their model and their estimation method, and established with empirical evidence that the model has totally broken down in the mid-1970s, in both nominal and real terms.

Chapter III

MODIFYING THE NEW CAMBRIDGE MODEL

The review of literature has clearly identified the following objections to the New Cambridge (NC) model. First, it includes some ad hoc variables to achieve a better fit without any theoretical justification,[51] second, the estimation technique adopted by the Cambridge Economic Policy Group (CEPG), the originator of the model, is ad hoc and faulty; third, none of the empirical studies could corroborate the postulate of the NC theory for the post-1974 period.

According to the present study, the cause of the empirical breakdown of the NC model is believed to be the ad hoc approach in modelling and the adoption of a faulty estimation procedure. As such, with a view to applying the model to the Canadian economy, this chapter attempts to modify the NC model to correct the theoretical and econometric problems in general, and to fit the model into the Canadian economy in particular. It also proposes an alternative estimation technique.

---

[51] K.A. Chrystal (1981-a), "The New Cambridge Aggregate Expenditure Function: The Emperor's Old Clothes?", Journal of Monetary Economics, Vol. 7, No. 3, pp. 395-402.

The first section of this chapter deals with the modification of the model; the second section offers an alternative estimation procedure.

3.1 MODIFICATION OF THE MODEL

In order to avoid the ad hoc approach in modelling, the present study proposes a modification of the model based on the following principles:

i) the variable(s) which do(es) not have a sound theoretical basis should be dropped;

ii) the excluded variables which have a theoretical importance should be re-instated;

iii) the endogeneity of private sector disposable income should properly be maintained;

The NC model revised by the CEPG in 1976, is composed of the following equations:

$$Log(PX)=Log[a + bPDI + dPDI_{-1} + gHP + qST]+ U; \quad .....(3.1)$$

$$PDI = nPX + XN \quad .....(3.2)$$

$a, b, d, g, q > 0$; 'n' = 0.42;

where:

PX is aggregate private expenditure-composed of consumption and investment including change in inventories (stockbuilding), here investment excludes expenditures on housing;

PDI is private sector disposable income (composed of personal disposable income and undistributed corporation profits);

PDI_{-1} is previous period's PDI;

HP is change in hire purchase debt outstanding (consumer loans from non-bank financial institutions, instalment finance companies and department stores.);

ST is stockbuilding plus stock appreciation (i.e.

physical change in inventories plus inventory valuation adjustment);

U is the disturbance term. Since income and expenditure grow over time, the CEPG assumed heteroscedasticity with the disturbance term. In order to ensure homoscedasticity, they took the logarithmic transformation of their private expenditure function;

'n' is a co-efficient that represents the extent to which private expenditure influences the magnitude of private income in the current year. Through an iterative process, the CEPG estimated the PX function, with 'n' ranging from 0.0 to 1.0, and found that the value 0.42 for 'n' yields the best fit of the PX function. Thus, they select 'n' to be 0.42, implying that on the average, during the period under consideration, an additional 100 pounds of private expenditure would generate 42 pounds of private disposable income in the same year. Thus, 0.42 can be considered as a crude estimate of 'n'.

XN is a variable representing other exogenous determinants of income on which no observation was taken. This is, therefore, merely an error term.

According to the principles just laid down, these equations may be modified separately in the following manner.

3.1.1 Modifying the Aggregate Private Expenditure Function

In the PX function, variable ST has been used by the CEPG as a proxy for change in bank loans outstanding to the business sector(BAB). The NC school rationalized its inclusion by saying that increases in the value of stocks (both due to increases in the physical quantities of stocks and stock prices) more or less automatically gives rise to companies' bank borrowings.[52] But according to the first

[52] T.F. Cripps, W.A.H. Godley and M.J. Fetherston (1976), "Public Expenditure and the Management of the Economy:

principle, since observations on BAB are available, a proxy should not be used for it. Apart from this, ST includes the value of physical change in inventories which is a component part of the dependent variable PX making it a linear combination of ST. Thus, variable ST should be dropped from the private expenditure function on simple econometric ground.

After dropping the proxy variable ST, it is quite logical that BAB should be included as an explanatory variable in the model. Because a substantial portion of the corporate investment depends on corporate bank borrowings.

Following the initial success of the NC model, for the period 1954-72, Bispham[53] with new empirical evidence for 1972-74 claimed that the model had "....broken down massively". In response to Bispham's criticism, the CEPG produced a revised model in which they dropped the variable BAP with a plea that it had not been performing well.[54] This was an indication of their ad hoc approach in modelling. If we consider the theoretical importance of this variable, it seems reasonable to hypothesise that changes in

---

Memorandum to the Expenditure Committee", Ninth Report from the Expenditure Committee, Public Expenditure, Inflation and Balance of Payments, London, Her Majesty's Stationery Office, Jul.

[53] J.A. Bispham (1975), "The New Cambridge and Monetarists Criticisms of Conventional Policy Making", National Institute Economic Review, Vol. 74, pp. 39-55.

[54] T.F. Cripps, W.A.H. Godley and M.J. Fetherston (1974), "What is Left of the New Cambridge?", Cambridge Economic Policy Review, No. 2, pp. 46-49.

bank loans outstanding to the personal sector (BAP) contribute to variation in consumption, another major component of PX; therefore, the present study proposes BAP be retained in the PX function, according to the second principle.

The dependent variable PX, as defined by the CEPG for the U.K. economy did not include expenditure on housing. But in modelling the same function for Canada, we included expenditure on housing, because here, in the national income accounting framework, it is automatically considered as a part of investment. Therefore, in order to fit the NC aggregate private expenditure function more closely to the Canadian economy, a new variable such as mortgage loans approved (MTL)[55] has to be included as an additional explanatory variable. Because it is expected to be a powerful variable to explain the variation in housing expenditure and hence investment, a component of PX.

The variable change in hire purchase debt outstanding to the personal sector (HP) has been an explanatory variable in the model in every formulation. Theoretically speaking, HP is supposed to be a determinant of consumption, which is a part of PX. Empirically, it has been found in Britain to be a powerful variable in explaining the variation in PX. Therefore, it will remain in the PX function according to

---

[55] It should be noted that observations on MTL are collected as flows and they are gross in nature. MTL represents the initial amounts of mortgage loans approved by the lending agencies rather than the actual amount taken.

the second principle.

About the main explanatory variable private sector disposable income (PDI), there is no controversy. This seems to be the most powerful explanatory variable in the model. However, about the use of lagged private sector disposable income PDI_{-1}, some objections were raised by Chrystal and Darnell.[56] They argued that the current period's expenditure of the private sector depends on the disposable income of current period and the savings (S) carried over to the current period from the previous period. Therefore, according to them, it should be previous period's savings (S_{-1}) rather than disposable income which should appear in the PX function as an explanatory variable.

But the justification for using PDI and PDI_{-1} in the PX function can be found; first, in the Keynesian tradition of expressing consumption as a function of current and lagged disposable income; second, PDI_{-1} is a reasonable proxy for previous period's savings (S_{-1}), and finally, the purpose of constructing this function is to test the central hypothesis of the NC school, that the private sector expenditure adjusts to its disposable income within two periods, which can be verified only by considering the estimated co-efficients of current and lagged PDI. Therefore, without lagged PDI as an explanatory variable, it

---

[56] K.A. Chrystal and A.C. Darnell (n.d.), "The Aggregate Private Expenditure Function Again", Working Paper, University of Essex and University of Durham, unpublished.

is not feasible to test the NC hypothesis.

When the CEPG revised the model, they also incorporated a constant term on the right hand side of the PX function. The implication of a constant term is that the marginal and average propensities to spend out of disposable income are different. Since there is no reason to believe that the average and marginal propensities are the same, therefore its exclusion is not justifiable. Rather erroneous exclusion of the constant term can make the parameter estimates biased.

By way of summary, the modification of the PX function can be completed which takes the following form.

$$PX = a + bPDI + dPDI_{-1} + gHP + hBAP + jBAB + kMTL + U \quad ....(3.3)$$

where:

a, b, g, h, j and k > 0;

PX is aggregate private expenditure-composed of consumption, investment including change in inventories. This includes expenditures on housing;

PDI is private sector disposable income (composed of personal disposable income and undistributed corporation profits);

PDI_{-1} is previous period's PDI;

HP is change in hire purchase debt outstanding to the personal sector (consumer loans from sales, finance and consumer loan companies and department stores.);

BAP is change in bank loans outstanding to the personal sector (personal loans for the purchase of marketable stocks and bonds, and other consumer goods and services);

BAB is change in bank loans outstanding to the business sector (loans for construction, retail trade and service industries);

MTL is mortgage loans (from chartered banks, life insurance companies, trust companies, loan and other companies and central mortgage and housing corporation). Observations of MTL is collected as flows and they are gross in nature. MTL represents the initial amounts of mortgage loans approved by the lending agencies rather than what was actually taken;

U is the disturbance term; (The Goldfeld-Quandt test with Canadian constant price quarterly data for 1972-86 and current and constant price quarterly and annual data for 1962-86, suggests that in nominal terms, the aggregate private expenditure suffers from heteroscedasticity while in real terms, there has been no significant evidence of heteroscedasticity. Therefore, in order to normalise the function, logarithmic transformation will be adopted when estimated with current price data. The calculated and the critical values of 'F' of the Goldfeld-Quandt test for the null hypothesis of no heteroscedasticity are reported in appendix C).

3.1.2 Modifying the Private Sector Disposable Income Equation

The NC school originally added the PDI equation for the purpose of endogenising the variable PDI in estimating the PX function. But the way they specified it did not serve that purpose. Rather it unnecessarily complicated the whole estimation process. The PDI equation as originally specified by the CEPG is (3.2). This is not a behavioral equation; the CEPG replaced 'n' by its crude estimate (0.42). This is a restriction they imposed on a parameter co-efficient in the estimation process. They justified it by saying that the purpose of the PDI equation is to take care of the feedback effect of expenditure onto income, and hence correctly specifying 'n' is crucially important. In doing so they tried a wide range of values of 'n' from 0.0 to 1.0 and

settled at 0.42 to be the best, in the sense of producing the best fit for the model. Based on the same principle in the taking care of the feedback effect, they did not define the variable XN explicitly. They justified it by saying that the feedback effect of PX into PDI can be taken care of by appropriately specifying 'n' only. As such, observation of XN was not essential according to the CEPG. They used XN like the disturbance term, capturing excluded exogenous variables. But the problem of not taking any observation on XN means it is not adding any new information to the estimation process and restricting the parameter coefficient 'n' to be 0.42, is making the parameter estimates of the PX function biased downward.

With regard to the PDI equation two points are important to note. First, if endogeneity of PDI is ignored and the PX function is estimated as a single equation, then the estimates will suffer from simultaneity bias, if it is endogenised in the CEPG manner then, the parameter estimates of PX function will be artificially restricted downward as claimed by Chrystal(1981-a).

Therefore, in line with the third principle, the PDI equation needs to be specified more fully and appropriately. In doing so, the following points can be taken into consideration. According to the national income accounting procedure, at equilibrium, aggregate national income and expenditure are identically equal:

$$Y = PX + G + (X - M) \quad \ldots\ldots (3.4)$$

where equation (3.4) is national income accounting identity of the commodity market.

In the determination of Y, the government expenditure (G) and exports(X) are considered to be exogenously given, while aggregate private expenditure (PX) and imports (M) are considered to be endogenous. Thus for the determination of Y, in addition to PX, we need the following relations:

$$G = G_0 \quad \ldots\ldots (3.5)$$

$$X = X_0 \quad \ldots\ldots (3.6)$$

$$M = M_0 + mY; \quad 0 < m < 1 \quad \ldots\ldots (3.7)$$

Solution of this system of equations, along with identity (3.4) yields:

$$Y = [1/(1+m)] \; [G_0 + X_0 + M_0] + [1/(1+m)] \; PX \quad \ldots\ldots (3.8)$$

However, in our estimation process, we are interested in the private sector disposable income (PDI), not the aggregate gross national product (Y). But from Y, PDI can be computed by subtracting capital consumption allowance (CCA), indirect business tax less subsidy(IBTLS) and personal and corporate taxes (TA) and adding interest and dividend on government debt (IDGD) and net transfer to the private sector(TR). Thus the PDI function can be expressed as follows:

$$PDI = [1/(1+m)] \; [G_0 + X_0 + M_0] + [1/(1+m)] \; PX - CCA - IBTLS + IDGD + TR - TA. \quad \ldots\ldots (3.9)$$

Now (3.3) and (3.9) constitute a system of two equations. These two equations basically represent the model where the endogenous variables PX and PDI can simultaneously be estimated. In equation (3.9), the variables CCA, IBTLS, IDGD, TR and TA need some further clarification. Each is neither exogenous nor endogenous variables. Rather they can be considered definitional variables entered into this equation to define PDI and distinguish it from Y. In the estimation process, the parameter co-efficients of all these variables are restricted to unity.

3.2 ALTERNATIVE METHOD OF ESTIMATION

The PX function and the PDI equation that has been derived from the structural equations constitute the model that we are interested to estimate. Since the model is overidentified, two stage least squares (2SLS) method can be considered an appropriate technique. However, the novelty of this research is not the 2SLS estimation technique, but rather the legitimization of the endogeneity of PDI and its derivation from the structural equations.

SUMMARY

In view of the problems associated with the New Cambridge model, the equations have been modified and an alternative method of estimation is proposed. In modifying the

equations, ad hoc variables are dropped and important excluded variables have been re-instated. The alternative estimation method proposes the use of 2SLS technique by legitimizing the endogeneity of PDI.

Chapter IV

ESTIMATING MODELS AND TESTING HYPOTHESES

The objective of the present chapter is to test the following set of hypotheses:[57]

I. the modified Aggregate Private Expenditure Function estimated with the new method produces an overall good fit to the Canadian economy and yields good and reliable estimates of the parameters;

II. the estimated results obtained herein provide empirical support for the New Cambridge proposition that the private sector spends almost all of its disposable income with a short lag;

III. the modified model yields a better fit when the data period is extended from 1972-86 to 1962-86 and the results are empirically stable.

The New Cambridge (NC) aggregate private expenditure (PX) function (with the modifications applied herein) and the private sector disposable income (PDI) function[58] (derived from the structural equations of a more general model), take the following final form:[59]

---

[57] The hypotheses have been constructed in such a way so as to be accepted.

[58] For details, see chapter III.

[59] In nominal terms, the PX function displays heteroscedasticity in the disturbance term and hence, a logarithmic transformation has been applied to the PX function as a normalization device.

$$PX = a + bPDI + bPDI_{-1} + gHP + hBAP + jBAB + kMTL + U \quad .(4.1)$$

$$PDI = [1/(1+m)]\ [G_0 + X_0 + M_0] + [1/(1+m)]\ PX - CCA - IBTLS + IDGD + TR - TA \quad .(4.2)$$

where:

a, b, d, g, h, j, k and $m > 0$;

G_0, X_0 and M_0 are constants;

PX is aggregate private expenditure-composed of consumption, investment including change in inventories. Here investment includes expenditures on housing;

PDI is private sector disposable income (composed of personal disposable income and undistributed corporation profits);

PDI_{-1} is previous period's PDI;

HP is change in hire purchase debt outstanding to the personal sector (consumer loans from sales, finance and consumer loan companies and department stores.);

BAP is change in bank loans outstanding to the personal sector (personal loans for the purchase of marketable stocks and bonds, and other consumer goods and services);

BAB is change in bank loans outstanding to the business sector (loans for construction, retail trade and service industries);

MTL is mortgage loans (from chartered banks, life insurance companies, trust companies, loan and other companies and central mortgage and housing corporation);

U is the disturbance term;

m is marginal propensity to import;

CCA is capital consumption allowance;

IBTLS is indirect business tax less subsidy;

IDGD is interest and dividend on government debt;

TR is net transfer to the personal sector;

TA is personal and corporate income tax;

variables CCA, IBTLS, IDGD, TR and TA are definitional

and as such their co-efficients are restricted to unity.

Testing the hypotheses specified at the beginning of this chapter, involves the estimation of the model with two sets of constant price quarterly data: 1972-86 and 1962-86.

The rationale for preferring constant price data to those of current price, can briefly be explained as follows. In nominal terms, the explanatory variables are very likely to be correlated by a common variable price. Besides, the accelerated rate of inflation in the mid-1970s on the wake of the international oil crisis is likely to distort the relationship embodied in the PX function.

The use of quarterly data, in this context, can be justified on both macroecomonic and econometric grounds. From macroeconomic point of view; first, the largest component of private expenditure is consumption. The vast majority of the consumers have little or no access to credit and possess very limited financial assets. As a result, they account for the stability of a very short lag (less than a year) in the relationship between consumption expenditure and personal disposable income; second, a substantial portion of the corporate investment is financed by retained earnings which takes a much shorter time to adjust between corporate investment and undistributed corporation profits, rather than investment and raising equity capital by selling corporate bonds , stocks and shares. Econometrically, in

the case of quarterly data, the degrees of freedom is much larger than those under annual data. As a result, quarterly data are likely to yield more precise and reliable estimates. The estimation procedure, throughout this empirical investigation, will be 2SLS.

The first section of this chapter estimates the aggregate private expenditure function with 1972-86 data in order to test hypotheses I and II; the second section repeats the same estimation procedure in order to verify hypothesis III using an extended data set for the period of 1962-86.

4.1 TESTING HYPOTHESES I AND II

This section presents the estimated results of the modified aggregate private expenditure function and provides a detailed statistical analysis of the results and their implications with a view to determining the overall goodness of fit produced by the model and to test the central hypothesis that the private sector spends virtually all of its disposable income with a short lag.

The PX function estimated with constant price quarterly data for 1972-86 is presented in Table 7, in which R^2 is observed to be as high as 0.972 which means over 97 percent of the total variation in the dependent variable PX is explained by the model. In other words, it can be concluded that the model fits the data very well.

TABLE 7

Estimates of the Modified Aggregate Private Expenditure Function 1972-86 in Real Values

Regressors	Parameter Estimates	Calculated 't' ratios	Critical Value 't' of at the 5% level of significance with 53 degrees of freedom
Intercept	1946.608	2.097	1.67 (one tail test)
Private Sector Disposable Income(PDI)	- 0.326	-0.814	
Lagged Private Sector Disposable Income(PDI_{-1})	1.298	3.301	
Change in Hire Purchase Debt Outstanding (HP)	5.803	4.007	
Change in Bank Loans Outstanding to the Personal Sector (BAP)	0.048	0.352	
Change in bank Loans Outstanding to Business Sector (BAB)	- 0.038	- 0.383	
Mortgage Loans (MTL)	0.845	1.839	
Durbin Watson 'd' = 1.801 ;	'F' = 310.716;		R^2 = 0.972;

According to the 't' tests, out of six explanatory variables, only two are found to be statistically significant.[60] They are PDI_{-1} and HP. The computed 't' ratios corresponding to the parameter co-efficients of the variables PDI_{-1} and HP are observed to be 3.301 and 4.007 respectively. The critical value of 't' at the 5 percent level of significance with 53 degrees of freedom is 1.67.[61] Therefore, variables PDI_{-1} and HP exert significant influence in explaining the variation in the dependent variable. Although the parameter co-efficients of PDI and BAB are negative, they are not statistically significant. The 't' test also suggests that the intercept of the model is significant. But the variable MTL is not significant in the regression model.

Although R^2 is usually high with time series data, in this case, a very high R^2, along with insignificant 't' ratios for so many variables indicate the presence of multicollinearity in the model. And in fact, the correlation between PDI and PDI_{-1} is as high as 0.998[62] on account of constant price quarterly data.

---

[60] All significance tests are carried out at the 5 percent level.

[61] This tabulated value of 't' corresponds to one-tail test

[62] In the NC literature, it can be found that under similar situation, Chrystal (1981-b) estimated the revised NC model in the presence of a correlation co-efficient between PDI and PDI_{-1} as high as 0.98. For details, see K. A. Chrystal (1981-b), "The New Cambridge Aggregate Expenditure Function: Correction and Confirmation", Discussion Paper, No. 189, University of Essex.

One of the basic problems with multicollinearity is that the estimated results are very sensitive to variation in data and that it is impossible to isolate the influence of correlated variables in explaining the variation in the dependent variable.

Therefore, a 't' test for the individual significance of the parameter estimates of PDI and PDI_{-1}, is not appropriate. Rather, the statistical significance of the variables PDI and PDI_{-1} should be tested with the help of the joint 'F' test. For this purpose, two separate 'F' tests have been performed for the null hypotheses: H_1: $(b+d)=0$; and H_2: $(b+d)=1$.

For hypothesis H_1, the calculated value of 'F' with 1 and 53 degrees of freedom is 1038.049, whereas the tabulated value of 'F' for the relevant degrees of freedom at the 5 percent level of significance is 4.035. Since the calculated value falls far beyond the critical value, the null hypothesis H_1 is rejected i.e. the sum of the co-efficients of PDI and PDI_{-1} is jointly significantly different from zero.[63]

For hypothesis H_2, the calculated value of 'F' with 1 and 53 degrees of freedom is 0.814 which clearly falls within the critical region at the 5 percent level of significance. Therefore, the null hypothesis H_2 cannot be rejected. That

---

[63] The implications are discussed in detail, later in this section.

is, the sum of the coefficients of PDI and PDI_{-1} is not significantly different from unity.

The Durbin-Watson 'd' statistic is used to test whether the model suffers from autocorrelation. In this case, the upper and lower limits of the Durbin-Watson 'd' statistic for 60 observations and 6 explanatory variables at the 5 percent level of significance are 1.41 and 1.77 respectively. According to this test, if the computed value of the 'd' statistic lies between 1.77 and (4 - 1.77), then the hypothesis of no first order autocorrelation would conclusively be accepted. It is observed that the computed value of 'd' is 1.801. It can therefore be concluded that the model does not suffer from first order autocorrelation.

According to the theory underlying the New Cambridge private expenditure function, the parameter co-efficients of all the explanatory variables are expected to be positive and statistically significant. The negative value of the co-efficient of PDI and its insignificant 't' value are attributable to the high collinearity between PDI and PDI_{-1}, and as such, their joint significance is measured by the 'F' test.

The parameter co-efficients of BAP, BAB and MTL have not been found statistically significant. However, the presence of these variables in the PX function are theoretically justifiable; and more importantly, their absence would cause specification error making the estimates biased.

Thus, on the overall, the model fits the Canadian data quite well notwithstanding the problem of multicollinearity. Of course, multicollinearity does not jeopardise the quality and reliability of the estimates.[64]

Whether hypothesis II, that the private expenditure adjusts to its disposable income with a short lag, is accepted or rejected depends on the sum of the estimated coefficients of the variables PDI and PDI_{-1} . If the sum is close to unity, then the hypothesis can be accepted. From the estimated model, it is observed that the parameter coefficients of the income terms- PDI and PDI_{-1} are -0.326 and 1.298 respectively. The individual values of these estimates and their sum (0.972) is irrelevant in this context because of the high correlation between PDI and PDI_{-1} . However, the statistically relevant 'F' test has made the conclusion that the estimated sum of PDI and PDI_{-1} is less than but close to unity. This means almost 100 percent of the private sector disposable income is spent within two quarters.

Thus the modified model, estimated with the constant price quarterly data for the period of 1972-86 has supported hypotheses I and II.

---

[64] Detailed discussion on the possibility of avoiding the problem of multicollinearity follows in the next subsection.

4.2 TESTING HYPOTHESIS III

This section estimates the New Cambridge aggregate private expenditure function by extending the constant price quarterly data backward from the period of 1972-86 to 1962-86. The purpose of this extended regression is to examine whether the model yields a better fit and stable results over a longer period of time.

A Chow test will be applied to investigate if there has been any significant shift of the parameter co-efficients between the periods 1962-71 and 1972-86. A series of regression runs will also be carried out on this model in various functional forms to examine the impact of some individual variables on the overall goodness of fit of the model. In addition, the model will be estimated with constant price quarterly data for 1962-86 in the first difference form. The rationale of doing this is to verify whether or not the stationary time series (i.e. in first difference form) produce the same set of results as those of non-stationary time series (i.e. the levels).

The estimated model, presented in Table 8, suggests that R^2 has increased from 0.972 to 0.994 when the model is fitted to a longer data set (i.e. 1962-86). Thus the explained variation as a proportion of total variation has slightly improved.

TABLE 8

Estimates of the Modified Aggregate Private Expenditure Function 1962-86 in real Values

Regressors	Parameter Estimates	Calculated 't' ratios	Critical Value of 't' at the 5 % level of significance with 93 degrees of freedom
Intercept	1561.738	6.772	1.65 (one tail test)
Private Sector Disposable Income (PDI)	-0.278	-0.759	
Lagged Private Sector Disposable Income (PDI_{-1})	1.262	3.438	
Change in Hire Purchase Debt Outstanding (HP)	4.831	4.906	
Change in Bank Loans Outstanding to Personal Sector (BAP)	0.041	0.359	
Change in Bank Loans Outstanding to Business Sector (BAB)	-0.027	-0.342	
Mortgage Loans (MTL)	1.101	3.451	
Durbin-Watson 'd' = 1.615;	'F'=2562.573;		R^2 = 0.994;

The 't' statistics for the extended data set also indicate an improvement. The variable MTL has become statistically significant; it was insignificant with the 1972-86 data set.

Therefore, the improved R^2 and the statistical significance of an additional explanatory variable clearly represent a better fit of the model when regressed over a longer period of time.

The negative sign and the insignificant co-efficient for PDI is again due to multicollinearity.[65] Although, the co-efficient for the variable BAB is still negative, it is statistically insignificant. Similarly, variable BAP is also insignificant.

For the extended data set, 'F' tests on the joint significance of PDI and PDI_{-1} , have been applied once again to test the same set of hypotheses: H_1: (b+d)=0; and H_2: (b+d)=1. The results again rejects H_1 but not H_2 at the 5 percent level of significance.[66] Thus, it can be safely concluded that the sum of the co-efficients of PDI and PDI_{-1} are jointly highly significantly different from zero but not

---

[65] The constant price quarterly data for 1962-86 also represents a correlation co-efficient between PDI and PDI_{-1} to be as high as 0.998.

[66] For hypothesis H_1 , the calculated value of 'F' at 1 and 93 degrees of freedom is 13701 while the relevant tabulated value is 3.950, thus the null hypothesis H_1 is clearly rejected. For hypothesis H_2, the calculated value of 'F' at the appropriate degrees of freedom is 3.855 which is less than the critical value (3.950) and hence the null hypothesis H_2 cannot be rejected.

significantly different from unity. This means the variables PDI and PDI_{-1} are jointly powerful in explaining the variation in PX and that the private sector expenditure is adjusted to its disposable income within two quarters for 1962-86 as well.

Based on all of these results, it appears that the extended data set produces a better overall fit to the model, except the fact that the Durbin-Watson 'd' test cannot conclusively reject the presence of first order autocorrelation with the model.[67]

The deterioration of the Durbin-Watson 'd' statistic may cause some suspicion about the stability of the model. In order to test for structural shift of parameters, between the regimes of 1962-71 and 1972-86, a Chow test was carried out.[68] This test could not detect any significant structural shift of the parameter co-efficients of the aggregate private expenditure function between the two periods in question.[69]

---

[67] For the model the computed value of 'd' is observed to be 1.615 which lies between the lower limit (1.57) and the upper limit (1.78) defining the inconclusive range of the 'd' test for 100 observations and six explanatory variables at the 5 percent level of significance.

[68] For details of the 'F' statistic for Chow test, see D. Gujrati (1978), The Basic Econometrics, New York, McGraw Hill Book Company, Chapter 13, p. 306.

[69] The Chow test is applied to the null hypothesis that there is no structural shift of the parameter co-efficients between 1962-71 and 1972-86. For this test the calculated value of 'F' is 1.45. The tabulated value of 'F' with 7 and 86 degrees of freedom at the 5 Percent level of significance is 2.13. Since the calculated

To check if it is possible to avoid the problem of multicollinearity and its consequences by dropping the variable PDI_{-1} from the model, a separate regression has been run on the model without PDI_{-1}. The results are reported in the first column of Table 9.

The estimated results suggest that the R^2 remains more or less the same. The variable PDI becomes highly statistically significant and its co-efficient is as high as 0.983 i.e. less than but very close to unity. Other things remain almost the same, except that the parameter co-efficients of BAB becomes positive but still remains statistically insignificant. Also MTL becomes statistically insignificant; and more interestingly, the model yields conclusive evidence of first order autocorrelation.[70] Thus, for the appropriate specification of the model the lag structure with the PDI variable must be retained in the model, even though it causes multicollinearity. Because autocorrelation is a more serious problem than multicollinearity.[71]

---

value falls within the critical region, the null hypothesis cannot be rejected. This means there is no significant shift of the parameter co-efficients between the periods in question.

[70] For details, see appendix B.4.1.a.

[71] Multicollinearity makes the estimates too sensitive to variation in the data set and it becomes impossible to isolate the individual influence of correlated variables in explaining the variation in the dependent variable. Autocorrelation makes the estimates inefficient and the significance tests imprecise.

TABLE 9

Comparison of Estimates of the Modified PX Function in Real Values Dropping PDI_{-1}, BAP and BAB 1962-86

Regressors	Parameter Estimates Dropping PDI_{-1}	Parameter Estimates Dropping BAP	Parameter Estimates Dropping BAB
Intercept	1727.517 (9.249)	1591.410 (7.975)	1571.000 (7.031)
Private Sector Disposable Income (PDI)	0.983 (141.201)	0.069 (0.239)	-0.229 (-0.697)
Lagged Private Sector Disposable Income (PDI_{-1})	.....	0.914 (3.123)	1.212 (3.686)
Change in Hire Purchase Debt Outstanding (HP)	4.068 (5.118)	4.620 (5.378)	4.971 (5.023)
Change in Bank Loans Outstanding to Personal Sector (BAP)	0.116 (1.234)	.....	0.031 (0.288)
Change in Bank Loans Outstanding to Business Sector (BAB)	0.082 (1.337)	0.017 (0.257)	.....
Mortgage Loans (MTL)	0.384 (1.918)	0.926 (3.528)	1.063 (3.645)
R^2	0.995	0.995	0.994
Durbin-Watson 'd' =	0.736	1.275	1.595

Figures in parentheses represent 't' ratios

The estimated results of the model dropping BAP are reported in the second column of Table 9 which suggest that there has been no significant change with the results, except that the parameter co-efficients for BAB and PDI become positive. However, they still remain statistically insignificant.[72]

Dropping BAB, the regression results are reported in the third column of Table 9. They are more or less the same as those obtained by dropping BAP,[73] except that the parameter co-efficient of PDI again becomes negative remaining statistically insignificant.

Thus the modified aggregate private expenditure function seems to be quite stable when estimated with constant price quarterly data, though in some restricted sense.

As a further test for the robustness of the results of the modified model, a series of additional regressions have been run to investigate whether the results are stable when estimated with other forms of data. A brief comparison of the results are reported in Table 10.

To fulfill this objective, a regression was first run with the current price quarterly data for 1962-86. The results conclusively suggest that the model suffers from first order autocorrelation making the parameter estimates

---

[72] For details, see appendix B.4.1.b

[73] For details, see appendix B.4.1.c.

TABLE 10

Comparison of Estimates of the Modified PX Function with Different Forms of Data

Regressors	Parameter Estimates Current Price Quarterly Data	Parameter Estimates Constant Price Annual Data	Parameter Estimates Current Price Annual Data
Intercept	-4.754 (-3.526)	-376.463 (-0.498)	-1.396 (-1.664)
Private Sector Disposable Income (PDI)	0.809 (6.347)	1.004 (149.186)	0.503 (1.092)
Lagged Private Sector Disposable Income (PDI_{-1})	0.166 (1.306)	-0.512 (-0.409)	0.455 (0.996)
Change in Hire Purchase Debt Outstanding (HP)	0.357 (2.473)	-0.134 (-0.910)	0.129 (1.391)
Change in Bank Loans Outstanding to Personal Sector (BAP)	0.005 (0.724)	0.039 (0.455)	0.012 (1.003)
Change in Bank Loans Outstanding to Business Sector (BAB)	0.010 (1.646)	0.454 (2.051)	0.010 (1.247)
Mortgage Loans (MTL)	0.177 (2.980)	0.094 (1.243)	0.059 (1.054)
R^2	0.999	0.999	0.999
Durbin-Watson 'd' =	0.561	2.408	1.477

Figures in parentheses represent 't' ratios

inefficient[74] and significance tests imprecise. Two other regressions were run with annual data both in real and nominal terms for the period of 1962-86. In both the cases, Durbin-Watson 'd' test cannot unambiguously indicate whether or not the model is free from autocorrelation.[75]

As a result of this ambiguity, 'F' tests have been performed on the hypotheses: H_1: (b+d)=0; and H_2: (b+d)=1. With the constant price annual data, the calculated 'F' values for these hypotheses are 5.32 and 6.163 respectively. The tabulated value of 'F' with 1 and 17 degrees of freedom at the 5 percent level of significance is 4.45. Thus, hypotheses H_1 and H_2 are rejected at the 5 percent level of significance. That is, based on the 'F' tests, it can be concluded that (b+d) are jointly significantly different from zero and one as well. The implication is that the variables PDI and PDI_{-1} are jointly significant in explaining the variation in PX but the sum of their coefficients is not close to unity which means the private

---

[74] For details, see appendix B.4.2. The intercept of the estimated model with current price data is not strictly comparable with that of constant the price. Because in nominal terms, the logarithmic transformation of the PX function requires the conversion of the negative values into positive ones. This is done by adding a constant of 10000 to the observations of all the variables in question. Hence, the intercept is scaled up. However, all other parameter estimates remain unaffected as a result of this conversion.

[75] The conclusive range of no first order autocorrelation for 24 observations and 6 explanatory variables is 0.93 - 1.90. The calculated 'd' values in constant and current price data are 2.408 and 1.477 respectively. They fall in inconclusive regions.

sector surplus is not close to zero.

Similarly, 'F' tests have been performed on H_1 and H_2 when estimated with current price annual data. Here the calculated 'F' values for H_1 and H_2 are 10972.2 and 20.052 respectively. The conclusions drawn in these cases are the same as those drawn in the case of constant price quarterly data.[76]

The probable reason that the model does not yield a fit as good as expected in nominal terms is that, in current price data, apart from the collinearity between PDI and PDI_{-1}, all other explanatory variables are likely to be correlated by price. Furthermore, the unprecedented rate of increase in the price in the mid-1970s on the wake of the international oil crisis may have seriously distorted the relationship embodied in the aggregate private expenditure function.

In the case of the model's failure in annual data, both in real and in nominal terms, it may be noted that the conversion of quarterly data into annual form, substantially reduced the number of observations and hence degrees of freedom. The reduced degrees of freedom puts an additional constraint on the estimate of the aggregate private expenditure function.

---

[76] For details, see appendix B.4.3. and B.4.4. For the interpretation of the estimated function in appendix B.4.4., the above footnote applies.

In order to verify the estimated results in non-stationary and stationary time series, a separate regression has been run with constant price quarterly data for 1962-86 in first difference form. The results are reported in appendix D where it can be observed that R^2 is as low as 0.307. Such a low R^2 suggests that the data does not fit the model well. From the 't' tests it appears that the explanatory variables such as PDI, PDI_{-1} and HP exert significant influence in explaining the variation in PX. The 'F' test on the joint significance of PDI and PDI_{-1} suggest that the sum of the parameters 'b' and 'd' is significantly different from zero but not from one. This means that the variables PDI and PDI_{-1} are jointly significant in explaining the variation in PX and that the almost all of PDI is spent within two quarters.[77] However, the poor statistical fit makes these conclusions very weak.

Therefore, based on all these findings, it can safely be concluded that the modified NC aggregate expenditure function and the estimation method modified by the present study, demonstrate an improvement with the model in terms of the overall goodness of fit, reliability and quality of estimates and more importantly, it supports the central New Cambridge hypothesis that the private sector expenditure

---

[77] The calculated values of of 'F' for the null hypothesis b+d=0 and b+d=1 are 24.811 and 0.088 respectively with i and 93 degrees of freedom. The tabulated value of 'F' with appropriate degrees of freedom at the 5 percent level of significance is 3.950. Thus the null hypothesis b+d=0 is rejected while that of b+d=1 is not rejected.

adjusts to its disposable income with a short lag.

However, these results are obtained from a particular kind of data that is constant price quarterly data for the periods of 1972-86 and 1962-86. With any other kind of data (i.e. current price quarterly, and current and constant price annual), the model seems to be producing no good fit nor is it supporting the central NC hypothesis.

SUMMARY

The modification proposed to the NC aggregate private expenditure function and to their method of estimation by this study has produced a good fit to the Canadian economy when estimated with the constant price quarterly data for 1962-86. It also supports the central NC proposition that the private sector adjusts expenditure to its disposable income within two quarters. In current price quarterly data, it does not work, nor does it work with the annual data of any kind, nominal or real.

Chapter V

SIMULATING MODELS AND VALIDATING HYPOTHESES

The New Cambridge hypothesis that the private sector is more or less in balance has already been tested and accepted for Canada, though in a very restricted sense. This is done through the means of a series of regression analyses carried out in chapter IV on the modified aggregate private expenditure (PX) function, developed by this study.

The present chapter aims at examining the empirical validity of this function with the help of simulation techniques. For this purpose, an historical simulation experiment is constructed based on the estimates of the aggregate private expenditure function represented in the following equations.[78]

Constant Price Quarterly Estimates of the Modified Aggregate Private Expenditure Function (1972-86).

$$PX = \underset{(2.097)}{1946.608} - \underset{(-0.814)}{0.326}\ PDI + \underset{(3.301)}{1.298}\ PDI_{-1} + \underset{(4.007)}{5.803}\ HP$$

$$+ \underset{(0.352)}{0.048}\ BAP - \underset{(-0.383)}{0.038}\ BAB + \underset{(1.839)}{0.845}\ MTL. \quad \ldots\ldots\ldots\ldots\ldots\ldots (5.1)$$

$R^2 = 0.972$; 'F' = 310.716; Durbin-Watson 'd' = 1.801.

---

[78] The 'F' test on the joint significance of the variables PDI and PDI_{-1} suggests that the private sector expenditure adjusts to its disposable income within two quarters.

Constant Price Quarterly Estimates of the Modified Aggregate Private Expenditure Function (1962-86)

$$PX = \underset{(6.772)}{1561.738} - \underset{(-0.759)}{0.278}\ PDI + \underset{(3.438)}{1.262}\ PDI_{-1} + \underset{(4.906)}{4.831}\ HP + \underset{(0.359)}{0.041}\ BAP - \underset{(-0.342)}{0.027}\ BAB + \underset{(3.451)}{1.101}\ MTL. \quad \ldots\ldots\ldots\ldots\ldots\ldots (5.2)$$

$R^2 = 0.994$; 'F' = 2562.573; Durbin-Watson 'd' = 1.615.

The historical simulation applied to (5.1) and (5.2), in this context, is designed to track the behavior of the aggregate private expenditure for the periods of 1972-86 and 1962-86 respectively. In order to monitor this performance, the estimated models will be simulated from the beginning to the end of the estimation periods in question.

The simulation results will be analysed and evaluated in relation to the model validation with the help of the visual comparison of the actual and simulated paths traced by the historical movement of the dependent variable,[79] and the standard summary statistics obtained by the simulation experiments.

The first section of this chapter analyses the meaning and implications of the graphical representation of the actual and simulated paths. It will also define and discuss the nature and the statistical properties of the quantitative simulation measures and their appropriate use to evaluate the goodness of fit of the simulated models. The

---

[79] In this case, it refers to aggregate expenditure of the private sector.

second section carries out the application of the graphical method and the quantitative simulation measures to draw conclusions about the goodness of fit of the simulated models.

5.1 ANALYSIS OF THE SIMULATION TOOLS

The graphical approach of simulation analysis involves comparing the simulated (forecast) values of the dependent variable with its corresponding observed values. This comparison can be considered as a test of the tracking performance or goodness of fit of the model. Moreover, such a comparison may isolate the problem areas of the model which then makes it easier to improve specification of the model if necessary.

To make a precise judgement about the "closeness" of the actual and simulated time paths of the dependent variable, it is necessary to go beyond visual inspection and look for some quantitative statistical measures of forecast accuracy.

The standard numerical statistics that are usually used in evaluating a simulation experiment are: root mean square (rms) error, root mean square percent (rmsp) error, and Theil's inequality co-efficients (tic). They are defined as follows:[80]

---

[80] For details, see R.S. Pindyck and D.L. Rubinfeld (1976), "Econometric Models and Economic Forecasts", New York, McGraw Hill Book Co., Chapter 10, pp. 308-35.

$$\text{rms error} = \sqrt{\frac{1}{T}\left[\text{sum}(P_t - A_t)^2\right]} \quad \text{.....(5.3)}$$

$$\text{rmsp error} = 100\sqrt{\left[\frac{1}{T}\left[\text{sum}\{(P_t - A_t)/A_t\}^2\right]\right]} \quad \text{.....(5.4)}$$

$$\text{tic} = \sqrt{\frac{1}{T}\left[\text{sum}(p_t - a_t)^2/\text{sum}\, a_t^2\right]} \quad \text{.....(5.5)}$$

where:

T is the number of periods in simulation;

A_t is the actual value of the dependent variable in period t;

P_t is the predicted value of the dependent variable in period t.

'a' and 'p' are the relative changes of A and P respectively.

For a particular simulation experiment, the selection of an appropriate summary statistic involves careful consideration of its meaning and properties. In general, rmsp error is preferred to rms error. The reason is that rmsp error is expressed in terms of percentage and hence it is easier to interpret and use than that of rms error which is expressed in absolute terms in the same units as the dependent variable concerned. However, rms error is preferred to rmsp error if the actual values of the dependent variable are small or if they switch frequently between positive and negative values.

In the present case, since the observed values of the dependent variable PX are large, rms error might give a misleading conclusion, if its absolute value is considered without referring to the large actual values of the dependent variable. However, rmsp error, expressed in percentage term cannot mislead a reader and hence is more appropriate in the present context.

Although it is fairly simple to calculate these summary statistics, it is not simple to know how 'close to zero' is acceptable when one evaluates the tracking performance of the simulation model.

In the absence of an established statistical norm, the critical values of these summary statistics are generally determined by the the model-builder.

In addition to rms error and rmsp error, Theil's inequality co-efficient can also be used to evaluate a simulation model. For convenience, it can be decomposed to identify the sources of simulation error. The components of Theil's inequality co-efficient are: the bias, UM; the variance, US; and the covariance, UC. The bias proportion is an indication of systematic error in the simulation, hence a value close to zero is preferred. The variance proportion is an indication of the variability of the dependent variable, hence a value close to zero is once again preferred. The covariance proportion measures the

unsystematic error, i.e. the residuals of UM and US from unity, hence a value close to unity is preferred in this case.[81]

5.2 ANALYSIS OF THE GOODNESS OF FIT

In examining the goodness of fit produced by the simulation technique applied to the estimated aggregate private expenditure function for 1972-86 and 1962-86 would be considered first by looking at the representation of the actual and the simulated paths produced by the model.

The graphs for the two periods are presented in Figures 1 and 2. In Figure 1, the actual and the simulated paths run from the first quarter of 1972 to the last quarter of 1986. A visual overview of the graph suggests that the model is fairly accurate in tracking the historical movements of the aggregate private expenditure. Most of the turning points are identified quite well over the sample period.

In Figure 2, the actual and the simulated path run from the first quarter of 1962 to the last quarter of 1986. The tracking is quite good in this case as well.

The graphical inspection is not enough to validate the model. The numerical simulation statistics are more precise and hence more powerful in evaluating a simulation

---

[81] For details, see G.N. Ganga (1988), "Stabilization Policies in Guyana 1977-85", a Ph.D. dissertation, Department of Economics, University of Manitoba, Chapter 5, section 5, pp. 200-217, unpublished.

Figure 1

Actual and Simulated paths Traced by the Modified Aggregate Private Expenditure Function with Constant Price Quarterly Data 1972-- 86

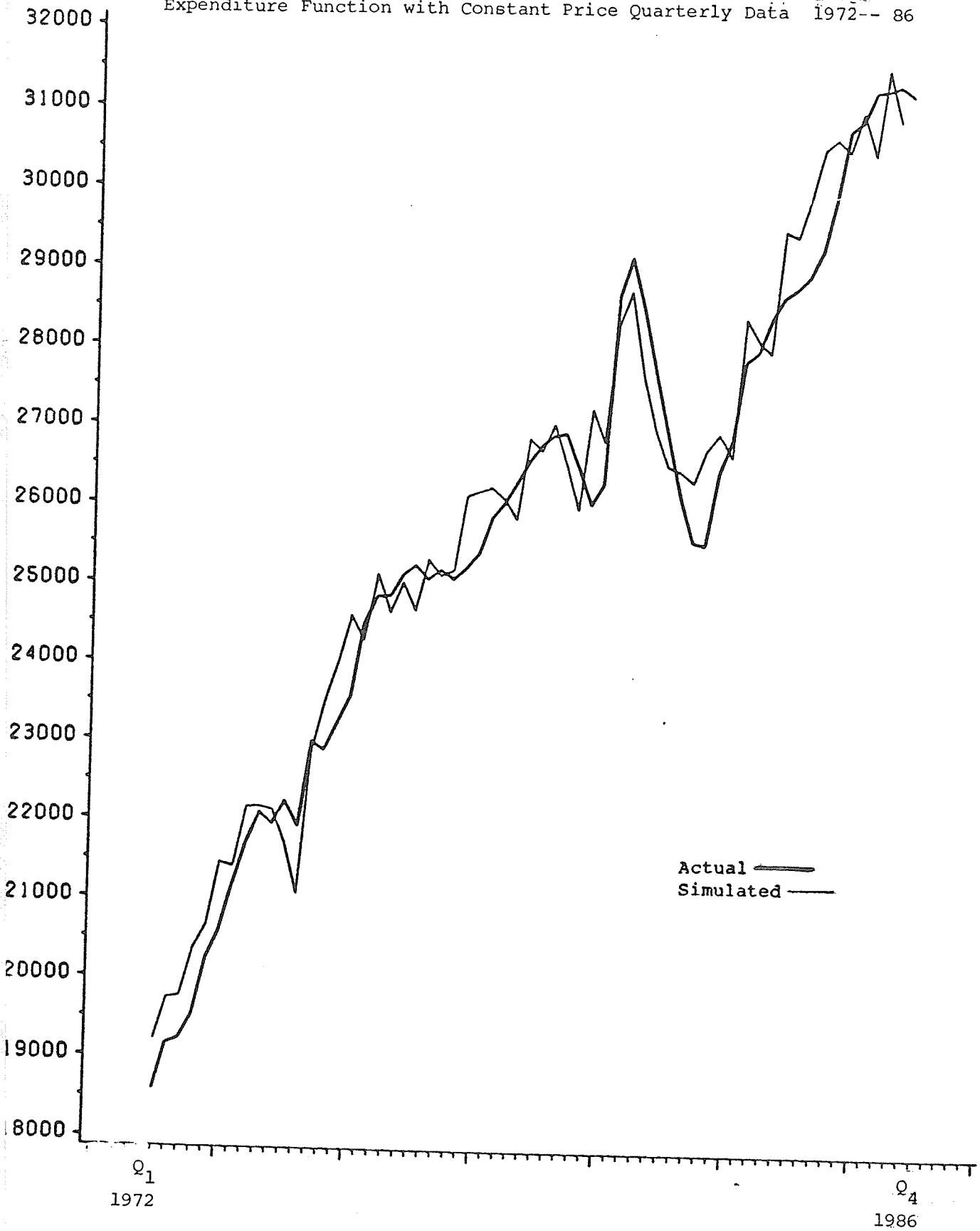
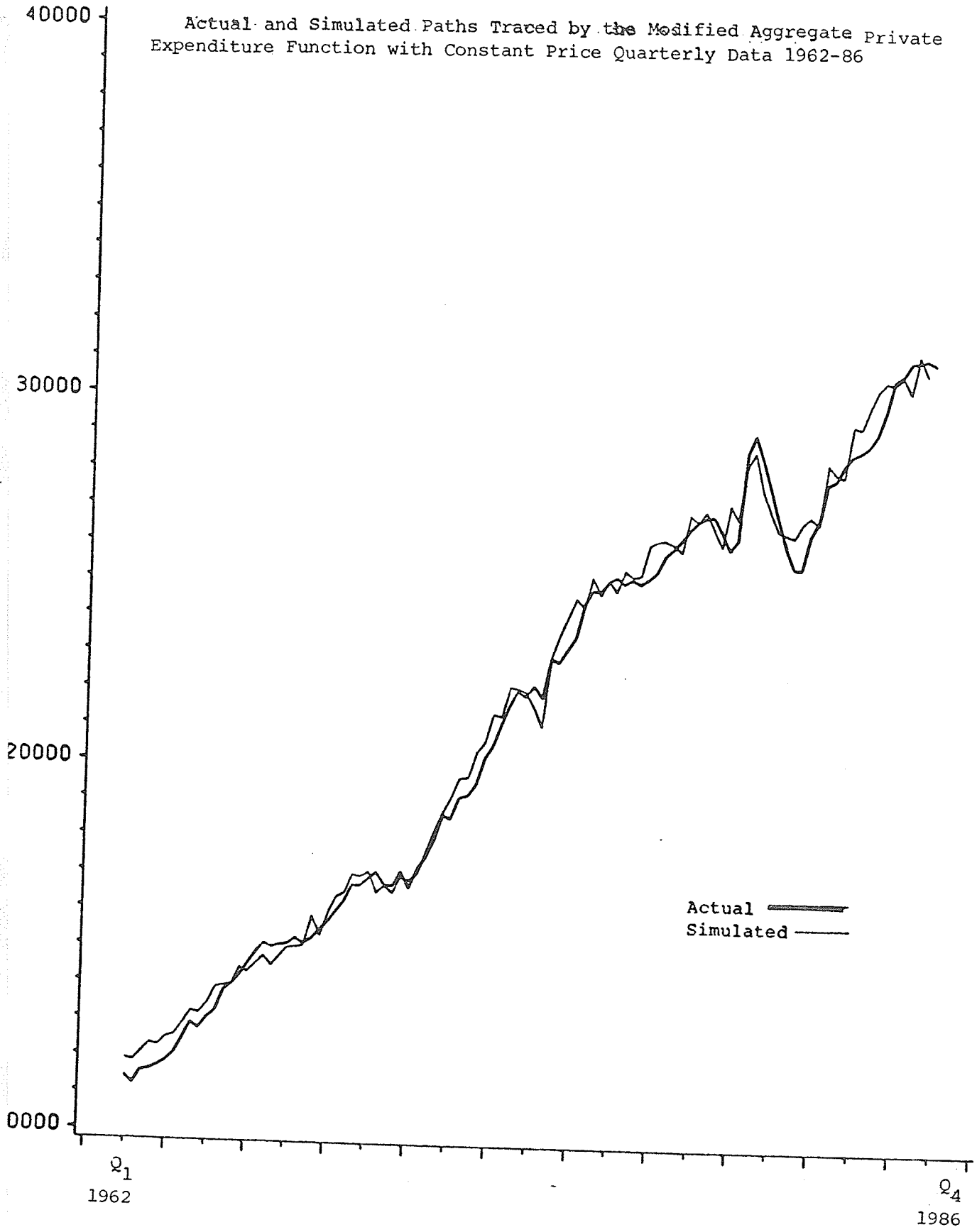


Figure 2

Actual and Simulated Paths Traced by the Modified Aggregate Private Expenditure Function with Constant Price Quarterly Data 1962-86



experiment.

The summary statistics of the simulation experiment on the aggregate private expenditure function for the period 1972-86 are presented in Table 11.

In this Table the rms error is observed to be as high as 556.960. If it is considered in absolute terms, it is quite high. However, if it is viewed in relation to the actual observed values of the dependent variable and is converted into percentage terms, it becomes rmsp error which, in this case is 2.130 percent. This means that percentagewise the error is not very high by any standard.

Theil's inequality proportions for this simulation experiment suggest that the model overall gives a very good fit. Considering the proportions, specifically the bias ratio is observed to be 0.002, which means the model does not represent any significant systematic error. The variance proportion is 0.003 which is again very close to zero. For a good fit, the covariance is expected to be close to unity. In this case, it is 0.996 which is extremely close to unity.

Thus based on the summary statistics, it can be concluded that the modified aggregate private expenditure function fits the data very well for the sample period 1972-86 in real values.

TABLE 11

Constant Price Quarterly Simulation of the Modified Aggregate Private Expenditure Function 1972-86

Dependent Variable	rms error	rmsp error	Decomposition Proportions of Theil's Error Statistics		
			Bias(UM)	Var(US)	Cov(UC)
PX	556.960	2.130	0.002	0.003	0.996

For details of these decompositions, see R.S. Pindyck and D.L. Rubinfeld (1976), "Econometric Models and Economic Forecasts", McGraw Hill Book Co., Chapter 10, pp.308-35.

TABLE 12

Constant Price Quarterly Simulation of the Modified Aggregate Private Expenditure Function 1962-86

Dependent Variable	rms error	rmsp error	Decomposition Proportions of Theil's Error Statistics		
			Bias(UM)	Var(US)	Cov(UC)
PX	475.280	2.242	0.000	0.001	0.999

For details of these decompositions, see the reference at the bottom of the previous Table.

When the data period is extended from the period of 1972-86 to that of 1962-86, the simulation statistics as reported in Table 12, display a slightly better fit, except that the rmsp error has increased from 2.130 to 2.242 percent.

Therefore, the simulation experiment carried out in this chapter on the modified aggregate private expenditure function, suggests that it is a stable and a valid function in real terms, though, in a very restricted sense. It thus validates and re-confirms the New Cambridge hypothesis that the private sector represents more or less a zero balance in the Canadian context.

SUMMARY

Using the estimates of the modified aggregate private expenditure function, a simulation experiment has been applied for the periods 1972-86 and 1962-86. The simulation results for both periods have been evaluated with the help of graphs and some quantitative simulation measures. All the measures suggest that the modified NC model is stable and valid.

Chapter VI

SUMMARY AND CONCLUSION

After a consideration of the macroeconomic and econometric problems associated with the New Cambridge (NC) aggregate private expenditure function, the present study proposes a modification to the model and suggests an alternative estimation technique.

In modifying the model, three points have been taken into consideration; first, elimination of the specification error from the NC aggregate private expenditure function by including the important but hitherto excluded variables such as change in bank loans outstanding to the personal sector (BAP) and change in bank loans outstanding to the business sector (BAB), second, by excluding the ad hoc variable stockbuilding in the private sector (ST); third, by adding a new variable mortgage loans approved (MTL) as an explanatory variable to adapt the model to the Canadian economy. For the original NC aggregate private expenditure function, MTL was not relevant as the expenditure on housing was not included in their definition of PX.

In estimating the aggregate private expenditure function, this thesis endogenises private sector disposable income and jointly estimates the two equations with the two stage least

squares (2SLS) method. The ad hoc nature of PDI equation is abandoned, and it is derived from a set of structural equations and the national income accounting identity describing the commodity market.

Using constant price quarterly data for 1972-86, this research shows that the modified aggregate private expenditure function estimated with the alternative technique not only yields a good fit, but also appears to confirm the NC hypothesis that the private sector is more or less in balance.

In order to test the sensitivity and stability of these results, the data period has been extended backward to 1962-86 and a separate regression was run on the model with the extended data set. When estimated over this longer period of time, the model fits the data better than the period 1972-86, except that the presence of first order autocorrelation cannot be rejected conclusively.

The model is also estimated with the constant price quarterly data for 1962-86 in the first difference form to verify whether or not the stationary time series (i.e. the first difference form) produce the same results as the non-stationary time series (i.e. the levels). It has been found that the stationary time series produced a remarkably different set of results particularly with respect to R^2 which is as small as 0.307

In order further to validate the regression results, the present study carries out simulation experiments on the estimated aggregate private expenditure functions for 1972-86 and 1962-86. The simulation statistics corroborate the regression results.

The empirical findings on the modified aggregate private expenditure function obtained by this thesis, is not altogether unambiguous. The current price quarterly data and the constant and current price annual data for 1962-86 have not produced a good fit of the model.

Due to the ambiguity of the empirical findings, it should be noted that policy conclusions cannot be drawn without qualifications. As it has been seen, the present study has established a two-way link between the government budget deficit and the current account deficit, though in terms of constant price quarterly data only.

The first implication of the small private sector balance is that the private sector is not a source of instability or cyclical fluctuations in the economy. Therefore, the best way to conduct fiscal policy is to establish norms for whatever full employment budget and external and internal balance, and not to fine tune the economy based on short term forecast or fluctuations.

The private sector of the economy, as has been empirically found by this study, though in a very restricted

sense, to be in balance, implies that an increase in government spending in excess of its revenue, is almost completely offset by an increase in balance of payments deficit on current account. Thus, attempts to lower the level of unemployment through fiscal means can put the economy into balance of payments difficulties. Based on this argument, a policy of trade restriction can be recommended.

But this kind of policy, implicitly denies the right of some people to gain from trade expecting that import restriction increases national income so much to make everyone better off. This expectation is based on the assumption that import restriction does not push up the domestic prices of imported goods which is questionable. Canadian imports, specially food, are very likely to be price inelastic, hence an import restriction on food would possibly push the price up. Thus much of the beneficial effects of imports control on GNP would be offset by this price effect.[82]

Another assumption of an import restriction policy is that the prices of domestically produced goods would remain unaffected by the expansion in real output. This is also subject to controversy. It can at best be tenable in the short run but not at all in the long run. (Hall: 1978)

---

[82] R.E. Hall (1978), "A Comment of the Fetherston and Godley and Posner Paper", in K. Brunner and A. Meltzer (et. al.), Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economics, North Holland, pp. 87-89.

Another aspect of an import restriction policy is that it does not let the market work which has definitely an allocative role to play. When the market is closed, allocative efficiency is lost. As Russell and Wakeman[83] write:

> "No doubt, other things being equal, a high value of multiplier is better than a low value, but to try to achieve this high value by closing import markets, lowering the economy's overall efficiency, and thus lowering GNP is like cutting off your nose to spite your face."

Although the present study addresses some of the basic questions hitherto unanswered in the NC literature, such as issues of ad hoc modelling and faulty estimation method, it does not claim to have solved all the problems associated with the New Cambridge model. Due to the presence of multicollinearity in the modified aggregate private expenditure function, i.e. a very high correlation between the private sector current disposable income (PDI) and that of lagged disposable income (PDI_{-1}), the sign and the significance level of the estimated co-efficient of PDI have not been found according to the expectation. Therefore, further research is required to make the aggregate private expenditure function free from multicollinearity.

---

[83] T. Russell and L.M. Wakeman (1978), "New Cambridge Economics Without Markets", in K. Brunner and A. Meltzer (et. al.) Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economies, North Holland, pp. 95-101.

Although two explanatory variables, change in bank loans outstanding to the personal sector (BAP) and the change in bank loans outstanding to the business sector (BAB), are theoretically justified, empirically they have not been found significant. For some other country, it may be worthwhile to examine if they play any significant role in the model.

In deriving the PDI equation, instead of the process adopted by the present study, some other models for Y can be tried. As for example, the St. Louis model[84] relating Y to the current and lagged values of money and government expenditures less taxes. Y can also be expressed as a function of government expenditure, tax rate and U.S. real GNP (which affects Y via exports).

The aggregate private expenditure function can also be respecified by incorporating a new explanatory variable such as issue of corporate bonds and stocks. Because, a substantial portion of the company investment is financed by sale of corporate bonds and stocks in Canada.

The deterioration of the Durbin-Watson 'd' statistic on the extended data set (1962-86) creates a suspicion about the stability of the model over a longer period of time. A Chow test is performed to detect if there is any structural shift of the parameters between the periods 1962-71 and

---

[84] L.C. Anderson and K.M. Carlson (1970), " A Monetartist Model for Economic Stability", Federal reserve Bank of St. Louis Review, No. 52, pp. 7-25.

1972-86. The outcome of the test is surprisingly negative. The fall in Durbin-Watson 'd' statistic and the failure of the Chow test makes it a puzzle. Further research may be undertaken to resolve this puzzle.

The model is found to have been insignificant for current price data. It has also been insignificant for annual data both in real and in nominal terms.

The answer as to why the model is so sensitive to changes in the nature of the data may be considered in the light of the most fundamental weakness of the model. According to Russell and Wakeman (1978): The NC approach to balance of payments analysis violates an

> ".....important property of any relevant economic model-that it should be about maximizing agents in a coherent general equilibrium framework." (Russell and Wakeman:1978).

Thus, further research is required to extend this model into a general equilibrium framework where wages, prices, interest rates, trade volumes, budget and current account deficits will be simultaneously determined.

Appendix A

CORRELATION CO-EFFICIENTS BETWEEN THE REGRESSORS

A.1. The Constant Price Quarterly Data 1962-86.

	PX	PDI	PDI_{-1}	HP	BAP	BAB	MTL
PX	1.00000	0.99700	0.99612	-0.27706	0.16223	0.12086	0.08806
PDI	0.99700	1.00000	0.99848	-0.31190	0.14602	0.10340	0.06811
PDI_{-1}	0.99612	0.99848	1.00000	-0.31770	0.14991	0.11101	0.05181
HP	-0.27706	-0.31190	-0.31770	1.00000	-0.02993	0.01075	0.04965
BAP	0.16223	0.14602	0.14991	-0.02993	1.00000	0.40510	0.24735
BAB	0.12086	0.10340	0.11101	0.01075	0.40510	1.00000	0.21924
MTL	0.08806	0.06811	0.05181	0.04965	0.24735	0.21924	1.00000

A.2. The Current Price Quarterly Data 1962-86.

	PX	PDI	PDI_{-1}	HP	BAP	BAB	MTL
PX	1.00000	0.99916	0.99893	0.21876	0.16627	0.04432	0.70867
PDI	0.99916	1.00000	0.99963	0.20573	0.15584	0.03053	0.69953
PDI_{-1}	0.99893	0.99963	1.00000	0.20937	0.15941	0.03006	0.69454
HP	0.21876	0.20573	0.20937	1.00000	0.07105	0.03466	0.17214
BAP	0.16627	0.15584	0.15941	0.07105	1.00000	0.37155	0.20586
BAB	0.04432	0.03053	0.03006	0.03466	0.37155	1.00000	0.10486
MTL	0.70867	0.69953	0.69454	0.17214	0.20586	0.10486	1.00000

Appendix B

ESTIMATES OF SOME VARIANTS OF THE MODIFIED AGGREGATE PRIVATE EXPENDITURE FUNCTION

B.4.1 CONSTANT PRICE QUARTERLY DATA 1962-86

a. PDI_{-1} Dropped:

$$PX = \underset{(9.249)}{1727.517} + \underset{(141.201)}{0.983}\ PDI + \underset{(5.118)}{4.068}\ HP + \underset{(1.234)}{0.116}\ BAP$$

$$+ \underset{(1.337)}{0.082}\ BAB + \underset{(1.918)}{0.384}\ MTL$$

$R^2 = 0.995$; D-W 'd' = 0.736; 'F' = 4474.527.

b. BAP Dropped.

$$PX = \underset{(7.975)}{1591.410} + \underset{(0.239)}{0.069}\ PDI + \underset{(3.123)}{0.914}\ PDI_{-1} + \underset{(5.378)}{4.620}\ HP$$

$$+ \underset{(0.257)}{0.017}\ BAB + \underset{(3.528)}{0.926}\ MTL$$

$R^2 = 0.995$; D-W 'd' = 1.275; 'F' = 4009.182.

c. BAB Dropped.

$$PX = \underset{(7.031)}{1571.000} - \underset{(-0.697)}{0.229}\ PDI + \underset{(3.686)}{1.212}\ PDI_{-1} + \underset{(5.023)}{4.971}\ HP$$

$$+ \underset{(0.288)}{0.031}\ BAP + \underset{(3.645)}{1.063}\ MTL$$

$R^2 = 0.994$; D-W 'd' = 1.595; 'F' = 3230.689.

B.4.2. CURRENT PRICE QUARTERLY DATA 1962-86

$$PX = \underset{(-3.526)}{-4.754} + \underset{(6.347)}{0.809}\ PDI + \underset{(1.306)}{0.166}\ PDI_{-1} + \underset{(2.473)}{0.357}\ HP + \underset{(0.724)}{0.005}\ BAP + \underset{(1.646)}{0.010}\ BAB + \underset{(2.980)}{0.177}\ MTL$$

$R^2 = 0.999$; D-W 'd' = 0.561; 'F' = 23152.745.

B.4.3. CONSTANT PRICE ANNUAL DATA 1962-86

$$PX = \underset{(-0.498)}{-376.463} + \underset{(149.186)}{1.004}\ PDI - \underset{(-0.409)}{0.512}\ PDI_{-1} - \underset{(-0.910)}{0.134}\ HP + \underset{(0.455)}{0.039}\ BAP + \underset{(2.051)}{0.454}\ BAB + \underset{(1.243)}{0.094}\ MTL$$

$R^2 = 0.999$; D-W 'd' = 2.408; 'F' = 5463.688.

B.4.4. CURRENT PRICE ANNUAL DATA 1962-86

$$PX = \underset{(-1.664)}{-1.396} + \underset{(1.092)}{0.503}\ PDI + \underset{(0.996)}{0.455}\ PDI_{-1} + \underset{(1.391)}{0.129}\ HP + \underset{(1.003)}{0.012}\ BAP + \underset{(1.247)}{0.010}\ BAB + \underset{(1.054)}{0.059}\ MTL$$

$R^2 = 0.999$; D-W 'd' = 1.477; 'F' = 8056.230.

Appendix C

RESULTS OF GOLDFELD-QUANDT TEST FOR DIFFERENT PERIODS WITH DIFFERENT KINDS OF DATA

Time period	Nature of Data	Computed Value of 'F'	Critical Value of 'F'	Degrees of Freedom
1972-86	quarterly (real)	1.10	6.37	4, 4
1962-86	quarterly (real)	1.77	1.84	31, 31
1962-86	quarterly (nominal)	79.71	1.84	31, 31
1962-86	annual (real)	1.15	9.28	3, 3
1962-86	annual (nominal)	16.01	9.28	3, 3

For the definition of 'F' for Goldfeld-Quandt Test, see A. Koutsoyiannis (1977), Theory of Econometrics, New Yoork, Mac Millan Publishing Co. Chapter 9, p. 186.

Appendix D

THE MODIFIED AGGREGATE PRIVATE EXPENDITURE FUNCTION 1962-86 IN FIRST DIFFERENCE QUARTERLY REAL VALUES

Regressors	Parameter Estimates	Calculated 't' ratios	Critical Value 't' of at the 5% level of significance with 53 degrees of freedom
Intercept	18.057	0.377	1.67 (one tail test)
Private Sector Disposable Income(PDI)	00.721	4.594	
Lagged Private Sector Disposable Income(PDI_{-1})	00.222	2.270	
Change in Hire Purchase Debt Outstanding (HP)	01.856	2.648	
Change in Bank Loans Outstanding to the Personal Sector (BAP)	00.074	1.596	
Change in bank Loans Outstanding to Business Sector (BAB)	00.033	0.758	
Mortgage Loans (MTL)	00.055	0.228	
Durbin Watson 'd' = 2.010 ;	'F' = 6.805;		R^2 = 0.307;

Appendix E

A NOTE ON DATA

E.1 INTRODUCTION

The present study uses quarterly time-series data for 1972-86. In order to verify the stability of the aggregate private expenditure function, the present study also extends the time period backward to 1962. It also examines the sensitivity of the model with annual data for the period 1962-86.

E.2 MANIPULATION OF DATA

The variables PX, PDI, CCA, IBTLS, IDGD, TR and TA have been collected as flows and seasonally adjusted.[85]

Data on mortgage loans approved (MTL)[86] were collected as flows but seasonally unadjusted. In order to make them comparable with the other series, they were seasonally adjusted with U.S. census method X-11.

---

[85] Observations on these variables were collected quarterly as annual rates and then converted to quarterly rates by dividing them by 4.

[86] It should however be noted that observations on MTL are gross in nature. The figures represent the initial amount of loans approved rather than what is actually taken.

Observations of change in hire purchase debt outstanding (HP), changes in bank loans outstanding to personal(BAP) and business sectors(BAB) were taken as stocks as month-end values of March, June, September and December. They were also seasonally unadjusted. Again, they were converted into flows from stocks by taking successive differences between two periods and then were seasonally adjusted with the same method as mentioned above.

All the data were collected in current prices and then deflated to constant prices, with the help of appropriate deflators, considering 1971 as the base year. Consumption, personal disposable income, and dividend on government debt, net transfer to the personal sector and personal income tax are deflated by CPI; investment in fixed capital, undistributed corporation profit, capital consumption allowance, indirect business tax less subsidy and corporate income tax are deflated by the investment price index;

The constant price quarterly data are the deflated quarterly data. The current price annual data are the sum of the current price quarterly values for each year. The constant price annual data are similarly the sum of the constant price quarterly values for each year.

Appendix F

LIST OF DATA

F.1 CURRENT PRICE QUARTERLY DATA 1962-86

All the values are expressed in millions of Canadian dollars

YEAR	QUARTER	AGGREGATE PRIVATE EXPENDITURE	TOTAL PRIV. SECTOR DISPO-SABLE INCOME	CHANGE IN HIRE PURCH DEBT OUTSTNDG	CHANGE IN BANK LOAN OUTSTNDG (PRSNL SCTR
1962	1	8694	7588	42.000	83.7
1962	2	8583	7565	34.300	107.1
1962	3	8880	7767	53.000	-10.4
1962	4	8947	7890	58.200	12.5
1963	1	9085	7933	52.700	37.2
1963	2	9208	8177	58.800	62.3
1963	3	9422	8233	42.600	79.7
1963	4	9762	8521	40.400	90.4
1964	1	10156	8651	48.100	107.8
1964	2	10102	8700	71.500	118.7
1964	3	10363	8874	68.700	100.3
1964	4	10558	9030	44.300	98.6
1965	1	11122	9367	132.400	114.9
1965	2	11315	9455	77.200	175.8
1965	3	11578	9842	72.800	121.0
1965	4	11925	10065	77.600	132.8

1966	1	12355	10429	52.500	83.9
1966	2	12706	10532	48.700	9.9
1966	3	12709	10643	69.400	53.7
1966	4	12864	10893	34.400	35.8
1967	1	13002	11030	9.800	79.0
1967	2	13236	11449	25.200	170.7
1967	3	13220	11503	-9.000	154.0
1967	4	13420	11760	40.500	127.9
1968	1	13792	11845	74.800	121.4
1968	2	14094	12398	56.800	80.5
1968	3	14455	12652	52.300	217.0
1968	4	14849	12980	71.800	316.5
1969	1	15400	13262	65.000	317.8
1969	2	15606	13354	120.500	172.7
1969	3	15905	13646	165.600	-56.9
1969	4	16219	13784	142.100	18.9
1970	1	16083	14090	51.033	47.4
1970	2	16251	13870	51.033	9.4
1970	3	16643	14300	51.033	202.5
1970	4	16310	14423	51.033	239.4
1971	1	16910	14970	51.033	298.0
1971	2	17461	15480	-38.300	284.1
1971	3	18075	16055	6.500	317.9
1971	4	18952	16476	11.800	358.9
1972	1	19067	17104	73.900	279.1
1972	2	19842	17789	102.200	370.2
1972	3	20107	18007	75.100	440.2
1972	4	20714	18858	106.900	442.8

1973	1	21807	19447	75.900	527.9
1973	2	22684	20739	109.80	542.5
1973	3	23856	21513	104.00	395.8
1973	4	24984	22436	85.10	320.5
1974	1	26214	23275	83.50	551.0
1974	2	26943	24334	89.40	399.1
1974	3	28208	25033	56.90	379.7
1974	4	28736	25236	-21.80	520.4
1975	1	31271	27936	18.10	511.9
1975	2	31792	29102	-26.7	512.1
1975	3	33046	30334	17.2	615.5
1975	4	34337	31414	32.0	737.5
1976	1	36361	32272	142.2	663.3
1976	2	37504	33820	32.8	813.7
1976	3	38100	33742	-8.8	783.1
1976	4	39020	34927	49.6	694.2
1977	1	39978	35111	-49.0	813.4
1977	2	40613	36434	-26.1	509.0
1977	3	41578	37184	50.1	530.7
1977	4	42095	38604	3.8	765.6
1978	1	43117	39875	-40.2	750.0
1978	2	44278	40755	117.0	805.7
1978	3	45945	41944	97.8	736.5
1978	4	47370	43245	91.4	702.5
1979	1	49382	44825	-17.5	756.5
1979	2	51036	47113	-40.7	1346.5
1979	3	52742	48404	-5.5	953.0
1979	4	54269	49822	-9.1	460.6

1980	1	55617	50980	61.5	861.2
1980	2	56103	52013	-31.7	420.5
1980	3	56550	53919	-254.5	892.2
1980	4	58930	55336	100.4	1552.4
1981	1	66373	59854	183.5	1088.9
1981	2	69302	61945	168.3	711.1
1981	3	69545	62030	137.5	912.1
1981	4	69025	63234	38.2	-1050.7
1982	1	68814	63926	-273.4	-141.7
1982	2	68090	64697	-246.6	-349.6
1982	3	68005	65853	-138.2	-24.6
1982	4	68790	67001	-170.2	93.4
1983	1	71814	67854	26.3	-578.7
1983	2	73593	69785	94.5	453.8
1983	3	77357	74231	-84.5	259.9
1983	4	78522	73931	-53.8	788.4
1984	1	80161	75357	102.6	476.2
1984	2	81496	78564	0.6	-45.6
1984	3	82410	79548	186.8	1026.5
1984	4	83478	81540	160.8	1345.0
1985	1	85624	83292	82.3	437.5
1985	2	88306	84649	361.6	314.1
1985	3	91544	85163	126.5	2188.1
1985	4	92785	86807	316.2	-8695.2
1986	1	95627	86869	238.5	10049.5
1986	2	96409	88823	306.4	766.6
1986	3	97602	89382	553.7	1896.0
1986	4	98368	90871	278.1	1359.3

YEAR	QUARTER	CHANGE IN BANK LOAN OUTSTNDG(BUS. SCTR)	MORTGAGE LOANS	CAPITAL CONSUMPTION ALLOWANCE	INDRCT BUS. TAX LESS SUBSIDY
1962	1	264.7	259.4	1290	1332
1962	2	288.1	281.5	1303	1347
1962	3	193.6	263.6	1310	1405
1962	4	-171.0	227.4	1333	1362
1963	1	117.2	324.2	1354	1414
1963	2	-67.9	312.7	1371	1381
1963	3	142.1	294.7	1397	1432
1963	4	191.6	406.2	1481	1487
1964	1	154.5	315.4	1472	1541
1964	2	249.7	357.2	1515	1613
1964	3	122.6	360.6	1541	1638
1964	4	115.2	511.5	1580	1649
1965	1	231.2	408.5	1612	1743
1965	2	269.5	388.3	1637	1797
1965	3	172.9	467.0	1685	1862
1965	4	280.2	455.0	1721	1882
1966	1	75.3	366.3	1765	1958
1966	2	172.8	278.1	1815	1998
1966	3	109.8	381.7	1858	2059
1966	4	135.5	310.6	1884	2015
1967	1	102.5	475.2	1910	2195
1967	2	181.2	597.0	1951	2213
1967	3	407.3	394.9	1942	2209
1967	4	186.4	312.1	1983	2235

1968	1	393.9	620.4	2014	2365
1968	2	-126.6	429.7	2074	2355
1968	3	148.4	522.0	2092	2435
1968	4	250.5	667.8	2128	2507
1969	1	426.3	629.5	2181	2613
1969	2	495.9	591.5	2214	2668
1969	3	72.3	497.0	2286	2690
1969	4	194.4	514.2	2338	2751
1970	1	-5.6	479.0	2383	2782
1970	2	56.5	391.9	2435	2799
1970	3	265.1	757.5	2485	2861
1970	4	38.9	661.4	2503	2857
1971	1	325.8	669.0	2545	2946
1971	2	335.0	728.8	2605	3049
1971	3	658.5	844.6	2663	3119
1971	4	1033.4	926.7	2704	3162
1972	1	739.9	935.0	2801	3380
1972	2	746.3	816.3	2843	3369
1972	3	615.3	855.9	2933	3476
1972	4	499.3	864.9	3054	3588
1973	1	999.3	1081.1	3179	3708
1973	2	789.8	1120.4	3291	3721
1973	3	1038.2	1025.4	3414	3885
1973	4	1341.9	818.9	3500	4085
1974	1	851.3	1211.5	3655	4466
1974	2	978.6	1008.1	3794	4660
1974	3	835.4	712.5	3899	4558
1974	4	1146.3	467.0	4006	4279

1975	1	-39.8	958.9	4347	4379
1975	2	998.0	1516.0	4503	4302
1975	3	1056.6	1568.6	4618	4329
1975	4	1198.5	1661.5	4802	4574
1976	1	1882.6	1560.6	4992	5156
1976	2	611.1	1502.3	5095	5398
1976	3	1556.7	1578.0	5259	5394
1976	4	1677.1	1584.7	5392	5572
1977	1	1375.3	1551.7	5558	5800
1977	2	935.4	1789.3	5691	5923
1977	3	906.3	1748.9	5842	6031
1977	4	514.2	1825.4	5952	6153
1978	1	727.2	1401.8	6190	6408
1978	2	872.6	1368.4	6295	6350
1978	3	1464.7	1564.0	6513	6400
1978	4	1090.4	1339.4	6664	6696
1979	1	2955.4	1265.2	6898	7016
1979	2	3275.9	1441.8	7114	6834
1979	3	2422.3	1564.7	7313	7047
1979	4	3135.9	1306.2	7529	7028
1980	1	2461.2	1203.8	7753	7171
1980	2	4720.6	728.6	7926	7187
1980	3	-835.3	1188.5	8127	7214
1980	4	5092.0	1449.9	8368	7619
1981	1	4863.8	1251.1	8591	8880
1981	2	5221.3	1184.7	8798	9387
1981	3	6212.3	998.3	9016	9847
1981	4	-2373.6	853.6	9361	10127

1982	1	1161.5	883.6	10787	9919
1982	2	-75.0	577.8	11056	9585
1982	3	316.0	671.7	11128	9735
1982	4	-2042.0	1275.6	11385	9669
1983	1	-2565.9	1405.4	11334	9438
1983	2	-2572.1	1464.7	11586	10149
1983	3	-1764.5	1289.3	11961	10313
1983	4	-431.6	1091.4	12179	10235
1984	1	172.3	1284.8	12281	10531
1984	2	458.9	1289.0	12562	10505
1984	3	2075.5	1110.7	12791	10765
1984	4	991.3	1160.7	13040	11222
1985	1	37.5	1523.3	13157	11545
1985	2	469.8	1106.5	13508	11577
1985	3	-1604.6	1898.4	13689	11964
1985	4	773.7	1510.7	13828	12370
1986	1	8571.1	1377.7	14095	13055
1986	2	-8498.5	1501.4	14242	13052
1986	3	689.9	1805.6	14626	14263
1986	4	-2634.0	2017.1	14671	13553

YEAR	QUARTER	INTRST. & DIVND. ON GOVT. DEBT	NET TRNSFR. TO PERSNL. SECTOR	PERSNL. & CORPN. TAX PAID	CONSMR. PRICE INDEX (1971=100)	INVST. PRICE INDEX (1971=100)
1962	1	592	753.00	1552	77.4	72.1
1962	2	617	743.00	1635	77.6	72.5
1962	3	633	721.00	1604	78.0	72.7
1962	4	660	764.00	1637	78.3	72.9
1963	1	671	699.25	1661	78.6	73.8
1963	2	689	770.00	1686	78.8	74.1
1963	3	684	758.00	1730	79.2	74.9
1963	4	704	798.00	1820	79.3	75.0
1964	1	724	805.00	1873	79.6	76.2
1964	2	734	820.00	1952	79.9	77.3
1964	3	755	824.00	2008	80.1	77.4
1964	4	769	832.00	2035	80.5	77.7
1965	1	781	885.00	2085	80.9	80.2
1965	2	788	893.00	2141	81.3	80.7
1965	3	822	898.00	2172	81.8	81.1
1965	4	840	910.00	2262	82.3	81.8
1966	1	874	945.00	2440	83.2	83.9
1966	2	890	988.00	2535	84.1	84.9
1966	3	905	979.00	2623	84.5	85.5
1966	4	911	1032.00	2713	85.3	86.0
1967	1	923	1152.00	2851	85.8	87.5
1967	2	941	1188.00	2786	86.7	87.1
1967	3	971	1226.00	2981	87.7	86.8
1967	4	999	1309.00	3042	88.4	87.2

1968	1	1034	1328.00	3259	89.5	87.3
1968	2	1061	1454.00	3231	90.4	87.7
1968	3	1092	1497.00	3414	91.1	87.9
1968	4	1101	1522.00	3640	92.1	88.5
1969	1	1150	1544.00	3778	92.7	90.4
1969	2	1193	1598.00	4000	94.0	91.5
1969	3	1230	1602.50	4029	94.8	91.5
1969	4	1275	1677.00	4245	95.8	92.4
1970	1	1261	1767.00	4292	96.8	93.7
1970	2	1309	1740.00	4467	97.8	95.0
1970	3	1320	1870.00	4447	97.8	95.3
1970	4	1330	1919.00	4443	98.2	96.9
1971	1	1345	2119.00	4595	98.4	98.1
1971	2	1341	2075.00	4800	99.7	99.5
1971	3	1382	2234.00	5026	100.4	100.5
1971	4	1444	2286.00	5155	101.4	101.8
1972	1	1588	2409.00	5218	102.6	102.6
1972	2	1625	2625.00	5375	103.6	103.3
1972	3	1682	2679.00	5651	104.7	104.2
1972	4	1729	2708.00	5891	106.2	105.6
1973	1	1789	2733.00	6404	107.7	108.0
1973	2	1893	2890.00	6123	109.9	111.2
1973	3	1992	2989.00	6346	112.2	113.7
1973	4	2101	3147.00	6865	114.3	117.3
1974	1	2192	3390.00	7403	117.2	122.4
1974	2	2333	3546.00	7546	120.8	128.3
1974	3	2452	3752.00	8354	124.4	133.6
1974	4	2593	3834.00	8591	128.9	137.3

1975	1	2857	4142.00	8837	132.7	145.9
1975	2	2932	4430	9017	135.400	149.800
1975	3	3084	4662	9602	138.600	153.600
1975	4	3185	4714	9626	141.700	158.000
1976	1	3278	5100	9778	143.600	162.833
1976	2	3423	4957	9816	146.000	165.867
1976	3	3592	5086	10435	148.300	169.067
1976	4	3739	5323	10538	150.100	172.100
1977	1	3793	5587	11254	153.200	175.133
1977	2	3856	5625	11127	156.800	178.700
1977	3	4035	5889	11358	159.600	182.800
1977	4	4160	6007	11159	162.600	185.467
1978	1	4624	5935	11494	165.500	189.767
1978	2	4753	6466	12242	168.400	194.000
1978	3	4979	6552	12623	171.800	197.067
1978	4	5317	6706	13503	175.500	202.433
1979	1	5517	6694	13727	182.100	205.167
1979	2	5665	6866	13362	186.200	209.467
1979	3	5712	7052	14205	190.800	214.200
1979	4	6187	7111	14820	195.700	218.200
1980	1	6280	7595	15081	200.500	223.100
1980	2	6730	7829	15113	205.800	228.500
1980	3	6804	8397	15437	211.500	235.033
1980	4	7009	8665	16565	217.800	243.133
1981	1	7980	8806	15158	224.600	249.067
1981	2	8391	8919	14920	230.000	256.567
1981	3	10026	9258	16729	236.900	261.933
1981	4	10277	9619	16617	242.200	267.600

1982	1	21177	10536	22864	249.600	271.667
1982	2	12163	11185	22672	255.800	274.333
1982	3	12090	12151	22602	262.600	276.733
1982	4	10954	12586	22070	267.000	277.600
1983	1	11066	12974	22945	268.800	278.833
1983	2	10974	13012	24233	271.700	279.467
1983	3	11386	13297	22682	275.700	280.800
1983	4	11701	13354	24463	279.000	282.700
1984	1	11472	13559	25235	281.400	281.567
1984	2	12363	13769	25170	283.200	283.400
1984	3	13139	14027	26189	286.000	283.400
1984	4	13742	14345	27096	288.200	285.533
1985	1	13412	14822	26863	292.300	289.200
1985	2	13695	14995	27423	294.700	292.200
1985	3	13560	15130	28678	297.400	293.367
1985	4	13720	15440	29505	300.400	295.767
1986	1	14339	15606	29950	305.320	303.218
1986	2	14267	15766	30229	307.187	306.927
1986	3	14139	16032	30272	310.455	310.464
1986	4	14314	16982	31499	314.190	313.742

Appendix G

DATA SOURCES

Bank of Canada (1972), Bank of Canada Monthly Review, Ottawa, June, Tables: 16, 59, 61; Nov. Table: 61.

----------(1973), Bank of Canada Monthly Review, Ottawa, Jan. Table: 55; June, Tables: 10, 47, 58; Dec., Tables: 19, 62, 63.

----------(1974), Bank of Canada Monthly Review, Ottawa, Jun. Table: 58; Dec. Tables: 16, 63, 65.

----------(1975), Bank of Canada Monthly Review, Ottawa, June, Tables: 10, 59; Dec. Table: 64.

----------(1976), Bank of Canada Monthly Review, Ottawa, June, Tables: 66, 67; July, Table: 60; Dec. Tables: 10, 20, 60.

----------(1977), Bank of Canada Monthly Review, Ottawa, June, Tables: 18, 67; July, Table: 67; Dec. Table: 65.

----------(1978), Bank of Canada Monthly Review, Ottawa, June, Table: 61; Dec. Tables: 14, 67, 68.

----------(1979), Bank of Canada Monthly Review, Otttawa, March, Table: 54; June, Tables: 50, 65, 67; Dec. Tables: 10, 20, 61.

----------(1980), Bank of Canada Monthly Review, Ottawa, July, Tables: 61, 67; Dec. Tables: 14, 20, 65, 67.

----------(1981), Bank of Canada Monthly Review, Ottawa, Dec. Tables: 10, 61.

----------(1982), Bank of Canada Monthly Review, Ottawa, June, Tables: 14, 50, 61, 65, 67, 69; Dec. Tables: 20, 67.

----------(1983), Bank of Canada Monthly Review, Ottawa, July, Table: 67.

----------(1984), Bank of Canada Monthly Review, Ottawa, June, Tables: 67, 69; Oct., Tables: 10, 61; Dec., Tables: 9, 10, 54, 61, 65, 67.

----------(1985), Bank of Canada Monthly Review, Ottawa, Dec. Table: F1.

----------(1986), Bank of Canada Monthly Review, Ottawa, June, Tables: E1, E2, H11, I1, I3; July, Table: H4.

----------(1987), Bank of Canada Monthly Review, Ottawa, Feb., Tables: C8, H11, I3; May, Table; C8; June, Tables; E1, E2, H11, I1, I3; July, Tables: H4, H11, I3.

----------(1954), Bank of Canada Statistical Summary, Ottawa, pp. 37-39; 59, 61.

----------(19570, Bank of Canada Statistical Summary, Ottawa, pp. 30-31; p. 68, 74; pp. 75-76 and pp. 118-119.

----------(1959), Bank of Canada Statistical Summary, Ottawa, p. 99, p. 138.

----------(1961), Bank of Canada Statistical Summary, Ottawa, pp. 30-31; p. 104, 109, 143, 144.

----------(1964), Bank of Canada Statistical Summary, p. 102, 109, 133, 134.

----------(1965), Bank of Canada Statistical Summary, Ottawa, p. 144.

----------(1969), Bank of Canada Statistical Summary, Ottawa, pp. 36-37,p. 126, 133, 153, 154.

----------(1970), Bank of Canada Statistical Summary, Ottawa, pp. 847-48, p. 992.

Central Mortgage and Housing Corporation (1955), Canadian Housing Statistics, 1-2 Quarters, Ottawa, p. 16.

----------(1956), Canadian Housing Statistics, 1st. Quarter, Ottawa, p.16.

Statistics Canada (1974), National Income and Expenditure Accounts: Vol. 2, The Quarterly Estimates (1947-74). Ottawa, pp. 112-19; 120-27; 121-27; 133-37; 137-43; 193-99; 218-25.

----------(1980), National Income and Expenditure Accounts, Quarterly Estimates, 4th. Quarter, Ottawa, pp. 36-37.

----------(1981), National Income and Expenditure Accounts, Quarterly Estimates, 4th. Quarter, Ottawa, p. 34-35; 38-41; 56-59.

----------(1982), National Income and Expenditure Accounts Quarterly Estimates, 2nd Quarter, Ottawa, pp. 34-35; 36-37; 40-43; 56-57.

----------(1986), National Income and Expenditure Accounts, Quarterly Estimates, 4th. Quarter, Ottawa, pp. 2-3; 4-5; 6-7; 13-15; 32-33.

----------(1987), National Income and Expenditure Accounts, Quarterly Estimates, 2nd. Quarter, Ottawa, pp. 2-3; 12-14; 32-33.

----------(1987), CANSIM Series, Ottawa, Nos. B122; B1627; B3805; D65004; D71082.

Appendix H

SAMPLE SAS PROGRAMS

```
//WAHID JOB ',,,I=100,T=60,L=20,F=DAI1','SAS',MSGLEVEL=(1,1)
// EXEC SAS,SIZE=3000K
//SYSIN DD *
DATA BASE;
```

H.1 SAS 2SLS ESTIMATION PROCEDURE

```
PROC SYSLIN 2SLS DATA=BASE OUT=BASED0;
ENDOGENOUS PDI PX;
INSTRUMENTS PDI1 HP IBTLS CCA TR IDGD TA;
MODEL PDI=PX CCA IDGD TR IBTLS TA /DW;
RESTRICT IDGD=1;
RESTRICT CCA=-1;
RESTRICT TA=-1;
RESTRICT IBTLS=-1;
RESTRICT TR=1;
MODEL PX=PDI PDI1 HP BAP BAB MTL /DW;
OUTPUT P=PREDD0 R=RESD0;
```

H.2 SAS SIMULATION PROCEDURE

```
PROC SIMNLIN DATA=BASEB10 OUT=D1 OUTPREDICT STAT THEIL;
ENDOGENOUS PXR;
EXOGENOUS PRDIR HPR BAPR BABR MTL;
PARAMETERS C0 C1 C2 C3 C4 C5 C6;
PXR=C0+C1*PRDIR+C2*LAG(PRDIR)+C3*HPR+C4*BAPR+C5*BABR+C6*MLR;
PROC PRINT DATA=D1;
DATA BASEBB1;
SET BASEB10;
APXR=PXR;
TIME=TIME;
KEEP APXR TIME;
DATA M1;
MERGE D1 BASEBB1;
PROC GPLOT DATA=M1;
PLOT PXR*TIME APXR*TIME/OVERLAY;
```

BIBLIOGRAPHY

Ando, A. and Modigliani, F. (1963), "The Life Cycle Hypothesis of Savings: Aggregate Implications and Tests", American Economic Review, Vol. 53, PP. 55-84.

Anyadike-Danes, M.(1982), "The New Cambridge Hypothesis and Fiscal Planning", Cambridge Economic Policy Review, April, Vol. 8, No. 1, pp. 33-38.

Bispham, J. A.(1975), "The 'New Cambridge' and Monetarist Criticisms of "Conventional" Policy Making", National Institute Economic Review, November, Vol. 74, pp. 39-55.

Blinder, A. S.(1978), "What's New and What's Keynesian in the 'New Cambridge' Keynesianism?", in K. Brunner and A. Meltzer (et.al.), Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economies, North Holland, Vol. 9, pp. 67-85.

Chrystal, K.A. (1981-a), "The New Cambridge Aggregate Expenditure Function: The Emperor's Old Clothes?", Journal of Monetary Economics, Vol. 7, No. 3, pp. 395-402.

_____(1981-b), "The New Cambridge Aggregate Expenditure Function: Correction and Confirmation", Discussion Paper, No. 189, University of Essex.

Chrystal, K.A. and Darnell, A.C. (n.d.), "The Aggregate Private Expenditure Function Again", Working Paper, University of Essex and University of Durham (Unpublished).

Cripps, T.F., Godley, W.A.H. and Fetherston, M.J. (1974), "Public Expenditure and the Management of the Economy: Memorandum to the Expenditure Committee" Ninth Report from the Expenditure Committee, Public Expenditure, Inflation and the Balance of Payments, Jul. London, Her Majesty's Stationery Office. Jun. 17, G-21, Paras 1-17.

----------(1976), "What is Left of New Cambridge?", Cambridge Economic Policy Review, No. 2, pp. 46-49.

Cuthberston, K.A. (1979), Macroeconomic Policy: The New Cambridge, Keynesian and Monetarist Controversies, London, Mac Millan Press Ltd., Chapter 3, pp. 53-89.

Fetherston, M.J. (1975), "Estimation of Simultaneous Relationships: A U.K. Private Expenditure Function", Working Paper, Cambridge (U.K.) Department of Applied Economics, University of Cambridge.

Fetherston, M.J. and Godley, W.A.H. (1978), "New Cambridge Macroeconomics and Global Monetarism: Some Issues in the Conduct of U.K. Economic Policy", in K. Brunner and A. Meltzer (et. al), Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economies, North Holland, Vol. 9, pp. 33-65.

Ganga, G.N. (1988), " Stabilization Policies in Guyana 1977-85", a Ph.D. dissertation, Department of Economics, University of Manitoba, unpublished, chapter 5, section 5, pp. 200-217.

Godley, W.A.H. and Cripps, T.F. (1973), "Balance of Payments and Demand Management: 1972-76", The Times, Jan. 8, p. 17.

---------- (1974), "London and Cambridge Economic Bulletin Part I: Why Britain Needs a Fresh Set of Principles to Manage Economy?", The Times, Jan. 22, p. 19.

Gujrati, Damadar (1978), Basic Econometrics, New York, McGraw Hill Book Company, Chapter 13, p. 306.

Hall, R.F. (1978), "A Comment on the Fetherston and Godley and Posner Papers", in K. Brunner and A. Meltzer (et. al.), Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economies, North Holland, Vol. 9, pp. 87-89.

Koutsoyiannis, A. (1977), Theory of Econometrics, Hong Kong, Mac Millan Publishing Company, Chapter 9. p. 186.

Maurice, Rita (et. al.)(1968), National Accounts Statistics: Sources and Methods, London, Her Majesty's Stationery Office, Chapter 13, pp. 390-407.

Mowl, Colin (1974), "Godley's Evidence to the Select Committee on Expenditure Regarding Demand Management: The Basic Proposition and Associated Econometrics" (Unpublished).

Neild, R.R. (1973), "London and Cambridge Economic Bulletin I: The Seeds of a Classic Inflation", The Times, Jul. 19, p. 27.

Pindyck, R.S. and Rubinfeld, D.L. (1976), Econometric Models and Economic Forecasts, New York, McGraw-Hill Book Company, Chapter 10, pp. 308-35.

Russel, T. and Wakeman, L.M. (1978), "New Cambridge Economics Without Markets: A Comment", in K. Brunner and A. Meltzer (et. al.), Carnegie-Rochester Conference Series on Public Policy: A Supplementary Series to the Journal of Monetary Economics, Public Policies in Open Economies, North Holland, Vol. 9, pp. 95-02.

Smith, R.P. (1976), "Demand Management and the New School", Applied Economics, Vol. 8, No. 3, pp. 193-05.

Stamler, H. (1975), "Some Further Investigations into New Cambridge Expenditure Functions", (Unpublished), June.