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THE STRUCTURE OF RDX2

PART 1

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THE STRUCTURE OF RDX2

Part 1

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This study was prepared as part of the econometric research programme of the Research Department of the Bank of Canada. The views expressed are those of the authors and no responsibility for them should be attributed to the Bank.

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PREFACE

RDX2 is a large aggregate econometric model of the Canadian economy. It is a product of the continuing programme of econometric research sponsored by the Research Department of the Bank of Canada. Since the publication of RDX1 in 1969, many numbers have flowed through our hands. The structure of the economy has been shifting and major revisions of the national accounts [10] have forced us to form new views of the recent economic history of Canada. In addition to these changes, our expectations have increased concerning the variety of questions that the RDX series of models should be able to face, as we have sought to apply the many lessons learned from RDX1. For instance, our interest in the international repercussions of national economic policies has led us to develop detailed explanations of trade and capital flows and associated portfolio changes; the monetary sector of RDX2 is more fully developed; and the links between the monetary and real economies more fully articulated. The net effect of all these forces is that RDX2 is much larger and more interrelated than RDX1. The links between the sectors of RDX2, and the links between RDX2 and variables generated in other countries, are more extensive than those of any other national econometric model of which we are aware. RDX2 will be subject to alteration as we continue with our simulations and add to the data sample, but, as a whole, RDX2 is much less 'preliminary' than RDX1. We used RDX1 as a learning device to a great extent. Long before our experiments with that model were complete we had developed many equations preferable to those in

the RDX1 structure. The extensive revisions of the national accounts ensured the obsolescence of RDX1, which is based on unrevised national accounts data. Subsequently we have devoted our efforts entirely to RDX2 rather than attempting to use the revised data to rebuild RDX1.

We continue to be fortunate in having an everchanging cohort of able and enthusiastic collaborators. Some of them have made contributions too large and too specific to be properly acknowledged by a mere listing of names. Al Coombs has been our principal systems engineer and has devoted many dedicated hours and much ingenuity to the improvement of our estimation and simulation programmes. The primary data are the responsibility of Marg Fitzpatrick and a revolving group of assistants, using balance of payments data developed by Roy Flett and Doug Smee, and so on. Jim Dingle, during the course of a year devoted to the project, was a notable jack-of-all-sectors and in particular was responsible for a good deal of early development of our measures of wealth. Tom Maxwell has done much of the estimation and simulation of the model of the foreign exchange market, and Jillian Broadbent has been a valuable contributor of equations for long-term capital movements and related current account items. Tom Brady has done the bulk of the estimation work in the financial sector. We were fortunate to have Lynne Duncan, Terry Ford, and Paul Masson as enthusiastic helpers during the summers of 1970 and 1971. Other people who have provided important help or advice that has influenced RDX2 include Alan Adamson, John Fountain, Guy Glorieux, Sandy Schellenberg, Danielle Tuchmaier, Mike Walker, and Edith Whyte. The study has been efficiently typed, under some pressure of time, by Judy Crew, working on a

typewriter terminal linked to tape storage and high-speed printers. Effective use of this system has led us to abandon footnotes and to keep text and equations separate. Margaret Bailey, as editor, has prepared the manuscript for the printer and supervised its publication. Not only has she saved us from many follies of fact and prose but she has done this and performed a myriad of other chores with astonishing patience and continuous good humour.

We are grateful, of course, for the continued advice and support of the rest of the Research Department.

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RESUME

La publication du présent ouvrage - The Structure of RDX2 - constitue le dernier stade de la mise au point, au Département des recherches de la Banque du Canada, d'un nouveau modèle économétrique trimestriel de l'économie canadienne. Le modèle RDX2 est un instrument de travail beaucoup plus élaboré et plus souple que le RDX1, qui l'a précédé; le nombre de fonctions estimatives de comportement qu'il englobe est presque trois fois plus élevé que celui du premier modèle et la structure fondamentale de presque tous les secteurs est différente. Comme dans le cas du RDX1, le RDX2 vise à constituer un instrument susceptible de simuler de façon réaliste, à court et moyen terme, l'éventail des politiques économiques que le gouvernement canadien pourrait adopter dans diverses situations. C'est pourquoi une attention particulière a été accordée à l'élaboration des secteurs gouvernemental et monétaire du modèle et à leur intégration dans l'ensemble de l'économie. En outre, le RDX2 diffère très nettement du RDX1 par le traitement beaucoup plus détaillé qu'il réserve aux équations relatives au commerce extérieur du Canada et aux mouvements de capitaux entre le Canada et l'étranger. Cette importance accrue accordée au secteur international dans le nouveau modèle s'explique par la nécessité de représenter d'une façon plus précise l'incidence internationale des politiques économiques et de l'évolution conjoncturelle à l'étranger et au Canada et, accessoirement, par le désir d'établir une relation entre le RDX2 et le modèle très élaboré de l'économie américaine qu'est le MPS.

La diversité des objectifs du RDX2 a conduit à la définition d'un certain nombre de concepts théoriques. Ainsi, le concept du prix auquel les capitaux sont susceptibles d'être offerts est le fruit de nos évaluations de la valeur marchande courante des composantes de la valeur nette du patrimoine national, qui comprennent les immobilisations des entreprises, la dette publique, les logements et les biens de consommation. On obtient également une évaluation du taux anticipé de l'augmentation des prix à la consommation à partir du prix de l'offre des capitaux, évalué en termes réels et en termes nominaux. Ce prix influence les dépenses d'investissement, les flux internationaux de capitaux et le comportement de l'épargne. Par contre, le taux anticipé de l'inflation influe sur l'évolution des taux des salaires, sur la construction résidentielle et sur les décisions en matière de politique économique des pouvoirs publics.

L'interdépendance des demandes portant sur les facteurs de production - bâtiments, machines, équipement et main-d'oeuvre - se fait sentir dans tout le modèle RDX2. Les demandes relatives à ces facteurs interdépendants ont été intégrées dans une fonction synthétique de la production, de sorte que leur compatibilité et celle de leur processus d'ajustement se trouvent assurées. Ce schéma suppose que les entreprises cherchent à minimiser leurs coûts et se traduit par une amélioration sensible des équations relatives à la constitution des stocks, à l'emploi, aux heures de travail et aux dépenses en immobilisations. La fonction synthétique de la production permet de définir de nouvelles méthodes d'évaluer l'offre globale, la demande, le degré d'utilisation de la capacité de production et les variations à court terme de la productivité. Ces évaluations, en retour, jouent un rôle important dans les équations relatives aux

prix et au commerce extérieur. Un modèle portant sur la demande pour les divers facteurs de production permet en outre de mesurer les tendances de la productivité de la main-d'oeuvre - qui constitue un élément déterminant du niveau des salaires réels dans les entreprises.

Le RDX2 cherche, beaucoup plus que ne le font la plupart des autres modèles, à déterminer l'évolution des dépenses et de la composition des portefeuilles en fonction des taux de croissance du revenu et du patrimoine national. Ainsi, dans le RDX2, les flux internationaux de capitaux sont, pour la plupart, liés directement à l'évolution des portefeuilles canadiens et étrangers ainsi qu'à la composition de ces portefeuilles et aux taux de rendement. Parallèlement, la demande du secteur non financier pour diverses catégories d'avoirs liquides est déterminée à l'aide d'un modèle qui a trait au comportement des portefeuilles et tient compte de la contrainte imposée par la croissance du portefeuille global de ces avoirs. Dans le cas du gouvernement fédéral, des provinces et des municipalités, il a été tenu compte de tous les mouvements de fonds, de sorte que les relations assurant l'équilibre entre flux et stocks ont dû être spécifiées.

Le modèle comporte vingt-et-un secteurs. Pour les besoins de la simulation, il est aisé d'en exclure soit un ou plusieurs secteurs, soit une ou plusieurs équations. Les chapitres 2 à 11, dans la première partie de l'étude, présentent une analyse, secteur par secteur, des équations du modèle. Ces dix chapitres portent sur les sujets suivants: la consommation et la construction de logements; les investissements et la production des entreprises; le commerce extérieur; l'emploi et les heures de travail dans les entreprises, la population active et la

démographie; la répartition des revenus: les salaires, les bénéfices et les dividendes; la formation des prix; les opérations des gouvernements; le secteur financier; la balance des capitaux à long terme; les cours du change, les réserves officielles et les mouvements des capitaux à court terme.

La seconde partie de l'étude, publiée séparément, présente les équations qui constituent actuellement le modèle RDX2 - classées d'abord par secteurs puis, à l'intérieur de chaque secteur, selon leur numéro d'ordre.

Comme dans le cas du RDX1, The Structure of RDX2 sera suivie d'une analyse approfondie de la dynamique du RDX2 - analyse dont les résultats seront publiés ultérieurement. On trouvera au Chapitre 12 une introduction à la dynamique du RDX2. On y expose notamment la fidélité avec laquelle le modèle parvient à suivre l'évolution de l'économie canadienne, non seulement au cours de la période qui a fourni les données de base mais également par la suite, ainsi que ses réactions au test que représente l'introduction de tout un éventail de politiques économiques possibles.

PRECIS

The publication of The Structure of RDX2 marks completion within the Research Department of the Bank of Canada of a new quarterly model of the Canadian economy. RDX2 is a much larger and more flexible tool than its predecessor, RDX1. There are almost three times as many estimated behavioural relationships in RDX2 as in RDX1, and the underlying structure of almost every sector is different. As with RDX1, RDX2 is intended to be a vehicle for realistic short- and medium-term simulation of alternative policy choices open to government; hence particular attention has been paid to the elaboration of the government and monetary sectors of the model and to their integration with the total economy. In addition, RDX2 differs most markedly from RDX1 in the expanded treatment given to Canada's international trade and capital flow relationships. This expanded treatment of the international sector of the model arises from a desire to represent more adequately the international repercussions of foreign and domestic events and policies, and, derivative from this, our undertaking to link RDX2 with the large scale MPS model of the U.S. economy.

The variety of objectives for RDX2 has led to a number of theoretical developments. The concept of the supply price of capital is an outgrowth of our measurement of current market values for components of domestic net worth, which includes business capital stock, government debt, dwellings, and consumer durables. A measure of the expected rate of increase of consumer prices derives from measures of the supply price of capital in both real and nominal terms. The supply price of capital

influences investment expenditure, international capital movements, and savings behaviour. The expected rate of inflation influences wage rate movements, residential construction and public policy decisions.

A model of interrelated demands for buildings, machinery and equipment, and labour services has ramifications throughout RDX2. A synthetic production function underlies the related factor demands in such a way that consistency of factor demands and adjustment is assured. This scheme, which assumes cost-minimizing behaviour, gives rise to much-improved equations for inventory demand, employment and hours, and capital expenditure. Our synthetic production function allows us to develop new measures for aggregate supply, demand, capacity utilization, and short-term changes in productivity. These measures in turn play important roles in our equations for prices and foreign trade. The factor-demand model also gives rise to a trend measure of labour efficiency that is the main determinent of the level of the business real wage.

In RDX2 a good deal more attention is given than in other models to specifying expenditure and portfolio allocation behaviour under varying rates of growth of income and wealth. For example, in RDX2 most international capital flows are tied directly to growth in domestic and foreign portfolios as well as to existing portfolio proportions and rates of return. Correspondingly, the demands of the nonfinancial sector for various liquid assets are determined (through constrained estimation of portfolio behaviour) by the growth of the total portfolio of such assets. Flow-of-funds accounting is made complete for federal as well as provincial and municipal

governments so that here too we specify the necessary connections between stock and flow equilibrium.

The model is comprised of twenty-one sectors. For purposes of simulation, one or more sectors or any single equation or group of equations may be easily exogenized. Chapters 2 to 11, appearing in Part 1 of the study, contain a sector-by-sector discussion of the equations of the model. The ten chapters in Part 1 of the study dealing with the equations are entitled: Consumption and Residential Construction; Business Investment and Output; Foreign Trade; Business Employment and Hours, Labour Force, and Population; Income Distribution: Wages, Profits and Dividends; Price Formation; The Operations of Governments; The Financial Sector; The Long-Term Capital Account; and Foreign Exchange Rates, Official Reserves, and Short-Term Capital Flows.

Part 2 of the study (a separate volume) contains the equations currently in the RDX2 model arranged by sector and numbered within each sector.

As with RDX1, The Structure of RDX2 will be followed by an extensive examination of the dynamics of RDX2, which will be published in a subsequent study. Chapter 12 of the present study contains an introduction to the dynamics of RDX2 through a recording of the intra- and post-sample tracking qualities of the model and its response to a representative sample of policy shocks.

CHAPTER 1

AN INTRODUCTORY SURVEY OF THE MODEL

A Introduction

RDX2 is our contribution to the latest generation of aggregate econometric models. Like the higher generation computers that have made its estimation and simulation feasible, RDX2 is a much larger and more flexible tool than its predecessor, RDX1. The users of RDX1 will find little that is familiar in RDX2. There are almost three times as many estimated behavioural equations in RDX2 as in RDX1, and the underlying structure is different in almost every sector. We have tried to make good use of the lessons learned from our first model, and the structure of RDX2 reflects everywhere our attempts to improve upon RDX1.

Although we have devised a highly interdependent model, which will be fully comprehensible to us only after many months of simulation, we are hopeful that its basic structure will remain fairly stable for some time. Therefore we are taking the earliest opportunity to distribute our equations and data so that other researchers can share in the process of learning about and consequently improving RDX2. This version of the model is preliminary in the sense that we expect to improve on some of the specifications during the course of the simulation experiments we plan to undertake. After testing and a full range of experiments, we shall publish the results along with the revised

equation structure and parameter estimates. The main change in the parameter estimates will probably arise from the use of the structurally ordered instrumental variables estimation technique (SOIV, described in [19] and [44]) in place of ordinary least squares (OLS). As with RDX1, we ensure consistency by using instrumental variables regression in the second stage of the procedure. Our experience with applying both methods of estimation to RDX1 suggests that the equation structure and main single-stage parameter estimates are not likely to be altered much by the simultaneous equation estimation.

In this chapter we outline the research strategy underlying RDX2 and preview the more comprehensive description of its structure to be found in Chapters 2 to 11. We shall defer until Chapter 12 a discussion of the main chains of causal influence to be found in the model. Even that discussion will be fairly sketchy, since we would prefer to present a complete analysis after we have had more experience with using RDX2. Appendix A, an alphabetical list of the variables used in the model, and Appendix B, the equations of the model divided into twenty-one sectors, appear in Part 2 of the study. The explanation of RDX2 is in this volume - Part 1 of the study.

We state in section B of this chapter what we wish to do with RDX2, and outline some of its unifying features. In section C we make a preliminary survey, under five headings, of the main aspects of each sector of the model.

B Sources and Uses of RDX2

RDX2 is intended to be a vehicle for realistic short- and medium-term simulations of alternative policy choices. This primary objective as well as other anticipated demands on the model shaped our approach to its construction and has led to a number of theoretical developments.

We have completed the modelling of government activities (begun in [28]) so as to clarify the roles of governments and include all important policy instruments in a fairly accurate way.

Our continuing interest in monetary policy encouraged us to make use of recent developments in monetary and expenditure theory to forge a variety of links between goods markets and financial markets.

Our undertaking to link RDX2 with a large model of the U.S. economy (a project outlined in [36]) strengthened our already substantial resolve to explain international flows of goods, capital, and people well enough to picture the full international repercussions of domestic events and policies.

Inflationary experience in the late 1960s affected the development of RDX2 in two ways. First, we became anxious to explain wage and price movements in more structural detail. Second, because of the shifting gap between nominal and real rates of interest we were forced to be much more precise than we and other researchers have been in modelling the influence of price expectations on behaviour.

The variety of objectives for RDX2 has led to a number of theoretical developments. As a consequence, no grand centerpiece emerges, although there are a number of features pervasive enough to merit advance billing and others that will be demonstrated as the various sectors are described.

1 The supply price of capital

Our concept of the supply price of capital (RHO) is an outgrowth of our measurement of current market values for components of domestic net worth, which includes business capital stock, government debt, dwellings, and consumer durables. We have been able to estimate the supply price of capital in both real and nominal terms, and consequently to derive a measure of the expected rate of increase in consumer prices. The supply price of capital influences capital expenditure, international capital movements, and savings behaviour. Expectations about a variety of factor costs determine the degree of factor substitution in the factor-demand model described below.

2 Investment and output

Our model of the interrelated demands for buildings, machinery and equipment, and labour services has ramifications throughout RDX2. A synthetic production function underlies the related factor demands in such a way that consistency of factor demands and adjustment is assured. This scheme, which assumes cost-minimizing behaviour, gives rise to greatly improved

equations for inventory demand, employment and hours, and capital expenditure. In addition, it allows us to develop new measures for aggregate supply, demand, capacity utilization, and short-term changes in productivity. These measures in turn are important in our equations for prices and foreign trade. The factor-demand model also gives rise to a trend measure of labour efficiency, which is the main determinant of the level of the business real wage.

3 Stock and flow equilibrium

We go further than other model-builders in specifying expenditure and portfolio allocation behaviour that makes sense under varying rates of growth of income and wealth. For example, most of our international capital flow equations are tied directly to growth in domestic and foreign portfolios as well as to existing portfolio proportions and rates of return. Correspondingly, the demands of the nonfinancial sector for various liquid assets are determined, through constrained estimation of portfolio behaviour, by the growth of the total portfolio of such assets. Flow-of-funds accounting is made complete for federal as well as provincial and municipal governments so that here too we specify the necessary connections between stock and flow equilibrium. Our zeal also led us to specify our main price and wage equations so that prices and wages have reasonable equilibrium levels as well as rates of change. We do not emphasize portfolio and other stock or level equilibrium properties at the expense of reasonable

disequilibrium properties, because we have developed a range of disequilibrium adjustment mechanisms. We have also concentrated much effort on specifying expectations mechanisms and the time paths for adjustment. Features of the new adjustment processes include a ratio of aggregate demand and supply imbalance derived from the new supply and demand concepts we describe in Chapter 3, and a measure of credit availability based on the ratio of chartered bank earning liquid assets to total assets (RABEL). The difference between RABEL and its target value (RABELD) has important effects on bank loans, international capital movements, and domestic expenditure.

RDX2 is characterized by other novel features, but they are well entrenched in particular sectors and are therefore described in the next section of this chapter or in Chapters 2 to 11 devoted to sector-by-sector study of the model.

C A Preview of the Main Features of RDX2

In this section we make the first references to equation numbers and variable names. Those who wish to take maximum advantage of our cunningly devised scheme for variable names ought now to consult the instructions at the beginning of Appendix A, which is in the other volume of this study - Part 2. There we explain how a good deal can be divined about the nature of a variable, as well as the units in which it is expressed, by referring to just the first letter in its name. We also explain

in Appendix A our set of notations, each preceded by J, for a number of simple algebraic operations.

In this section the twenty-one sectors of the model are described briefly under five headings. The sectors of the model are numbered from 1 to 21, and the equations within Appendix B (also in the other volume of this study - Part 2) are ordered by sector number and also by the number of each equation within that sector. For example, the behavioural equations in Sector 19 for long-term capital flows are numbered from 19.1 to 19.13. The technical relationships, mostly accounting identities that accumulate asset and liability accounts, are placed after the behavioural equations in each sector.

1 Private aggregate demand

This grouping consists of four sectors, comprising thirty-four behavioural equations and twenty-five technical relationships. Consumer expenditure (Sector 1) and residential construction (Sector 2) are discussed in Chapter 2. Investment and output (Sector 3) are taken up in Chapter 3, and foreign trade (Sector 4) is treated in Chapter 4.

The model of aggregate consumption expenditure employed in Sector 1 is based on expected wage income, expected nonwage income, the rate of return on savings, and capital gains and losses on equities and government debt. Estimates of disposable labour income are derived from income components of the national accounts and appropriate taxation statistics. Estimates of nonwage income are derived from the time series we have developed

on household wealth and relevant rates of return. National accounts estimates of consumption of services are modified to include imputed service flows emanating from household stocks of durable goods. The consumption equations are fitted in constant-dollar per capita form.

Expenditure on consumer durable goods is represented by two relationships: one equation for total expenditure on motor vehicles and parts and another for expenditure on all other consumer durables. In each equation we employ a stock-adjustment model, with the desired stock of durables depending on relative prices, wage income and nonwage income.

The residential construction equations in Sector 2 involve a split between single-detached dwellings and all forms of multiple dwellings. There are separate equations for housing starts and the related housing stocks of single-detached and multiple dwellings, and a combined equation for residential construction investment.

The business fixed investment equations in Sector 3 embody a flexible accelerator and cost-minimizing behaviour based on a pre-specified production function, vintage measures of capital intensity, expected output, and expected prices of capital and labour services. The prices of capital services depend on tax rates, depreciation rates, the supply price of capital, and the expected prices of capital goods. Stocks of machinery and equipment (KME) and of non-residential construction (KNRC) enter as separate factors into the production function. We chose the parameters of the production function after a search over a grid of alternatives. The demand for labour was obtained from the

same framework, after allowing for Harrod-neutral technical progress.

The production function is used along with actual inputs of capital, employment, and hours worked, to derive UGPPS, a measure of current supply of private nonfarm business output. UGPPD is a measure of desired output based on the labour supply rather than the current level of employment.

The inventory investment equation (also described in Chapter 3) has an 'intended' component based on a flexible accelerator that is driven by expected sales, and an 'unintended' component based on the excess of the supply variable, UGPPS, over non-inventory demand (UGPP-IIB). The latter component, multiplied by its estimated coefficient in the inventory equation, is used as a measure of unintended inventory accumulation or decumulation. This amount is subtracted from UGPP in order to obtain UGPPA, which we then use as our best measure of final demand. Thus we use UGPPA, rather than UGPP, as the driving variable in the business fixed investment equations, and UGPPA/UGPPD becomes the favoured index of imbalance between aggregate demand and supply.

In Sector 4 there are nine equations representing imports and exports of goods, thirteen equations for services, and nine technical relationships accumulating aggregate trade flows. Imports and exports of goods, estimated in constant dollars, are disaggregated both by commodity classification and by region of origin or destination. For this purpose we classify Canada's trading partners into two groups: the United States, and all other countries. Disaggregation by commodity is more extensive for imports than for exports. Imports of goods are divided into

as many as five separate groups, constructed from the ten basic Standard Industrial Trade Classification (SITC) classes, with transportation equipment separated for special treatment. Two principal benefits flow from the extensive disaggregation on the import side. First, disaggregation by region considerably improves our ability to explain the aggregate flow. Second, disaggregation by commodity reveals considerable information about the basic structure of the relationships involved.

The principal explanatory variables in the trade equations are: (a) the level of economic activity, domestic or foreign, (b) relative prices, (c) capacity utilization rates, domestic and foreign, and (d) qualitative variables generally used to describe special circumstances. In the case of imports the activity variable is a weighted sum of the components of domestic final demand, where the weights are based on the input-output coefficients reflecting import content, modified to suit the SITC commodity classification scheme.

The relationships explaining the levels of receipts and payments for various service flows also distinguish between Canada's two distinct trading regions. All these equations are estimated in current dollars. The relationships explaining travel payments and receipts, and freight and shipping payments and receipts are related to their 'natural' determinants - per capita consumption of services and trade flows, respectively. The interest and dividend payments and receipts equations provide an important link between the capital and current accounts of the balance of payments. Interest payments to the United States depend on the product of Canadian interest-bearing liabilities

and a weighted average of past Canadian and U.S. interest rates. The weights depend on new bond issues and the split between Canadian- and U.S.-pay securities. Dividend payments to the United States are derived from a distributed lag model applied to cash flow accruing to U.S. shareholders. The other interest and dividend flows are based on the applicable debt and interest rate series.

2 Private sector employment and wages, prices, and income distribution

Here we treat four sectors in three chapters. In Chapter 5 we deal with the equations of Sector 5 for employment and hours in the private sector. Chapter 6 contains a description of the Sector 6 equations for private sector wages and the Sector 8 equations for profits and dividends. In Chapter 7 we discuss the twenty-three price equations of Sector 7.

Employment in mining, manufacturing, and other business (NMMOB) is explained by a distributed lag adjustment towards desired labour input (NMMOBD) derived from the production function. NMMOBD is the quantity of labour that, working normal hours in conjunction with the actual capital stock, would yield a value of output equal to final demand (UGPPA). The deviation of average weekly hours in mining and manufacturing (HAWMM) from its normal value is then explained by the proportionate difference between actual and desired employment. Thus average hours worked represents the immediate adjustment mechanism. Employment and the capital stock adjust more slowly. Employment

and hours in construction are treated separately, since the sum of investment in residential and non-residential construction gives a separate activity measure for the construction industry. Employment in construction is explained chiefly by a moving average of construction activity, along with some additional impact caused by the deviation of current activity from its moving average, and the overall unemployment rate. Hours are determined primarily by the deviation of non-residential construction from its moving average. Here too, changes in hours represent a short-term rather than a long-term way of accommodating changes in labour requirements.

The main business wage rate equation, that for mining, manufacturing, and other business (WQMMOB), is based on a proportionate money wage response towards an equilibrium real wage determined mainly by labour efficiency, and to a lesser extent by the rate of unemployment and the expected rate-of-increase of consumer prices. This switch to an equation determining the real wage level means that there is no long-run trade off in the wage equation between the rate of unemployment and the rate of increase in the main business wage rate. The wage rate in construction (WQC) is obtained by a more usual percentage-change form strongly dependent on the unemployment rate and the expected rate of increase in consumer prices.

Our 'theory' of profits is implicitly embodied in our models of output, employment, investment, and price and wage determination. Thus the equation for corporate profits represents an attempt to approximate an aggregate business profit statement on the basis of current-dollar values of output, book

depreciation, employment expenses, and interest costs. The dividend equations embody lagged adjustments to changes in the relevant measures of after-tax profits plus book depreciation. Wage income is determined in Sector 8 by adjusting the wage bill for direct taxes and transfers to and from governments and non-residents. Gross private product is obtained from gross national product by subtracting accrued farm income, farm wages, and wage payments by all governments and noncommercial institutions. The result, YGPP, provides a reasonable approximation to the current-dollar output of the business sector.

Sector 7 contains twenty disaggregated price equations and three equations defining aggregate prices. In the latter we use a base-weighted aggregation for the Consumer Price Index (PCPI) and a current-weighted aggregation for the implicit deflators for gross national expenditure (PGNE) and private output (PGPP).

Investment and consumption prices are determined by a mixture of cost factors, the relationship between supply and demand, and sales taxes. The manufacturers sales tax is important in equations for the price of machinery and equipment and of building materials used in residential and non-residential construction. The two construction deflators are explained directly by labour and materials costs. Materials prices are affected by capacity utilization, normal unit labour and capital costs, and prices of forest products in export markets. The price of machinery and equipment depends heavily on the U.S. price, owing to the high import content of these products and the practice of pricing domestic output to match the landed price of imported substitutes. The consumption deflators are explained by

normal unit labour costs, import prices, short-term productivity, capacity utilization and retail sales taxes.

The Consumer Price Index is explained by a base-weighted average of a number of the implicit expenditure deflators. The aggregate national accounts deflators are determined exactly as they were originally derived - as ratios of current-dollar to constant-dollar expenditure totals.

Relationships explaining the various import prices contain weighted averages of foreign price deflators and the foreign exchange rate as their principal arguments. The weights themselves are determined by the commodity composition of Canadian imports. On the export side, prices are determined by world export prices, the U.S. private nonfarm output deflator, and a weighted average of Canadian aggregate demand deflators - the weights being governed by the commodity composition of Canadian exports.

3 The operations of governments

The six sectors under this heading will be described in Chapter 8 and in a forthcoming separate study [22]. The sectors for direct taxes (Sector 9), indirect taxes and other government revenues (Sector 10), and transfer payments to persons (Sector 11) are similar to those in RDX1, except that federal government revenues and transfer payments are treated separately from those of provinces and municipalities. For the equations in Sectors 9-11 we employ the models described in an earlier study of government sector equations [28]. Sector 12, federal government

wage rates, employment, investment, and other expenditures, and Sector 13 covering an even broader range of provincial and municipal items, represent a considerable amount of innovation. By treating as endogenous a wide range of government expenditures usually treated as exogenous, we made the simulation properties of RDX2 substantially different from those of other models. Our equations for these expenditure items typically involve policy variables as well as demand variables, so that one can assess the extent to which various employment, wage rate, and expenditure series have been used as policy tools and how much their movements have been dictated by demand for government services. The structure of these equations can be altered in various ways to simulate the consequences of different types of government reaction.

Sector 14 contains important accounting that links the current expenditures and revenues of governments to changes in foreign exchange reserves, government cash balances, and government debt of various kinds. These links are of great importance in specifying the various portfolio balance effects of alternative fiscal and monetary policy mixes.

4 The financial sector

The financial sector is comprised of the equations in Sectors 15 to 18 and is described in Chapter 9. Equations in Sector 15 include demand functions for liquid asset holdings of the private domestic nonfinancial sector of the economy. The estimation of these equations was carried out subject to

portfolio consistency constraints. Nine asset categories are used, including deposits in chartered banks, deposits in non-bank financial institutions, and government debt. The equations in Sector 16 for chartered bank assets determine the earning liquid asset ratio (RABEL), which is used in our measure of credit availability.

A variety of interest rates are determined by the equations in Sector 17. The basic interest rate in RDX2 is the short-term Government of Canada bond rate (RS), which is explained by means of a central bank reaction function rather than through a conventional money supply-demand model. Thus, we treat the interest rate as the primary target of monetary policy. Interest rates on deposits, mortgages and three additional maturity classes of government debt are also explained. The market value of the business capital stock, the supply price of capital, and the expected annual rate of change in the Consumer Price Index are jointly determined in Sector 18.

5 International capital flows and the foreign exchange market

Thirteen equations for international movements of capital in long-term form are in Sector 19, and the accumulation of international assets and liabilities is detailed in Sector 20. Both sectors are described in Chapter 10. In Sector 21 and Chapter 11 we present our model of the foreign exchange market.

Our two direct investment inflows to Canada, as well as the corresponding outflow to the United States, are estimated in Sector 19 as proportions of the net business financial

requirements of the borrowing country. These ratios are influenced by international differentials in the supply price of capital and sometimes by business borrowing requirements in the investing country and various special factors. Gross new issues of Canadian bonds sold in the United States are explained in two equations. In both cases the flow is estimated as a proportion of total borrowing requirements and determined chiefly by the tightness of Canadian financial markets rather than by interest rates on outstanding bonds. By way of contrast, trade in outstanding bonds and shares is generally explained in stock-adjustment models depending on rates of return on outstanding issues and portfolio proportions of lenders. In summary: direct investment decisions are assumed to be taken jointly with decisions to make capital expenditures in the borrowing country; new issues of Canadian bonds sold to U.S. residents depend on borrowing requirements and the ease of floating bonds in Canada; and all other flows depend primarily on rate-of-return differentials and the composition of the lenders' portfolios.

Sector 20 contains equations that cumulate capital flows into asset and liability positions. The most detailed accounting is used for claims by U.S. residents on Canadian assets or institutions. Holdings of government and of corporate bonds are separately cumulated at balance of payments book value. Direct investment is cumulated, along with retained earnings on direct investment, and regularly revalued according to changes in the replacement prices of Canadian assets. U.S. portfolio holdings of Canadian shares are separately cumulated and revalued.

Liabilities to other foreign holders of Canadian securities are cumulated and revalued on a more aggregated basis, the only split being between government bonds and other securities. Canadian holdings of foreign securities are built up, without revaluation, from the balance of payments flows. The asset and liability accounts are used in the explanation of international flows of interest and dividends, and in the determination of the market value of Canadian private sector wealth.

Sector 21 is described in Chapter 11, and simulation experiments with the sector are reported in [31]. There are separate behavioural equations for private and official excess demand for foreign exchange. The price of foreign exchange (PFX, in Canadian dollars per U.S. dollar) is then determined by the market-clearing condition. Private excess demand for foreign exchange is based on a stock-adjustment model that depends on lagged responses to the balance of trade and long-term capital flows, the covered differential between the Canadian short-term rate and a weighted average of U.S. domestic and Euro-dollar interest rates, the accumulated stock of Canadian net short-term liabilities to foreigners, and a special variable representing the speculative pressures on the Canadian dollar in 1Q68. Official excess demand for foreign exchange depends on a highly nonlinear model of the commitment to support the price of foreign exchange between two established support points, and a second exchange rate variable reflecting greater willingness to sell foreign exchange when the price is above par than to buy it when the price falls below par. This equation also contains a trading

strategy variable and the beginning-of-quarter difference between target and actual reserves.

The forward exchange market is represented by a reduced-form equation for its price; this equation includes the balance of trade and capital flows, the interest differential, a speculative variable, and net changes in the forward liabilities of the foreign exchange authorities.

In the remaining equations of Sector 21 we use the relevant balance sheet and balance of payments constraints to determine short-term capital flows, the level of reserves, and net short-term indebtedness between Canada and all countries.

This completes our capsule preview of the structure of RDX2. Chapters 2 to 11 contain more detailed descriptions of the various sectors, and we attempt in Chapter 12 to make some preliminary assessment of how the model works as a whole.

CHAPTER 2

CONSUMPTION AND RESIDENTIAL CONSTRUCTION

SECTORS 1-2

A The Framework for Analysis

1 Consumption vs expenditure

In RDX2 we make a firm distinction between consumer expenditure and the consumption of services by households. We start with the assumption that consumer expenditure on non-durables, semi-durables, and services is matched by consumption in the same quarter. By contrast, household expenditure on motor vehicles and other durables is assumed to add to the stocks of these goods, with the relevant consumption item defined as the services flowing from the stock of durables on hand. In the national accounts similar treatment is accorded to dwellings - expenditure is treated as part of investment and the corresponding consumption of services is defined as the rental on all dwellings, including an imputed rental on dwellings occupied by owners. In effect, we extend the national accounts treatment of dwellings to motor vehicles and other durables. This treatment required the construction of a new series for the imputed rental value of motor vehicles and other durables (CSMVOD).

We describe the two consumption equations (one for non-durables and semi-durables and the other for services, including CSMVOD) in section B of this chapter, the expenditure equations for motor vehicles and other consumer durables in section C, and the residential construction model in section D. The remainder of section A is devoted to the income and relative price concepts that underlie the consumption equations.

2 Types of income

We treat wage income, nonwage income, and revaluation gains and losses separately because of differences in methods of measurement, conceptual foundation, and the probable impact on consumption behaviour. Our chief innovation lies in the use of the components of our wealth series to define new series for nonwage income and for revaluation gains and losses.

2.1 Disposable wage income

The income components of this variable (YDW, defined in equation 8.6) include wages, salaries, and supplementary labour income, military pay and allowances, unemployment insurance benefits, other government and business transfer payments to persons, and the after-tax return from nonfarm unincorporated business. The items deducted in moving to disposable income include employer-employee contributions to social insurance and government pension plans (TRSIGPR+TUIRF+TCPPF+TQPPPM), personal income taxes deducted at source (net of refunds), hospital and

medical care insurance premiums, and all other direct transfers from persons to governments, with the exception of motor vehicle licences and permits. The main direct taxes not charged against wage income in our accounting are personal income taxes paid by instalments. Except for a small portion charged against the income of unincorporated business, these taxes are assumed to apply to nonwage income. This simplifying assumption accords fairly well with the facts, because in general only wages and salaries are taxed at source, whereas taxes on nonwage income are paid by instalments.

When the disposable wage income variable is used in the consumption equations, it enters with an eight-quarter polynomial distributed lag to capture the expectations process whereby the time series of current incomes is converted to an expected future income. We consider in section B what adjustments in scale must be made in order to interpret an average of past values of a growing earnings stream as a measure of expected lifetime earnings.

2.2 Disposable nonwage income

We make use of two measures of nonwage income, the smaller one based on the current national accounts data (personal disposable income minus disposable wage income), and the larger one, representing permanent disposable nonwage income, based on wealth components multiplied by imputed real rates of return. Both series are net of personal income taxes paid by instalments and all other direct taxes paid to governments with the exception

of income taxes and employer-employee contributions to social insurance and government pension plans. Our new measure (YPDNWP, defined in equation 8.11) is more than twice as large as the national accounts series, chiefly because YPDNWP takes into account a number of items not included in the national accounts definition of personal income - undistributed profits of corporations, as well as imputed income from monetary claims on the government, from motor vehicles and from other consumer durables.

The trickiest part of defining a permanent nonwage income stream from each component of wealth is finding a comparable standard of measurement when some returns are fixed in nominal terms and others grow with increases in the price level. The best examples to use are the interest on the public debt (including the direct and guaranteed debt of provinces and municipalities) and the earnings derived from resident-owned business fixed assets and inventories. As shown in section F of Chapter 9, if a growing profits stream (denoted by x), which is expected to grow at a rate g, accrues to the owners of business assets with a market value v, then the 'permanent' value of the earnings stream is x+gv. In terms of RDX2 variables, x+gv is equal to the nominal supply price of capital (RHO) times the market value of business assets (VKB). The expected value of interest on the public debt is more simply defined as being equal to the long-term rate of interest (RL) times the market value of the resident-held debt (VLGB11).

Although we can define permanent income streams in nominal terms for the various components of net household wealth, are

they what we want? If our consumption equations are to be fitted in constant (1961) dollars, then we shall want to define our nonwage income variable so that it can be deflated by the current value of the Consumer Price Index (PCPI) to obtain permanent nonwage income measured in 1961 dollars. To do this, all future values of the income stream must be expressed in prices of the period in which expectations are being formed. Put another way, we must subtract from each nominal rate of return the expected rate of price inflation g', before multiplying by today's asset value, in order to define a permanent income stream in terms of today's dollars. Reverting to the example used earlier, the permanent rate of return from business assets will be equal to $[(x+gv)/v]-g'$, or simply x/v if profits per unit of business assets are expected to grow at the anticipated rate of inflation (i.e. g=g'). In RDX2 terminology the expected permanent return from business assets, in today's dollars, is equal to the market value of assets (VKB) times the supply price of capital in real terms (RHOR, equal to RHO-PCPICE, where PCPICE is the expected rate of change in consumer prices). To measure the permanent return from government debt in terms of today's dollars, one must subtract from the nominal return (RL) the expected rate of inflation (PCPICE). By analogy with the argument in Chapter 9, if the interest stream x, in today's dollars, is expected to decline at the rate g, then the permanent return is x-gv, where v is the current market value of the bonds. In terms of RDX2 variables, the permanent stream is therefore defined as the real rate of interest (RL-PCPICE) times the market value of the public debt.

A parallel treatment is given to the imputed permanent income streams derived from most other components of household wealth. Foreign assets of Canadian residents are an exception, as the lack of asset values leads us to use recent average earnings to measure expected earnings. For dwellings, motor vehicles, and other consumer durables the imputed income is equal to a constant times the current replacement value of these stocks. The constant in each case is an estimate of the average real rate of return on savings. Ideally we should prefer to use current market values, but the replacement values of the depreciated stocks represent the best available.

Because we use replacement rather than market values for the stocks, we must use an average rather than a current value for RHOR as a measure of opportunity cost. Otherwise we would overstate the variance in expected nonwage income resulting from a change in RHOR.

A special case is posed by the non-interest-bearing debt of the federal government - the stock of 'high-powered money'. Here the imputed 'rental value' is measured by the opportunity cost RL-PCPICE, that is, the real rate of return one could get by investing in bonds rather than holding cash.

The theory underlying our treatment of household claims on governments is fairly conventional, but has some disturbing features. Private sector balance sheets are fully consolidated, but household claims on governments are treated as private wealth, and no account is taken of real assets owned by governments. Any increase in the public debt expands permanent nonwage income, unless taxes on nonwage income are raised enough

to cover the interest payments on the debt. If the interest payments are mainly financed by further debt issues (as is the case in the normal simulation context in which tax rates remain fixed), then expected permanent income rises regardless of the use to which the funds are put. If the funds are used to expand transfer payments to persons, then disposable wage income also rises and the whole process begins to resemble a sophisticated confidence trick. Perhaps when the costs and benefits of various government sector activities are more clearly measured it will be possible to lift the 'veil of government' and define private sector wealth (and therefore expected nonwage income) by reference to the asset side rather than the liability side of government sector balance sheets. These developments must await the next generation of macro-models, if not the next generation of theorists and model-builders. In the meantime, it is appropriate to conclude a soul-baring paragraph by noting a spot of double counting in our present procedures. The assets of government-owned business enterprises are included as part of the business capital stock, and the stock of direct and guaranteed government debt undoubtedly includes some issues used to finance investment in government-owned business enterprises. Because the form of the available data does not lend itself to consistent disaggregation, we accept what we hope is a fairly slight upward bias in our measure of expected nonwage income. The bias is likely to be slight because the profits of government-owned business enterprises are small in relation to total profits.

Taxes on nonwage income are measured by current tax accruals, so as to abstract from the lags and seasonality in the

tax collection process. The use of current tax accruals to represent future accruals, measured at today's prices, reflects the simplifying assumptions that taxable nonwage income is expected to increase at the same rate as nonwage income and that future tax rates are expected to be adjusted so that they absorb the same proportion of taxable nonwage income. We are considering methods of inflating the tax accruals series to embody assumed expectations more in line with historical experience.

2.3 Revaluation gains and losses

The meaning and purpose of our series for revaluation gains and losses (YKGP, defined in equation 8.12) are best introduced by contrasting our treatment of nonwage income and wealth with procedures used by other researchers. Previous theories making use of nonhuman wealth in aggregate consumption functions, whether emphasizing the role of wealth as potential consumption (as in life cycle models, e.g. [2]) or as a measure of permanent nonwage income [21], have been derived on the assumption of a constant discount rate. In RDX2 we have taken some pains to define variables for the supply price of capital in both nominal (RHO) and real (RHOR) terms. From the point of view of a saver investing in shares, the supply price of capital is the rate of return on savings - the discount rate used in establishing present values. If there is some variance in the discount rate used to value future income streams, then changes in the market value of wealth no longer have unambiguous meaning. An increase

in the aggregate market value of wealth can be generated by new savings, because there has been an increase in the stream of future earnings expected to arise from the existing stock of assets, or because there has been a drop in the discount rate. Consumption models employing the market value of wealth are valid only if the discount rate is unchanged and there are no other changes in the desired stock of wealth.

YPDNWP is defined as an expected nonwage income series to capture the income effect of wealth changes induced by changes in either the expected flow of constant-dollar earnings or in the discount rate. We also need a way of representing the revaluation gains and losses that arise if there are changes in the present value of expected returns from existing assets. We define this series as the change in the market value of wealth, net of savings in the current period. This definition measures capital gains, net of any changes in wealth attributable to changes in the desired stock of wealth effected by net current savings or dissavings.

The series for expected nonwage income and revaluation gains and losses embody between them both price-induced and interest-induced wealth effects. If the prices of all goods and services drop, with real rates of return unchanged, there will be a rise in the real value of our synthetic nonwage income series - a real balance effect of the sort emphasized by Patinkin [47]. Offsetting revaluation losses will, however, take place on those wealth components valued at replacement prices.

Any decline in the nominal rate of interest, with real rates of return unchanged, leaves the expected nonwage income from

bonds unchanged, but gives rise to capital gains on bonds because of changes in the bond valuation ratios. (See equations 14.2 to 14.5 described in Chapter 8.) These interest-induced capital gains (emphasized in theory by Metzler [42]) form part of our series for revaluation gains and losses. If an easier monetary policy leads to lower nominal and real rates of interest, then there will be revaluation gains on both bonds and shares. On the other hand, expected nonwage income will fall as debts mature and are refinanced at the new lower rates of interest. The net impact on consumption will depend on the relative importance of nonwage income and revaluation gains in the consumption equations, as well as on the effects of the lower rates of interest operating through other routes - relative prices, savings, investment, and foreign capital flows.

3 Savings and the rate of return

For given tastes, profiles of expected wage incomes, and stocks of wealth the decision whether to consume now or later rests upon expected changes in prices as well as the available rate of return on savings. The net incentive to save is measured in RDX2 by RHOR, which is equal to the nominal rate of return on savings (RHO) less the expected rate of increase in consumer prices (PCPICE). RHOR is defined after deduction of corporation tax but before personal tax, so that no account is taken of any changes in the personal tax treatment of investment income. We tried RHOR in both consumption equations, but found a strong intertemporal substitution effect only in the equation for non-

durables and semi-durables. The rate of return on savings also influences the purchase of motor vehicles and other consumer durables by appearing in the relative price term described below.

4 Relative prices

Relative prices influence consumption indirectly, as they play important roles in the expenditure equations for motor vehicles and other consumer durables. Changes in expenditure on motor vehicles and other consumer durables alter the stocks of those assets and hence alter both the imputed consumption of services from motor vehicles and other durables, and the expected stream of nonwage income.

The relative price terms in the expenditure equations are ratios of the implicit rental price for the durable to the current-weighted average of the prices of services, non-durables, and semi-durables. The rental price is defined as the purchase price of the durable times the sum of a quarterly depreciation rate and a series equivalent to the quarterly supply price of capital in nominal terms. The denominator of the relative price ratio should perhaps be defined as an expected price, over a horizon equal to the average lifetime of the consumer good. This treatment would be analagous to that adopted in the factor-demand equations explained in Chapter 3. An alternative procedure in the present case would be to define the rental price of the durable to take account of expected capital gains, i.e. to use RHOR rather than RHO as the supply price of capital. In the next version of RDX2 one of these alternatives to the present

definition of relative prices will probably be adopted, although we suspect that neither of them will do much to alter the coefficients or the simulation properties of the equations.

B Consumption Equations

1 Description

CNDSD Consumer expenditure on non-durables and semi-durables (Equation 1.1)

The dependent variable is the expenditure series, in 1961 dollars, divided by the non-institutional population fourteen years of age and over (NPOP). The independent variables include expected nonwage income, the real rate of return on savings, an eight-quarter distributed lag on disposable wage income, a constant, constrained quarterly variables times the lagged dependent variable, and the difference between the national accounts measure and our synthetic measure for nonwage income. All the income variables are deflated by the product of NPOP and the Consumer Price Index, so that they are, like the dependent variable, on a real per capita basis. The revaluation gains variable was tried, but did not improve the equation. All the income variables used and the rate of return on savings have significant coefficients. We found the statistical properties of the equation as a whole to be quite satisfactory. The coefficient of variation is only 1.01%, and there is no apparent autocorrelation of residuals.

The only variable appearing in the equation without being heralded in the previous section is the difference between the national accounts measure and the RDX2 measure of nonwage income. There are three possible justifications for this variable. The most obvious interpretation is that it is a measure of transitory nonwage income because of the attempt in the national accounts to measure current income received, whereas our YPDNWP is an approximation of permanent nonwage income. The second possibility is that there are measurement errors in both series, and so the inclusion of both helps to avoid the downward bias in coefficients caused by independent errors of measurement. The third interpretation emphasizes the fact that the RDX2 concept of nonwage income is over twice as large as the disposable national accounts series, has more imputed components, and is not so closely related to current cash receipts. If the third justification were the most relevant, one would expect to find a coefficient on the national accounts series greater than on the RDX2 series. In fact the implied coefficients on the two nonwage income variables are nearly the same in this equation, and higher on the RDX2 series in the services equation.

The coefficient of -608.8 on RHOR implies an elasticity for this consumption category of -.14 with respect to changes in the real rate of return. Because CNDSD is about five times as large as personal savings, the implied rate-of-return elasticity of savings is about .70. This is, of course, a substitution effect, which could be cancelled out by offsetting income effects. The implications of the income coefficients are outlined below in section B.

CS+CSMVOD Consumer expenditure on services, including imputed services from the stock of motor vehicles and other consumer durables (Equation 1.2)

The dependent variable is the sum, in real per capita terms, of consumption of services as defined in the national accounts, imputed services from consumer motor vehicles as well as other consumer durables used by their owners, and medicare payments made by provinces. Income variables include those used in the non-durables equation plus a seven-quarter lag distribution on the revaluation gains variable. The rate of return on savings did not enter the equation. Apparently the negative interest elasticity of CMV and CDO filtering through into CSMVOD is offset by changes in the volume of purchased services. The equation also includes a dummy variable covering the second and third quarters of 1967, and accounting for an apparent underrecording of service expenditure by residents during Expo67.

Taken as a whole, the equation fits well, with a coefficient of variation of only .63% and no significant autocorrelation of residuals. Revaluation gains appear to influence consumption only slightly, with a sum of weights of merely .026. However, changes in expected earnings cause a large proportion of capital gains, and both of the nonwage income variables have large and strong coefficients.

2 Interpretation of Equations 1.1 and 1.2

The equations discussed above will be re-estimated shortly, with 1969 added to the sample period, data changed because of

forthcoming historical revisions to the quarterly national accounts, and consistent estimation methods used to reduce the possibility of simultaneous equations bias. In the meantime, interpretation of the present coefficients may help to shed some light on the income and consumption concepts underlying our equations.

It is useful to consider the effects of a change in income on total consumption. An increase in disposable wage income of $100 will lead, over the following eight quarters, to an increase in consumption of $82. The rest finds its way into savings, and thus generates a larger stream of expected and current nonwage income.

Expected wage income, in terms of today's dollars, may be either higher or lower than our eight-quarter average. On the one hand, the real wage rate grows at about the same rate as the labour efficiency factor (ELEFF). On the other hand, the consumption horizon of each wage earner is longer than his earning horizon for wage income. We have made no estimates of the probable net effect of these two influences.

An increase in nonwage income has different effects depending on the form it takes. If dividends from Canadian corporations to taxpaying persons rise, with current and expected profits unchanged, then accrued taxes rise according to the current average rate paid on nonwage income, less the dividend tax credit. For every $100 that gets into disposable nonwage income, consumption rises by about half that amount. If current and expected profits rise by $100, with dividends unchanged, consumption rises by $66. If current and expected profits

increase by $100 and average payout ratios and tax rates apply, about $85 extra will be spent on consumption, excluding the small effects flowing through the capital gains term.

C Expenditure on Motor Vehicles and Other Consumer Durables

1 Theoretical structure

Both durables equations are estimated in a capital stock-adjustment framework with gross expenditure as the dependent variable. If replacement investment is hypothesized to be some fraction of the lagged stock, then the expenditure equations have the following form, using CD to represent expenditure on a consumer durable and KDD to represent the desired stock:

$$CD = b(KDD-J1L(KD)) + c(J1L(KD))$$

In our applications of this model, the desired per capita stock (KDD) is made a linear function of income variables, relative prices, and a constant term. To derive an estimate of the adjustment parameter, b, we must make some assumption about the size of the replacement coefficient, c, because the coefficient on the lagged capital stock is an estimate of c-b. There is no theoretical requirement that the coefficient c should be the same as the exogenous depreciation rate used in constructing the stock series. However, this assumption, which

we use below in interpreting the results of our equations, is convenient and fairly harmless.

2 Estimated equations

CMV Consumer expenditure on motor vehicles and parts (Equation 1.3)

Gross expenditure on consumer motor vehicles, in constant dollars per capita age fourteen and over (NPOP), is the dependent variable. The determinants of the desired stock of consumer motor vehicles are expected nonwage income, an eight-quarter lag distribution on disposable wage income, and relative prices. The income variables are deflated by the product of NPOP and the Consumer Price Index. As outlined in section A, the relative price variable has the implicit cost of car ownership in the numerator and a weighted average price of non-durables, semi-durables and services in the denominator. The high coefficient on the lagged stock indicates a fast expenditure response to changes in the desired stock of cars. If the replacement coefficient c is taken to be equal to the depreciation rate of .055 per quarter, then the estimated coefficient of adjustment is about .41 per quarter.

Taking the adjustment coefficient as given, we can calculate the elasticities of the equilibrium stock with respect to its determinants, using the estimated coefficients and the sample means of the variables. These elasticities are 1.94, .22, and -.20 with respect to changes in disposable wage income, expected nonwage income, and relative prices, respectively. Also relevant

are the impact elasticities of expenditure with respect to changes in the current period's disposable wage income, expected nonwage income, and relative prices. These elasticities are respectively 3.37, 1.22, and -1.09. The impact elasticity of CMV with respect to changes in RHO is about one-fourth as large as that for relative prices, because RHO is about one-third as large as the constant depreciation rate entering the relative price term.

As might be expected, given the volatility of investment expenditure in general and of the car market in particular, the equation as a whole does not fit as closely as do the consumption equations. It has a coefficient of variation of 7.04%, and an RB2 of .939.

CDO Consumer expenditure on durables (excluding motor vehicles and parts) (Equation 1.4)

In this equation we make use of four rather than two income measures. Otherwise it is similar in structure to the motor vehicles equation. The two additional income variables are the difference between measured and expected nonwage income, and a seven-quarter distributed lag on the series for revaluation gains and losses. The four income variables used are therefore exactly the same as those appearing in the equation for the consumption of services. We attempted to achieve similar parallelism in the motor vehicles equation, but measured nonwage income and revaluation gains had no apparent effect.

Although relative prices and all the income concepts play suitable roles in the CDO equation, the coefficient on the lagged

stock is so low as to imply a much slower stock adjustment than for motor vehicles. If we assume once again an equivalence between the replacement coefficient and the assumed depreciation rate, the implied value for the adjustment coefficient b is only .084. This may well be an underestimate of the speed of adjustment, perhaps because of an upward trend in the desired stock attributable to steady increases over time in the variety of consumer durables offered. Perhaps we ought to have guessed in advance that the stock of refrigerators built up over past years would not dampen this year's demand for snowmobiles.

We calculated the equilibrium elasticities, measured at sample means, of the stock of other durables with respect to relative prices and to the four income variables. They are -.67 for relative prices, 1.20 for disposable wage income, .005 for the RDX2 concept of expected nonwage income, .21 for national accounts nonwage income, and .006 for revaluation gains and losses. Current-period expenditure elasticities, following the same order, are -.792, .421, .006, .248 and zero. The current impact elasticity is zero for revaluation gains because this variable enters the equation with a distributed lag and has a coefficient of zero in the current period. Only the current-period weights are used in calculating the impact elasticities. The equation fits quite well, with a coefficient of variation of 1.99% and an RB2 of .984.

In summary, the RDX2 equations for consumption and expenditure on consumer durables fit well and give fairly reasonable roles to wage income, the rate of return on savings, the prices of durable goods, and expected income from the

components of wealth. We are, however, uneasy about the relationship between our two concepts of nonwage income. When both variables are used, some components of nonwage income are counted twice and others only once. We expect to reorganize our treatment of nonwage income in the next edition of RDX2, possibly in a way that takes account of the different degrees of liquidity of the various components of wealth and nonwage income.

D Residential Construction

1 Private investment in residential construction

The main variable explained in Sector 2 is private investment in residential construction (IRC). One can obtain better results for this equation by treating single-detached and multiple dwelling starts separately. This is so, because single-detached houses can be more quickly constructed than high-rise buildings of multiple units, and the average single unit gives rise to a larger expenditure than the average multiple unit. Equation 2.1 for IRC shows the lag pattern of expenditures following starts to be more complex, as well as longer, for multiples. The lag distribution for singles has declining weights over four quarters. The lag distribution for multiples is spread over five quarters and has two peaks, presumably because multiple starts are a mix of two main types of housing with sharply differing construction periods. One type, comprising semidetached dwellings, row housing, and similar

structures, can be built as fast as single-detached dwellings, but for construction of the other type, high-rise apartments, much more time is required. Thus the peak in the current quarter represents mainly expenditure on row housing and so on, whereas the peak in quarter t-3 probably represents mainly expenditure on high-rise construction.

The basic assumption underlying our regression of constant-dollar expenditure on housing starts is that each type of housing start gives rise to a fixed amount of constant-dollar expenditure. If the size or quality of dwelling units changes over time, our procedure will be suspect. We should like to take quality changes into account, but the available data do not permit us to do so. For one thing, the national accounts expenditure data are constructed without reference to the size of houses. In addition, the only available index of the size of new units is that for the floor area of new houses financed under the National Housing Act (NHA). The variance of this series is a misleading measure of house size because changes over time in the permitted maximum value of NHA mortgages and in construction prices alter the relationship between the size of the average new house and the size of the average new NHA-financed house.

The IRC equation fits well, with an RB2 of .964 and a standard error of $17.9 million. If the equation is fitted using total housing starts rather than the component series, the standard error rises to $21.6 million.

2 The supply functions approach versus the reduced-form approach to the determination of housing starts

In specifying the RDX2 equations for housing starts, we made substantial use of the model developed for RDX1 by Lawrence B. Smith [51]. A central feature of Smith's approach is the treatment of housing starts equations as supply functions for builders. Thus, prices and rents relative to construction costs play a key role as measures of the profitability of new construction projects. Similarly, credit conditions are a determinant of the rate of return on equity in rental units and of the imputed rental cost of owner-occupied units. In the case of speculative single-family housing projects, credit conditions are viewed as influencing builders through the cost and availability of temporary or bridge financing and through the anticipated influence of carrying charges on prospective buyers.

In view of the difficulty of obtaining an appropriate measure of housing prices ([51] pp.11, 17), as well as certain problems encountered in extrapolating Smith's model so as to explain more recent behaviour, we decided to use a market reduced-form approach. In the present specification, the price term is solved out and replaced by determinants of final demand. Demand in terms of the desired stock of units is assumed to depend on the price of housing, real disposable income per household (in distributed lag form), and credit conditions. Separate equations are included for starts of single-detached dwellings (HSTS) and multiple dwellings (HSTM), with the dependent variable in each case divided by the number of

households and the lagged stock entering as a determinant of the demand for new units.

In the fitted equations income was dropped from the single unit equation (equation 2.2) because it failed to enter significantly, but the lagged stock entered both equations as expected. The other variables used were measures of credit conditions (discussed in the next section), and a dummy variable (ZWW) to allow for the winter building incentive programme in effect from 3Q63 to 2Q66. The latter variable entered linearly and interacted with seasonal dummies to measure the seasonal shift in starts induced by this programme. The representation of final demand remains a somewhat unsatisfactory aspect of our housing starts model. In particular, we have probably inadequately explained the substantial increase in the proportion of multiple unit starts that occurred during the 1960s. Land costs, as introduced by Smith, and some demographic variables were tried with little success.

2.1 Housing starts and credit conditions

Several variables are used to represent the cost and availability of mortgage credit as well as the influence of short-term credit conditions on builders.

The interest rate on conventional mortgages (RMC) is used as the measure of the cost of mortgage credit. This rate enters significantly in equation 2.2 for single-detached units. Following Smith, we tried the differential between the mortgage rate and the bond rate as a measure of the availability of

institutional mortgage financing. However, this variable did not enter significantly. As an alternative to this interest differential we tested the four-quarter change in assets of trust and loan companies [J4D(ATL)] since this change was found to be significant in the mortgage lending equations (equations 17.9 and 17.10, described in Chapter 9). It enters the multiples equation significantly.

As in Smith's model, mortgage approvals for singles (HAPCMHCS) and for multiples (HAPCMHCM) made by Central Mortgage and Housing Corporation (CMHC) were tested. HAPCMHCM enters the multiples equation significantly and although no direct role for HAPCMHCS has been found in equation 2.2, there are indirect effects of CMHC approvals for single-detached dwellings on HSTS since HAPCMHCS is one of the determinants of RMC (see equation 17.8) and RMC affects HSTS directly.

We also tested a dummy variable (QNHA) to allow for a change in structure with the removal of the ceiling on the NHA mortgage rate in 1967. (See Chapter 9, section G.) QNHA enters the multiples equation with a significant coefficient.

Finally, the measure of credit availability based on the chartered bank earning liquid asset ratio (RABEL) enters significantly in both the singles equation and the multiples equation.

3 Stock of dwellings

SHS Stock of single-detached dwellings (Equation 2.4)

This equation is estimated in first-difference form to remove the strong trend influence. We intend the equation to reflect the combined effect of completions of new houses, conversions of houses from single to multiple occupancy, demolitions to make way for new construction, fire loss, and scrapping. The coefficient on the lagged stock shows an annual proportional rate of decline of almost 2%, presumably comprising mainly conversions plus demolitions. The sum of the coefficients on lagged starts is .856, probably less than 1 because of demolitions to make way for new buildings. The standard error is 2,451 units, about .07% of the average stock in 1968.

SHM Stock of multiple dwellings (Equation 2.5)

This equation is also estimated in first-difference form. The lagged stock does not enter the equation, but there is a significant positive constant term, which presumably represents the effect of conversions from single to multiple occupancy. The sum of the coefficients on multiple starts is about .62, too low to be believed as a partial result. If the negative coefficient on the current quarter's starts is ignored, the sum rises to .92. Could it be necessary to demolish three units in order to make room for ten?

One may perhaps wonder why it is not possible to be more precise about the size of the housing stock. We constructed our housing stock series by using the results of quinquennial

censuses of the number of housing units. From one bench mark to the next we accumulated the stock by adding newly completed units and by adjusting it to take account of identified conversions and demolitions. The discrepancy between the accumulated series and the next bench mark is allocated evenly over the quarters between the census dates. We therefore have an approximate relationship between starts and the estimated stock, and are not surprised to find an imprecise conversion of starts into the resulting stock of housing. In terms of the housing model as a whole, the effect of coefficients summing to less than 1 on starts in equations 2.4 and 2.5 is to increase the number of starts resulting from a given change in any determinant of the desired stock in equations 2.2 and 2.3.

Equation 2.5 has an RB2 of .549, and a standard error of 3,340 units, about .15% of the average 1968 stock of multiple dwellings.

CHAPTER 3

BUSINESS INVESTMENT AND OUTPUT

SECTOR 3

A Introduction

This chapter contains the theory underlying our model of the interrelated demands for capital and labour, a discussion of our estimated business capital accumulation equations, and a catalogue of the various associated measures of output, aggregate demand and supply, and capacity utilization.

In the model of interrelated factor demands we treat three factors explicitly: the stock of business non-residential construction; the stock of business machinery and equipment; and total paid hours worked in mining, manufacturing, and other business. We assume that these inputs are combined within a three-factor Cobb-Douglas production function with constant returns to scale and Harrod-neutral technical progress to produce UGPP, the RDX2 concept of business output. UGPP is obtained by subtracting from constant-dollar gross national expenditure the total of constant-dollar farm wages, accrued farm income, plus wages paid in public administration, defence, and all noncommercial institutions.

We suppose also that the aggregate business economy never operates exactly on the efficient frontier represented by the aggregate production function, and that at least some of the

apparent discrepancy is attributable to abnormal rates of utilization of either type of fixed capital stock, or of employed labour. Since independent estimates of the degree of utilization of existing capital and employed labour are unobtainable, it is not feasible to estimate the aggregate production function directly. We therefore use a variety of sets of production function parameters as a priori inputs to distributed lag labour and capital adjustment models. The final choice of production function parameters is based on a combination of a priori plausibility (the production function elasticities should be consistent with income shares) and the accuracy of the derived investment and employment equations. The theoretical basis for the model is outlined in section B, and the derived equations for business fixed investment are discussed in section D. The equations explaining employment and hours are contained in Sector 5 and described in Chapter 5.

Once one has an aggregate production function for UGPP, one can derive several useful synthetic measures of actual or potential output. For example, if actual capital, the 'potential' labour force and 'normal' hours are put into the production function one obtains a measure of 'desired' output (UGPPD), conditional on ex post factor substitutability and on the use of the average level of factor utilization over the data period as a proxy for the unknown desired level. The production function may also be used with actual capital, hours, and employment as inputs. This procedure gives us a synthetic aggregate supply variable (UGPPS) measuring what output would be

in the current period if there were no offsetting short-term changes in factor productivity.

This aggregate supply variable plays an important part in helping to define the buffer-stock role of inventories, a matter taken up in detail in section C where we deal with the aggregate inventory equation. One by-product from our more precise definition of unintended inventory accumulation is a new concept for aggregate demand, UGPPA, equal to actual output less unintended inventory accumulation. Expectations about future values of this variable are what drive the business fixed investment equations, reported in section D. The availability of an appropriate measure of final demand also allows us to solve the production function for the level of employment desired by producers faced with given capital stocks. This desired level of employment (NMMOBD) drives the main employment and hours equations, described in Chapter 5.

To complete the chapter, we present in section E a catalogue of the various concepts of supply, demand, and capacity utilization derived from our model of production and investment and used throughout RDX2.

B The Basic Model

Interrelated factor demands are fun. They either will be or already are fashionable in macroeconomic applications ([12], [46]), but they are very messy. Once one starts down the road toward acknowledging imperfect foresight and costly adjustment,

one finds that everything is related to everything else. For example, if both capital and labour are adjusted only with time lags, and if there are limits to short-term changes in productivity, then it may be a mistake to use actual output as a basis on which to form expectations about desired future output [23]. For our initial experiments, however, we assumed that we could roughly compensate for any such measurement errors by suitable adjustments in the parameters of the expectations process on UGPP. We subsequently derived a measure of unintended inventory accumulation and now use the aggregate demand variable UGPPA as a basis for expectations about desired future output.

Nobody has yet been rash enough to consider a full neoclassical framework in which output and all factor inputs are determined solely by expected relative prices. There are too many measurement errors, too many dangers in aggregating across diverse products, too many non-clearing markets, and too much heterogeneity in expectations to allow this procedure much chance of success. Most of the models referred to as neoclassical (such as those of Jorgenson, e.g. [37]) avoid these difficulties, in part, by suppressing one relevant factor price (the wage rate) and then introducing the level of output as an exogenous variable entering into a flexible accelerator investment model. In these models the desired capital/output ratio depends only on the relative price of capital services and output. This procedure is rationalized by an assumption that the labour input can be easily adjusted in the short run to meet fully any changes in desired output. The actual level of output is presumably then decided by taking as given the price of output, the price of labour

services, and the amount of the existing capital stock. We were denied access to this approach because of our belief that both capital and employed labour are relatively fixed factors.

Our procedure has therefore been to assume cost minimization ([12], [41]), thus combining the demand for labour and the demand for capital in a single decision process depending on the expected price of capital and of labour services. These factor demands also depend on expected output. In the first stage we defined expected output by using UGPP and the parameters of the best expectations process derived in our previous study of expectations in investment behaviour [29]. We made use of UGPPA, the aggregate demand concept explained in section C below, in our final equations.

1 Costs to be considered

We take account of three separate inputs to the production function: labour in terms of man-hours of standard efficiency (named HEFF for the exposition in this chapter), the stock of machinery and equipment (KME), and the stock of non-residential construction (KNRC). We do not have the stock of inventories (KIB) entering directly; consequently the role of inventories in the production process remains rather vague.

Static optimization with respect to the factor inputs mentioned above requires that the relative cost of each pair of inputs should be proportional to their marginal physical products. We postpone for several paragraphs the problems

involved in applying such a model in the presence of time lags and uncertainty.

If the hypothetical production function is

$$UGPP = A\,[(KME)^{**}a]\,[(KNRC)^{**}b]\,[(HEFF)^{**}c]$$

and the implicit rental costs of KME and KNRC, as percentages, are RCME and RCNR, respectively; and if the hourly wage rate after corporation tax is (WQMMOB/13 HAWMM)(1-.01 RTCA), shortened to WH for this exposition; then we can use the marginal conditions to solve for the desired ratio of output to any of the factor inputs.

Thus, since the ratio between any two factor inputs is of the form, e.g., HEFF/KME = (c/a)(.01 RCME/WH), we can use the production function to solve for the capital/output and labour/output ratios as follows:

$$KMEY = \frac{1}{A}\left(\frac{a}{b}\right)^{b}\left(\frac{a}{c}\right)^{c}\left(\frac{WH}{.01\ RCME}\right)^{c}\left(\frac{.01\ RCNR}{.01\ RCME}\right)^{b}$$

$$KNRY = \frac{1}{A}\left(\frac{b}{a}\right)^{a}\left(\frac{b}{c}\right)^{c}\left(\frac{WH}{.01\ RCNR}\right)^{c}\left(\frac{.01\ RCME}{.01\ RCNR}\right)^{a}$$

$$\text{Desired}\left(\frac{HEFF}{UGPP}\right) = \frac{1}{A}\left(\frac{c}{a}\right)^{a}\left(\frac{c}{b}\right)^{b}\left(\frac{.01\ RCME}{WH}\right)^{a}\left(\frac{.01\ RCNR}{WH}\right)^{b}$$

Before we consider how this framework might be applied in a dynamic context with uncertainty, we ought to conclude the discussion of costs with a short explanation of the rental prices of capital services (RCME, RCNR). The concept is quite simple:

the implicit rental price is a fraction of the replacement price, where that fraction depends on the (combined) rate of depreciation and obsolescence, and on the supply price of financial capital (represented by a weighted average of RHO and RHO2, the measures of the Canadian and U.S. supply prices of capital) less an approximation to what can be recovered by way of deductions under the corporation income tax. RCME and RCNR thus represent rental prices after corporation income tax. Personal income tax enters only to the extent that it influences RHO, the required rate of unlevered pre-personal-tax return that must be paid in order to lodge domestic business shares in the portfolios of residents and non-residents. The formulae for the rental prices can be derived either by analogy with actual rental markets, or from the maximizing conditions for the revenue function of an owner-user of capital goods. Our expression for implicit rental prices is simpler than some such expressions, because we have converted several disparate tax allowances for depreciation into a single present-value series measured as a proportion of the price of capital goods. (A similar procedure has been used by Hall and Jorgenson in [25], p.16.)

Equations 3.9 and 3.10 give the exact expressions for the two rental price variables. The expectations weights on the investment prices determine the expected price of the capital good at the midpoint of the construction period. These weights are derived from the expectations process used in [29]. The second term in each equation shows the proportion of the cost of the assets that is not recoverable by means of corporation income tax reductions. In equation 3.9, for example, if the corporation

tax rate (RTCA) were 100% and if all assets could be charged immediately against taxable income (e.g., CPVME = .50), then the implicit after-corporation-tax cost of IME would be zero. The normal value of CPVME, the present value of tax reductions due to depreciation allowances, is .3333, based on a declining balance depreciation rate of 20% per year, a discount rate of 10%, and an assumed marginal tax rate of 50%. The actual value of CPVME rises above or falls below .3333 if any special tax measures that alter allowable depreciation are in force. (For a history of these various special tax measures and the derivation of CPVME and CPVNR see [18], pp.66-69.)

The third term in each expression is the sum of the quarterly depreciation rate (as derived and interpreted in [18], pp.9-13 and p.59) and the tax-adjusted cost of capital. The nominal supply price of capital is measured before personal tax but after corporation tax. The supply price of capital is represented in these equations by a weighted average of RHO and RHO2, with weights depending on the proportion of the stock of Canadian business fixed assets and inventories (KB$, measured at replacement prices) financed by U.S. direct investment (LDIRV12, also measured at replacement prices). Why do we need to use RHO2 at all, if RHO represents the Canadian supply price of capital? The reason is that our sample of shares used in constructing the share market value of Canadian fixed assets and inventories includes only shares traded on Canadian stock exchanges. What ought we to assume about the supply price of capital for Canadian investments directly financed by U.S. parent companies? We have assumed that the U.S. supply price of capital is more relevant

than the Canadian price for these ventures. In short, the current weights attached to RHO and RHO2 depend on the financing patterns followed in previous periods. The weights respond over time so as to attach more importance to the lower of the two supply prices of capital. This shift in weights occurs because the proportion of new capital expenditures financed by U.S. direct investment drops when the U.S. supply price of capital is high relative to RHO.

Since interest payments are deductible under the corporation income tax, and since dividends and retained earnings are not, we reduced the weighted average of RHO and RHO2 by a proportion determined by the corporation tax rate and the amount of the total return to capital taking the form of interest payments. The supply price of capital used in these equations is the quarterly counterpart to the annual rate. Thus, in its final form, RCME represents the imputed cost of IME as a proportion per quarter, and has a pronounced upward trend, starting at about 3.9% in 1955 and reaching a peak of 6.3% in 4Q66.

The corresponding variable for INRC is similar, except that the combined quarterly rate of depreciation and obsolescence is .01 instead of .05. The expectations weights are different because of the longer construction period, and the price and tax policy variables used are those appropriate for INRC. Because of the lower depreciation rate for KNRC, the imputed rental cost for non-residential construction (RCNR) is proportionately more dependent on the supply price of capital. RCNR is about 2.0% in 1955 and reaches a peak of 3.5% in 4Q66.

In the basic model, as described to this point, we determine desired values for the various inputs to the production function. These desired values are conditional upon known values for desired output and factor prices and upon the assumption that there are no lags or costs in the adjustment process. These conditions must now be relaxed.

2 Expectations and expenditure lags

In [29] we employed a model providing for full interaction between expectations and expenditure lags. That procedure required, for each type of investment, twice as many equations as there are quarters in the expenditure lag distribution. To hold down the number of equations required for RDX2 we simplified the approach in order to keep the expenditure and expectations processes related but functionally separate. We used the length of the investment lead time (i.e. the time from investment decision to completion of a project) to determine the future date to serve as a focus for expectations about factor prices.

In order to restrict the scale of our current experiments, we assumed that the results of our earlier investigations into expenditure lags [18] and expectations processes [29] are still valid for IME and INRC. These results are combined in RDX2 by assuming that expectations become operative only when projects are initiated, and that all subsequent alterations to the resulting time path of expenditures can be represented by special variables entering the investment equations separately. This is a similar framework to that used in the RDX1 equations [34], and,

as before, we allow for the possibility that some influence may be exerted by financial variables during the expenditure process.

By supposing that expectations are formed when a project is initiated, we can develop time series for desired capital stocks closely analagous to those of the static model. At any point in time, the desired capital stock that matters is the stock needed j periods ahead, where j is the length of the expenditure process. The expectations governing the choice of desired stock are those of desired output j periods hence, the price of fixed investment j/2 periods hence, current tax rates and tax provisions (current policies are therefore implicitly assumed to be long-lasting), and wage rates j+m periods hence, where m is the half-life of the building or equipment.

Wage rate expections are formed further into the future than capital goods prices because capital goods prices are fixed at the time of purchase, but labour is employed at wage rates that change continually during the life of the capital equipment. Therefore an addition to the expected rate of increase in prices and wages will increase the ratio of expected wage rates to expected capital equipment prices, and will lead firms to an immediate substitution of capital for labour in order to substitute capital equipment at 'today's' (t+j/2) prices for labour at 'tomorrow's' (t+j+m) wage rates.

Expectations about desired future output are for UGPPA twelve quarters hence in the case of INRC, and eight quarters hence in the case of IME. These horizons are equal to j+1, because each quarter's output is assumed to depend on the capital stock in place at the beginning of the quarter. In both cases

the expectations are based on actual values of UGPPA during quarters up to but not including the current one. The parameters of the expectations process are the same as those chosen in [29], but we use the mean quarterly growth rate of UGPPA 1Q52-4Q68 for g (see below). The expectations process takes account of extrapolative, regressive and trend-growth elements. The parameter g is the assumed trend rate of growth, and b represents the weight attached to the extrapolative element relative to the regressive element in expectations. The extrapolative and regressive elements attach exponentially declining weights to previous changes and levels, respectively. The parameter e represents the proportionately declining weight for the extrapolative element, and r represents the corresponding parameter for the regressive element. The parameter values used in the UGPPA expectations process are g = .0123, b = 1.5, e = 0.9, and r = 0.6.

The expectations about wage rates are generated by a slightly different process because they look so far ahead - twenty-three quarters for IME and seventy-eight quarters for INRC. The implied half-lives for investment goods (sixteen quarters for IME and sixty-seven quarters for INRC) are calculated by applying the assumed depreciation rates, 5% per quarter for IME and 1% per quarter for INRC. The expectations weights are the current-period weights (based on the expectations process with g = .0128, b = 1.5, e = 0.9, r = 0.6) multiplied by (1+g)**(j-m).

Our simplifications have thus enabled us to retain the key elements of the expectations mechanisms for prices and output,

while at the same time keeping the number of equations to a minimum. Next we consider how to move from desired capital stocks to desired investment.

3 Factor substitution, ex ante and ex post

To what extent are factor proportions embodied in capital equipment and buildings? Expected factor prices change over time, hence there will be changes over time in the optimal capital/output ratios, KMEY and KNRY. When firms compare the existing capital stock to the desired future stock, do they calculate the productive capacity of existing equipment by using the desired capital/output ratios applicable when the capital was built, or by using ratios based on presently expected factor prices? This question did not matter much in the context of either the RDX1 investment equations or those in [29], since the desired capital/output ratios were slow-moving trends. Now that we are making the desired capital/output ratios endogenous variables these issues must be faced.

We have tested both vintage and nonvintage versions of our factor-demand equations for capital and labour. The vintage approach is feasible chiefly because we use exponential decay depreciation rates. If we had made an alternative assumption that the capital stock was comprised of 'one-hoss shays', the problem of keeping track of their licence numbers would have been considerable. The concept of proportional depreciation permits a simpler procedure. We developed a concept of 'preferred output' - the amount produced if each part of the capital stock

is employed using the factor proportions governing investment decisions at the time that part was acquired. There will be separate values of 'preferred output' for each type of capital, since the two types have different desired capital/output ratios and different depreciation rates. To find the output preferred for each vintage of capital goods, it is necessary to associate each quarter's investment with some desired capital/output ratio. This we have done by linking IME with J3L(KMEY) and INRC with J5L(KNRY). The lag in each case is approximately j/2. Actually, investment in each quarter comprises expenditures started in a number of previous quarters. Given fairly smooth movements in KMEY and KNRY, our simplification does not do violence to reality.

The values for preferred output are then obtained by accumulating increments and continually writing down the total by the relevant depreciation rates. Thus for IME we have:

$$UGPPAMP = .95\ J1L(UGPPAMP) + IME/J3L(KMEY) \qquad (3.11)$$

and for INRC we have:

$$UGPPANP = .99\ J1L(UGPPANP) + INRC/J5L(KNRY) \qquad (3.12)$$

Base values for UGPPAMP and UGPPANP are derived by dividing KME and KNRC in 4Q55 by the corresponding values of the desired capital/output ratios derived from the RDX1 trend-through-troughs procedure. (See [18] page 26.)

If there is a gap between desired output and UGPPAMP or UGPPANP, the flexible accelerator comes into play. The accelerator applies independently for IME and INRC. At this point the question of an appropriate time horizon gets a little tricky. We want to measure desired output j periods in the future, yet UGPPAMP and UGPPANP measure preferred output using the current capital stock. As we have sworn off the full-blown forward-looking model with its 2j equations, another simplification is necessary. We simplify here by assuming that knowledge of projects already underway and coming to fruition within the next j periods will lead firms to respond less than fully to an indicated gap between expected UGPPA and current preferred output. The output gap is defined as desired output minus UGPPAMP in the case of IME and as desired output minus UGPPANP in the case of INRC. These two gaps are converted into capital stock gaps when multiplied by KMEY and KNRY, and into synthetic investment series by application of the appropriate distributed lags for expenditures.

An alternative procedure to this vintage approach would be simply to apply the RDX1 model directly, thus implying that capital goods can be equally well employed in any factor proportions, so that there is full ex post as well as ex ante substitutability. This alternative was tested and found to be inferior to the vintage approach in the investment equations. Our attempts to mix the two approaches also produced results favouring the pure vintage approach in the investment equations, although the nonvintage version was more successful in the employment equations.

C Business Inventory Investment

One major difficulty with the usual models of inventory accumulation (e.g. as discussed in [17], pp.6-15) is that the buffer-stock role for inventories is not properly identified. The buffer-stock variable is defined as the difference between expected sales and actual sales, with a coefficient that should lie between zero and 1, depending on how easily production levels can be adjusted. Aside from the problem of identifying the coefficient when sales expectations are themselves determined by current and lagged sales, the usual models are based on the assumption that production can be fully altered from quarter to quarter. In view of the long lags that characterize the demands for labour and capital, we prefer not to use expected sales as a proxy for production plans.

The explicit production function developed to integrate our fixed investment and employment equations gives rise quite naturally to a more precise definition of planned output. In our first experiments with the fixed investment equations we used gross real private output (UGPP) as the basis for expectations about desired future output. A search over plausible values for production function parameters produced a 'best fit' (in terms of the derived investment equations, with dependent variables summed to provide calculated values for total business fixed investment) having parameter values a = .205, b = .145, c = .65. The implied labour share is close to that indicated by the statistics on aggregate income distribution. Our assumption of Harrod-neutral (labour-augmenting) technical progress, when combined with the

labour requirements defined by the production function and the actual trend in total man-hours worked in mining and manufacturing, determines the average rate of increase in labour efficiency. The rate of technical progress enables us to construct a time series for the actual labour inputs in terms of efficiency units. When this labour input is used in the production function along with the beginning-of-quarter stock of capital goods, the result is a synthetic output series called UGPPS.

We interpret UGPPS as a short-run aggregate supply variable. It represents what would be produced in the current quarter if the factor inputs currently employed are used at trend levels of productivity. The inducement for buffer-stock accumulation of inventories is defined by the excess of UGPPS over all non-inventory categories of final demand, i.e. UGPPS-(UGPP-IIB). When the normal output of currently employed factors of production exceeds current final demand, firms may underutilize the employed factors or allow the excess production to accumulate in inventories, or do both. The coefficient on our buffer-stock variable will indicate the average relative importance of these two kinds of adjustment.

Although the innovations proposed above seem justified on theoretical grounds, they proved to be empirically essential in our attempts to estimate a reasonable inventory equation using the revised national accounts data. The new quarterly series for the change in business inventories has considerably more variance than the old series and is not adequately explained by the RDX1 equation. The RDX1 equation, based on sales, the change in

sales, the lagged stock of inventories, an unemployment index, and improved by the addition of a four-quarter moving average of the real supply price of capital (RHOR) had an RB2 of .74 when fitted for the period 1Q56-4Q68 using the old national accounts data. Using the revised data, the RB2 fell to .68 and all the coefficients, except that on the unemployment index, became insignificant. The addition of the buffer-stock variable defined above increased the RB2 to .86 and greatly strengthened the sales and lagged capital stock variables.

The passive inventory accumulation variable coupled with some revisions of the sales variables cause the unemployment index to drop out of the equation altogether. In RDX1 we thought of the employment index as a variable reflecting the degree of business confidence, but our present work suggests that this index is more likely to be a misspecified measure of aggregate supply since it is partly a measure of current employment relative to a moving average.

The RDX1 sales variable excluded expenditure on consumer services and government wages, and included total exports less total imports. This sales concept was referred to as 'purged' GNE. In RDX2, the purging process is carried further by defining the relevant export and import series as net of services. Furthermore, we thought that investment expenditure ought to be treated separately from consumer expenditure since no retail inventories are associated with the former, and substantially different sorts of goods are involved. We were also uneasy about the reasoning underlying the subtraction of imports from the sales variable. In order to ensure that an increase in final

sales, offset by an increase in imports, is irrelevant to inventory holders, one must assume that stocks of imported goods are held constant while these changes in sales occur. We now think it more reasonable to assume that final expenditure in Canada on at least some types of imported goods will lead to temporary reductions of inventories of such goods. In short, domestic inventories may play a buffer-stock role with respect to imported goods. Thus it seems desirable to treat imports, investment, and consumption separately in the flexible accelerator component of the inventory equation. Although it might also be desirable to split up the buffer-stock variable, our aggregate supply variable permits no such disaggregation. We proceed now to consider the chosen equation.

IIB Change in nonfarm business inventories (Equation 3.3)

In estimating this equation, we generalize the basis for expected sales to include data from the current quarter and seven lagged quarters. The implicit expectations weights are constrained to lie on a second degree polynomial passing through zero at quarter t-8. Since the appearance of the lagged inventory stock in the equation implies a response lag common to all components of expected sales, the difference in Almon weights among the various expenditure categories must reflect any differences in response pattern as well as in definition of sales expectations.

The equation contains: a constant term; three constrained quarterly variables, each multiplied by the lagged inventory stock; the lagged stock itself; the buffer-stock variable (UGPPS-

(UGPP-IIB); and lag distributions on three expenditure series. The largest expenditure series is the sum of consumer expenditure on goods, exports of goods, and government current nonwage expenditure. The weights are fairly evenly distributed, with a modest peak three quarters back. Interpreted in conjunction with the coefficient on the lagged inventory stock, the weights imply a marginal stock/sales ratio of 1.54, or .385 if annual sales are used for the denominator of the ratio. The sum of the coefficients on imports of goods is negative and about equal in size to the positive sum on the consumption variable. However, the equation fits noticeably better than when imports are simply subtracted from the sales variable, because the time pattern of response is quite different. The coefficients on imports have weights that are first positive and then negative. These coefficients suggest that inventories play an additional buffer-stock role with respect to imported goods. Any increase in imports of goods leads to some immediate increase in inventories, although in the longer term a higher import content of final demand reduces desired inventories in relation to final demand because of the implied decrease in domestic production.

The weights on investment, the third of our sales components, are positive first and then negative, suggesting extrapolative expectations. The pattern is similar to that for imports. The sum of weights is only one-fourth as great as that on consumption expenditure. It seems reasonable that the equilibrium ratio of inventory stock to fixed investment should be low, in the light of the high direct import content of machinery and equipment investment, the high direct labour

content of construction, and the absence of retail inventories of investment goods.

The coefficient on the buffer-stock variable is .461, indicating that, in addition to intended inventory investment derived from the expected sales variables, almost half of any difference between UGPPS and non-inventory final demand will be absorbed in, or taken from, inventory stocks. Any remaining difference between UGPPS and final demand (taking into account both the flexible accelerator and the buffer components of inventory accumulation) is accounted for by short-term changes in productivity. The buffer-stock variable is the strongest in the equation, with a t-value of over 9. The equation as a whole provides a considerably better fit than any of our earlier models. The standard error of estimate is $66 million, and the RB2 is almost .89.

The results of the inventory equation suggest a way of removing some of the unintended portion of aggregate output. We hope thereby to approach a measure of aggregate demand less affected than is UGPP by short-term supply constraints. Our new demand variable is called UGPPA, and is equal to UGPP minus .461(UGPPS-89.9-(UGPP-IIB)). (The constant 89.9 is the mean of the adjustment term and is included in the expression so that UGPP and UGPPA will have the same mean values.) This was not the only alternative open to us, for we could have defined the unintended component of inventory accumulation as .461(UGPPS-(UGPP-IIB+intended inventory investment)), where intended inventory investment is defined by the coefficients on the sales variables and the lagged inventory stock. This alternative

procedure gave us values for UGPPA that performed less well in the fixed investment equations, so we continue to use the simpler definition. We turn now to the fixed investment equations based on UGPPA.

D Business Fixed Investment Equations

As we indicated in section B, both vintage and nonvintage versions of the derived investment equations were fitted to quarterly data for the period 1Q59-4Q68. In addition to running the two versions as alternative equations, we estimated equations containing both vintage and nonvintage synthetic investment series as independent variables. Only the vintage variables were significant in the equations where both appeared, so the vintage version is presently employed in RDX2.

Equations 3.1 and 3.2 show the results for IME and INRC. Both equations are estimated net of a constant proportion of the lagged capital stock. Our earlier experiments indicated that gross investment equations, fitted with these same fractions of the lagged capital stock as independent variables, produced coefficients of 1.0 on these 'depreciation' variables. (See [18] pp.18-30, and pp. 58-60.)

Our initial estimates of the IME and INRC equations contained only seasonal variables and the synthetic investment series. Very low Durbin-Watson statistics in the initial estimation of the net investment equations indicated that important systematic variables either had been misspecified or

left out. This should be no surprise to anyone, for our aggregate production function with fixed coefficients is being used to represent a wide variety of processes. Some of these processes were in use for only part of the data period, and in general the relative importance of the various processes shifts over time.

As well, in our synthetic investment series we take no account of variations in the timing of investment outlays in response to changes in financial conditions, supply constraints, or other factors. We therefore tested a number of supplementary timing variables, and the preferred results are embodied in equations 3.1 and 3.2.

The IME and INRC equations each have three variables influencing the speed with which a gap between actual and desired capital stock is filled. Four separate variables are involved, and each is measured as a ratio to a moving average. The resulting indexes measure the inflow of foreign direct investment funds, cash flow generated by Canadian corporations, bank loans to business, and the rate of interest on long-term bonds. The direct investment and cash flow variables enter both equations, and the loans index and the interest rate index influence IME and INRC, respectively. All the timing variables enter with polynomial distributed lags. Their net effect is to improve substantially the goodness of the fit and the residual properties of the equations. The resulting IME equation has no first-order autocorrelation of errors, and has a standard error of $44.7 million. The INRC equation fits even more closely, with a standard error of $20.8 million, but retains fairly high

autocorrelation of residuals. Re-estimation of both equations using the Hildreth-Lu procedure leaves the structure of the IME equation untouched, but reduces moderately the coefficients on the timing variables in the INRC equation. We hope that our timing variables reflect genuine causal forces, and are not just mopping up a complicated pattern of autocorrelated errors traceable to some other source.

The low coefficients on the gap variables in the two investment equations suggest that either output or price and cost expectations, or both, are more regressive than they are assumed to be in our model. Alternatively, we might argue that the low coefficients are due to errors of measurement in the variables defining KMEY, KNRY, and UGPPA, or that certain supply constraints in the investment goods industries are not represented by movements in the national accounts price deflators. This feature of our results is not new to our present framework, however, for it characterized both the RDX1 equations [18] and the "forward-looking" model [29]. Even though improvements are yet to be made in the present equations, we regard them as being structurally and empirically superior to the RDX1 equations.

E Aggregate Supply and Demand and So On

In this section we catalogue the various concepts we have derived from UGPP. Some of them have been explained earlier in the chapter; others (UGPPD and the capacity utilization

variables) are introduced here. The preferred output series, UGPPAMP and UGPPANP, are specific to the investment equations, and need not be re-explained now. We start with a description of our real output variables.

UGPP Gross private business product, excluding agriculture and noncommercial services, 1961 dollars (Equation 3.13)

Our object in defining this variable was to approximate some measure of total output produced by the business sector. In RDX1 we made extensive use of a total private sector domestic expenditure variable (called YGPK), to which we added government nonwage expenditure to obtain an approximation of private sector output. We also made use of a series (called Y) for real domestic product ex agriculture. As a way of measuring the output of the nonagricultural business sector, the combination of YGPK and government nonwage expenditure is inadequate because it implicitly includes farm output and value added by noncommercial institutions (mainly schools, hospitals, and universities). Real domestic product ex agriculture has the disadvantage of including the value added both by the government sector and by noncommercial institutions. In RDX2 we attempt to overcome this difficulty by constructing a private output variable especially for our purposes. The current-dollar version, YGPP, is obtained (as shown in equation 8.5) by subtracting from YGNE all wages, salaries, and supplementary allowances paid by governments and noncommercial institutions, farm wages, and accrued farm income. We thereby assume that wage payments represent the value added by governments and noncommercial institutions, and that accrued farm

income plus farm wages represent value added in the agricultural sector. The corresponding constant-dollar output variable, UGPP, is obtained by subtracting 1961-dollar equivalents of government and institutional wage payments, and farm income, from constant-dollar gross national expenditure (YGNE/PGNE). These constant-dollar wage series are employment series multiplied by the relevant 1961 wage rates. Details of the calculations for PGPP are shown in equation 7.22, so that equation 3.13 defines UGPP as UGPP = YGPP/PGPP.

Our production function analysis treats UGPP as the output from KME, KNRC, and NMMOB. However, this is not strictly correct, for UGPP includes the value added by the construction industry, and, although KME and KNRC are the corresponding total capital stocks, NMMOB does not include construction industry employment (NC). In some of our experiments we adjusted for this discrepancy either by using NMMOB plus NC as the employment input or by subtracting construction wages, in constant-dollar terms, from UGPP. These further complications did not make any significant difference, so we continue to use NMMOB as the employment input to the production function for UGPP, and to explain employment in construction separately. In 1968, the average number employed in construction was less than 10% as large as in mining, manufacturing, and other business.

UGPPA UGPP adjusted to remove unintended inventory changes (Equation 3.14)

This variable provides a measure of aggregate demand that differs from actual output (UGPP) by the subtraction of any

increase in inventories arising from their buffer-stock role, i.e. UGPPA is equal to UGPP less the buffer-stock variable (minus its sample mean) multiplied by its estimated coefficient from the inventory equation. In using UGPPA rather than UGPP as the basis for expectations about desired future output, we are supposing that any increase in output resulting in unintended inventory accumulation does not give rise to greater desired levels of capital stock and employment.

We cumulated the difference between UGPP and UGPPA (or rather took a twelve-quarter moving sum to avoid having one more equation) as a measure of excess or deficient inventories. This measure was tried, in preference to the stock/sales ratio of RDX1, as an independent variable in the price equations.

UGPPD Desired output based on production function with actual capital stock, average employment rate, and trended weekly hours (Equation 3.15)

This variable, like UGPPS, is a measure of output forthcoming at average productivity levels. UGPPD is what the assumed production function would yield if the capital stock and the labour force were utilized to an average extent. The production function inputs are the actual (beginning-of-quarter) stocks of KME and KNRC, the employment series NMMOB adjusted for untypical rates of unemployment, and 'normal' hours. 'Normal' hours are obtained from a regression of average weekly hours worked in mining and manufacturing (HAWMM) on a constant and a time trend. The adjusted employment series is obtained by multiplying the actual level of NMMOB by (1+NL/NE-1.05179), where

1.05179 is the average value of the ratio of the total labour force (NL) to the employed labour force (NE). UGPPD does not represent full capacity output, for it assumes an average level of factor utilization, and hence has the same mean value as actual output UGPP. If, on average, the providers of labour and capital services would have preferred a higher level of utilization, then UGPPD is less than desired output by the proportion that the desired degree of factor utilization exceeds the historical average.

Since UGPPA is our concept of aggregate demand, and UGPPD our longer-term measure of aggregate supply, the ratio of one to the other gives some measure of the extent to which aggregate domestic supply and demand are out of balance. This ratio is an important determinant of prices and foreign trade - two of the main mechanisms that restore balance between domestic supply and demand.

UGPPS Aggregate supply based on production function with actual factor inputs (Equation 3.16)

This variable, already described in section B, indicates the level of output forthcoming, at average productivity levels, from the beginning-of-quarter capital stock combined with current labour inputs. In the presence of an exogenous change in aggregate demand, UGPPS responds faster and more strongly than UGPPD, because changes in employment and average weekly hours are induced by the change in demand. Actual output (UGPP) responds even more than UGPPS, owing to short-term changes in productivity. This result is, quite naturally, a consequence of

lags in the processes of altering capital stocks and the level of employment, and also a consequence of limitations in the extent to which it is possible or desirable to vary average weekly hours. Actual output itself does not respond fully to a change in aggregate demand (as measured by UGPPA) because of the buffer role played by the stock of business inventories.

Thus if we arrange our UGPP concepts in a row with UGPPA (aggregate demand) at one end and UGPPD (desired output) at the other, then UGPP (actual output) and UGPPS (the current supply variable) are in the middle, with UGPP adjacent to UGPPA and UGPPS beside UGPPD. This plethora of UGPP's seems confusing at first, but we have gained confidence in these concepts as each version appears to serve faithfully its allotted role.

CHAPTER 4

FOREIGN TRADE

SECTOR 4

A An Overview of the Sector

In this chapter we describe the twenty-two behavioural and nine technical relationships comprising the foreign trade sector of RDX2. Section B of the chapter contains a description of the nine constant-dollar equations for trade in goods - six equations for imports and three for exports. Section C is concerned with the five current-dollar equations for capital service payments and receipts, all of which provide links between the capital account and the current account of the balance of payments. In section D we discuss the eight current-dollar equations relating to payments and receipts for travel, and for freight and shipping.

The construction of a fairly large number of trade equations was dictated by our desire to treat flows between Canada and the United States separately from those between Canada and other countries. This split is necessary to permit the linkage of RDX2 with the MPS quarterly model of the U.S. economy. A separate report on the linkage project [36] contains some supplementary discussion of the fourteen behavioural equations for trade flows between Canada and the United States. The greater disaggregation of the Canadian-U.S. flows was also prompted by their relatively

large size and by the availability of suitable explanatory variables from the U.S. model. The heterogeneity of Canada's other major trading partners reduced the potential gains available from disaggregation by commodity for this group of countries.

Another general feature of our trade equations is that the equations for goods are estimated in constant dollars, whereas those for services are in current dollars. The treatment of flows of goods in constant dollars is consistent with our expenditure equations elsewhere in the model. Some of the service flows, such as interest and dividend payments, do not have any 'real' equivalents, so that no conceptually adequate price deflators can be obtained. For travel expenditure, and for freight and shipping, the available price data were not good enough to encourage us to develop and explain constant-dollar series. In order to derive constant-dollar measures of total imports of goods and services (M, equation 4.27), and total exports of goods and services (X, equation 4.28), we make use of exogenous price indices for imports and exports of total services.

The eight technical relationships in this sector are all merely totals or balances of the constant- or current-dollar measures of trade flows. Current-dollar trade totals are constructed separately for flows between Canada and the United States (M$12 and X$12, equations 4.23 and 4.24), and between Canada and other countries (M$13 and X$13, equations 4.25 and 4.26).

To complete this brief overview of the sector, and to preview some of the results, we have constructed Table 4.1 in which we list the behavioural equations of Sector 4, present estimates of exchange rate elasticities, and give some idea of the size of the various flows. The relative magnitudes of each of the items are given by the 1968 average quarterly flows in millions of current dollars. The table also includes some total items (MG$, M$, XG$, X$, XBAL$) with associated flows that may be larger than the sum of their listed components since the table does not contain the exogenous components of the totals. The unlisted exogenous components are shown explicitly in equations 4.23 to 4.31.

The elasticities in Table 4.1 are calculated with respect to changes in the price of foreign exchange (PFX). In order to calculate elasticities for the current-dollar flow of goods, we had to calculate first the elasticity of each trade price with respect to PFX, and then calculate the direct and indirect (acting through the trade price) effects of PFX on the constant-dollar flow. Some of the import prices have unit elasticity with respect to the exchange rate because the equations were estimated with the dependent variable defined as the trade price divided by PFX as described in Chapter 7. One import price (PMNTE13) is exogenous, and we have shown it to have an elasticity of 1.0 with respect to PFX because we run our revaluation simulations using that assumption. For simulations with the exchange rate moving between its 1962-1970 fixed support points, the only import prices that vary are the four covering imports of goods (excluding motor vehicles and parts) from the United States. The

TABLE 4.1 EQUILIBRIUM EXCHANGE RATE ELASTICITIES

Canadian Imports	Exchange Rate Elasticities of Constant-Dollar Flow	Trade Price	Current-Dollar Flow	Average Quarterly Flow in 1968	1968 Flow Effect of 1% Drop in PFX
MFB12	-1.15	1.0	-0.15	113.6	0.17
MEF12	-0.30	1.0	0.70	72.5	- 0.50
MCM12	0	1.0	1.0	107.8	- 1.08
MMF12	-0.65	0.84	0.19	1069.4	- 2.03
MMV12	0	0	0	687.2	0
MNTE13	-0.82	1.0	0.18	741.4	- 1.33
MG, MG$	-0.54		0.19		- 4.77
MINT$12			0	125.0	0
MDIV$12			0	143.5	0
MTR$12			-1.59	177.5	2.82
MFS$12			-0.10	140.3	0.14
MID$13			0	46.0	0
MTR$13			0.67	74.5	- 0.50
MFS$13			0.80	92.5	- 0.74
M$			0.07	4322.8	- 3.05
Canadian Exports					
XMV12	0	0	0	602.7	
XNMV12	0.74	0.35	1.09	1628.5	-17.75
XNW13	0.21	0.27	0.48	886.3	- 4.25
XG, XG$	0.39		0.62		-22.00
XID$12			0	57.8	0
XTR$12			1.77	222.8	- 3.94
XFS$12			0.86	116.8	- 1.00
XID$13			0	30.5	0
XTR$13			0	222.8	0
XFS$13			0.34	106.0	- 0.36
X$			0.60	4520.8	-27.30
XBAL$					-24.25

Note:
The elasticities are calculated using the sample means of the variables as they appear in the equations. The 1968 average flows are in current dollars. $ denotes a current-dollar variable. Trade with the United States is denoted by 2, with other countries by 3. FB is food and beverages, EF is energy fuels, CM is crude materials, MF is manufactures, MV is motor vehicles, NTE is everything except transportation equipment, G is total goods, INT is interest, DIV is dividends, TR is travel, FS is freight and shipping, ID is interest and dividends, NMV excludes motor vehicles, and NW excludes wheat. XBAL$ is total current-dollar exports minus imports.

motor vehicle trade prices are exogenous, awaiting more precise modelling of the shifting structure of North American auto production. All the main export prices are influenced by the exchange rate as reported in Chapter 7, reflecting the assumption that prices for many Canadian exports are affected by world market prices as well as by domestic conditions.

As a final note, the elasticities for trade totals are calculated on the assumption that the exogenous trade flows and the prices of service imports and exports are unaffected by exchange rate movements. The chief justifications for this treatment are that the exogenous items (such as imports of aircraft) are lumpy, are not clearly influenced by relative prices, and constitute a fairly small part of total trade.

The reader who has grappled with Table 4.1 will by now either have closed the book or be ready to consider the equations themselves.

B Merchandise Trade

1 Imports of Goods from the United States (Equations 4.1-4.5)

There are five equations for imports from the United States. The commodity disaggregation is the same as that agreed upon for Project LINK, except that we treat motor vehicles and parts separately, and leave exogenous other transportation equipment and miscellaneous imports (SITC 9). The Project LINK categories are food and beverages (SITC 0,1), energy fuels (SITC 3), crude

materials (SITC 2,4), and manufactures (SITC 5-9). This split was chosen with an eye to using linked national models to explain world trade flows (the concepts and equations underlying the project are described in various chapters of [3]); thus it is not surprising to find from Table 4.1 that most Canadian imports lie in the manufactures category.

In explaining trade flows between Canada and the United States, we were aware that each equation for Canadian imports would also be an equation for U.S. exports in our linked simulations. We therefore investigated various U.S. supply constraints, in addition to U.S. domestic prices, as factors explaining Canadian imports.

The central driving variable in each of our imports of goods equations is a synthetic measure of import requirements. In the motor vehicles equation we simply use consumer expenditure on motor vehicles. For crude materials we use the RDX2 measure of business output (UGPP). For the other equations the import requirements variable is a weighted average of up to six final demand categories. The a priori weights used in each case are based on input-output information (from the 1961 Dominion Bureau of Statistics (DBS) input-output table [7], the latest available) about the amount of different types of imports represented in each final demand category. For each import category the weights on the various components of final demand are scaled so that they sum to unity. The weights are strikingly different in the various equations. For example, in equation 4.1 for imports of food and beverages, 83% of the weight is attached to consumer expenditure on non-durables and semi-durables (CNDSD), and no

weight is given to fixed investment. By contrast, in equation 4.4 for imports of manufactures, the implied weights attached to CNDSD and to business fixed investment in machinery and equipment are about .07 and .70, respectively.

Relative price variables enter the import equations either as separate variables, as in equation 4.1 for food and beverages, or multiplied by the import requirements variable, as in equation 4.2 for energy fuels and equation 4.4 for manufactures. In equations 4.3 and 4.5 for crude materials and for motor vehicles the relative price variables did not show a significant influence in either of the forms tested. The definition of a relative price variable depends on the type of commodity involved. For example, imports of food and beverages are assumed to flow directly into consumption so that the relative price is the relevant import price divided by the Consumer Price Index. Imports of energy fuels, chiefly industrial coal and crude oil, enter the production process at an early stage, and thus the price of business product is divided by the import price to define the relative price. A similar treatment is used in the equation for imports of manufactures, although here there are important amounts of consumption goods as well as investment goods involved. In the latter two cases, the relative price is defined with the domestic price in the numerator because the price variable is multiplied by the demand variable.

The main reason for including capacity utilization rates in both Canada and the United States is that the measured trade prices do not reflect market-clearing prices. This may happen either because the reported prices do not reflect fully the

variance in actual prices, or because firms prefer to vary the length of order books, quantity discounts, or other conditions of supply rather than make frequent price adjustments. Under this argument, there is little reason for the relationship between the implicit market-clearing price and the quoted price to be different for Canadian than for U.S. prices. Thus one might expect to find, as in equation 4.3 for crude materials, that Canadian and U.S. capacity utilization rates have a symmetric impact on the northbound flow of goods. In that equation, in fact, the ratio of Canadian to U.S. capacity utilization replaces entirely the relative price variable.

In equation 4.4 for imports of manufactures the U.S. capacity utilization rate did not perform its expected role, so the Canadian utilization rate appears on its own.

In addition to the general influences described above, there are a few special purpose variables in these import equations designed to reflect abnormal influences in some commodity groups. The most important of these variables is QAUTO, representing the increasing degree of integration of North American auto production after the Canada-United States Automotive Agreement took effect in 1965. This variable appears in the equations for both northbound and southbound flows of motor vehicles and parts, depicting how both flows have been increasing in size relative to motor vehicle production and use in the two countries.

2 Imports of goods from other countries (Equation 4.6)

We have a single equation for imports of goods from countries other than the United States. The dependent variable is total imports of goods from these countries, excluding a small exogenous series for transportation equipment and for unclassified commodity transactions (SITC 9). The main causal variable in the equation is a weighted combination of final demand categories times the price of business product divided by the import price.

3 Exports of goods to the United States (Equations 4.7-4.8)

In equation 4.8 we explain exports of goods other than uranium, aircraft, and motor vehicles. The main independent variables are U.S. capacity utilization, U.S. gross national expenditure multiplied by the rate of capacity utilization, and a relative price term. The numerator of the relative price term is the Canadian dollar equivalent of U.S. domestic investment prices and the denominator is the price of this category of Canadian exports. All these variables enter the equation with polynomial distributed lags extending as long as sixteen quarters for the U.S. expenditure variable. Canadian capacity utilization was not found to have a significant role in this equation.

Exports of motor vehicles (equation 4.7) are determined by the sum of Canadian plus U.S. expenditure on consumer durables, all multiplied by QAUTO. We should have preferred to use

consumer expenditure on motor vehicles rather than total expenditure on durables, but such a split is not made for the U.S. within the MPS model. Exports of motor vehicles and parts to the United States were relatively minor prior to the 1965 auto pact, and our estimation period starts only in 1Q63.

4 Exports of goods to other countries (Equation 4.9)

This equation is estimated in log-linear form. Thus variables that were multiplicatively related in our other equations are separate terms in this equation. The main variables are total world trade (excluding U.S. and Canadian imports), a relative price variable, and Canadian capacity utilization. There is also a separate world trade variable spanning the flexible exchange rate period, indicating that the elasticity of Canadian exports with respect to the volume of world trade was marginally higher during the flexible exchange rate period. The elasticity of exports with respect to relative prices and capacity utilization is about -.75 in both cases, compared to 1.07 for the volume of world trade. The relative price variable is the Canadian export price divided by the Canadian dollar equivalent of the price index for world exports of goods.

C Capital Service Payments and Receipts

We have adopted the point of view that a model of an open economy cannot be complete unless it has structurally appropriate equations not only for capital flows but also for the consequential international flows of interest and dividends. Otherwise, one cannot assess correctly the net balance of payments effects of monetary and fiscal policies. In that connection it has been argued (e.g. [54]) that the alleged comparative advantage of using monetary policy to attain a balance of payments target may not exist if account is taken of the higher service imports involved - interest payments on foreign-held debt. These are, of course, caused by the higher domestic interest rates designed to induce the inflows of capital needed to shore up a temporarily weak balance of payments. The resolution of this issue depends on the answers to a number of empirical questions. For example, when there is a sustained interest rate change, how rapidly will the new rates come into effect on the total stock of international indebtedness? A precise answer to this question requires vintage accounting for international indebtedness and direct information or assumptions about its maturity structure. The scantiness of available data on trade in outstanding securities denies us the opportunity of developing such accurate specifications, but we think we have developed much better equations than those previously available. Even in macro-models designed with the balance of payments in mind, the international interest and dividend equations, if they exist at all, are driven by proxy variables for debt and rates of return. Therefore these equations cannot be used to undertake realistic policy simulations.

Within the confines set by the data and the degree of aggregation in our explanation of capital flows, we have developed a number of disaggregated indebtedness series and weighted average interest rates. In constructing equations for interest payments on foreign-held long-term debt, we accumulate the appropriate indebtedness series (based on data for new issues and retirements of bonds, and trade in outstanding bonds) to which we apply weighted averages of past long-term interest rates (using weights that depend on the volume of gross new issues). In explaining dividend payments, our basic intent is to isolate the fraction of corporate profits that accrues to foreign shareholders and then to develop equations based on some theory of dividend payments.

The capital service payments equations are more detailed and disaggregated than the receipts equations. This is so because our accounting for Canadian liabilities is more precise, and because Canadian capital service payments are much larger than the corresponding receipts. We describe the payments equations first.

1 Interest and dividend payments to foreign residents
(Equations 4.16-4.17 and equation 4.20)

There are separate equations for interest and dividend payments to U.S. residents, and a combined equation for payments to other foreign residents.

Equation 4.16 for interest payments to the United States (MINT$12) is based on a synthetic interest payments series

entering the equation by itself and also multiplied by the three constrained quarterly variables. The dependent variable is a quarterly flow, and the synthetic series an annual equivalent. The estimated coefficient of .259 on the average quarter is reassuringly close to, although significantly above, its theoretically correct value of .250.

The synthetic interest payments series is the product of a debt series (LCB12+LGB12) accumulated from balance of payments statistics, and a weighted average of past values of Canadian and U.S. long-term interest rates. There are several stages in the endogenous weighting of these interest rates. A weighted U.S. rate is constructed by multiplying the U.S. rate in the current and preceding nineteen quarters by the corresponding quarterly total of the flow of new Canadian bond issues sold in the United States (plus sales of outstanding Canadian bonds in the United States). This product in each quarter is then divided by the exchange rate for that quarter, and the resulting values are summed over twenty quarters, divided by the twenty-quarter sum of the relevant capital inflows, and then multiplied by PFX. The exchange rate adjustment requires explanation. The U.S. synthetic rate applies to the U.S.-pay portion of Canadian bonds held by U.S. residents. If PFX at any time is higher than the exchange rate when a bond was originally issued, the Canadian dollar equivalent of U.S.-pay coupons is proportionately increased. Thus the synthetic U.S. interest rate series contains a component equal to the ratio of current PFX to a twenty-quarter average of past values of PFX, where the weights on past values

depend on the flow of bonds sold to U.S. residents in each quarter.

The weighted average Canadian interest rate is similar but simpler to calculate because no adjustment is required for exchange rate changes. All that matters is the Canadian dollar value of bonds at the time of purchase and the yields then prevailing. Our series may be biased if there is a systematic difference between interest rates on new issues and RL, the average yield on Government of Canada bonds of ten years and over to maturity.

The weighted U.S. and Canadian interest rates are combined with the relative weights .757/.243, reflecting an estimate of the split between U.S.-pay and Canadian-pay issues among the Canadian corporate and government bonds held by U.S. residents.

We think that equation 4.16 captures the main determinants of the flow of interest payments to the United States and will allow us to simulate some of the important current account consequences of monetary policy. The equation fits closely, with an RB2 of .972, a standard error of $5.12 million, and a coefficient of variation of 7.25%. The mean value of the flow in 1968 was $125 million per quarter.

Equation 4.17 for dividend payments to the United States by Canadian corporations (MDIV$12) is based on the cash flow accruing to the credit of U.S. shareholders rather than on total dividend payments. We allow the structure and timing of dividends paid to foreign shareholders to differ from those of dividends paid to Canadian shareholders, since U.S. shareholders often have different interests than Canadian shareholders.

Because many corporations are controlled by U.S. shareholders, we expect to find these different circumstances reflected in different dividend payout policies.

The main independent variables are the four-quarter moving sum of corporate cash flow accruing to U.S. shareholders, and the dependent variable lagged four quarters. An increase in cash flow evokes an apparent response that is slightly slower and smaller than the corresponding response in the case of dividends paid to Canadian shareholders. (See equation 8.2.) The equilibrium payout ratio to U.S. shareholders is 20.2% of cash flow, with three-fourths of the change taking place in the first year. A payout of 20.2% of after-tax profits plus book depreciation is equivalent to 37% of after-tax profits. The accuracy of these results, as indicators of management policy, depends on the validity of LDIRV12 and LPCV12, our measures of the values of the claims of U.S. direct and portfolio investors. The accounting underlying these series is described in section D of Chapter 10.

The RB2 of equation 4.17 is .853, with a standard error of $16.3 million - about 14% of the average value of the quarterly flow over the sample period.

Interest and dividend payments to other countries (MID$13) are explained together in equation 4.20. A simple treatment is excused by the fairly small size of the series. MID$13 has a sample mean of $35 million, less than one-sixth as large as the average value of interest and dividends paid to the United States. The main independent variable is the product of the book value of indebtedness of business (LDIPRV13) and governments

(LGB13) to other countries and a weighted average of a constant and a twenty-quarter simple moving average of the Canadian long-term interest rate (RL). A simple moving average of RL is used because we do not explain corporate debt and equity flows to other countries separately in RDX2. A weight of 24.1% is attached to the interest rate series because interest payments make up that portion of MID$13. The constant .013 used in the rate of return implies that dividends are a constant fraction (excluding seasonal fluctuations) of the book value of direct and portfolio investment including retained earnings. Attempts to make direct use of corporate cash flow in explaining the dividend component of MID$13 were not successful. The equation has an RB2 of only .596, but the standard error is just $5.4 million, and the equation has enough structure to be worthwhile.

2 Interest and dividend receipts from foreign countries (Equations 4.10 and 4.13)

Only aggregate book value figures are available for Canadian claims on U.S. residents and on residents of other foreign countries. We therefore have equations for aggregate interest and dividend receipts from the United States (XID$12, equation 4.10) and from other countries (XID$13, equation 4.13).

Equation 4.10 is estimated as a ratio of total U.S. interest and dividend payments. The main independent variable is the ratio of the indebtedness of the United States to Canada (A12) to the Canadian dollar equivalent of the sum of U.S. household wealth (VCN$2) and A12. This ratio enters the equation

multiplied by the four linear quarterly variables, Q1 to Q4. Although the fit is not good, the structure is reasonable.

We found equation 4.13 more difficult to handle because no suitable series exist for wealth and investment income in other countries in which Canada invests. Structurally, the equation is similar to that for MID$13, as the main independent variable is the book value of the indebtedness of other countries to Canada (A13) multiplied by a weighted average of a constant and a twenty-quarter moving average of the U.K. long-term interest rate (RLUK). The constant is equal to the average sample value of the moving-average interest rate, and the relative weights attached to the constant and to the interest rate series are .696/.304, corresponding to the relative amounts of dividends and interest in the total flow.

The equation is substantially improved by the addition of the variable QXDIV accounting for an extraordinary $60 million dividend payment from a U.K. subsidiary. QXDIV is 1.0 in 4Q64, and takes a significant coefficient of 54.6, so it is playing an appropriate role. The resulting equation has an RB2 of .759 and a standard error of $7.76 million, which is about 32% of the average size of XID$13 during the sample period. The main coefficient is .284; it would be .250 if interest and dividends were both paid on A13 according to a twenty-quarter moving average of RLUK.

Taken as a group, the interest and dividend payments and receipts equations provide significant links between the current account and the capital account of the balance of payments, and

will add considerable range to the simulation experiments that can usefully be undertaken using RDX2.

D Payments and Receipts for Other Services

1 Travel payments (Equations 4.18 and 4.21)

Both flows are estimated as ratios to the labour force population (NPOP), and depend principally on total current-dollar expenditure on consumer services and the exchange rate. The exchange rate elasticity of 'real' travel expenditure is high in the case of travel to the United States, about -2.59 if the U.S. prices paid by Canadian tourists are assumed to be unaffected by changes in the exchange rate. The corresponding price elasticity for travel to other countries is small, only -.33. Thus the exchange rate elasticity of the current-dollar flow for MTR$13 is .67, as shown in Table 4.1 and by the positive coefficient on PFX in equation 4.21. The travel equations also show a shift from U.S. travel to other foreign travel after 1958. This is attributed to increased duty-free allowances, but other explanations seem more plausible to us. There was also a drop in travel overseas for the duration of Expo67, an event that provided obvious domestic competition for travel abroad.

2 Travel Receipts (Equations 4.11 and 4.14)

Equation 4.11 for travel receipts from U.S. residents is estimated as a ratio to total U.S. population. The receipts depend chiefly on per capita U.S. consumption expenditure, the exchange rate, and Expo67. In Table 4.1 a current-dollar exchange rate elasticity of 1.77 is indicated, which is equivalent to an exchange rate elasticity of .77 for the constant-dollar flow. Thus we have some evidence that Canadians considering U.S. travel are more responsive to exchange rate variations than are U.S. residents considering travel to Canada.

The shortage of expenditure variables for the 'other countries' group led us to estimate equation 4.14 for travel receipts as a function of current-dollar world trade and Expo67. No exchange rate effect was found.

3 Freight and shipping payments (Equations 4.19 and 4.22)

The main determinant of freight and shipping payments to the United States is current-dollar imports of goods from the United States (MG$12). The equation also indicates that the sharp expansion of imports due to the auto pact has not led to a corresponding increase in freight and shipping payments. The exchange rate term, when considered in conjunction with the exchange rate elasticity of MG$12, indicates elasticities with respect to PFX of -.10 and -1.10 for the current- and constant-dollar flows, respectively.

Equation 4.22 for freight and shipping payments to other countries depends on current-dollar imports of goods from those countries, the exchange rate and the opening of the St. Lawrence

seaway. The latter event increased the ability of foreign carriers to transport imports closer to Canadian centres of population thus replacing transport previously provided by domestic carriers. The exchange rate elasticity shown in Table 4.1, calculated to take account of the exchange rate elasticity of current-dollar goods imports, indicates a positive elasticity for the current-dollar flow and a small negative elasticity for the constant-dollar flow. Thus an increase in the price of foreign exchange leads to a decrease in the volume of services purchased but to an increase in the number of Canadian dollars expended on services.

4 Freight and shipping receipts (Equations 4.12 and 4.15)

Equation 4.12 for receipts from the United States depends on current-dollar exports of goods to the United States, with a lesser effect from exports induced by the auto pact. Equation 4.15 for receipts from other countries depends on current-dollar exports of goods to those countries. Both equations show a hypothetical negative impact of the St. Lawrence seaway on Canadian freight and shipping receipts.

That completes our description of the trade equations of RDX2. We are not overly proud of them, and there is much further work to be done on this sector as better data become available for trade prices and constant-dollar flows. In the meantime the present equations do include many important factors in Canada's trading experience.

CHAPTER 5

BUSINESS EMPLOYMENT AND HOURS, LABOUR FORCE, AND POPULATION

SECTOR 5

A Introduction

In the business employment equations explained in this chapter we treat employment and hours in mining, manufacturing, and other business separately from employment and hours in construction. The former are explained in section B and the latter in section C. The equations for mining, manufacturing, and other business are part of the factor-demand model set out in Chapter 3; those for the construction industry are simpler relationships based primarily on the level of construction activity. Equations for employment by governments and schools are located in Sectors 12 and 13 and explained in Chapter 8.

The size of the labour force and relevant measures of the total population are largely determined by demographic relationships and only indirectly affected by the endogenous variables of RDX2, at least in the short run. Nevertheless, a number of economic factors affect labour force participation, and in our labour force equation (equation 5.5) we have tried to assess their net aggregate impact. This equation is described in section D. We have made the total population endogenous to RDX2 by including equations for immigration and emigration, both of

which depend significantly on economic conditions in Canada and other countries. These equations are described in section E. Our equations for population, labour force participation, and employment in business, government, and noncommercial institutions combine to define the level of unemployment (with the aid of exogenous variables for farm employment and some residual employment categories). Because the rate of unemployment plays an important role in our equations for wage rates and some government expenditures, we attach some value to accuracy in our employment, labour force, and population equations. In addition, the estimated employment series has important effects in equations for profits, prices, foreign trade, personal taxes, and so on.

B Employment and Hours in Mining, Manufacturing, and Other Business

1 The level of employment

There are a number of ways of deriving a demand for labour from the production function and relative prices. Which of these is most appropriate depends mainly on the costs and speed of altering labour inputs, a subject about which little is known. We assume that the costs of adjusting hours per week are less in the short run than are the costs of adjusting employment. This assumption is consistent with the RDX1 employment and hours equations. (See [34], pp.13-15.) We also assume that in the

longer run the desired level of average weekly hours is determined by slow-moving social and economic trends, while the level of employment is adjusted to meet the labour requirements indicated by desired output, production function elasticities, and factor prices. Thus several sorts of labour adjustment may be going on at the same time. Three sorts of possible adjustment are represented by the following variables.

(a) 'Short Gap'. This variable is found by taking the chosen production function, inserting the actual capital stock and the current value of the aggregate demand variable (UGPPA), and then calculating the implied labour input in terms of man-hours. The latter is divided by the linear trend value of average weekly hours in mining and manufacturing to get the labour input in terms of men of unchanged efficiency working a 'normal' number of hours per week. The difference in trend between this series and the actual level of employment in mining, manufacturing, and other business is removed and attributed to Harrod-neutral technical progress. The difference between the resulting series (NMMOBD) and the actual level of employment in the previous quarter can then be used as the main input to a standard adjustment equation for the number of employed workers.

(b) 'Long Gap'. This variable has the same general characteristics as the short-gap variable, except that the output variable is expected UGPPA and the capital inputs are obtained by multiplying KMEY and KNRY by expected UGPPA. The long-gap variable represents the gap between current employment and that required to produce expected output in conjunction with the

corresponding capital stocks chosen in the light of prevailing expectations about future factor prices.

(c) 'Vintage Gap'. This variable differs from the other labour gaps and is derived from the 'preferred output' concept. The vintage-gap variable represents the difference between current employment and that required to produce current output using labour according to the optimal output/labour ratios built into each vintage of the capital stock.

We estimated employment and hours equations based on the three labour-gap concepts described above. The vintage gap is the concept most compatible with the approach adopted in the investment equations, but the vintage gap does not perform as well as the short gap in the equation for the change in employment in mining, manufacturing, and other business. As an alternative specification, we tried adding the change in employment in construction to our dependent variable (since construction capital stock is in the capital stock series KME and KNRC, and since UGPP includes value added by the construction industry). Calculated employment in construction (obtained from an independent equation) was then subtracted from the calculated total in order to get calculated NMMOB. This method was inferior to that used in equation 5.1 determining NMMOB directly. Equation 5.1 is quite successful, and the implied trend rate of increase in labour efficiency indicated by the short gap is not unreasonable. The labour-efficiency variable (ELEFF) grows by .68% per quarter, or 2.75% per year. The final equation contains only the short gap, NMMOBD-J1L(NMMOB), since neither of the other measures of labour demand add any explanatory power. This

equation contains as well a set of constrained seasonals multiplied by lagged NMMOB. As measures of the quantity or quality of the available labour supply, we also considered man-days lost in strikes and the unemployment rate. These variables did not improve our equation.

The standard error of estimate is 26.3 thousand men, less than .65% of the average value of NMMOB in 1968. The coefficient on the short gap implies a slow adjustment, in response to a current labour excess or shortage, of about 12.1% in the current quarter.

2 The hours equation

The basic causal variable in equation 5.3 for HAWMM is the proportion of the desired labour input (NMMOBD) that is not met by current employment. The dependent variable is the difference between actual and normal weekly hours expressed as a proportion of normal weekly hours. This specification has been chosen because the basic input to the production function is expressed in terms of man-hours, which we approximate by (HAWMM)(NMMOB). A given increase in required man-hours can be met by an increase in men or a similar percentage increase in hours. We suppose that hours are a short-run rather than a long-run source of labour, having assumed that in the long run average weekly hours follow a downward trend in response to the general demand for more leisure. Thus our hours gap has nonzero values only to the extent that current employment (assuming normal hours are worked)

does not provide for current labour requirements as measured by the short-gap variable.

The coefficient on the labour gap suggests that 13% of the labour requirement not met by current employment is met by changes in hours worked. The remaining short-term variations in output are presumably accommodated by changes in the degree of utilization of employed factors (i.e. short-term changes in factor productivity). The standard error of estimate is about .2 hours, or .5% of the average value of HAWMM.

C Employment and Hours in Construction

Three approaches to equations 5.2 and 5.4 were tried, starting with a simplified version of the hierarchical model used for the main business employment and hours equations. We turned to simpler models when this model did not prove to be applicable to the construction industry. We treated construction separately because we can employ the endogenous output variable IRC+INRC and thereby obtain a better explanation of the construction wage needed in equations 7.6 and 7.7 for construction prices.

1 Hierarchical adjustment

This specification is parallel to the employment and hours equations in mining, manufacturing, and other business but it did not work satisfactorily. A stock-adjustment model was assumed for man-hours - the labour input to the construction industry.

Firms were assumed to have a desired level of man-hours, which depends on seasonal factors, the trend of investment in construction, the deviation of investment from this trend, and unemployment in the economy as a whole. It was further assumed, and experiments supported the assumption, that low unemployment indicates difficulty in recruiting competent workers, so that marginal man-hour requirements increase. The lagged adjustment of man-hours to desired man-hours gave a good equation for man-hours, and from it we obtained the coefficients of the determinants of desired man-hours. The desired level of employment was assumed to be such as would provide the desired man-hour input at the standard work week, which we took to be the linear trend value of average weekly hours in construction. A regression of actual employment (NC) on desired employment and lagged actual employment fitted well. The next step was to explain the actual hours worked in terms of the desired man-hours unfilled by adjustments in the level of employment. However, in none of the specifications we tried for average weekly hours was this gap a significant variable. Linear seasonal variables accounted for most of the variation in hours, and the unfilled gap alone did not provide much explanatory power.

2 Separate equations for total man-hours and employment

One alternative to our first approach is to construct an equation for the lagged adjustment of man-hours to desired man-hours, as well as an equation with similar explanatory variables describing the lagged adjustment of men to desired men and

defining average weekly hours by means of the identity linking employment, average hours, and total man-hours. Although the explanatory power of this specification was quite good, examination of the coefficients showed no difference in structure between the man-hours and the employment equations. In particular, the speed of adjustment to desired man-hours was no quicker than the speed of adjustment to the desired level of employment. This finding conflicts with our general theory of employment adjustment, according to which overtime temporarily provides for an increase in desired labour input, if the increase in demand is judged to be permanent, until hiring of men can fill the gap. Thus our residual, hours, was mainly capturing seasonal fluctuations. It was not determined by economic factors.

3 Separate equations for employment and average hours

The specification finally adopted has independent equations for men and for hours. The constrained quarterly variables appear with substantial coefficients in equation 5.2 for paid employees in construction, reflecting seasonal employment movements independent of the level of construction activity. The trend in required employment, as the construction industry expands, is represented by a twelve-quarter moving average of the sum of residential construction and non-residential construction investment. The rate of unemployment helps to explain in two ways the number of men employed. When the construction industry is slack, indicated by high unemployment, firms do not trim their labour force proportionately. They use their workers less

intensively, reducing hours and fostering some paid underemployment. The hoarding of workers is logical, considering hiring costs and the danger of losing competent workers to other firms when construction picks up. The second effect concerns the hiring of marginal workers during a boom. In these circumstances, the need for more workers forces firms operating in a tight labour market to hire people with lower productivity than the firms' regular, experienced employees. The low level of unemployment indicates that the supply of competent workers is becoming exhausted and that marginal workers have to be hired. Conversely, when unemployment is high it is relatively easier to find good people; hence fewer people are needed for a given level of output in the construction industry. We use the unemployment rate for the whole economy as a proxy for the rate of unemployment in the market for actual and potential construction workers.

The difference between the current level of construction investment and its moving average enters the equation because we assume that some of the increase in the industry's output is achieved by hiring more men currently. In this context, we tried the ratio of the wage rate to construction materials costs, on the assumption that prefabricated materials bought from other industries could be substituted for labour according to relative prices. This ratio did not help the equation. Finally, the employment equation contains the lagged dependent variable, since we hypothesize a lagged adjustment to the desired level of employment. The RB2 for equation 5.2 is .983, and its standard

error is 6.7 thousand men, about 2% of the average number employed.

Equation 5.4 for average weekly hours worked in construction (HAWC) contains a constant, constrained seasonals, and the difference between current investment in non-residential construction and its twelve-quarter moving average. The constrained seasonal variables are of substantial importance; as a group they explain about 80% of the variance in hours. As expected, an activity variable in construction does account for some of the movement in hours. We tried other cyclical variables - such as the ratio of investment in construction to the capacity output of the economy as a whole, or to the moving average of investment - but none performed as well as the one chosen. In particular, investment in non-residential construction alone was better than total construction investment or investment in residential construction alone. Two reasons for this occur to us. Residential construction is supposed to be counter-cyclical to some extent (in fact the sign of the coefficient on IRC minus its twelve-quarter moving average was negative). An alternative explanation is that non-residential construction is probably done by large firms, and the surveys of large establishments give us our data for average weekly hours.

Equation 5.4 has an RB2 of .889 and a standard error of about .5 hours.

D Labour Force Participation

Equation 5.5 for the labour force (NL) is similar to that used in RDX1. The variables carried over from RDX1 include the proportion of the labour force population in school, and personal real disposable income per member of the labour force population. The labour force population (NPOP) is defined as the noninstitutional population 14 years of age and over. The relevant school population (NPOPSS) therefore includes all those 14 and over attending schools or post-secondary educational institutions full time.

The dependent variable in equation 5.5 is the first difference of the participation rate, measured as a percentage. The first difference in the percentage of the labour force population in school enters the equation twice, once multiplied by Q1+Q2 and again multiplied by Q3+Q4. Both expressions have negative coefficients, naturally enough. The variable for the second half of the calendar year has a larger coefficient, presumably because the academic year starts about the end of the third quarter.

The income variable helps the equation, whereas two more defensible alternatives - the degree of capacity utilization, and the unemployment rate - do not. Thus we have a personal income variable supposedly standing for the marginal benefits of labour force participation.

We took advantage of our population change equations to add a new variable to the participation-rate equation - the first difference in a nineteen-quarter moving sum of immigration minus

emigration. The underlying theoretical assumption here is that immigrants and emigrants are more likely than other members of the population 14 years of age and over to be members of the labour force. To some extent this variable may be picking up indirectly the influence of unemployment on the participation rate, because net immigration is negatively related to recent unemployment rates.

The equation has an RB2 of .982 and a standard error of about .19 per cent of the labour force population.

E International Migration

Our equations for population movements are for total immigration and total emigration. The former is measured with reasonable precision, but the figures for total emigration are defined as a residual in the population balance sheet. The division of population flows between those to and from the United States and those to and from other countries would provide greater symmetry with our treatment of trade and capital flows. However, we can specify our aggregate immigration and emigration equations to reflect the effects of U.S. economic variables on migration to and from Canada. What we cannot do, with our present equations, is show the influence of Canadian-U.S. migratory flows on the U.S. population. Because these movements are small relative to the total U.S. population, our aggregate treatment is probably adequate. We are more interested in the

ten times larger relative influence of the migratory flows on the Canadian population and labour force.

Our fairly crude equations for immigration (NIMS, equation 5.6) and emigration (NEMS, equation 5.7) both depend strongly on the Canadian unemployment rate. For the emigration equation the reasoning is fairly unambiguous - higher unemployment in Canada provides a push for Canadians to look elsewhere for jobs. In the immigration equation, where the impact of the Canadian unemployment rate is much stronger, the causality is less easy to identify. When the Canadian rate of unemployment is very low, immigration to Canada is attractive because jobs are plentiful. However, a more important direct result may be the higher level of advertising and official encouragement offered by federal and provincial governments as well as private business firms. We should like to separate the effects of federal government expenditure designed to encourage immigration, but the difficulties of measuring the policy component of the relevant expenditures and the problem of collinearity with the general unemployment rate thwarted our preliminary efforts.

Both migration equations are estimated in ratio form, with the labour force population (NPOP) in the denominator. In addition to the Canadian unemployment rate, the immigration equation depends on an eight-quarter distributed lag on the ratio of the Canadian real wage to a weighted index of real wages in Great Britain, Italy, Germany and the United States. For each of the three European countries, the largest providers of emigrants to Canada, the real wage is defined as a wage index divided by a consumer price index. The combined European real wage rate index

(EWEURO) uses weights of .54, .32, and .14 on the real wage indexes of Great Britain, Italy, and West Germany, respectively. The weights are proportional to the total 1956-1968 migration from each of these countries to Canada. The European real wage rate index, which has a base 1961=1, is combined with the U.S. real wage (after the latter is put on a base 1961=1) using weights of .86 on EWEURO and .14 on the U.S. real wage index. These weights depend on the 1956-1968 migration from the United States and from the three European countries. These four countries provided 1.15 million of the 1.88 million Canadian immigrants during the period 1956-1968.

Although the final equation uses the Canadian and foreign real wages in ratio form, we also estimated equations into which the Canadian and foreign wage rate variables entered separately. The sums of coefficients on the two variables were almost exactly the same, but the average lag on the Canadian real wage variable was longer than on the foreign real wage variable. This may be due either to longer lags in finding out about wages and prices in countries other than where one is living, or to the fact that the real wage index is one of two variables measuring current Canadian economic conditions. Because of this difference in lag structures, the Canadian real wage enters the ratio with a one-quarter lag in the final equation.

The effect on immigration of changes in the Canadian unemployment rate is greater than the effect of changes in real wage rates, although adjustments to a new level of the unemployment rate take longer to work themselves out. The estimated coefficients are such that a decrease in RNU from 5% to

4% will increase the average inflow of immigrants by about 43% over a three-year period, with no effect at all for the first two quarters. By comparison, a 10% increase in the Canadian real wage rate, relative to that of the source countries, will increase the average flow of NIMS by almost 18% over eight quarters.

The NIMS equation also contains an eight-quarter distributed lag on NPOP. There is no reason to suppose that the elasticity of NIMS with respect to NPOP should be unity, and indeed we suspect that a rapidly growing domestic labour force population, with the unemployment rate and relative wage rates unchanged, should discourage immigration. In fact the estimated elasticity of the dependent variable with respect to NPOP is -1.5, implying in equilibrium a .5% decrease in immigration for a 1% increase in NPOP.

The emigration equation (equation 5.7) has a constant term, three constrained quarterlies, and lags of five quarters with declining weights on four-quarter moving averages of the reciprocals of the Canadian and the U.S. unemployment rates. Both rates enter significantly with opposite signs. The slightly greater coefficient on the U.S. rate as opposed to that on the Canadian rate not only illustrates that the United States is the major recipient of Canadian emigration, but suggests that the 'pull' from job opportunities there may be stronger than the 'push' from the existence of unemployment in Canada. We also tried variables for the real wage differential between Canada and the United States, the tightening of the U.S. immigration laws at the end of 1965, and for the influence of recent immigration from

Europe on subsequent emigration to the United States. None helped the equation significantly, and the relatively low RB2 of .321 probably demonstrates, as much as anything else, the fact that emigration flows are defined as a residual in the rather imprecisely measured population balance sheet.

Both migration equations show a substantial impact of current economic conditions on migration flows; more than enough to justify the inclusion of the migration equations in RDX2.

CHAPTER 6

INCOME DISTRIBUTION: WAGES, PROFITS, AND DIVIDENDS

SECTORS 6 AND 8

A Introduction

The equations described in this chapter explain the distribution of business income between wages and profits, the allocation of profits between dividends and retained earnings, and the compilation of personal income. The relevant equations are not all in Sectors 6 and 8, for, in order to determine the private sector wage bill, the wage rate equations of Sector 6 must be combined with the employment equations of Sector 5. We complete the explanation of total personal income distribution in Chapter 8 where we explain incomes arising from transfer payments and employment by government, as well as income redistribution through the tax system.

RDX2 has explicit equations for all the main components of the income side and the expenditure side of the national accounts, in both current and constant dollars. We carry further than we did in RDX1 the application of a complete set of income distribution equations, and follow the RDX1 procedure of using the national accounts identity to determine the residual income item YRES. Because we treat the national accounts residuals (ENARES and ENARES$) as exogenous variables, YRES is

the net solution error from the income and expenditure equations. Under an expansionary simulation, a series of positive values for YRES would provide a measure of the extent to which our income distribution mechanism fails to distribute fully the increase in gross national expenditure. For purposes of simulation, we treat YRES as though it were part of total personal income (YP). Alternative ways of disposing of YRES are possible. Simulations will show whether YRES ever gets large enough to make the choice an important one.

We proceed, in section B, to explain the business wage rate equations and the wage bill identity of Sector 6, and in section C to describe the profits and dividends equations of Sector 8. Section D at the end of the chapter is a brief summary of the various personal and national income identities contained in Sector 8.

B Business Quarterly Wage Rates

We explain two business quarterly wage rates, one for mining, manufacturing, and other business (WQMMOB), and the other for construction (WQC). The first applies to over 80% of total business employment; the second is important more because of its links with construction prices than because of its impact on the total wage bill.

1 A model of the real wage level in mining, manufacturing, and other business (Equation 6.1)

In RDX1, we employed a business wage rate equation of a typical sort (e.g. [4], [48], [49]) wherein the four-quarter percentage change in the money wage rate depended on changes in consumer prices, profits per unit of output, and on the dependent variable lagged four quarters. In constructing RDX2, we have taken advantage of our integrated model of production, employment, and investment to develop an equation for the level of the real wage in mining, manufacturing, and other business. As parts of the grand set of assumptions underlying our production model, we have measures of both trends and short-term changes in labour productivity. The long-term productivity variable (ELEFF) becomes the main determinant of the real wage. As well, the short-term productivity measures were given a chance to enter the equation.

The unusual feature of the WQMMOB equation is that the money wage moves towards an equilibrium real wage. This specification differs from that used by Kuh [38] in which the money wage rate moves towards an equilibrium money wage. The difference is not great, for Kuh's equilibrium money wage depends on the price level along with productivity and the unemployment rate. In equation 6.1 the dependent variable is the one-quarter percentage change in WQMMOB. Consumer prices, measured by the Consumer Price Index (PCPI), enter the WQMMOB equation twice: in the denominator of the lagged real wage, and then separately in the form of PCPICE, the expected annual percentage change in the

Consumer Price Index. Other variables in the equation include the labour efficiency factor (ELEFF), a nonlinear transformation of the unemployment rate and the dependent variable lagged four quarters.

This structure requires some explanation. The equilibrium level of the real wage is determined primarily by ELEFF, a synthetic variable having a sample mean of 1 and representing the level of labour efficiency. The coefficient on ELEFF is slightly below that on the lagged real wage. Both variables have approximately the same sample means, so that a 1% increase in our measure of labour efficiency leads to a .87% increase in the real wage. The unemployment variable is an eight-quarter linear lag distribution on the square of the ratio of the labour force to the number of unemployed. The influence of this variable is slight and does not increase if the specification is changed to permit an additional impact in the short run. Why should the unemployment rate influence the equilibrium real wage? Alternative rationales are available. On the one hand, workers of differing efficiency may be paid the same money wage thereby encouraging employers to lay off the least efficient workers first. Thus the marginal product of labour and the rate of unemployment increase and decrease together. On the other hand, the existence of a large 'reserve army of the unemployed' reduces the bargaining power of wage and salary earners and hence lowers the equilibrium real wage.

What kind of wage behaviour is implied by the equation taken as a whole? In a stationary situation with constant prices and no increases in efficiency there would be no expectation of price

increases, and the real wage level would be determined by the existing level of ELEFF and the unemployment rate. With increasing prices and constant labour efficiency, the Consumer Price Index and the quarterly wage (WQMMOB) would grow at about the same rate. Although the equilibrium coefficient on PCPICE is larger than .25, PCPICE has weights summing to less than 1 on past changes in PCPI. (See equation 18.2.) If the equilibrium coefficient on PCPICE were above .25 by exactly the same proportion that the PCPI weights in the PCPICE equation fall short of 1, then inflation in the Consumer Price Index, unaccompanied by any change in ELEFF or the unemployment rate, would not lead to any change in the real wage. The relevant value is .25 because an annual percentage change in prices is being compared with a quarterly percentage change in the wage rate. Although the relevant coefficients are estimated imprecisely they show the absence of money illusion in the wage bargain.

The structure of our wage adjustment equation is such that if the coefficient on PCPICE were very low, indicating some money illusion, the result would not be a drop in the rate of increase of the real wage, although this would be the case in the usual wage change equations. Our equation would reveal a drop in the level of the real wage until the point is reached where prices and wages grow at the same rate. In equation 6.1, therefore, money illusion does not mean a continually dropping real wage in the presence of inflation, but a real wage that is lower than it would have been in the absence of inflation.

2 Quarterly wage rate in construction (Equation 6.2)

The construction wage rate equation (WQC) is of lesser importance than the equation for WQMMOB, and is of a more usual type. The fit is good, with an RB2 of .974 using one-quarter percentage changes in WQC as the dependent variable. The independent variables are the expected rate of change of prices, the inverse of the unemployment rate, and the one-quarter percentage change in average weekly hours in construction. The coefficient slightly greater than 1 on the average weekly hours variable suggests that the other variables determine the average hourly wage, with increases in hours worked leading to slightly more than proportionate increases in the average quarterly wage.

The coefficient on PCPICE is well above .25, indicating that, other things equal, the construction wage rises faster than the expected rate of price increase. The influence of the unemployment rate is substantial, being such that a drop in the unemployment rate from 6% to 5% would increase the rate of growth of the quarterly wage rate in construction by .36% per quarter.

The technical relationship appearing at the end of Sector 6 shows the accumulation of the total wage bill (YW) from the component wage rate series and employment series. There are five endogenous employment series. Business employment (NMMOB and NC) is explained in Sector 5 and employment in federal administration (NGPAF) in Sector 12. The remaining equations for employment in provincial and municipal administration (NGPAPM) and in elementary and secondary schools (NIS) are located in Sector 13. The business wage rate equations are explained in this chapter.

The government administration wage rate equations are in Sectors 12 and 13 and explained in Chapter 8.

The exogenous series for paid employment in agriculture (NFP) and in noncommercial institutions other than schools (NIOS) were multiplied by the corresponding exogenous wage rate series to obtain the relevant components of the wage bill. Taken together, these exogenous components are relatively small, averaging less than 8% of the total wage bill over the period 1952-1968. The remaining components of the wage bill are total wage supplements in business (YWSLP), schools (GWSSM), and government administration (GWSF, GWPASPM).

C Corporate Profits and Dividends

Equation 8.1 for profits of corporations represents our crude attempt to construct an aggregate profit and loss account for the corporate sector. The first variable is the sum of corporate bond interest payments (ECINT) and current-dollar capital consumption allowances (CCAC$). These are the best variables we could find to measure the relevant accounting charges for the use of capital. The coefficient on this variable is well over 1, possibly because of cyclicity in omitted corporate interest payments or because variations in book depreciation allowances are not reflected in the national accounts.

To represent sales plus inventory accumulation, we use the current-dollar value of business output net of the income of

unincorporated business (YGPP-YNFNC), minus total indirect taxes less subsidies (TILGS). The cost of labour is represented by the business sector wage bill, including supplements. Both the revenue and labour cost variables have strong coefficients slightly less than 1 in value - an appropriate result since both contain portions relating to the unincorporated business sector.

The equation as a whole is very satisfactory, with a standard error of $39.2 million, slightly over 3% of the sample average. The theory of profits underlying the accounting relationship is made explicit in our equations for factor demands, inventory accumulation, aggregate supply and demand, and price and wage formation. Because of various lags in the factor-demand equations, there are short-run changes in factor productivity that lead to short-term changes in profits not fully reflected by changes in the supply price of capital or the market value of the business capital stock. Thus we smooth the profits series slightly, by taking a four-quarter moving sum, to approximate a normal profits series in the Sector 18 equations defining the supply price of capital.

There are two dividend equations in Sector 8 - equation 8.2 for dividends paid to Canadian residents (YDIV11) and equation 8.3 for dividends paid to foreign shareholders (YDIVF). Both equations assume Lintner-type (40) distributed lag adjustment of dividends to changes in the relevant measures of after-tax profits plus book depreciation. The proportion of total cash flow attributable to each type of shareholder is determined by our measures of the international indebtedness of Canadians

(LDIRV12, LPCV12 and LDIPRV13) in conjunction with the replacement value of the business capital stock (KB$).

Alternative equations were fitted using profits rather than cash flow as the driving variable, but in each case the profits version fitted less well than the cash flow version. The equilibrium dividend payout ratios with respect to the relevant measures of cash flow can be derived by taking account of the coefficient on the lagged dependent variable and noting that the cash flow variable is defined as a four-quarter sum. For dividends paid to Canadians, the payout ratio is 23.0% of cash flow (equivalent to 41.5% of after-tax profits). For dividends paid to foreigners, the ratio is 22.6% of cash flow corresponding to 40.6% of profits. The conversion from a cash flow to a profits basis is made by using the ratio of cash flow to after-tax profits in 1968. The response pattern appears to be slower for dividends paid to foreign shareholders than for dividends paid to Canadians.

Equation 8.3 for YDIVF is needed to complete the definition of undistributed corporate profits (YCR, equation 8.10). We treat dividend payments to the United States (MDIV$12) separately in equation 4.17, and combine dividend and interest payments to other countries (MID$13) in equation 4.20. The dividend series in the foreign trade sector are measured net of withholding tax, whereas YDIVF takes no account of that tax.

D Some Income Accounting

In equation 8.4, current-dollar gross national expenditure (YGNE) is defined as the sum of its components. Equation 8.5 contains YGPP, the current-dollar definition of the business real output variable (UGPP) described in Chapter 3. The remaining technical relationships in Sector 8 include the simulation residual, YRES, described at the beginning of this chapter, four personal income concepts, and our measure of revaluation gains and losses. Disposable wage income (YDW, equation 8.6) is based on the wage bill, military pay, nonfarm non-corporate income, and the relevant tax and transfer items applicable to wage income. Disposable wage income is defined separately because it is used in our consumption equations. Equations 8.8 and 8.9 contain the usual definitions of personal income (YP) and personal disposable income (YDP). In equations 8.11 and 8.12 we define series for permanent disposable nonwage personal income (YPDNWP) and for capital gains on equities and bonds (YKGP). These identities are discussed in part 2.2 and part 2.3 of section A in Chapter 2.

CHAPTER 7

PRICE FORMATION

SECTOR 7

A General Features of Price Equations

Our approach to price explanation in RDX2 involves separate equations for each main component of aggregate demand and for each main category of imports and exports of goods. The aggregate national accounts deflator (PGNE) and the private product deflator (PGPP) are then determined as the ratios of the relevant current- and constant-dollar totals. The Consumer Price Index (PCPI) is explained by a base-weighted average of the appropriate final demand deflators. By specifying and estimating equations for disaggregated prices, we found ourselves better able than we were in RDX1 to estimate the appropriate impacts of foreign influences, supply and demand imbalance, and indirect taxes.

Although we have twenty separate stochastic price equations, each equation still represents such a wide range of industry behaviour that no one simple model can apply to all. Consequently we have tried to find suitable explanatory roles for a number of influences that are important in one or more sorts of pricing theory.

1 Cost factors

Most theories attach considerable importance to the role of unit labour costs. 'Normal' unit labour costs are given a key role in mark-up theories used to explain price determination when price changes are potentially costly to make or administer. (See [16] and [39].) In models based on short-run profit maximization under competitive conditions (e.g. [16] pp. 1160-1162), current unit labour costs play the dominant role. From the point of view of builders of macroeconomic models, the choice is a crucial one. If current rather than 'normal' unit labour costs are used, the typically high coefficient obtained on the unit labour cost variable is likely to produce the simulation result that any increase in aggregate demand will cause prices to drop for several quarters until wage rates and employment rise enough to offset the increase in output. The reason for this result is that employment is more stable than output, leading to short-term changes in labour productivity when output levels change. In order to avoid this problem, we ought to specify price equations that allow short-run productivity changes and other factors influencing unit labour costs to have separately estimated effects. Obviously, a reasonable theory of productivity changes is required here.

Within RDX2 there is a theory of short-run productivity changes implied by the lagged adjustments to changes in capital and labour requirements. We have explained in Chapter 3 and Chapter 5 the mechanisms whereby unexpected changes in final demand give rise to unintended inventory changes and to changes

in the degree of utilization of employed capital and labour, as well as to the usual changes in average weekly hours, employment and investment. The changes in the degree of utilization of employed labour and capital define what are usually referred to as short-term changes in labour productivity. The asymmetry in the treatment of capital and labour probably arises because machines and buildings are not 'hired' and 'laid off' in an easily measurable way. Thus we cannot make a split, as we can for the labour market, between changes in the employment of capital goods and changes in the degree of utilization of employed capital goods. Even if this distinction were possible, it would not be possible to make separate attributions of changes in output to changes in the degree of utilization of employed labour and capital. Whether or not we follow usual practice in referring to the whole change in output not explained by changes in hours, employment, and capital goods as a change in labour productivity, we need to isolate this change.

Within RDX2 the short-term productivity variable can be defined as the reciprocal of the ratio of actual employment to the equilibrium level of employment, which is that level required to produce current output less unintended inventory changes (UGPPA), assuming the same length of work week in both cases. The equilibrium level of employment is derived by assuming the production function to hold exactly. For any given level of UGPPA, this equilibrium labour input falls over time according to the rate of Harrod-neutral technical progress built into the production function.

Corresponding definitions of 'normal' factor cost are obtained by dividing the total cost of factor inputs by the amount of output (UGPPS) that would be produced if the existing capital stock, employment, and average weekly hours were combined according to the assumed production function for UGPP.

Most price equations take account only of normal unit labour costs, and sometimes a variable for purchased materials. Such specifications ignore the effects of factor substitution in response to changes in technology or in relative factor prices. If capital is substituted for labour, total factor costs per unit of output will either rise faster or fall more slowly than unit labour costs. We have been able to consider factor costs fairly completely in RDX2 by developing series for unit labour costs and unit capital costs, with unit factor costs as the sum of the two. The capital cost variable is obtained separately for each type of capital as the product of the net constant-dollar stock, the current replacement price, and the expected user (or owner) cost of capital for that type of capital. The fact that this variable did not improve most of the price equations may be considered a vindication of the traditional theory of mark-up pricing based on normal unit variable costs, or as evidence that we have failed to measure adequately the relevant costs of owning capital goods. Normal unit labour costs and capital costs enter separately in equation 7.10 for the price of non-residential construction materials.

The costs of materials are separately introduced in our construction deflators, but otherwise are not available in suitable form for use in explaining final demand prices.

Naturally we must take account of the prices of imported materials, and we do so in the manner to be explained in part 3 of this section.

2 Supply and demand

When price changes are costly or when prices are sluggish for other reasons any existing pattern of prices may give rise to an imbalance between supply and demand. If prices play any allocative role at all, this imbalance will affect price movements. The imbalance of supply and demand at existing prices has both stock and flow dimensions, and we attempt to take both into account. In flow terms we use the ratio of aggregate demand (UGPPA), i.e. output excluding unintended inventory changes, to 'desired' output (UGPPD). Desired output is what the production function would yield at average rates of employment and factor utilization. Both concepts have been described more fully in Chapter 3. In stock terms we use an approximation (being a twelve-quarter moving sum) to the cumulant of unintended inventory accumulation or decumulation. As long as inventory stocks are deemed to be excess by their holders, downward pressure on prices will occur whatever the flow relation between current demand and output. We think the moving sum of UGPP-UGPPA is more appropriate than the stock/sales ratio used in RDX1, because the former concept explicitly allows for cyclical changes in the desired stock/sales ratio resulting from changes in expected future sales.

3 Foreign influences

Foreign prices and activity can influence domestic prices in several ways. First, changes in foreign aggregate demand may lead, through changes in exports, to pressures on domestic prices. Unless the relevant characteristics of exports are different from those of other components of aggregate demand, these pressures are captured by the general measures of supply/demand imbalance described above.

Second, foreign prices influence domestic final demand prices because of the import content in each final demand category. We have attempted to obtain measures of the landed Canadian price of the import content of each expenditure category, usually based on some weighted average of relevant U.S. prices multiplied by the exchange rate.

Third, a number of domestically produced goods may be priced, other things equal, to compete with imported or importable substitutes. Some other Canadian products are sold in world markets or in particular foreign countries, or are potentially salable in such markets. As well, the prices of Canadian goods actually exported are naturally explained in part by foreign or world market prices. Prices of certain goods used in Canada (such as the forest products components of residential construction materials) are also affected directly by the prices available in export markets.

Finally, numerous other international links, especially between the United States and Canada, may lead to joint movement of prices. If Canadian and U.S. firms producing for their

national markets are under common management, price changes are more likely to be made in concert than when producers of corresponding goods in the two countries are unrelated. We do not doubt that a considerable amount of international price discrimination may occur, but once the related firms have decided on the appropriate amount of the differential, any subsequent price changes are more likely to be coincident when the major firms operate in both markets. If we employ U.S. price variables directly in corresponding Canadian price equations so as to reflect some of these ill-defined organizational links, we must be satisfied that excessive importance is not attached to the U.S. price merely because of the influence of shocks (omitted variables) common to both economies. If we are careful in the choice of instrumental variables, our simultaneous equation estimation method should protect our parameter estimates from this sort of bias.

4 The influence of sales taxes

One of the potential gains from our disaggregation of price explanation is that we may be able to estimate the effects of sales taxes on price formation. There are two main categories of sales tax in Canada - the manufacturers sales tax levied by the federal government and the retail sales taxes levied by all the provincial governments except the government of Alberta. Current-dollar national accounts expenditures include sales taxes, so that these taxes are automatically built into the measured prices. Only the manufacturers sales tax applies to

business investment and to residential construction expenditure, whereas different types of consumer expenditure are subject to varying amounts of both the manufacturers and the retail sales tax.

The dependent variables in most of our price equations are purged of sales taxes applied at the final point of sale. We did not attempt to calculate the impact of the manufacturers sales tax on retail prices of consumer items, because we lack the information to construct an appropriate weighted tax rate and because there has been no substantial variation in the basic rate applicable to consumer goods. The effects of the tax on investment goods are easier and more important to measure, since production machinery and building materials were both subject to varying degrees of tax exemption during the sample period. (See [28], p.69.)

Thus the machinery and equipment price and the prices of building materials are purged of the manufacturers sales tax, and consumer prices are purged of a weighted average of retail sales tax rates. Purging involves division of the measured price by 1 plus the relevant tax rate measured as a proportion. If the independent variables explaining the purged price do not include the sales tax rate, this procedure implies that (ignoring the indirect effects) any change in the rate of sales tax under simulation will produce a corresponding change in the price to the purchaser. In all our equations we generalize this procedure so that the tax may lead to changes in demand that affect the eventual price to the producer. This possibility is allowed for by trying a distributed lag on the tax rate as an explanatory

variable in each purged price equation. Although the dynamic pattern of response may differ from price to price, in most markets we would expect the sum of weights on the tax variable (measured as a proportion) to be between 0 and -1.

In the following sections we explain how the general factors outlined above are depicted in our equations. We describe the equations for the main domestic expenditure deflators in section B, for the prices of imports and exports in section C, and for the derived aggregate prices in section D.

B Domestic Expenditure Prices

Here we explain the equations for four categories of consumption expenditure, four types of private investment expenditure (plus two related equations for the prices of construction materials), and three categories of government expenditure. We leave until section D the description of how our estimate of the Consumer Price Index is derived from the national accounts deflators. For most of the price equations the standard error of estimate and the coefficient of variation are very close in size, since all prices have the base 1961=1. Although most of the price level equations have very low Durbin-Watson statistics, re-estimation to remove the first-order autocorrelation by the Hildreth-Lu technique did not affect these equations materially. All quoted elasticities were estimated by using the ordinary least squares coefficients and the sample means of the variables.

1 Consumer prices

The four equations discussed here are for the prices of non-durables and semi-durables, services, consumer motor vehicles, and other consumer durables.

PCNDSD Price of consumer non-durables and semi-durables (Equation 7.1)

In this equation the implicit deflator is explained by normal unit labour costs, a weighted average of U.S. prices, and the retail sales tax rate variable. Normal unit labour costs are defined as the ratio of the wage bills in mining, manufacturing, and other business, and in construction to UGPPS, and enter the equation in an eight-quarter lag distribution. The equilibrium partial elasticity of PCNDSD with respect to normal unit labour costs is about .76. The elasticity with respect to the import price, which is weighted according to the CNDSD content of each of the five main categories of goods imports, is about .11, slightly below the likely import content in consumer expenditure on non-durable and semi-durable goods. The pattern of weights on the retail sales tax rate indicates that for an increase of one percentage point in RTISPM the purged price falls in the first two quarters by almost 1%, but then starts to rise again so that in equilibrium there is only a .2% decline in the purged price and almost all of the tax increase is passed on to consumers.

PCS Price of consumer services (Equation 7.2)

This index is constructed primarily from wage rate data, and that is the way our equation explains it. The close-fitting equation is based on the quarterly wage rate (WQMMOB), the sales tax rate multiplied by the lagged price index, and the three constrained seasonal variables multiplied by the lagged dependent variable. The coefficient of -.76 on the sales tax rate variable is high partly because most consumer services are not subject to the retail sales tax.

PCMV Price of consumer motor vehicles (Equation 7.3)

The nature of the Canadian car industry has been changing ever since the Canada-United States Automotive Agreement took effect in the mid-1960s. Under this agreement the removal of tariffs on autos and parts is tied to certain broad rules of production sharing. Two results have been the growing integration of the North American auto industry and the establishment of auto assembly plants in Canada by other foreign manufacturers. One of the announced aims of the pact is lower Canadian car prices. However, it is hard for us to be precise about price consequences because of the complicated structure of the industry and the basic difficulties we encountered in constructing the price data. In our attempt to capture the price effects of the auto pact, we employ the variable QAUTO used in the auto trade equations to represent the increasing rationalization of the North American auto industry.

Our equation combines a unit labour costs variable, the price of U.S. consumer durables (multiplied by the exchange

rate), a time trend, the short-term productivity variable, and the auto pact variable already described. The estimated parameters show a very high elasticity with respect to normal unit labour costs, offset by a strong downward time trend and a strong effect of the auto pact variable. These results may flow directly from the quality of the basic data, but they may nevertheless raise problems under simulation. A 1% increase in normal unit labour costs in the business sector has a partial impact on PCKV of 4% to 5%, spread over three years. The partial elasticity with respect to the U.S. price is slightly less than 1. These generally upward influences are offset, in our estimated equation, by a quarterly time-related rate of price reduction of almost 2%.

Consumer durables, both cars and other durables, are the only national accounts categories where serious attempts have been made to account for quality changes. These prices have therefore risen less rapidly than the other national accounts deflators. If price adjustments for quality change are made either in a regular manner or in some other way unrelated to cost and demand forces, then the use of time trends in the price level equations may be the best way of allowing for these adjustments.

PCDO Price of other consumer durables (Equation 7.4)

When the PCDO equation is estimated with a linear time trend along with the endogenous causal variables, it has a standard error of about .7%, sensible coefficients on the structural variables, and a downward time trend (all else held constant) of .47% per quarter. This is offset by a high elasticity (about

1.37) of PCDO with respect to normal unit labour costs. The cyclical productivity variable has a modest impact, the elasticity of price being about .17 with respect to the ratio of actual to desired employment. The elasticity with respect to the U.S. consumer durables price multiplied by the exchange rate is .28. This is slightly more than the direct import content, but the excess is easily explained by the pricing of domestic production to match the landed price of imports.

The distributed lag on the sales tax variable has a sum of weights of -.69, suggesting an unrealistically high price-elasticity of demand by consumers. The equation suggests that the final price rises only .3% for a 1 percentage point increase in retail sales tax rates. Part of the difficulty in estimating realistic coefficients on the sales tax variable arises from its close approximation to a time trend. (The simple correlation between QTIME and the Almon variable for RTISPM is .94.) Taking more explicit account of federal sales and excise taxes may help, but here also there is little variance in the tax rates applicable to consumer durables.

2 Investment prices

PIME Price deflator for business investment in machinery and equipment (Equation 7.5)

The equation for the purged price is driven by distributed lags on the price of machinery imported from the United States (PPD2) times the exchange rate, normal unit labour costs, the manufacturers sales tax rate applicable to machinery and

equipment, the corresponding U.S. price entering on its own, and a four-quarter moving average of UGPPA/UGPPD, the flow measure of demand/supply imbalance.

The sales tax variable used here is a weighted average of that applicable to production machinery and equipment (about 88% of the total) and that applicable to other machinery and equipment, chiefly motor vehicles. The coefficients on the sales tax variable show a significant amount of realignment of pre-tax prices for a given change in sales tax rates. The large changes in the rates applicable to production machinery and equipment (see [28], p.69) give this variable a substantial amount of independent variance and allow us to place more reliance on the resulting coefficients. Initially a large amount of the tax is absorbed by sellers (about half after two quarters), but this proportion is subsequently reduced to 35% as new catalogues and contracts come into force in later quarters.

The elasticity of PIME with respect to unit labour costs is about .25, spread over five quarters according to a series of declining weights. The U.S. price multiplied by the exchange rate has a sum of coefficients equal to .35, slightly less than the import content of IME. However, there is a substantial additional impact from the U.S. price entering on its own. Since this variable has an insignificant weight in the current quarter, it cannot simply be reflecting coordinated pricing decisions made under common management unless the U.S. national accounts prices reflect actual price changes on a more current basis than the Canadian statistics. Another way of interpreting the variable is to assume that some of the variance in prices caused by changes

in PFX is absorbed by the U.S. exporters of machines to Canada. This would cause PPD2 to enter alone as well as multiplied by PFX.

The capacity utilization variable has coefficients summing to .25 on a four-quarter moving average of UGPPA/UGPPD. This corresponds roughly to an elasticity of the same magnitude. The equation as a whole fits closely, with an RB2 of .996 and a coefficient of variation of .54%.

PIRC Price deflator for private investment in residential construction (Equation 7.6)

Both construction deflators have the same equation structure based on the costs of labour and materials. This is consistent with the procedures used in constructing the indices. Since it is hard to define a unit of construction output and since little information has been collected on bid prices, the national accounts deflators for both residential and non-residential construction are based on the assumption of a fixed ratio of output to materials input (following [13]).

Our equation shows PIRC responding with lags to the quarterly wage in construction and the price of materials used in residential construction. The elasticity of PIRC with respect to the materials price is .73, and it is about one-fourth as great with respect to the wage rate. The difference between these elasticities is greater than one would expect from the composite DBS residential construction cost index, which has a ratio of materials/labour input of .625/.375. Variables representing demand/supply imbalance do not improve the fit of the equation.

This is not surprising, since the national accounts residential construction price series is based directly on cost data. The coefficient of variation is about 1%.

PINRC Price deflator for business investment in non-residential construction (Equation 7.7)

This equation is similar to the equation for PIRC, except that a different materials price index is used. Constrained quarterly variables multiplied by the wage rate are also used in order to pick up a small seasonal variance not evident in PIRC. The materials price index has about the same coefficients as the corresponding variable in the PIRC equation, but the wage variable in PINRC is much weaker, with a coefficient less than .1. The coefficient of variation is 1.23%.

PKIB Price of the nonfarm business inventory stock (Equation 7.8)

The national accounts implicit price deflator for inventory investment takes positive and negative values, large and small, because it is obtained as the ratio of the changes in current- and constant-dollar stocks. We therefore follow the same procedure in RDX2, calculating current- and constant-dollar inventory stocks separately. This requires us to explain PKIB, the price of the inventory stock. Our equation is straightforward, utilizing a four-quarter average of UGPPA/UGPPD, the Consumer Price Index (PCPI), and a time trend with a negative coefficient to offset some of the upward trend in PCPI. The coefficient of variation is .52%.

PRM Price index for residential construction materials (Equation 7.9)

PNRM Price index for non-residential construction materials (Equation 7.10)

The first step in explaining these prices is to purge them of their sales tax components. This purging process takes account of the estimate that 54% of the pre-tax materials expenditure for IRC is on taxable items. The corresponding proportion for non-residential construction materials is .46. A comparison of the two purged series and consultation with the weighting diagram used in their construction (181 pp. viii-ix) shows that the composition of residential and non-residential construction materials is markedly different. Residential construction is characterized by a much higher proportion of lumber and lumber products (42.6% compared to 10.5% in non-residential construction materials) and a much lower proportion of more highly manufactured items. For example, plumbing and heating, electrical equipment, and metal products total 27.4% of residential construction materials compared to 56.7% of non-residential construction materials. Thus, although we tested symmetrical sets of specifications for the two equations, we were not surprised to find that the price of forest products exports had a much greater impact on the price of residential than of non-residential construction materials. Use of the export price for forest products is justified to the extent that foreign and domestic markets are both available to producers. Even those forest products that do not enter construction directly represent, to a degree, alternative uses for forest resources.

The available import price series did not aid in the explanation of either materials price index. We found that the degree of aggregate demand/supply imbalance (as measured by UGPPA/UGPPD) has a much larger influence on PRM than on PNRM.

The major difference between the two equations is that the price of residential construction materials depends on normal unit labour costs, whereas PNRM depends on both unit labour and unit capital costs. This difference is reasonable, since in non-residential construction greater use is made of highly manufactured materials. The elasticity of PNRM is about .54 with respect to unit labour costs and about .07 with respect to unit capital costs. The elasticity of PRM with respect to unit labour costs is about .90.

The fit of both equations is good, with coefficients of variation of .93% for residential and .55% for non-residential construction materials.

3 Government expenditure prices

In RDX2 we explain the separate prices for non-residential construction and machinery and equipment expenditure by governments, as well as an aggregate deflator for nonwage current expenditure (defined by using the wage rate as the price index for wage expenditure). At present the investment deflators (equation 7.18 and 7.19) are explained simply as linear functions of the corresponding deflators for private investment. Although these equations are adequate we hope to improve the specification

by taking account of the differences in the 'mix' of investment expenditure in the public and private sectors.

Government nonwage current expenditure comprises mainly services and nonwage defence expenditure. The deflator (PGCNWG, equation 7.17) is assumed to vary with the price of imports of manufactured products from the United States (PMMF12) and the price of consumer services (PCS). These prices enter the equation with six-quarter distributed lags, weighted respectively by the proportions of current defence expenditure (excluding military pay and allowances) and other nonwage current expenditure to total nonwage current expenditure.

C Foreign Trade Prices

In this section we discuss our specification of the equations for export and import price deflators. We explain two deflators for exports: one for the exports of all goods (except uranium, aircraft and parts, and motor vehicles and parts) to the United States (PXNMV12) and the other for exports of all goods (except uranium, aircraft and parts, and wheat) to other countries (PXNW13). The four import prices we explain correspond to the real flows modelled in equations 4.1 to 4.4 and described in section B of Chapter 4. At the moment price deflators for exports and imports of services, as well as price deflators for imports of goods from countries other than the United States, are exogenous in RDX2. As long as these prices remain exogenous it is necessary to make some adjustments in order to simulate

appropriately the consequences of a change in the price of foreign exchange (PFX). Some of the possible steps we might take are outlined in section A of Chapter 4.

1 Export deflators (Equations 7.11-7.12)

The price deflators for exports are estimated in level form and depend mainly on a weighted average of domestic prices, either U.S. or world prices, and the exchange rate. In equation 7.11 final demand deflators for consumption of goods (excluding motor vehicles) and investment in machinery and equipment are averaged with weights that reflect the export content of each final demand category. The price index for exports of forest products (PXFP) enters the equation independently. The elasticities of PXNMV12 with respect to domestic prices and PXFP are about .21 and .63, respectively. For the price of exports to third countries (equation 7.12) domestic final demand prices and PXFP are averaged with weights reflecting the relevant distribution of the export bundle to these countries. The elasticity of PXNW13 with respect to this average price is about 1.28.

PXNMV12 also depends on the price of U.S. nonfarm business product (PXBNF2) expressed in Canadian dollars, with an elasticity of about .19. Similarly, PXNW13 is influenced by the price index for world exports of goods (PWXG), increasing by .4% for every 1% increase in PWXG (with PFX constant).

Finally, current and lagged values of the exchange rate enter the equations for both export deflators. It is difficult

to know what coefficient to expect on PFX since the net effect of movements in the exchange rate will depend on the weighted average of the elasticities of demand for different components of exports as well as the relative proportion of exports priced in Canadian dollars. The estimated coefficients imply that with a 1% decrease in PFX, PXNMV12 will fall by .15% after four quarters have elapsed, whereas PXNW13 falls .31% immediately but then gradually increases, with the slightly anomalous result that the net effect of the decrease in PFX (a revaluation of the Canadian dollar) is to increase the price of exports to third countries by about .13%.

Both equations fit well, explaining 98% of the variance in PXNMV12 and 97% of the variance in PXNW13. The coefficients of variation for the two equations are .8% and 1.4%, respectively.

2 Import prices (Equations 7.13-7.16)

Each of the four prices of imports of goods from the United States is estimated as a four-quarter percentage change in the Canadian dollar import price divided by the exchange rate. The main independent variable in each equation is the four-quarter percentage change in an appropriately weighted average of U.S. prices. The exchange rate enters separately in equation 7.16 explaining the price index for imports of manufactures (PMMF12), and the negative coefficient indicates that over four quarters about 17% of any change in the exchange rate is offset by changes in the U.S. dollar price paid to U.S. producers.

On the whole the test statistics for equations 7.13-7.16 are disappointingly poor, although the values of the coefficients imply that the equations should perform reasonably well in simulation.

D Composite Price Indexes

In this section we discuss the Consumer Price Index, the aggregate national accounts implicit deflator for gross national expenditure (PGNE), and the implicit deflator for our private sector output variable (PGPP). We also refer briefly to the implicit price deflator for CSMVOD.

PCPI The Consumer Price Index (Equation 7.20)

This is a base-weighted index, so we explain it by a base-weighted sum of five national accounts deflators. The weights are determined by the shares of each of the national accounts categories in the basket of goods priced according to the CPI. The equation fits very closely, with a standard error of only .0026 on a 1961 base equal to 1. A significant negative constant term, and a coefficient of 1.09 on the synthetic PCPI, indicate that our national accounts categories are too aggregated to explain entirely the change in expenditure mix that has caused the Consumer Price Index to grow considerably faster than the GNE deflator over the last fifteen years. We have captured some of the seasonal change in the expenditure mix by including the constrained quarterly variables multiplied by the synthetic PCPI.

How well does our set of disaggregated price equations perform if account is taken of the inaccuracy in our equations for the prices of the PCPI components? To make an assessment, one must first re-estimate the PCPI equation over a shorter data period, matching the shortest data period used for any of the equations for the component prices. The standard error of the PCPI equation fitted 1Q58-4Q68 is .0024. If the equation is estimated over the same time period using the calculated rather than the actual values for PCNDSD, PCS, and the other consumer prices in PCPI, the standard error rises to .0040. Thus the errors in the equations for the component prices are not large enough to disturb the good fit of the PCPI equation.

PGNE Price deflator for gross national expenditure.

(Equation 7.21)

This price is determined within the model in the same way as it is defined in the national accounts, i.e. as the ratio of current-dollar to constant-dollar expenditure. We have equations in RDX2 for most of the constant-dollar expenditure components, and their current-dollar counterparts are obtained by multiplying each expenditure by its own price. (See equation 8.4.)

PGPP Price deflator for gross private business product

(Equation 7.22)

To obtain this price we first subtract from constant- and current-dollar gross national expenditure the constant- and current-dollar amounts representing value added by government,

agriculture, and noncommercial institutions. PGPP is then obtained, as is PGNE, by simple division.

PCSMVOD Implicit price deflator for imputed consumer services from the stocks of motor vehicles and of other consumer durables (Equation 7.23)

PCSMVOD is defined as the ratio of the current-dollar imputed income series to CSMVOD. The numerator of the ratio is determined by applying the rates of depreciation and opportunity cost used in equation 1.7 (for CSMVOD) to the replacement values of the relevant stocks and flows.

CHAPTER 8

THE OPERATIONS OF GOVERNMENTS

SECTORS 9-14

A Introduction

The government sectors of RDX2 contain equations explaining the major revenues and expenditures of the federal and provincial-municipal governments, as well as identities that indicate the financing implications of changes in the expenditure or asset accounts of the two levels of government. Our revenue equations have been constructed to include, wherever possible, explicit policy parameters as well as an accurate representation of the dynamic behaviour of the revenue item under consideration. Thus, for most of our tax equations we regress actual collections on a synthetic collections series that is derived by multiplying a weighted average rate by an appropriate base and that is then adjusted to reflect payment or recording lags or both. Specification of tax equations in this manner has two advantages. First, in constructing our synthetic tax series, we can take account of the essential complexities of the tax structure; this allows us to indicate explicitly the relevant policy parameters. Second, the criterion of an appropriate specification is very simple - the estimated coefficient should not be significantly different from 1. Thus the coefficients can be used to assess

the accuracy with which we have captured the relevant features of the tax.

The expenditure equations we present are of two types: transfers to persons and both current and capital expenditure on goods and services. To construct the former we follow the procedure employed for the revenue equations, using our knowledge of the relevant legislation and introducing the rates of transfer payments as policy parameters. For goods and services expenditure, however, we have no hope of duplicating the tight analytical structure of the tax and transfer equations. In general we assume that such expenditure responds to the demand for government services and, where appropriate, to relative prices, credit conditions and variables that can be viewed as representing targets of stabilization policy. Such equations are useful for forecasting expenditure in the absence of policy changes or for indicating the induced effects of changes in tax or transfer rates on government expenditure, but they contain no explicit policy parameters. Thus alternative policies can be easily assessed only when one has, or assumes, some a priori knowledge of their future effects on different categories of goods and services expenditure.

In the remainder of this chapter a brief explanation is provided of the equations presented in Sectors 9-14. The reader is referred to [28] and to a forthcoming study [22] for a discussion of the specifications adopted, alternatives that might be considered, sources of data used to create many of the policy parameters, and suggestions for forecasting the exogenous variables.

B Revenue Equations (Sectors 9-10)

1 Personal income tax collections (Equations 9.1-9.29)

In modelling personal income tax collections we distinguish between assessed wage income (YWAS) and assessed nonwage income (YNWAS) since these types of income fluctuate differently, are taxed at differing effective rates and are characterized by different lags between the accrual of tax liability and the payment of tax. Because taxes on wage income (TPS) are deducted at source, a one-month lag generally occurs between the accrual of tax and its collection. Nonwage income recipients assess themselves and pay their tax (TPO) in quarterly instalments. Annual values for YWAS and YNWAS are linked to corresponding series in the national accounts by means of annual regressions estimated from 1950 to 1968. We then define the quarterly series for YWAS and for YNWAS in equations 9.8 and 9.9 by applying the estimated coefficients from the annual regressions to the quarterly values of the independent variables. A similar procedure is employed to generate a quarterly series for NT (equation 9.7), the number of tax returns filed.

Exogenous spreading ratios (equations 9.10-9.21) are used to allocate YWAS, YNWAS and NT to four broad income classes, based on assessed income (under $3,000; $3,000-$5,000; $5,000-$10,000 and over $10,000). We calculate separate weighted average tax rates for each of these classes, a procedure enabling us to capture the degree of progressivity in the rate structure in an appropriate way. The assumption that, in each income class,

average assessed wage income equals average assessed nonwage income allows us to split the number of filed tax returns into wage and nonwage categories (equations 9.22-9.29). In each income class, for each of the categories of income, the number of tax returns is multiplied by the average level of exemptions and deductions (an exogenous variable depending on a set of policy parameters and the distribution of demographic characteristics among income classes), and the result is subtracted from assessed income to get taxable income. Sets of weighted average tax rates representing total federal tax, 'basic tax' and provincial surtaxes are applied to taxable income, and the results are summed across income classes to get tax accruals on wage income (TAW, equation 9.5) and on nonwage income (TANW, equation 9.6). In addition TANW is adjusted to take account of the dividend tax credit. Stochastic equations then link TPS (equation 9.1) to TAW, and TPO (equation 9.2) to TANW.

The provincial portion of the personal income tax is explained in equation 9.3. Provincial tax is calculated by applying provincial rates to the federal 'basic tax'. The federal government collects the tax on behalf of all provinces except Quebec and then remits the provincial shares. Therefore we assume a two-month lag between accruals and collections for all provinces but Quebec and a one-month lag for Quebec. Finally, having determined TPS, TPO and TPYPM, the federal share of the tax (TPYF) is given as a residual (equation 9.4).

Although the income tax submodel is complex it enables one to estimate quickly the effects of changes in relative shares, income distribution, 'basic tax' rates, federal tax rates,

abatements to provinces, provincial surtaxes, exemption levels, or the rate of dividend tax credit.

2 Corporation tax accruals (Equations 9.33-9.36)

Total corporation tax accruals net of provincial logging and mining taxes (equation 9.33) are estimated as a function of a weighted marginal tax rate, taxable corporate profits and a qualitative dummy variable designed to correct the overstatement of tax liabilities due to the use of a weighted marginal rather than a weighted average tax rate. Federal corporation income tax accruals (equation 9.35) are determined in a similar manner and provincial corporation income tax accruals are given residually (equation 9.36). Taxable corporate profits (YCT, equation 9.34) are estimated as a function of national accounts profits (net of YPCCB and TCAPLMT) with adjustments for losses approximated by cyclical and trend variables. Qualitative dummy variables are used to measure the effects on YCT of accelerations (ECCA63A) and reductions (ECCA66R) in capital consumption allowances for tax purposes.

3 Transfers from persons to provincial-municipal governments (Equations 9.30-9.32)

Hospital and medical care insurance premiums (TRHPMPR) are estimated simply as a function of a weighted average hospital insurance premium rate multiplied by the labour force, with the addition of a term representing medical care insurance premiums,

which were introduced in 3Q68. This estimation extends to the end of 1969, since the variable created to capture medicare premiums was insignificant when the estimation period was constrained to end in 4Q68. The personal share of motor vehicle licences and permits (TRMVPMPR) depends on a weighted average rate of licence fee for noncommercial motor vehicles, and on the number of vehicles (UKRMVNC). UKRMVNC is defined quarterly, using the coefficients from an annual regression on the constant-dollar stock of motor vehicles and parts (KMV), with the unemployment rate added to capture cyclical variation in scrappage rates.

4 Indirect taxes and other government revenue
(Equations 10.1-10.7)

With the exception of excise taxes and duties (TIEXF), customs duties (TICUSF), and the witholding tax (TWF), the indirect tax equations presented in Sector 10 depend on weighted average tax rates and variables chosen to represent the appropriate base. Thus in the equation for the manufacturers sales tax (TISF, equation 10.1) the general sales tax rate (RTISF) is applied to consumer expenditure on goods, and the rates of tax on building materials (RTISFR) and on production machinery and equipment (RTISFME) are applied to investment in non-residential and residential construction, and to investment in machinery and equipment, respectively. The actual rate applied to investment in non-residential construction is .46 RTISFR/(100+.46 RTISFR), since only 46% of pre-tax INRC is

subject to tax. Similarly the rate applicable to residential construction expenditure is adjusted to reflect the fact that only 54% of that expenditure (net of tax) is taxable. RTISFME applies only to production machinery and equipment (about 88% of the total) and the remainder is subject to the general sales tax rate. The coefficient on the first term in equation 10.1 should be less than 1 since the federal sales tax is levied on the manufacturer's sale price whereas consumer expenditure on goods includes federal and provincial-municipal sales taxes as well as the retailer's margin. The low coefficient on the second term may be due to an overestimate of the proportion of taxable investment expenditure as well as to the assumption that this proportion is identical for public and private investment.

The retail sales tax (TISPM, equation 10.4) is a function of the weighted average retail sales tax rate and consumer expenditure on goods, deflated by 1+.01 RTISPM to put it on a pre-tax basis. The coefficient indicates that receipts from taxes on services and on sales of secondhand goods more than outweigh the effect of exempt items included in consumer expenditure on goods.

The gasoline tax (TIGASPM), modelled in equation 10.5, depends on weighted average tax rates for gasoline and diesel oil, exogenous ratios indicating the number of gallons of gasoline per noncommercial vehicle (EGAS), the number of gallons of diesel oil per commercial vehicle (EDO) and the stocks of noncommercial and commercial motor vehicles. The stock of commercial motor vehicles is proportional to KME and appears

throughout the model in the form .00009392 KME. This relationship is based on the annual regression results described in [22].

The business share of motor vehicle licences and permits (equation 10.6) is estimated as a function of the stock of commercial motor vehicles and a weighted average rate of licence fee applicable to such vehicles.

Federal customs duties (equation 10.2) are a function of imports of goods expressed in current dollars with dummy variables to reflect the imposition of surcharges in 1962-1963, the duty-remission programme of 1964, the Canada-United States Automotive Agreement and the Kennedy Round of tariff reductions. A time trend captures the general reduction in tariffs over the estimation period as well as any substitution of untaxed or relatively lightly taxed items for goods subject to higher tariffs in the import mix. The estimated coefficients indicate that, after full implementation, the Kennedy Round will result in tariff reductions of about 20%.

Excise taxes (other than the manufacturers sales tax) and excise duties are a simple function of consumer expenditure on goods, with a dummy variable to capture the removal of the excise tax from automobiles in 2Q61.

Finally, the non-resident withholding tax (equation 10.7) is estimated as a function of dividend payments to the United States (MDIV$12), interest payments to the United States (MINT$12), and interest and dividend payments to other countries (MID$13), all measured net of the tax. These three variables have been added together in the equation and the coefficient implies an effective tax rate of 16.79%. This is somewhat higher than the average

effective statutory rate (about 12% in 1965), presumably because we have understated the true tax base by omitting such items as royalties, management fees, etc.

C Expenditure Equations (Sectors 11-13)

1 Transfers to persons (Equations 11.1-11.6)

Five of the six equations in Sector 11 are devoted to explaining the operation of the Unemployment Insurance Fund. The number of persons enrolled in the fund (NINS, equation 11.3) is related to paid nonfarm employment and the number of persons unemployed, with dummy variables to capture the increase in coverage in 3Q68 and the extension of coverage to agricultural workers in 2Q67. The decline in the number enrolled, as a proportion of paid nonfarm employment, is due partly to increasing per capita income (which reduces the proportion of employed persons eligible for coverage) and partly to structural shifts in the labour force between covered and uncovered occupations. For example, expansion of the health and education industries in which most employees are uninsured reduces proportional coverage. Equation 11.4, in which the number of claimants (NCL) is explained, depends on the level of enrolment in the fund and the number unemployed. In equation 11.6 we determine the number of employed contributors (NEMPS) residually, and in turn use this figure to explain the flow of contributions into the fund (TUIRF, equation 11.1). Benefit payments (GTPUIBF)

are explained in equation 11.2 by the number of claimants and a weighted maximum benefit rate (ERUIB), which is an explicit policy variable.

In equation 11.5 we explain the portion of interest payments on the federal public debt that remains after excluding such payments as interest on pension funds, on nonmarket issues held in government accounts, and on Bank of Canada holdings of federal debt. These excluded payments (EIFDMIS) in 1968 amounted to about 35.5% of total federal interest payments. The remaining payments are explained by the end-of-quarter stocks of Government of Canada direct market issues (LGBF), treasury bills (LGFTB), and Canada Savings Bonds (LGFCSB), each weighted by an appropriate coupon rate to develop a synthetic interest series.

2 Current expenditure on goods and services (Sectors 12-13)

This expenditure is disaggregated into wage and nonwage categories and the wage expenditure is further divided into employment and wage rate equations. Explanations of wage rates and employment are given separately for federal and provincial-municipal public administration and defence (exclusive of military pay and allowances) categories, as well as for elementary and secondary schools under municipal control.

2.1 Federal expenditure (Equations 12.1-12.3)

Demand for labour by the federal government is estimated in ratio form, with employment per capita (NGPAF/NPOPT) responding

to real personal income, relative prices, total population and the unemployment rate.

The relative price term is defined as a ratio of the price of labour (an index of the quarterly wage rate including supplements, with 1961=1) to the price of government nonwage current expenditure (PGCNWG). Although we expect a part of nonwage current expenditure to be complementary to employment the substitution effect appears to dominate, as the relative price term enters with a negative sign and a t-value of 7.8. Employment per capita adjusts to a change in relative prices over a period of four quarters, with an equilibrium elasticity of about -.6 (evaluated at the sample means).

The level of employment per capita also responds to changes in the demand for government services, reflected by real personal income and population. Although the pattern of adjustment is identical for both these variables, employment responds more rapidly to changes in real personal income than to changes in population (three years as opposed to five years). The equilibrium elasticities of employment per capita with respect to YP/PCPI and NPOPT are 1.07 and -1.79, respectively. Thus, if population increases by 1% with real per capita income constant, the level of employment will increase by .28%. The response of employment to changes in real per capita income varies directly with the change in population. For example, if per capita income increases by 1% with a 1% increase in population, NGPAF will increase by about 1.35%. A similar increase in per capita income with a 2% increase in population implies an increase of about 1.63% in NGPAF. Finally the level of the unemployment rate

affects NGPAF, indicating policymakers' responses to variations in an important target of stabilization policy.

The federal government quarterly wage rate (WQGPAF) is assumed to respond to the average level of wages in the rest of the economy (WQAXF). In equation 12.2, estimated in logarithmic form, the indication is that WQGPAF adjusts to WQAXF over an eight-quarter period with an equilibrium elasticity of about 1.10. The magnitude and speed of response vary seasonally, as well as with current and past conditions in the labour market.

The federal wage rate and employment equations perform reasonably well. A regression (1Q57-4Q68) of the actual wage bill on the calculated wage bill has an estimated coefficient not significantly different from 1.0, an RB2 of .98 and a standard error of $7.3 million (or 2.4% of the average quarterly value of the wage bill in 1968).

Our explanation of federal current nonwage expenditure (GCNWF, equation 12.3) has some satisfactory features, although the strongly significant time trend makes the specification suspect. Ideally, we should like to define our dependent variable net of capital consumption allowances (CCAGF$) and defence nonwage expenditure, both of which are included in GCNWF in the national accounts. We have not yet been able to obtain a data series for defence nonwage expenditure and we suspect that, throughout our estimation period, the downward trend in the dependent variable was due to a rapid decline in this category of expenditure. GCNWF does respond positively to changes in real personal income, but the magnitude of the response seems extremely strong with the equilibrium elasticity approaching 4.0.

Although we suspect that the coefficients on YP/PCPI and QTIME are both too large because of the high simple correlation between them (.97), attempts to respecify the equation to reduce the collinearity were not successful. Looking at the brighter side, however, the equation does explain almost 90% of the variance in nonwage current expenditure; and the relative price term, which performed so well in the NGPAF equation, enters here also, this time with an equilibrium elasticity of a little over -.5. In addition GCNWF responds quickly, and fairly strongly, to changes in the unemployment rate and to expected rates of price change (PCPICE). The elasticities of GCNWF with respect to these targets of stabilization policy are .41 and -.22, respectively. Although the equation will probably serve for short-run forecasting purposes it may well produce curious results in policy simulations. And since this category of expenditure is relatively large (the mean quarterly value of the dependent variable over the period from 1Q58-4Q68 is $238.3 million) it may be better left exogenous for many of our experiments.

2.2 Provincial-municipal expenditure (Equations 13.1-13.4)

Over 99% of the variance in provincial-municipal employment (NGPAPM, equation 13.1) is explained by real personal income, relative prices, credit conditions, and a variable constructed to reflect the budget constraint facing provincial-municipal governments. Recent studies of state and local government expenditure in the United States have emphasized this constraint and attempted to model it by including an appropriate income

variable, adjusted to represent a revenue base, in their econometric specifications [5] [24]. The coefficient on this variable is interpreted as reflecting a compromise between the level of services demanded and the level of services public officials think it possible to supply with a given revenue base. One problem with this type of approach is that the relationships between total revenue and the revenue base are not explicitly spelled out, and so it is not possible to simulate directly the effects on expenditure of a change in the budget constraint due to changes in tax rates. Since for RDX2 we have developed detailed equations relating different revenues to appropriate tax rates and bases, we attempted to use this information to construct a variable that would capture the budget constraint confronting provincial-municipal governments. The variable we chose, defined as (YTOTPM-GBCPPPM)/(YTOTPM-GBALPM+GALPM), represents the proportion of total (national accounts and nonnational accounts) expenditure that can be financed without recourse to the capital market. The elasticity of NGPAPM is about .2 with respect to this variable and about 1.1 with respect to real personal income. In addition credit conditions, represented by (RABEL-RABELD)/RABEL and RL, affect the demand for labour. The elasticity of NGPAPM with respect to the long-term interest rate is about -.08, whereas a 1% increase in (RABEL-RABELD)/RABEL, which is the variable we use to measure the availability of credit, increases the level of employment by about .03%. Finally, as was the case with NGPAF, we found that the demand for labour by provincial-municipal governments was sensitive to relative prices. In virtually all the specifications tested the relative price term (defined analogously to that used in equation 12.1) was strongly significant and the price elasticy of NGPAPM never varied much from -.5.

Equation 13.2, which is used to explain the average quarterly wage rate (WQGPAPM), is similar in structure to equation 12.2. A regression of the actual wage bill on the wage bill calculated from equations 13.1 and 13.2 over the period 1Q58-4Q68 has a coefficient not significantly different from 1.0, an RB2 of .99 and a standard error of $5.9 million (or 1.7% of the average value of the wage bill in 1968).

Provincial-municipal current nonwage expenditure (GCNWPM), net of capital consumption allowances and medical care insurance payments (equation 13.4), is explained primarily by real personal income and relative prices. The elasticity of GCNWPM with respect to relative prices is about -.43, whereas the response to changes in personal income depends on the borrowing requirements of the provinces and municipalities relative to their mean borrowing requirements over the estimation period. If current borrowing requirements equal their average level then a 1% increase in YP/PCPI will lead to a .5% increase in GCNWPM over four quarters. The change in the seasonal pattern, represented by the interaction of constrained quarterly dummies with QDSEAS, is due to differing seasonal patterns in the provincial and municipal series and the relative predominance of provincial expenditure in the total after 1965. QDCENT is a dummy variable equal to 1.0 in the period 3Q66-2Q67 and zero elsewhere. The rationale for the inclusion of QDCENT is not clear, although the usefulness of the variable is obvious. In the four quarters in

which QDCENT takes nonzero values, GCNWPM was about 45% higher than in the previous four quarters and about 20% higher than in the following four quarters. Since GCNWPM is calculated as a residual it is virtually impossible to explain why this bulge should have occurred, but we suspect that the increased expenditure may have been related to Canadian centennial celebrations, particularly to an acceleration in repairs to the provincial and municipal infrastructure. The effect of QDCENT is to increase GCNWPM over the period from 3Q66-2Q67 by about $248 million, or 27.5% of what it otherwise would have been.

Equation 13.3 explaining employment in elementary and secondary schools under municipal control (NIS) is straightforward. The teacher/student ratio depends on real per capita personal income, the number of students, the change in the number of students, the long-term interest rate, and the level of provincial grants per student to municipal governments. Equilibrium elasticities of the ratio with respect to the income and grants variables are .20 and .11, respectively. The interaction of the coefficients on JW(NPOPS) and JW[J1D(NPOPS)] implies that a 1% increase in the number of students enrolled will cause NIS to increase by .1% in the current quarter and by about .07% in each of the succeeding twelve quarters. Thus in equilibrium the elasticity of NIS with respect to NPOPS is about .95, implying a slight increase in the student/teacher ratio with per capita income and grants per student held constant. Finally, the long-term interest rate enters significantly and with the appropriate sign; the interest elasticity of school employment is quite low (about -.04 spread over eight quarters).

Attempts to explain the quarterly wage rate corresponding to NIS were unsuccessful so we have decided to leave WQISM exogenous for the time being.

3 Capital expenditure on goods and services (Equations 12.4, 13.5, 13.6)

The recent major revision of the national accounts [10] provides consistent quarterly time series for fixed capital formation by governments. We have used this information to develop equations explaining investment in non-residential construction by the federal and provincial-municipal governments, disaggregating the latter expenditure category into expenditure on construction of elementary and secondary schools under municipal control (INRCSM) and on other non-residential construction by provincial-municipal governments (INRCGPM). Some attention was devoted to modelling machinery and equipment expenditures, but, in view of the relatively small amounts of money involved and the large number of coefficients in the preferred structural equations, it was decided to leave these categories exogenous to RDX2. However, some equations for government investment in machinery and equipment will be reported in [22].

The basic model we use to explain government investment is a flexible accelerator model of the type employed in RDX1 [18]. Current net investment is assumed to depend on present and past values of a gap between desired and actual capital stock. Variables designed to capture the reaction of investment to

variations in policy targets or credit conditions enter linearly. These variables are specified in index form so that they affect the dynamic response of investment but in equilibrium become effectively absorbed in the constant term.

Equation 12.4, in which we explain federal investment in non-residential construction (INRCGF), is estimated in per capita form. Real per capita personal income and population determine the desired per capita stock of non-residential construction. The estimated weights on these variables are convolutions of three separate weighting patterns representing the way in which past values of the variables affect the desired capital stock, the extent to which a given value of the gap results in a decision to invest (which is assumed to depend on the relation between past and current values of the gap), and the response of investment outlays to a given decision to invest. The estimated coefficients imply that in equilibrium the elasticity of the capital stock is about .63 with respect to real personal income and about .36 with respect to population. Current and lagged values of the ratio of a four-quarter average of the unemployment rate to a twelve-quarter average of the unemployment rate enter the equation with positive coefficients, indicating that the response to a given gap will be greater when the current value of the unemployment rate is high relative to past values.

Equation 13.6 in which we explain INRCSM is similar to equation 12.4. The equilibrium elasticity of the stock of schools is about .90 with respect to real personal income and about 1.66 with respect to the number of students. The pattern of response to a gap between the desired and the actual stock of

schools is affected by the level of grants from provinces to municipalities.

For the nonschool investment of provincial-municipal governments (INRCGPM) we were unable to develop a satisfactory specification that included the effects of the lagged stock. We finally chose a simple accelerator model, based on the assumption that the stock of capital provided by provinces and municipalities is in part complementary to the stock of all other residential and non-residential construction and in part dependent on the level of real final demand exclusive of changes in this stock. The short-run response of INRCGPM is affected by the budget constraint of provincial-municipal governments as well as the real long-term interest rate. But again we have specified these variables in index form so that in equilibrium gross investment varies only in response to changes in the stock of other residential and non-residential construction, with an elasticity of about .43.

D Changes in Government Asset and Liability Accounts (Sector 14)

When specifying the transactions of the public sector it is important to make the links between expenditure, taxation and the pattern of government financing as explicit as possible. Only when these links have been adequately specified is it possible to take proper account of the interdependent nature of fiscal and monetary policies, and the portfolio effects of different policy

choices. Sector 14 contains a number of accounting identities that describe these links as well as some supporting stochastic equations.

In equations 14.6-14.8 we define the net national accounts position of the federal government, the provincial-municipal governments, and hospitals, respectively. Equation 14.9 is the identity equating total sources and uses of funds for the federal government. Any net use of funds not financed by an increase in Government of Canada direct market issues (LGBF) or a decrease in government cash balances (DDGFB) will lead to an automatic increase in the stock of treasury bills. The difference between corporation taxes accrued and collected, which is an important use of funds, is determined endogenously, since TCCF is explained in equation 14.1. The specification of this equation is intended to capture actual payment practices as set out in the relevant legislation and is described in some detail in [28], pp.72-80. GAMIS, which is an exogenous variable defined residually by equation 14.9, represents net changes in federal asset accounts excluding advances to the Foreign Exchange Fund. We intend to disaggregate GAMIS to a greater degree as it becomes worthwhile to focus on changes in particular asset accounts, either by explaining them stochastically or using them in the explanation of other relationships or (hopefully) both.

The gross borrowing requirements of provincial-municipal governments (GBRPM), as defined in equation 14.11, are used in equation 14.12 to determine the stock of direct and guaranteed bonds outstanding. We weight the resident-held stock of all government bonds by a market-valuation ratio (PLGI, equation

14.10) and the resulting market value (VLGB11) enters the private sector wealth variable. (See equations 18.3 and 18.4.) As well as adding directly to the stock of wealth, VLGB11 is used in the creation of our series for permanent nonwage disposable income (YPDNWP) and revaluation gains and losses (YKGP), which directly influence consumption behaviour.

PLGI is a weighted average of federal and provincial-municipal valuation ratios, which are themselves weighted averages of stochastically determined valuation ratios for each of the four maturity classes of Government of Canada direct market issues (equations 14.2-14.5). PLGF1C, PLGF2C, PLGF3C and PLGF4C are weighted by the proportion of total resident-held Government of Canada direct market issues in each maturity class, and the results are summed to get an aggregate federal valuation ratio. This ratio is then scaled by EWLF, which represents the proportion of resident-held Government of Canada direct market issues to all government bonds held by residents. Since no breakdown of the maturity structure is available for provincial and municipal bonds we assume that such bonds are issued at regular intervals with an initial term to maturity of fifteen years. This assumption gives rise to the constants used to weight PLGF1C, PLGF2C, PLGF3C and PLGF4C in equation 14.10. We then scale the provincial-municipal valuation ratio by 1-EWLF in order to calculate PLGI.

Finally we should comment on the specification of the four valuation ratios modelled in equations 14.2-14.5. The data source for the valuation ratios is an issue-by-issue analysis of Government of Canada direct market issues outstanding at quarter

end from 1955 forward. However, rather than attempt to relate these price indices to interest rates in a general way, we used the same data to derive weighted average coupon rates and term-to-maturity variables for the four maturity classes. Given this information and market yields generated elsewhere in RDX2, we used the general formula for the present value of a bond with semiannual coupon payments to generate synthetic price series. These series were then used as regressors in our valuation equations. Evaluated at the sample means, the elasticities of PLGF1C, PLGF2C, PLGF3C, and PLGF4C with respect to the relevant interest rates are -.05, -.16, -.29 and -.60, respectively.

CHAPTER 9

THE FINANCIAL SECTOR

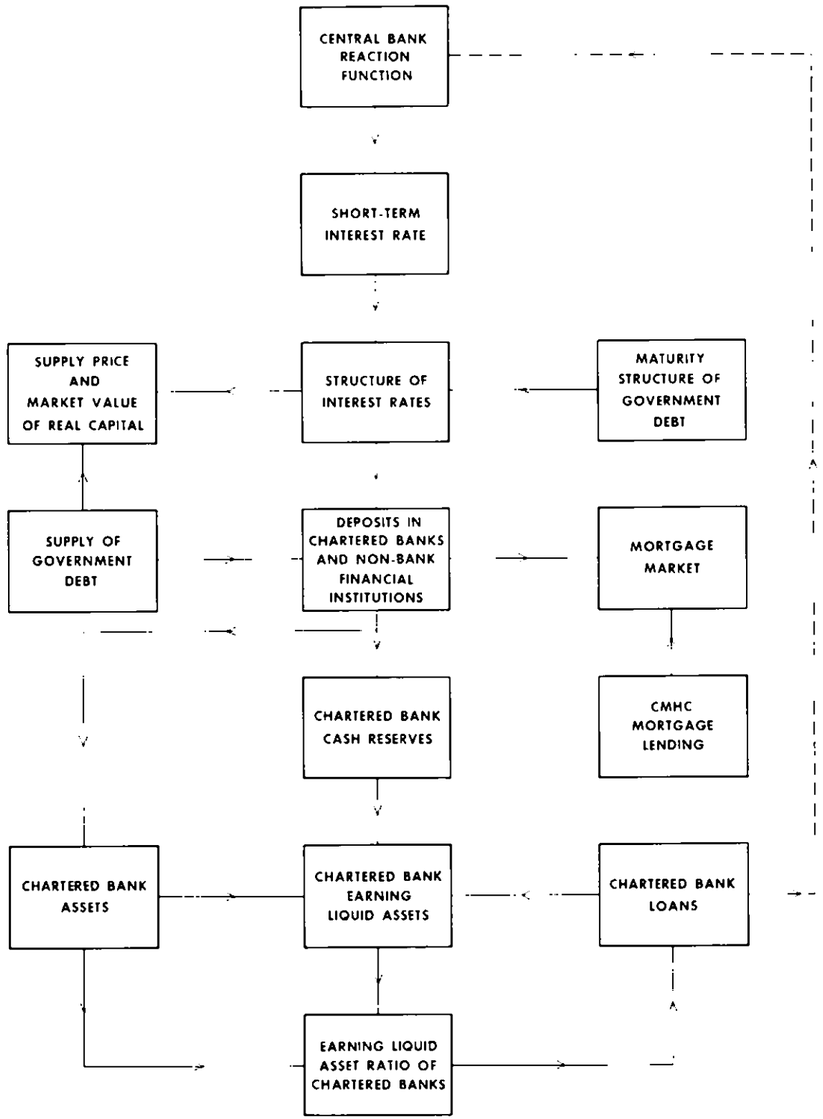
SECTORS 15-18

A General Outline

The basic structure of the financial sector is outlined in the flow chart below. This structure differs in three respects from that of a more conventional model in which the short-term interest rate is determined by the interaction of a money demand function with an exogenously determined money supply or monetary base. First, the interest rate is treated as the primary target of monetary policy and is determined by a central bank reaction function. Second, an attempt is made to approximate empirically the cost of capital or the supply price of capital as an important determinant of investment behaviour. Third, the role of the equations for bank assets and liabilities in the model is primarily to determine the ratio of earning liquid assets to total bank assets, which is then used as a measure of credit availability.

As indicated by the flow chart, the structure of the model is almost recursive. The short-term interest rate, determined by the reaction function described in section C below, feeds into the market reduced-form equations for other interest rates in the model described in section E and determines the demand for chartered bank liabilities, real capital assets, and the

FLOW CHART OF THE FINANCIAL SECTOR



liabilities of non-bank financial institutions. The demand functions for financial assets are treated in the context of a portfolio model estimated simultaneously and subject to consistency constraints on the coefficients, as discussed in section B. In view of the wide variance in the market value of real capital, the market for this asset is specified as a reduced-form equation (outlined in Section F) outside the general portfolio model.

The demand for bank liabilities determines the size of total bank assets and the volume of cash reserves that must be supplied to achieve the interest rate target. These variables in turn, together with the demand for bank loans, determine the quantity of earning liquid assets and the earning liquid asset ratio (RABEL). This latter variable feeds back into the demand for bank loans. In addition, the rate of growth of bank loans is assumed to influence the central bank's interest rate target and therefore feeds back to the reaction function. This set of equations is discussed in section D.

An additional link with the real sector is provided by the demand for deposits in non-bank financial institutions, which feeds into the mortgage market. This is discussed in section G.

B The Demand for Liquid Assets

1 Scope and specification of the model

The financial sector of RDX2 includes demand functions for eight categories of liquid asset holdings of the private domestic nonfinancial sector. These categories include currency, four types of chartered bank deposits, two types of trust and loan company deposits, and Canada Savings Bonds. There is in addition an implicit demand function for a residual category defined as holdings of Government of Canada treasury bills and bonds, and provincial and municipal bonds less chartered bank day-to-day, call and short loans (ANFGN).

Our basic hypothesis is that the proportion of total liquid assets (A) held in each category (A(i)) depends on the rates of return (R(i)) and the ratio of income (Y) to total assets. Thus we assume:

$$A(i)/A = a(i) + b(i)Y/A + \sum_{j=1}^{9} c(i,j)R(j)$$

$$i = 1, 2, \ldots, 9$$

The income variable is included to represent the effect of transactions requirements on the choice of assets, given differences in transactions costs. These costs involve such things as service charges on chequing accounts, loss of interest on deposits that require a minimum holding period, and the cost in terms of inconvenience of shifting from an asset that does not

serve as a medium of exchange to one that does in order to satisfy requirements for transactions balances. Thus, the higher is income relative to total asset holdings, the higher will be the proportion of assets held in a form that involves a low cost of transactions. The implication is that the income variable will have a negative effect on the demand for less liquid assets.

2 Constrained estimation procedure

Since the above demand functions are specified in the form of ratios of each category to total liquid assets, constraints must be imposed on the coefficients to preserve the identity relating the total to the sum of the components. For example, any changes in rates of return may cause a shift in asset choice, but the effects must sum to zero over the whole portfolio. Similarly, a change in total wealth must be distributed over the portfolio so that the effects sum to unity. Since the dependent variables are in the form of ratios to total assets, this latter constraint applies to the constant terms.

If the parameters in each equation are estimated by least squares these constraints will be automatically satisfied provided that the same set of explanatory variables is used in each equation. If, however, some coefficients are set equal to zero (as would be the case, for example, if some asset pairs are not substitutes), the constraints must be incorporated into the estimation procedure. This may be done in the following manner. One first chooses a residual equation the coefficients of which will not be estimated directly, but will be determined by

applying the constraints. The remaining equations will then be estimated simultaneously subject to the constraint that the coefficients for any variable excluded from the residual equation must sum to zero. The joint estimation is carried out using a two-stage procedure suggested by Zellner [55] that allows for different residual variances for different assets as well as contemporaneous correlations between residuals in different asset equations.

3 Portfolio constraints in lagged adjustment models

The most convenient device for modifying the above model to allow for lagged responses to changes in the explanatory variables is the familiar stock-adjustment model. This approach leads to the inclusion of the lagged value of the dependent variable in each equation with coefficients interpreted as 1 minus the speed of adjustment. However, this formulation cannot be used directly in a portfolio context since the presence of each lagged dependent variable in only one equation prevents the imposition of consistency constraints across the portfolio. In fact, the simple stock-adjustment model is not consistent with a portfolio approach since it fails to account for the interaction between disequilibria in various asset holdings in a consistent way.

A modified stock-adjustment model that maintains consistency is given by the following formulation:

$$A(i)/A = a(i) + b(i)Y/A + \sum_{j=1}^{9} c(i,j)R(j) + (1-d)J1L[A(i)]/A + e(i)J1D(A)/A$$

A common speed of adjustment, d, is assumed for all assets and the change in total assets is included as an additional variable. This term can be interpreted as providing for an inertia effect with the coefficients e(i) determining the temporary allocation of an increase in total assets while the stock-adjustment process works itself out.

An alternative form of the model, which is convenient for constrained estimation, is given by the following equation:

$$A(i)/A = [a(i)+e(i)] + b(i)Y/A + \sum_{j=1}^{9} c(i,j)R(j) + (1-d)J1L[A(i)]/A - e(i)J1L(A)/A$$

Consistency is then achieved by the additional constraint that the coefficients e(i) sum to 1-d.

4 Empirical results (Equations 15.1-15.8)

For purposes of estimation the above model was modified as follows. First, dummy variables were added to allow for seasonality and other identifiable non-numeric factors. A dummy variable (QDB) with a value of unity from 1Q62 forward was

employed to allow for the introduction of foreign currency swapped deposits and for some changes in chartered bank policy regarding nonpersonal term and notice deposits. Similarly, the variable QDBA, with a value of unity from 3Q67 forward, was introduced to represent the effect of the 1967 Bank Act revision, under which the interest rate ceiling on bank lending was removed. Second, we allowed for portfolio scale effects by including the reciprocal of total assets as an additional variable. The third modification was prompted by the low speeds of adjustment that were obtained when the model outlined above was fitted. To allow for the possibility of a faster speed of adjustment for demand deposits (DDB), the lagged stock of this asset was included in the equations for demand deposits and implicitly in the equation for the residual asset. Similarly, a different reaction lag for currency is permitted by including the lagged stock in the equations for currency (ANFCUR) and for chartered bank personal deposits (DPB). A significant result was obtained only in the case of currency. The coefficients imply a speed of adjustment for ANFCUR of 72% per quarter compared with 30% for the others.

In view of the problem of multicollinearity among interest rates, the range of possible substitution effects was narrowed down by dividing the assets into two groups with zero cross-elasticities between assets not in the same group. The first group of assets (equations 15.1-15.4) is held primarily by households that have relatively small portfolios, whereas the second group (equations 15.5-15.8) comprises assets held primarily by businesses or by households that have relatively

large financial portfolios. Substitutability was permitted between the government securities variable (ANFGN) and assets in both groups. Within the first group significant substitution effects were obtained between personal savings and chequing deposits in chartered banks (DPB) and each of the other three assets, i.e. currency (ANFCUR), savings deposits in trust and loan companies (DSTL), and Canada Savings Bonds (LGFCSB). The government securities asset was found to be a substitute for each of the three categories of Canadian dollar deposits in chartered banks, i.e. personal deposits (DPB), demand deposits (DDB), and nonpersonal term and notice deposits (DNPTB), as well as term deposits in trust and loan companies (DTTL). In addition a significant substitution effect was obtained between DNPTB and foreign currency swapped deposits in chartered banks (DSWPB). In this case an additional constraint was imposed by entering the interest rates in the form of a differential. A shift in the substitution relationship between DNPTB and ANFGN was allowed for by including the relevant rate differential interacted with QDB.

In the equations for currency and bank deposits the coefficients on income are positive while income has a negative effect on ANFGN. This indicates that the proportions of these assets shift in response to transactions requirements as hypothesized above. The results for the inertia effect represented by lagged total assets were, however, somewhat puzzling. The only sizeable coefficient appeared in the ANFGN equation rather than in the currency and bank deposit equations where one would have expected the inertia effect to be concentrated. In the equations shown, coefficents more

consistent with this a priori view were obtained by excluding lagged total assets from the ANFGN equation.

C The Reaction Function of the Central Bank

1 Choice of the monetary policy instrument

The choice of a variable to be treated as an exogenous monetary policy instrument is complicated by conflicting criteria of selection. First, to be suitable for policy simulation, the variable must be controllable by the monetary authority. Second, the use of historical data to measure the response of the variable to policy changes requires that the variable was in fact consistently viewed as an instrument by the monetary authority over the period under consideration. Third, in order to identify behavioural parameters statistically (in the econometric sense) the exogenous policy variable must be truly exogenous in the sense that it is not systematically influenced by endogenous variables.

Based on the criterion of controllability, most existing models use bank reserves or the monetary base (bank reserves plus currency outside banks) as the policy instrument. In the Canadian institutional setting, a more appropriate choice appears to be chartered bank excess cash reserves or the ratio of excess cash to statutory deposits. Since required reserves are based on statutory deposits, defined as Canadian dollar deposit liabilities averaged over consecutive Wednesdays ending with the

second last Wednesday of the preceding month, control of total reserves implies control of excess reserves. Given the predictability of currency drains and other factors affecting the reserve base, the central bank can be viewed as exercising close control over the excess cash ratio.

In our view, the interaction of the excess cash supplied by the central bank with the level of cash desired by the chartered banks represents a key element in the short-run monetary policy transmission mechanism. Although we formulated a model of this process (see [15]), we have rejected it for use in the context of a quarterly model since the choice of this policy instrument violates the second and third criteria listed above. Over periods as long as a quarter the target level for the excess cash ratio is clearly heavily dependent on the behaviour of intermediate target variables, i.e. variables such as interest rates that are controlled only indirectly yet are viewed as links with the level of employment and other ultimate objectives of monetary policy. Since the third criterion of statistical exogeneity cannot be satisfied even by intermediate target variables and since policy actions are themselves influenced by economic events, we have attempted to surmount these problems by formulating a central bank reaction function.

2 Intermediate targets and the reaction function

The main intermediate targets of monetary policy appear to be interest rates, the rate of growth of the money supply or bank assets, and the rate of growth of bank loans. The levels of

these variables deemed appropriate are determined with a view to the ultimate objectives of full employment, price stability and balance of payments considerations. Our reaction function is formulated in terms of an equation explaining the short-term interest rate (RS, equation 17.1) as a function of other intermediate targets and measures of policy objectives.

The empirical experiments using a distributed lag function of the rate of growth of bank loans as the intermediate target produced the best results. In terms of ultimate policy objectives, the rate of change of prices and variables related to the balance of payments entered significantly. The U.S. bill rate was used with different coefficients for the fixed and flexible exchange rate period. The results imply somewhat greater concern with stabilizing the exchange rate in the flexible rate period than with stabilizing foreign exchange reserves in the fixed rate period. A dummy variable was used to explain the tightening of policy that occurred in the exchange market crises of 3Q62 and of 1Q68 and 2Q68. Experiments with other variables such as reserve holdings and balance of payments deficits failed to yield satisfactory results. The percentage change in the stock of outstanding government bonds was included to represent debt management considerations. The coefficient measures the extent to which the central bank permits the interest rate to rise in response to the pressure of government borrowing.

D Determination of Bank Assets

1 Cash reserves (Equations 16.1-16.4, and equation 16.7)

The equations for cash reserves were obtained by a combination of multiple regression and a priori choice of parameters approximating institutional relationships. Equation 16.1 for statutory deposits in chartered banks (DSTATB) approximates the definition of statutory deposits, which is in terms of average Canadian dollar deposits over the preceding month. Since our variable DSTATB is defined as statutory deposits outstanding for the last month of the quarter, it should be approximately equal to a simple average of beginning- and end-of-quarter actual deposits. Fitting a least squares regression on current and lagged actual deposits yielded a nonzero constant term and slightly different weights reflecting, among other things, the fact that items in transit (float) are netted out of Canadian dollar deposits (DCDPB) although they are included in DSTATB. The significant seasonal effects reflect seasonal differences in the intra-quarter patterns of variation in deposits that lead to seasonal differences in the relationship between average deposits and beginning- and end-of-quarter values.

The equation for the average required cash reserve ratio (RBCR, equation 16.4) is based on a priori coefficients chosen to approximate the requirements under the 1954 and 1967 revisions of the Bank Act. Until June 1967 RBCR was simply equal to 8%. Thereafter, the required minimum monthly average ratio for demand

deposits was increased in steps of one-half of 1% per month to 12%, while the ratio for notice deposits was similarly decreased to 4%. In our equation the components of statutory deposits are approximated by simple averages of beginning- and end-of-quarter values, and an adjustment is made to allow for the fact that personal chequing accounts are included with personal savings deposits in DPB rather than in DDB, even though they are subject to the higher reserve ratio.

In Equation 16.2, we explain chartered bank holdings of Bank of Canada notes (ABBCN) based on a simple behavioural hypothesis. The banks are assumed to hold an inventory to meet projected demand as reflected in the public's currency holdings and seasonal variables. A negative correlation with changes in currency holdings is also included to reflect the buffer-stock role of bank inventories.

Holdings of statutory Bank of Canada notes (ABSTATN), i.e. notes that are eligible to meet statutory cash reserve requirements, are calculated with a one-month lag in the same manner as statutory deposits. This variable was thus approximated in terms of actual notes at the beginning and end of a quarter. Seasonal variables were included to allow for the distortion of the end-of-quarter values caused by the strong seasonal pattern in note holdings.

Given excess cash reserves at the end of a quarter, which are taken as exogenous, chartered bank deposits at the Bank of Canada (ABBCD) are then determined in the identity (equation 16.7) relating total statutory cash to required and excess components.

2 Bank loans (Equations 16.5, 16.6)

The equations for personal loans (ABLP) and business and other general loans (ABLB) are formulated as reduced-form equations derived from supply and demand functions. Demand is represented by current-dollar cash requirement variables defined as consumer expenditure on durables in the case of personal loans, and business investment less cash flow in the case of business loans. Supply is assumed to be a function of a credit availability measure (defined as (RABEL-RABELD)/RABEL) based on bank liquidity. We define RABEL as the ratio of chartered bank earning liquid assets, less required secondary reserves, to total assets. RABELD is obtained by fitting a Lagrangian polynomial through the troughs in the RABEL series that occurred at January 1957, September 1959, August 1962, and December 1969. This trend line is used to allow for the fact that the minimum value of RABEL reached during these four periods of monetary tightness has declined from 20.1% in 1957 to 12.6% in 1969. Because in each case the trough in RABEL has been followed by a sharp levelling off in loan growth, the variable is used in a nonlinear form.

The best results for the liquid asset ratio variable were obtained by using a discrete lag of one quarter for personal loans and a constrained five-quarter polynomial lag for business loans.

3 Response of the banking system to monetary policy

The model outlined above implies the following role for the banking system in transmitting changes in monetary policy. (See flow chart in section A above.) Suppose the central bank raises its interest rate target in response to a change in internal or external economic conditions. This will require a contraction of the banking system achieved by a reduction in the reserve base, the magnitude of the fall in deposits being determined by the elasticity of the demand for deposits with respect to the interest rate. The fall in deposits will be matched on the asset side initially by declines in reserves and earning liquid assets. Consequently the reduction in the earning liquid asset ratio will dampen the rate of growth of bank loans, the magnitude of this effect being larger the closer is the initial liquidity ratio to the threshold value represented by RABELD. The lower liquidity ratio, as well as the higher interest rate, will then have a contractionary effect on aggregate demand.

An alternative view of the model is provided by considering the behaviour of the banking system under a constant interest rate target. In this circumstance the level of total deposits will be determined by demand since any increase in deposits will have to be supported by increases in the reserve base at the beginning of the next averaging period so as to maintain the interest rate target. In particular the supply of deposits will be adjusted to any changes in demand related to fluctuations in income. However, to the extent that an increase in income is generated by increased expenditure on durables and therefore

leads to increased demand for bank loans, two dampening factors come into play. First, the liquidity ratio will decline leading to a tightening of credit availability. Second, inclusion of the rate of growth of loans in the reaction function implies that the central bank will resist the loan growth by raising its interest rate target.

E The Structure of Interest Rates

1 The term structure (Equations 17.2-17.4)

The equations for intermediate and long-term interest rates are based on the Modigliani-Sutch [45] version of the expectations theory, which postulates that yield differentials between short-term bonds and those of other maturity classes depend on expectations regarding future levels of interest rates. Expectations are represented by distributed lag functions of past values of the short rate with weights that are estimated subject to polynomial constraints. Regression experiments suggested a lag of twenty quarters, and peaked lag distributions were obtained indicating a strong extrapolative component in the expectations process.

Additional variables were included in the regressions to reflect factors other than past experience that might influence expectations. First, the spread between U.S. and Canadian short rates was entered to allow for the fact that a large spread is likely to generate expectations of changes in the Canadian rate

given the close relationship between the two capital markets. Second, the spread between the long and short rate in the United States is included as a measure of expected future movements in U.S. rates. Third, the expected rate of increase of the price level is used to reflect the interconnection between expected rates of inflation and expected future nominal interest rates.

Relative supply variables were also tested, but the only evidence that they have any effect was the marginally significant coefficient obtained in the RL equation.

2 Rates of interest on deposits (Equations 17.5-17.7)

Equations are included in RDX2 for those rates of interest on deposits that are particularly sensitive to other market rates of interest. The rate on chartered bank nonpersonal term and notice deposits (RNPT) is determined by the short-term interest rate (RS) with different coefficients for two subperiods in the sample. Prior to 1962 the chartered banks followed a policy of tying the term deposit rate to the treasury bill rate (which is not used in RDX2), whereas more recently the term deposit rate has been set to reflect a broader range of competitive factors in the money market.

The rate of interest on foreign currency swapped deposits (RSWP) is tied to the covered Euro-dollar rate, and the yield on trust and loan company term deposits (RTTL) is a distributed lag function of the short-term interest rate. Rates of interest on chartered bank personal savings deposits (RPD), and trust and

loan company savings deposits (RSTL) are treated as exogenous to RDX2 at present.

F The Market Value of Real Capital and the Supply Price of Capital

1 Estimation of a time series for the market value of real capital

A time series for the market value of domestic business fixed capital assets and inventories was obtained by applying to the aggregate book value of these assets a valuation ratio obtained from balance sheet and stock market data for the seventy-six largest nonfinancial corporations whose shares have been traded on Canadian stock exchanges continuously since 1955. An estimate of aggregate book value was obtained by accumulating business investment expenditure at historic cost and deducting depreciation at the declining-balance rates specified for tax purposes (5% per annum for structures and 20% per annum for machinery and equipment).

The market value of the capital assets of the firms in our sample was estimated by assuming that the market values of financial assets and liabilities are equal to the book values. Thus, given the market value of the firms' equity, the market value of capital assets can be calculated as follows:

Market value of capital assets = Market value of equity
- Net financial assets at book value

An aggregate valuation ratio was then obtained by dividing the total market value of capital assets of firms in the sample by the total book value. The market value of the capital stock for all firms (VKB) was estimated by applying this ratio to the aggregate book value.

This time series for the market value of the domestic capital stock was used, in the manner discussed below, to derive the supply price of capital. The series was also used as a component of private sector wealth (V, equation 18.4), after an adjustment was made for the portion held by non-residents using the ratios RVB12 and RVB13 discussed in section D of Chapter 10.

2 A model determining the supply price of capital

The supply price of capital, following the terminology of James Tobin [53], is the rate of return required to induce investors to hold the existing stock of real capital in their portfolios. In view of certain recent developments in monetary theory, which suggest that the supply price of capital is a key link between the financial sector and expenditure decisions, we have attempted to approximate this variable empirically in RDX2. To distinguish the theoretical concept from our empirical approximation, we have adopted the convention of referring to the former as r and the latter as RHO. Given r and the expected future earnings stream x(t), the market value of real capital, v, is simply the present discounted value given by:

$$v = \int_0^\infty e^{-rt} x(t)dt$$

If the earnings stream is assumed to grow at a constant rate, g, beginning at an initial level, x, this integral reduces to:

$$v = x/(r-g) \qquad (1)$$

The rate of growth, g, is assumed to be equal to the expected rate of change of the price level as represented by a distributed lag function of past four-quarter rates of change of the Consumer Price Index (PCPI) and an error term:

$$g = JW\ [J4P(PCPI)] + u \qquad (2)$$

It should be noted that the expected rate of growth of earnings refers solely to earnings expected to accrue to holders of the existing stock and excludes earnings generated by future additions to the capital stock financed by new saving. Therefore, we assume that the expected rate of growth of earnings depends on past rates of change in the price level but not on changes in real output or profits. Inflation-induced capital gains will be the only source of earnings growth if productivity gains induce proportional increases in the real wage rate. This behaviour is in fact consistent with our main business wage determination equation, which yields an equilibrium elasticity of the real wage with respect to the labour efficiency variable (ELEFF) close to unity.

The determination of r through the portfolio preferences of investors is represented by a reduced-form equation derived from the supply and demand for real capital. The demand is assumed to depend on r and the long-term Government of Canada bond rate (RL). The differential between these rates of return is made a function of relative supply as measured by the ratio of the earnings stream from real capital, rv, to interest paid on government debt, h, and an error term, w. Thus, we have:

$$RL - r = a + b(rv/h) + w \qquad (3)$$

Using (1) to eliminate r from (3), we obtain:

$$RL - x/v = g + a + b(x + gv)/h + w \qquad (4)$$

Substituting for g using (2) yields:

$$\begin{aligned} RL - x/v = {} & JW\,[J4P\,(PCPI)] + a \\ & + b\,[x + JW\,[J4P\,(PCPI)]v]/h \\ & + u + w + b(v/h)u \end{aligned} \qquad (5)$$

3 Empirical estimation of the supply price of capital and the expected rate of inflation

Estimates of the parameters were obtained from a regression, based on (5), of RL-x/v on past rates of change of prices and the relative supply variable (equation 18.1). The current level of earnings, x, from the stock of real capital is taken to be the

sum of corporate profits net of tax accruals, corporate interest paid, net income of nonfarm unincorporated business less imputed labour income, and the profits of government business enterprises. A four-quarter moving sum of earnings is used, and v is the average of the beginning- and end-of-quarter values of VKB.

Since the weights in the expected rate of inflation variable enter nonlinearly in (5), the estimation was carried out using an iterative procedure. Almon polynomial constraints were employed to estimate the distributed lag weights on past changes in prices. The distributed lag weights obtained from this regression were used to generate a time series for the expected rate of change of prices (PCPICE, equation 18.2). Because error terms are included in equations (2) and (3), two different estimates of r can be obtained. From the definitional equation (1) r can be estimated as x/v+PCPICE and from the reduced-form portfolio equation (3) we have r=RL-a-b(x+PCPICE*v)/h. In the absence of any information concerning the relative size of the errors, we simply took an average of these two expressions to obtain a time series for RHO. The corresponding real rate of return, RHOR, is then obtained by subtracting PCPICE.

G The Mortgage Market

Our model of the mortgage market consists of equations for the rate of interest on conventional mortgages (RMC, equation 17.8) and for the supply of mortgage funds by non-bank financial

institutions (equations 17.9 and 17.10). Supply functions for trust and loan companies and life insurance companies are specified in the form of lagged adjustment models explaining the flow of mortgage approvals. Direct lending by CMHC and chartered bank approvals are treated exogenously. We have not attempted to include an equation for banks because they were not active in the market for a major part of our sample period (1960-1966). During this period mortgage rates rose above the 6% ceiling then in effect on bank loan rates.

1 Mortgage approvals

The mortgage approval equations are based on a stock-adjustment model modified to allow for the forward commitment procedure whereby institutional lenders agree to advance mortgage funds considerably before their actual disbursement. In view of this lag between approvals and disbursements, the usual stock-adjustment model is clearly inadequate. Our modified model can be derived as follows. For any time period we can write:

$$a = c - J1L(c) + d$$

where a is approvals, c is outstanding commitments at the end of the period and d is disbursements. The latter two variables can be approximated as distributed lag functions of current and past approvals:

$$c = JW(a)$$

$$d = JW(a)$$

In a full steady-state equilibrium when the stock of mortgages is constant at the desired level, the stock of outstandings will be equal to some multiple, k, of the stock of mortgages, where k depends on the weights in the distributed lag function relating c to a. We thus postulate that approvals are related to the desired stock of mortgages, m*, in the following way:

$$a = \gamma[km^* - J1L(c)] + d$$

In equilibrium, we will then have approvals equal to disbursements and a constant stock of mortgages and outstanding commitments. Approvals will exceed disbursements if the outstanding stock of commitments is below the equilibrium level.

Substituting for c and d we obtain a relationship of the form:

$$a = \gamma km^* + JW(a)$$

The desired stock of mortgages is assumed to be proportional to assets with the factor of proportionality dependent on interest rates in the form of the differential between a simple average of the NHA mortgage rate (RNHA) and the conventional mortgage rate (RMC), and the yield on long-term Government of Canada bonds (RL).

An additional interest rate variable was constructed to allow for the effect of the ceiling rate on NHA mortgages. This

ceiling rate was an effective constraint until the end of 3Q67. In 4Q67 the ceiling rate was set at 2.25% above the long-term Government of Canada bond yield. Subsequently the ceiling was removed altogether. Assuming that this 2.25% spread approximated the threshold beyond which the ceiling was no longer an effective constraint, we represent the effect of the ceiling by the differential between the bond rate plus 2.25% and the NHA rate. This additional interest rate variable was then multiplied by a dummy (QNHA), which takes on a zero value after 3Q67.

Since approvals may be made on the basis of expected future inflows of funds, we also included the four-quarter rate of change of assets in the case of trust and loan companies and of policy loans in the case of life insurance companies.

2 The conventional mortgage rate

The equation for the conventional mortgage rate is based on a market adjustment equation in which the change in the rate is assumed to be a function of excess demand. Disequilibrium is assumed to involve some form of non-interest rate rationing that generates observations on the supply curve but not necessarily on the demand curve. Thus, the actual supply in the form of the flow of approvals is included along with variables assumed to determine demand. These demand variables include income, number of households, prices, the existing stock of houses, and QNHA, the dummy variable described above.

CHAPTER 10

THE LONG-TERM CAPITAL ACCOUNT

SECTORS 19-20

A Introduction

Sector 19 of RDX2 contains a set of equations explaining quarterly long-term capital movements between Canada and the United States, and between Canada and other countries. Sector 20 is composed of equations determining international indebtedness accounts that, in conjunction with the relevant rates of return, are used elsewhere in the model to explain the international flows of interest and dividends required to service international investments and changes in retained earnings. Sectors 19 and 20 refer only to the long-term capital account. Equations for the short-term capital account and the foreign exchange market are contained in Sector 21 and explained in Chapter 11; the interest and dividend equations are among the foreign trade relationships of Sector 4.

The equations for the capital account and the related current account items of the balance of payments can be used within RDX2 to indicate the balance of payments consequences of alternative domestic and foreign policies. The separate explanation of current and long-term capital account flows between Canada and the United States, and between Canada and other countries allows us to disaggregate the U.S. flows to a

greater extent in order to make use of the U.S. variables explained within the MPS model.

This chapter is divided into four further sections. In section B there is a brief outline of the theoretical framework employed. Section C contains explanations of the equations explaining long-term capital movements, section D is devoted to the asset and liability accounts, and section E contains our summary comment. Within section C, we discuss the equations in approximately the order in which they appear in the structure of RDX2.

B Alternative Theoretical Approaches

1 Debtor models vs creditor models

"Neither a borrower nor a lender be..." - life is more fun as a quasi-reduced form. In the case of most purchases of one country's securities or real assets by residents of another country, the available equations and data are based on the assumption that foreign holders of securities receive the same return as domestic holders of similar securities. There is one class of securities that may merit special attention - domestic bonds or shares having their capital value and/or interest or dividend payments set in terms of a foreign currency. U.S.-pay bonds and shares issued by Canadian borrowers, particularly bonds, are important examples. It would be possible, on the basis of some (fairly unrealistic) assumptions, to treat

separately the markets for Canadian-pay Canadian securities and for U.S.-pay Canadian securities, and to determine separate interest rates for each kind of security. There could be separate supply and demand equations for U.S.-pay Canadian securities, and the resulting quantity traded could be interpreted (if Canadians were assumed not to hold such securities as assets) as one component of the capital flow between Canada and the United States. In this case (examined in some detail by Freedman [20]) it is not necessary to combine borrower and lender behaviour into a single quasi-reduced form equation.

Except for the class of securities noted above, foreign-held Canadian securities do not represent a distinct commodity for which there can be independent supply and demand equations. The change in the quantity of Canadian securities held by foreigners therefore cannot be interpreted simply as the securities-demand equation of foreign lenders or the securities-supply equation of domestic borrowers, but must contain both supply and demand elements. We therefore refer to our capital flow equations as quasi-reduced form equations to emphasize that they must contain the relevant supply and demand variables.

When international portfolio behaviour is being modelled, any ambiguity about the nationality of the decision-maker raises statistical problems. In which country's currency should the flow be normalized in order to avoid heteroscedastic errors? If the flow is to be normalized by a portfolio growth variable, should the scaling variable represent the growth in the borrower's liabilities or in the lender's assets? Our split

between new issues and trade in outstanding securities helps to deal with these questions, but in some cases the questions remain unanswered. However, by distinguishing between new issues and trade in outstanding securities, at least in the equation for Canadian bonds held by U.S. residents, we were able to treat some flows as primarily borrower-determined and others as primarily lender-determined. Although these considerations influenced our choice of an estimating form for the equations, we have in all cases tried to include demand influences in the supplier-oriented equations, and vice versa.

2 Pure flow models vs pure stock models

Many of the earlier empirical studies of Canadian international capital flows are of the so-called pure flow variety. The dependent variable is a capital flow and the independent variables include a rate-of-return differential and perhaps other variables reflecting exchange rate expectations, risk, and requirements for funds. This formulation has been subjected to theoretical criticism because: (a) it ignores realignment of existing portfolios in response to a change in the international rate-of-return differential, and (b) in its usual form it implies a continuing capital flow in response to a given and unchanging rate-of-return differential even if lenders' and borrowers' portfolios remain unchanged in size. The theoretical defences of the pure flow model must rest, in the first case, on the existence of relatively high decision-making and portfolio-switching costs. In the second case the model can only be

defended as a linear approximation that is reasonably correct if the flow of new investible funds is relatively constant. These defences are not really adequate, because, even if all portfolio adjustment has to take place via portfolio increments, the existing size and structure of the portfolio ought to influence the allocation of portfolio increments in response to given rates of return. As for the second defence, there is really no need to treat a multiplicative relationship as though it were additive.

The pure stock theory, by contrast, makes the stock of an asset a function of a rate-of-return differential, and sometimes of the total wealth of the assumed investor. If this model is fitted in first-difference form, then the capital flow is the dependent variable with the independent variables being the change in the rate-of-return differential and the change in portfolio size. Depending on the functional form used for estimation, this model, like the pure flow model, can have unrealistic equilibrium properties. For example, if the equation were fitted in linear form with the stock of the asset held by foreigners as the dependent variable and with the rate of return and the size of the foreign portfolio as independent variables, then the equation would imply that the rate-of-return effect was independent of portfolio size. If no allowance is made for lags in the adjustment process, the pure stock model implies rates of capital flow that become infinitely large as the length of the observation period approaches zero.

If portfolio size variables are omitted, then neither the pure stock nor the pure flow model is theoretically appropriate. If the pure stock model is estimated with the stock taken as a

fraction of the relevant portfolio size variable, then the pure stock model can be appropriate with or without portfolio growth, but only if the portfolio adjustment is costless and immediate.

If lags occur in the portfolio adjustment process, then a theoretically appropriate model must contain some elements of both the pure stock model and the pure flow model. Increments to portfolios may well be allocated according to the pure flow model based on one sort of lag process, although realignment of existing portfolios may be better described by a pure stock model based on some other lagged adjustment process.

Neither the pure stock nor the pure flow model takes account of the difficulty, mentioned in the previous section, that at least two portfolio magnitudes are relevant to the capital flow - the borrower's debts and the lender's assets.

3 Stock-adjustment models with lagged responses

The discussion above suggests that total capital movements may depend on two lag processes operating in response to portfolio growth and to rate-of-return differentials. One advantage of the split between new issues (treated primarily as a borrower decision) and trade in outstanding securities (treated as lender behaviour) is that it may help to unscramble these two lag processes. Borrower equations can show how new issues are allocated to various lending countries in the light of current or slightly lagged rates of return on new issues. On the other hand, lender equations may show a much longer distributed lag process of adjustment (because of decision-making and transaction

costs) to the proportions desired in the light of rates of return and risk considerations. Retirements of securities and the flow of new issues determined by the borrower equations will directly influence the lagged stock of securities, which is an important variable in the lender equations.

Most of the lender equations reported in this chapter are based on the assumption that portfolios are adjusted according to a pattern of geometrically decaying distributed lag weights. This assumption gives rise to the familiar stock-adjustment model as the preferred estimation form.

4 Transactions costs, exchange rate expectations, and risk considerations

Transactions costs may introduce substantial nonlinearity into the effect of rate-of-return differentials on the international distribution of new issues and on the realignment of existing portfolios. The existence of such costs could lead, under appropriate assumptions, to smaller equilibrium portfolio proportions invested in assets with higher transaction costs and to different speeds of portfolio adjustment in response to rate-of-return differentials of different sizes. A threshold model might be used appropriately to describe the responses of an individual asset-holder to changes in rates of return. A model for the investment of portfolio increments might well be different than one for reallocation of existing portfolios, since the former involves only the costs of search and purchase whereas the latter involves the costs of sales transactions as well.

Even if a pure threshold model were applicable for an individual portfolio owner, its edges become blurred when aggregate portfolio responses are being estimated. The situation gets even more complicated if the range of substitute securities changes over time, or if changes occur in transactions costs or in the risk characteristics of the available securities. When attempting to construct a manageable and empirically testable model, one must make some simplifying assumptions to reduce the extent to which these complications influence the structure of the equations. In our experiments with various nonlinear rate-of-return variables designed to capture the influence of transactions costs, we implicitly assumed that representative national rates of return were the only variables interacting with transactions costs. Thus we could represent the effects of transactions costs by inelastic portions of the partial relationship between target portfolio proportions and international interest rate differentials, or supply price of capital differentials. The functional form we used was the same as that employed to represent the 'rules of the pegged exchange rate game' in our equation 21.1 for the official demand for foreign exchange. If R1 is the domestic interest rate, and R2 the foreign rate, the variable takes the form:

$$|R1-R2|/|C-(R1-R2)(R1-R2)|$$

The constant C is the square of the limit to the difference between R1 and R2, the point at which supply or demand becomes perfectly elastic. The values of C tested all had square roots

greater than the historical maximum for R1-R2. Although we tried a number of different values for the permissible range of the interest rate differential, these nonlinear formulations generally fitted less closely than the usual linear model that ignores transactions costs.

Exchange rate expectations, one may safely assume, are formed differently under pegged and floating exchange rates. Under a floating exchange rate system, each participant may have his own idea of a normal exchange rate based either on some autoregressive process or on forecasts of the presumed market forces. Under a pegged exchange rate system, a similar process may apply during 'normal' conditions, with an entirely different process coming into play when the exchange rate hits a support point and forces heavy official buying or selling of reserves. Furthermore, the kind of expectations process that is relevant depends on the nature of the capital flow. The issuer of bonds in a foreign currency is concerned about the likely change in the exchange rate between the date of issue and the date of retirement. The portfolio purchaser of securities, on the other hand, may be guessing about exchange rate changes within his planned holding period, which may be only a few days or a few months. In our equations we tried various ways of modelling exchange rate expectations, including building them into rate-of-return differentials. Only two of these ways were successful in confrontation with the data. We used special variables to represent particular times of doubt during the fixed exchange rate period, using the same formulation that plays such an important role in our model of the foreign exchange market.

During the flexible rate period, we obtained some slight help from the linear difference between the actual exchange rate and an assumed value of $1 Canadian = $1 U.S.

Subjective risk variables, which provide a theoretical rationale for two-way capital flows, do not appear in our models of capital movements except in the form of variables reflecting expectations about the likelihood of particular events. There are two reasons for this situation. On the one hand, a critical survey of the variables that have been suggested as 'risk proxies' usually shows these variables to be open to diverse interpretations and likely to represent a jumble of other factors. On the other hand, in the process of simplifying theory to the point where it can be tested with small data samples, researchers who have had to suppress third country rates of return and other important influences can fairly easily persuade themselves that the dispersion characteristics of subjective probability distributions of rates of return (and the relevant covariances) are either stable over time or so unstable that suitable proxy variables cannot be found.

C Equations for Long-Term Capital Movements

In several cases, particularly in dealing with capital flows between Canada and other foreign countries (i.e. excluding the United States), the available rate-of-return and portfolio size data did not permit us to disaggregate capital flows as much as might be theoretically desirable. In other cases aggregation was natural because the disaggregated flows are small. Where

disaggregation was undertaken, as in the case of Canadian government and corporation bonds sold to U.S. residents, we treat retirements of foreign-held domestic bonds as exogenous variables, since they are not generally responsive to current conditions and are fairly easily forecast from independent information. Aside from retirements and some official new issues, the exogenous categories of long-term capital flows are Columbia River Treaty payments, government loans and advances, export credits, and miscellaneous long-term items not included elsewhere. These latter items are combined as FIL012 and FIL013 in the balance of payments identities.

In this section we present first the equations for direct investment flows from the United States to Canada, from other countries to Canada, and from Canada to the United States. Direct investment by Canada in countries other than the United States is treated as part of an aggregate long-term capital flow to those countries. We then discuss portfolio capital flows from the United States to Canada. In the third part of the section we consider portfolio capital inflows from other countries to Canada. Finally, we deal with portfolio capital flows from Canada to the United States, and total direct and portfolio long-term capital movements from Canada to countries other than the United States.

1 Direct investment

The theory underlying the direct investment equations is that flows, e.g. from the United States to Canada, ought to

depend positively on the marginal efficiency of capital in Canada and the supply price of capital in Canada. The former influence is self-explanatory. The latter influence arises because funds from a U.S. parent company, or from U.S. financial markets, and funds raised in Canada represent alternative sources of funds for Canadian firms either controlled in the United States or ripe for takeover by a U.S. firm. Correspondingly, the direct investment inflow from the United States to Canada ought to depend negatively on the marginal efficiency of capital in the United States and the supply price of capital in the United States. Since the aggregate level of investment expenditure is explained elsewhere in the RDX2 and MPS models, taking appropriate account of the factors determining the marginal efficiency of investment, we can use the level of investment expenditure as a predetermined variable in the direct investment equations. Only in the case of direct investment flows from the United States to Canada were we able to capture the separate influences of the attractiveness of investment opportunities in the two countries and of the difference between the supply prices of capital in the two countries. Even in this equation, as in any bilateral capital flow equation, we ought to have been able to capture also the effects of changes in investment opportunities or the supply price of capital in third countries. This would be too much to expect, given the indivisibilities and special factors involved in direct investment decisions.

FIDI12 Direct investment in Canada from the United States (Equation 19.1)

Although we made in the previous section what we thought was a fairly clear distinction between borrower and lender behaviour, we are presented in our very first equation with an apparently special case. Direct investment decisions are lender decisions all right, but the model is set up with direct investment estimated as a ratio to the product of a four-quarter moving average of Canadian corporate requirements for funds weighted by the share of business assets financed by direct investment from the United States. The total requirement for funds is defined as business fixed investment expenditure minus the sum of corporate retained earnings and book depreciation allowances. Requirements for funds are defined net of internally generated funds to match the balance of payments definition of direct investment inflows, which are measured net of any funds provided by retained earnings.

The reason for this apparent jumble of lender and borrower behaviour is that the corporate requirements for external funds are the result of decisions made by all Canadian firms, including those controlled in the United States. Ideally, we should like to be able to treat the take-over portion of direct investment separately and to estimate the non-take-over segment as a ratio to the external funds requirements of only those Canadian firms directly controlled in the United States. Although the available data are not good enough to permit separate treatment of the take-over portion of direct investment, we attempted to relate the cash requirements variable to the proportion of business

financing normally provided by U.S. parent companies. This is done, as mentioned above, by multiplying the aggregate cash requirement by the ratio of the stock of U.S. direct investment (LDIRV12, measured at replacement value) to total Canadian business fixed assets and inventories (KB$, also measured at replacement value). If anything happens to influence the current share of investment financed by FIDI12, this will alter the ratio LDIRV12/KB$ and thus alter the share of new financing thereafter 'normally' provided by U.S. direct investment.

The main causal variables in the equation, in addition to corporate cash requirements, are a nine-quarter distributed lag on the difference between the nominal supply price of capital (RHO) and the corresponding U.S. variable (RHO2), and a U.S. requirement-for-funds variable. The U.S. cash requirements variable is the U.S. equivalent to the Canadian corporate cash requirements variable, divided by total personal savings. It might be argued that we ought to use the differences between the real supply prices of capital, RHOR and RHOR2, rather than the nominal figures. If RHO-RHO2 differs from RHOR-RHOR2, then expected price changes are different in the two countries. If exchange rates are pegged, or if there are other factors restricting expected movements towards purchasing power parity, then the RHO differential may be more appropriate than the RHOR differential.

The two remaining variables are EGUIDE covering the period of application of the U.S. balance of payments guidelines, and ZDEPREC covering the period of adjustment to accelerated depreciation allowances made available in mid-1963 to firms with

25% Canadian ownership or with shares listed on a Canadian stock exchange. In both cases the apparent response of direct investment may have been as much a preemptive response to expected future measures as a direct response to the actual measures. This is particularly likely to be so in the case of the U.S. guidelines, which did not explicitly apply to direct investment in Canada (except in 1Q68) unless it was being used as a means of passing funds through Canada for portfolio investment abroad.

FIDI13 Direct investment in Canada from other countries
(Equation 19.2)

Since there are so many 'other countries', it is not possible to obtain an equation taking adequate account of competing uses for funds. As with direct investment from the United States, the direct investment inflow from other countries is estimated as a fraction of Canadian corporate cash requirements. There are two differences to note in the definition of cash requirements. A four-quarter moving average is used for FIDI12, this being the shortest lag that eliminates the purely seasonal variation in cash requirements. By contrast, a twelve-quarter moving average provides much better results for FIDI13, suggesting less immediate links between expenditures and direct investment inflows from parent companies in countries other than the United States. The second difference is that the liability accounting for other countries is less detailed than that used for debts to the United States, so we use a variable (LDIPRV13/KB$) involving both direct and portfolio investment to

represent the share of new financing 'normally' provided from foreign countries other than the United States.

Since we were unable to develop an 'other countries' equivalent to RHO or RHOR, we took the U.K. long-term bond rate (RLUK) to represent the alternative supply price of capital, and used a distributed lag on the differential between RHO and RLUK spread over fourteen quarters. This distribution seems long, but it is empirically stronger than any of the shorter distributions fitted. The other variable in the equation is QOIL, accounting for the identified foreign financing (in 4Q62) of the takeover of a large Canadian oil company.

FODI12 Direct investment from Canada in the United States (Equation 19.3)

This flow is estimated as a proportion of the Canadian dollar equivalent of U.S. corporate cash requirements, which turns out to be the only determinant that is both theoretically and empirically important. QSALE is empirically important, but of little theoretical interest because it has only one positive observation, in 3Q66, to account for an identified sale of a large U.S. subsidiary by a Canadian corporation.

2 U.S. portfolio investment in Canadian securities

Dealing with portfolio investment from the United States, our first decision was to declare retirements of all foreign-held Canadian bonds and new issues of Government of Canada direct and guaranteed bonds sold to foreigners to be exogenous variables. Since most bonds are retired only when they are due, it is natural to treat retirements of bonds as predetermined, and to forecast them by means of specific information about maturity dates of large issues held by foreigners. New Government of Canada issues of bonds to foreigners, especially foreign-pay bonds, are properly regarded as policy variables, except to the very minor extent that foreigners purchase new government issues in the Canadian bond market. Indeed, the only Government of Canada foreign-pay issues of major size in recent years were occasioned by the 1962 and 1968 exchange crises.

Still to be considered are new issues of corporate bonds, new issues of provincial and municipal (P&M) bonds, trade in outstanding bonds of corporations, trade in outstanding bonds issued by each of the three levels of government, and portfolio transactions in shares of Canadian corporations. We separate new corporate and P&M issues because they depend on different factors. There are two reasons for separating trade in outstanding government and corporate bonds. First, the new issue equation for each sort of bond depends more on the stock of that category of bond in the hands of U.S. holders than on the stock of both sorts combined. Second, we need to keep government and corporate bonds separate to help define our series (RVB12) for

the percentage of Canadian business fixed assets and inventories owned by U.S. residents.

We turn now to a discussion of the individual equations.

FINIPM12 Sales of gross new issues of provincial and municipal direct and guaranteed bonds in the United States (Equation 19.5)

This flow is presumed to depend primarily on decisions of borrowers and is estimated as a proportion of total gross new issues of P&M bonds (GBRPM), a series explained elsewhere in the model. (See equation 14.11.) Some reasonable equilibrium properties are guaranteed in equation 19.5, since a zero value for the flow will be predicted when provinces and municipalities are not issuing any new debt.

Although we experimented with interest differentials as well as liquidity measures, we found that the U.S. borrowing ratio was more closely related to Canadian bank liquidity than to the interest differential. One reason for the insignificance of the interest rate series is that the two rates we employ are those on outstanding Government of Canada bonds (RL) and U.S. corporate bonds (RCB2), while in times of bond market tightness a large new issue might well have to bear a significantly higher interest rate than that obtaining on outstanding issues.

Our measure of the tightness of the domestic bond market is the indicator of credit availability explained in section D of Chapter 9. The variable is based on the difference between the earning liquid asset ratio of the chartered banks (RABEL) and its target value. The target value, RABELD, declines through time.

The U.S. borrowing proportion, which averaged about 22% between 1956 and 1968, was also apparently affected by the exchange rate uncertainty, or by the policy announcements of the federal government discouraging foreign borrowing, or both, at the end of the flexible exchange rate period. We have defined the relevant period (following Freedman [20] p.119) to be 3Q60 to 3Q62 inclusive. The coefficient on QLOBO indicates a substantial reduction in the borrowing ratio during this period.

The final variable used in both new issue equations is related to the U.S. Interest Equalization Tax. EIETB takes the values -.2 from 3Q63 to 3Q64 inclusive, followed by 1 in 4Q64. The negative values represent postponements of new issues during the period when it was not certain that Canadian issues would be exempt. The passage of the law and the granting of the exemption were followed by a spate of deliveries of new issues in 4Q64.

FINIB12 Sales of gross new issues of Canadian corporate bonds in the United States (Equation 19.6)

This equation is very similar in structure to that for provincial and municipal bonds. The borrowing requirements variable is more roughly defined, being a twelve-quarter moving average of gross business fixed investment expenditure minus funds generated internally by corporations. The use of shorter averages of cash requirements gave rise to less accurate explanations of the flow FINIB12. The main difference between this equation and equation 19.5 for new P&M issues is that in the equation for corporate bonds the borrowing ratio is lower for the entire flexible exchange rate period, but not especially so

during the time when provinces and municipalities were being discouraged from foreign borrowing.

In addition, the FINIB12 equation shows some lender response, because the stock of Canadian corporate bonds held at the end of the previous quarter by U.S. residents, measured as a proportion of U.S. household wealth, enters with a negative sign. The stock of debt is measured in millions of Canadian dollars and U.S. household wealth in trillions of U.S. dollars. This is the correct way of specifying the variable only to the extent that the debt is denominated in U.S. dollars. Otherwise, the U.S. equivalent of the stock of debt will change when the exchange rate changes. In equation 19.5 a corresponding variable was used but it had an insignificant coefficient with the reverse sign. This may indicate that the desired proportion of P&M bonds in U.S. portfolios has grown over time to a greater extent than that of corporate bonds. Conversely, it is possible that the Canadian market has become more inhospitable for P&M bonds than for corporate bonds. In case this were so, possibly because of the large amount of P&M borrowing, we experimented to see whether the proportion of P&M bonds or corporate bonds in domestic portfolios had an impact on U.S. borrowing ratios. We could detect no such influence.

FITOGB12 Trade in outstanding Government of Canada, provincial and municipal bonds between Canada and the United States (net sales to the United States)
(Equation 19.7)

This equation is simple and quite satisfactory. It is presumed to reflect lender behaviour, whether in response to new issues by Canadian borrowers or to changes in interest rates. The U.S. portfolio share devoted to Canadian bonds is assumed to depend only on the difference between Canadian and U.S. long-term interest rates. More precisely, the extent to which portfolio realignments take place through trade in outstanding bonds depends only on rates of return. An increase of 1 percentage point in the Canadian interest rate would lead, according to the equation, to a $57 million inflow of funds to Canada during the current quarter through trade in outstanding government bonds. The flows in succeeding quarters would become successively smaller as the proportion of U.S. portfolios devoted to securities issued by governments in Canada rose to its new equilibrium level.

Since this equation, like the other equations for capital flows from the United States, contains the lagged stock measured as a proportion of U.S. wealth, the implication is that an increase of U.S. wealth would lead to net purchases of outstanding Canadian government bonds even if interest rates remain constant. But if new P&M issues in the United States were so large as to make the stock of Canadian government debt held in the United States rise at a faster rate than U.S. wealth, then there would be, for given interest rates, continual sales to

Canadians by U.S. residents of these outstanding government securities.

FITOBB12 Trade in outstanding Canadian corporate bonds between Canada and the United States (net sales to the United States) (Equation 19.8)

As with the trade in outstanding government bonds, this flow depends on the Canadian-U.S. long-term interest rate differential and on the lagged stock of Canadian corporate bonds divided by U.S. household wealth. In addition, the trade depends on two exchange rate expectations variables. The first, PFX-EPFXE, is equal to the exchange rate (in Canadian dollars per U.S. dollar) minus 1 until 3Q61, equal to zero during the period of exchange rate uncertainty (4Q61-3Q62), and equal to the exchange rate minus 1.081 from 4Q62 on. When the foreign exchange rate is above its supposed 'normal' value, there is an increased incentive to buy Canadian-pay securities in order to obtain capital gains when the Canadian dollar regains its 'normal' strength. The variable assumes 'par psychology' during the flexible exchange rate period and 'peg psychology' during the fixed exchange rate period. The quantitative importance of the variable is not great, leading to an initial flow response of $2 million per quarter for each cent that the exchange rate deviates from 'normal'. This may be compared with the initial interest effect of $6 million for a percentage point increase in the interest differential. The second exchange rate variable is the speculation variable, EF68E, taken from the foreign exchange model. In equation 19.8, EF68E indicates a $6 million capital

outflow in 1Q68 and a corresponding inflow in 2Q68. By contrast, its impact in the equation for the private demand for foreign exchange is almost 100 times as great.

The equation also contains a variable covering the flexible rate period, indicating slightly greater purchases of Canadian bonds at that time. This effect, which is not significant, may well be due to the exchange uncertainty of 1961-1962 followed by the U.S. Interest Equalization Tax in effect from mid-1963. Special variables for the IET were tried without success in this equation. The effect of the IET may well be to reduce the amount of gross sales and purchases of outstanding Canadian securities between Canada and the United States without altering the net flows appreciably.

FIPVB12 Purchases of Canadian corporate shares on a portfolio basis by U.S. residents. Gross new issues, less retirements, plus trade in outstanding shares (Equation 19.9)

This equation presents the classic problem of explaining large but industry-specific capital movements in the context of an aggregate model. The net flow series shows continous inflows to Canada until 1Q61 followed by almost continuous outflows until 2Q67 and then steady inflows until the end of the data period, 4Q68. If the net inflow to Canada in the late 1950s was a hangover from the Canadian resource-based boom in the mid-fifties and the outflow in the 1960s a consequence of disillusion and tax changes, what is the best way to explain these flows within the context of an aggregate model? Even with much more

disaggregation, we would no doubt find it difficult to explain the changing fashions of investor psychology by means of actual industrial achievements.

Only after adjusting the equation to account for a number of specific factors were we able to relate the flow to relative rates of return and portfolio growth. We fitted the equation as a change-in-stocks model with separate lag patterns for the change in the rate-of-return differential and the change in U.S. household wealth. In the light of the model adopted, which fits better than the stock-adjustment model using the lagged stock, the rate of return appears as a four-quarter distributed lag on first differences of RHOR-RHOR2, and a six-quarter distributed lag on changes in U.S. household wealth. In this equation, the RHOR differential fits better than the RHO differential, suggesting that portfolio purchasers may have a time horizon long enough to take account of price expectations but not long enough to envisage a re-pegging of the exchange rate as a consequence of the differing rates of inflation. The variables allowing for special factors include: QMIDEAST, which accounts for purchases of Canadian oil shares in the last half of 1967 because of the Middle East war; QUSTAX, which accounts for portfolio realignments following removal of U.S. tax provisions favouring mutual funds holding foreign equities; and QBROKE, which represents sales of Canadian shares during 1965 in reaction to the bankruptcy of Atlantic Acceptance, a major Canadian finance company.

To ensure that the equation would have reasonable stock equilibrium properties, it was estimated without a constant term.

If the equation had been allowed to have a constant term, this term would have indicated changes over time in portfolio composition even when portfolio sizes, rates of return, and all the other supposed determinants were held constant.

3 Portfolio capital inflows from other countries

We have made only a two-way split here, between government and all other Canadian securities. This split enables us to define our variable for the net wealth of residents as well as to calculate the market values of international indebtedness. Both series encompass new issues, trade in outstanding securities, and retirements.

FIGB13 Sales of Government of Canada, provincial and municipal bonds in other countries. Gross new issues, less retirements, plus net trade in outstanding bonds (Equation 19.10)

This flow was rather small (the largest observation was an outflow of $34 million during the exchange crisis in 2Q62) and our basic interest rate and lagged stock variables do not explain a very large proportion of its variance. The interest rate differential we employ is the Canadian long-term rate (RL) minus the U.K. long-term government rate (RLUK). The initial inflow response to a 1 percentage point increase in RL is about $12 million, with an unrealistically high eventual equilibrium stock change indicated by the very small coefficient on the lagged stock of bonds held. In this equation, as in all our equations

for capital flows to and from other countries, an aggregate that excludes only the United States, we are handicapped by lack of adequate foreign rate-of-return and portfolio size variables.

The large 1968 offerings of government bonds of Canadian issue in Europe are accounted for, rather than explained, by two separate variables. The first, the policy variable ZEUROF, is the $175 million ($ Canadian equivalent) Government of Canada second-quarter borrowing in Lire and Deutsche Marks. The second variable, QEUROPM, has the value 1/3 in 2Q68 and 1 in 3Q68. QEUROPM is intended to capture the demonstration effect that these federal bond issues had on P&M borrowing in Europe between June and September. (Hence 1/3 in 2Q68 and 1 in 3Q68.) The incentive effect was offset after that time, we assume, by the tightening of the German financial markets after revaluation of the Deutsche Mark. At any rate, the borrowing did not take place in 4Q68 on anything like the same scale as in 2Q68 and 3Q68.

FIBL13 Sales of Canadian corporate bonds and shares in other countries. Gross new issues, less retirements, plus net trade in outstanding bonds and shares (Equation 19.11)

This equation is based on the lagged stock of Canadian private securities held by residents of other countries, Canadian corporate cash requirements as defined in equation 19.6, and the nominal supply price of equity capital in Canada (RHO). We were unable to develop a satisfactory corresponding supply price of capital in the United Kingdom, so the Canadian rate appears on its own.

The initial inflow response to a 1% increase in the supply price of capital in Canada is about $19 million, with an eventual total portfolio stock adjustment of about $770 million.

4 Portfolio flows from Canada to the United States and total flows from Canada to other countries

FOPL12 Purchases of U.S. bonds and shares by Canadians. Gross new issues, less retirements, plus net trade in outstanding bonds and shares (Equation 19.12)

This equation is estimated in terms of U.S. dollars, employing a stock-adjustment formulation wherein the lagged total value of Canadian long-term claims on the United States (A12) is included as a fraction of V, the total market value of the net worth of Canadian residents. The rate-of-return differential is RHO-RHO2, and its coefficient shows a U.S. $9 million initial response for a 1 percentage point change in RHO. It is frequently argued that the large Canadian purchases of U.S. shares in the mid-1960s were due to the unavailability of Canadian shares in the electronics and other highly technological industries showing large increases in share prices during this period. Since many of these industries are defence-related, we used a fourteen-quarter distributed lag on U.S. military prime contracts for defence goods (ODG2) as a proxy for the mix of incentives causing Canadians to purchase these shares.

FOL13 Long-term direct and portfolio investment in bonds and shares in other countries from Canada (Equation 19.4)

The model employed here, as in the case of U.S. purchases of Canadian shares, is a change-in-stocks formulation. Thus the independent variables include changes in the determinants of the stock of FOL13 and the constant term is suppressed.

To capture the incentives to invest both directly and in portfolio form in OECD countries, we used the MPS model index of OECD capacity utilization (XBCF2) to reconstruct the series for OECD industrial production. We then used an eighteen-quarter distributed lag on the changes in OECD industrial production and found it to take a humped distribution with the greatest weight between two and three years back. This may be taken to represent a crude accelerator investment model for the direct investment component, which is about two-thirds of the total flow. Domestic portfolio growth is represented by the current change in V, the market value of private sector wealth. Neither the Canadian investment opportunities variable, nor the supply price of capital in Canada helped to explain the flow.

D Accumulation of Asset and Liability Accounts

The equations described in the previous section explain all the components (except some bond retirements and other miscellaneous exogenous items) of the long-term capital account of the Canadian balance of payments. These equations depend heavily on accumulated international assets and liabilities, as

do the equations in Sector 4 explaining international receipts and payments of interest and dividends. If RDX2 is to simulate the balance of payments consequences of various policies accurately, the important international asset and liability accounts must be made endogenous to the model. This we have done in Sector 20. The requirement however, raises a number of serious difficulties.

Consider first the lesser problem of accumulating series for foreign holdings of government bonds. Such series ought to be expressed in terms of market value or book value, in either case measured uniformly in terms of a single currency. Even if these data were available, it would be no easy task to calculate the supposed interest payments. Were a book value of debt used, the relevant interest rate series would be a lengthy or extensive average of interest rates on new issues, weighted by the relevant flows, taking due account of retirements. This is roughly the procedure followed in our equation 4.16 for interest payments to the United States. If the market value of debt were used, the interest payments would not be equal to the current yield times the current value of the debt, since the debt would include many bonds valued above or below redemption price, implying that some of the yield must be attributable to changes in capital value rather than interest payments. A prior problem is involved in measuring the debt in terms of a single currency. Our disaggregation is by country of residence of debtor and creditor, with no note taken of the currency in which the debt is denominated. Although one could split the new issues by currency, no corresponding split of trade in outstanding bonds or

retirements is possible, so that any vintage accounting by currency would soon go astray. In our accounting for the book value of Canadian government debt (bonds issued or guaranteed by either federal or P&M governments, LGB12, equation 20.1), we have merely accumulated the balance of payments flows. This procedure will misstate the debt owing, on retirement, for foreign-pay issues if changes occur in the exchange rate between issue and redemption.

Whatever the problems of accumulating government debt held abroad, they are dwarfed by those of handling claims on business assets. In dealing with Canadian claims on non-residents, we explain only aggregate flows, and have no appropriate scheme for valuing business assets in the debtor countries, so we accumulate balance of payments flows to determine claims on the United States (A12, equation 20.7) and other countries (A13, equation 20.8). This procedure forces us to ignore changes in market values and exchange rates subsequent to the date of investment, but because of data limitations we have scant alternative. The consequences of mismeasuring Canadian assets are not great, because the book value of Canadian international long-term assets (A12+A13) was only 18% as large in 4Q68 as the book value of Canadian liabilities. All the asset and liability accounting described above ignores short-term capital flows, since they are only available on a net basis and therefore unsuitable for addition to the gross indebtedness series.

We can accumulate Canadian business indebtedness to U.S. and to other foreign investors using more appropriate methods of valuation. In preliminary versions of RDX2, we valued

liabilities to foreigners investing in Canadian companies at either balance of payments book value or at imputed share market value. The latter valuation involved splitting the total market value of business fixed assets and inventories (VKB) into resident-owned and foreign-owned components on the basis of interest and dividends paid to domestic and foreign residents. The book value measures were unsatisfactory because they ignored changes in the value of assets after the date of original investment. Using the interest and dividend series to split market values begs the main issue, because a sensible model must contain some mechanism explaining interest and dividends paid to foreigners in terms of some underlying liability accounting. Thus we had to fall back on our unsatisfactory book value measures of liabilities in our initial explanation of interest and dividends paid to foreigners.

We have recently substantially improved the accuracy and theoretical appeal of our liability accounting by adopting the replacement value basis developed in the course of research on the Australian balance of payments [35]. There is more detail in our treatment of liabilities to the United States, so they will be explained first.

Liabilities to U.S. residents investing in Canadian business assets arise from direct investment, portfolio investment in Canadian shares, and portfolio investment in bonds issued by Canadian corporations. The liability on direct investment account (LDIRV12) is obtained by adding the direct investment inflows (FIDI12) and retained earnings on direct investment (FIYCRE12) to a stock revalued each quarter according to changes

in the replacement price of business fixed assets and inventories. This procedure, which is shown in equation 20.4, is based on the assumption that U.S. direct investors have, on average, zero net financial assets in Canada, and acquire buildings, machinery, and inventories in roughly the same proportions as do other purchasers of Canadian business assets. This assumption is not strictly correct, because the industrial mix of direct investment by foreigners is different from that for investment by resident-controlled firms. However, the assumption is sure to be more accurate than the zero revaluation assumption implied by accounting based on balance of payments book values.

The retained earnings series used in the accumulation is obtained by spreading the annual figures (recorded in the balance of indebtedness [91]) according to the quarterly variance of total corporate retained earnings. The series is determined within the model by equation 19.13 for FIYCRE12. Here the sum of that portion of dividends estimated to apply to cumulated direct investment and total retained earnings accruing to U.S. direct investors is explained by the product of total after-tax profits and the ratio of LDIRV12 to the replacement value of total business assets. The retained earnings appear only in the liability accounting of the model because the Canadian balance of payments statistics [11] do not include them as current account outflows and capital account inflows.

The liability to portfolio investors in Canadian equities (LPCV12) is treated differently from direct investment, because there is no series for retained earnings attributable to portfolio investors. Thus the periodic revaluation of the

liability must take account of the rate of retention of earnings as well as of the rate of increase in the replacement price of business assets. This is done in equation 20.3, on the assumption that U.S. portfolio investors own shares of firms with average retention rates.

Separate accounting for Canadian corporate bonds held by U.S. residents is made possible by the equations for new issues and for trade in outstanding bonds. Equation 20.2 for LCB12 uses these series, along with an exogenous series for retirements, to accumulate the liability from the balance of payments flows. The separate accounting for bonds and shares held by U.S. residents permits the estimation of separate equations for interest and for dividends as described in Chapter 4.

Liabilities to other foreign holders of Canadian business assets are accumulated at a more aggregated level using procedures that are more approximate than those referred to above. Direct investment flows (FIDI13), retained earnings of direct investment (FIYCRE13), and portfolio purchases of bonds and shares (FIBL13) are accumulated and revalued (in equation 20.5 for LDIPRV13) on the assumption that the value of the liability increases at the same rate as the replacement price of business assets. This represents too much revaluation for bonds and too little for portfolio shares; we hope that these offsetting errors are not far different in amount. The relatively small size of the components discourages us from disaggregating to allow more accurate revaluation. The aggregate liability series LDIPRV13 is used along with the corresponding series for government bonds (LGB13, equation 20.6) to explain the

combined series for interest and dividend payments (MID$13, equation 4.20).

In addition to their roles in explaining interest and dividend payments and capital flows, the various liabilities to foreigners investing in Canadian companies are used, as a ratio of the replacement value of total business fixed assets and inventories, to remove from household wealth the foreign-owned portion of the share market value of business fixed assets and inventories (VKB). These 'foreign ownership' ratios, RVB12 and RVB13, are defined in equations 20.9 and 20.10. The liability to U.S. investors includes the book value of company bonds (LCB12), the stock of portfolio equities (LPCV12) revalued for retained earnings and price level increases, and the stock of direct investment (LDIRV12) including retained earnings revalued according to increases in the price of business assets. The liability to other foreign investors is the accumulated sum of direct investment inflows, net portfolio purchases of business bonds and equities, and retained earnings on direct investment.

E Summary and Evaluation

We used different theoretical models to explain the major components of the long-term capital account of the balance of payments. In most cases the differences were dictated by the nature of the flow being explained. In all cases we insisted that the chosen equations have acceptable equilibrium properties according to the theory of allocation of growing portfolios.

Sometimes the imposition of these theoretical desiderata has a substantial cost in terms of goodness of fit. For example, when equation 19.6 for sales of gross new issues of corporate bonds in the United States is solved for the flow FINIB12, the calculated series explains only 22% of the variance of the actual flow from 1Q57-4Q68. We do better for the other major flows estimated as ratios - explaining 72% of FIDI12, 48% of FIDI13, 65% of FODI12, and 74% of FINIPM12. We hope that eventually it will be possible to build models with good fit and good theory to explain all the major capital flows. In the meantime, we are satisfied with the theory and fit of most of the equations, and prefer theory to fit for the remainder, hoping thereby to obtain reasonable simulation properties.

It is interesting to note the long adjustment lags in most of the equations for trade in securities (e.g. FITOGB12, FITOBB12, FIGB13, and FIBL13). The slowness of the implied portfolio realignment perhaps explains why pure flow models of capital movements have often dominated their alternatives in terms of goodness of fit. We have gone further than other researchers in our attempts to develop and use appropriate portfolio size and rate-of-return variables, and have still found in some cases that our stock-adjustment models produced results not very different from those of a pure flow model.

Although the results of simulations of the long-term capital account will be presented at a later date, we can present here an assessment of the explanatory power of our equations treated in groups for the period 1Q57-4Q68. Our equations for capital inflows (the FI equations), along with the exogenous retirements

series, explain 72% of the variance of the flows between Canada and the United States and 77% of that between Canada and all countries. The equations for capital outflows (the FO equations) explain 68% of the flows between Canada and the United States and 69% of the flows between Canada and all countries. If net long-term capital flow series are constructed from the calculated values for all the FI and FO components, they explain 57% of the variance of the net flow between Canada and the United States, 84% of that between Canada and other foreign countries, and 68% of that between Canada and all countries. Even if these net series were less close-fitting than alternative equations for the net flows, we should still prefer our sets of disaggregated equations because we can accumulate assets and liabilities separately, and split them between the United States and other countries to facilitate our policy simulations and our bilateral linkage of RDX2 with the MPS model of the United States.

CHAPTER 11

FOREIGN EXCHANGE RATES, OFFICIAL RESERVES, AND SHORT-TERM CAPITAL FLOWS

SECTOR 21

A Introduction

The growing literature on international short-term capital movements generally considers the dealings of private traders, speculators, and arbitrageurs, separately or together, but ignores governmental activities. It is usually assumed that the policy authorities determine either a fixed rate of exchange or a change in the level of foreign exchange reserves, with the value of the other factor left to be determined subsequently by market forces. Most of the empirical work on short-term capital flows is based on so-called fixed exchange rate systems in which there is an official commitment to buy or sell foreign exchange to keep its price within prescribed limits.

In this chapter we describe our model of the Canadian foreign exchange market operating under a pegged exchange rate system from 1Q63 until the Canadian dollar was floated in 2Q70. We believe that a realistic model of a pegged exchange rate system must explain the movements of both short-term capital and foreign exchange rates taking into account the interdependence of the private and official demand for foreign exchange. Although most of the usual studies are of short-term capital movements

(e.g. [6], [43], [52]), we estimate the private demand for foreign exchange. If trade and long-term capital flows are predetermined, as they usually are assumed to be in studies of short-term capital flows, the balance of payments identity can then be used to convert an estimate of short-term capital flows into an estimate of the change in reserves, or vice versa. The major difference between our approach and other approaches lies, therefore, not in the use of an equation determining the private demand for foreign exchange instead of an equation for private short-term capital movements, but in the use of separate equations for private demand and official demand that then interact to determine the exchange rate and the change in foreign exchange reserves.

In section B we describe the RDX2 equations for the foreign exchange market under a pegged exchange rate system. We conclude, in section C, with a discussion of our proposed method for determining the exchange rate and short-term capital flows under a flexible exchange rate system.

B The Foreign Exchange Market under Pegged Exchange Rates

The theory on which our model is based [27] applies equally to markets for foreign exchange of all delivery dates. For each market any number of separate demand equations may interact to determine an exchange rate and the change in the asset balance of each identified participant. In empirical application, however, one can estimate demand equations only where a substantial number

of market transactions are recorded in data series for quantities traded. Under a pegged exchange rate system, the change in official reserves may have sufficient variance to allow estimation of separate private and official demand equations for foreign exchange. It is more difficult to find promising series of the quantities of forward exchange traded. The foreign exchange authorities are not such regular participants in the market as are the private traders and even when official dealings are frequent the available data do not indicate the maturity structure of official forward exchange transactions. Thus we have been forced to represent the forward exchange market by a single reduced-form equation for the price of foreign exchange for 90-day delivery (PFXF). PFXF is measured in terms of the cost in Canadian dollars of one U.S. dollar.

Our model of the market for spot exchange consists of two excess demand equations and a market-clearing condition. These three equations can thus be solved, given the forward exchange rate, for the change in official reserves (FXO), the private demand for foreign exchange (FXP), and the spot price of foreign exchange (PFX).

FXO Official excess demand for spot exchange

(Equation 21.1)

This equation is our attempt to picture the process whereby the official foreign exchange reserves are managed in a system under which the exchange rate is pegged between two official support points. The behaviour modelled is that of the Canadian foreign exchange authorities, since it is they (and not the

foreign exchange authorities of the United States or some other country) who made the undertaking to maintain the exchange rate linking the Canadian and U.S. dollars. Thus it is the Canadian official purchases and sales of foreign exchange that provide the basic data on quantities traded. The equation must show how the official demand for reserves becomes infinite as the price of foreign exchange reaches its lower support point and the supply becomes infinite as the upper support point is approached. Between those two points there is room for other factors to come into play.

Our equation supposes that the official demand for foreign exchange is influenced by the target level of reserves (where applicable), a nonlinear approximation to the exchange rate rule, a variable reflecting additional willingness to support the Canadian dollar when it is weak, and a desire to 'test' the strength of the market at any time when the spot exchange rate moves through par. The exchange rate target (ZRESD), which applied from mid-1963 until 4Q68, was based on agreements between the U.S. government and the Canadian government. The two exchange rate variables are new to our current equations. The nonlinear variable is symmetric about 1.081, the midpoint of the permissible range of variation. It reaches plus infinity at 1.09 and minus infinity at 1.072. These extreme values are interpreted as the wholesale equivalent of retail prices at the permissible limits of 1% on either side of par. The second variable, reflecting asymmetry in exchange rate support policy, is always negative or equal to zero. It takes nonzero values only when the exchange rate is above 1.080, and these (negative)

values decrease linearly with the excess of the actual exchange rate over 1.080. The starting point for this variable was chosen after we experimented with a range of alternatives. In combination with the reserve target and the trading strategy variable, the two exchange rate variables explain 85% of the variance in the official demand for reserves. This is a substantial improvement in the fit of the model compared to the results from earlier experiments [27] using a shorter data period.

FXP Private excess demand for spot exchange

(Equation 21.1)

Private participants in the exchange market are assumed to be influenced by the volume of trade and long-term capital flows, the spot and forward prices of foreign exchange, the representative short-term interest rates in international centres, and the lagged stock of net short-term international liabilities. We have qualitative variables to represent the effects of the U.S. Interest Equalization Tax, and the speculative capital outflow from Canada in 1Q68 as well as the reversing inflow (assumed to be of equivalent size) in 2Q68. An additional variable accounting for the U.S. balance of payments guidelines was tried but it did not improve the fit of the RDX2 version of the FXP equation, although it appears in the 'pure flow' version reported in [31].

Collinearity among the various interest rates, between the spot exchange rate and forward exchange rate, and between most international interest rate differentials and the forward-spot

exchange rate differential forced us to impose some restraints on the generality of the model in order to obtain sensible parameter estimates. In particular, we constrained these variables to enter in the form of a covered interest rate differential, positive if in favour of Canada. We tried several experiments in which the interest rate differential and the forward exchange rate differential were allowed to have different effects, but the results were inferior to those of the constrained version. As a Canadian rate we use the short-term Government of Canada bond rate (RS). In an attempt to capture the changing relevance of domestic U.S. interest rates and the Euro-dollar rate, we developed a weighted average of the U.S. 90-day treasury bill rate (RTB2) and the 90-day London Euro-dollar deposit rate (REUR). The basic weights depend on the size of the Euro-dollar deposit market in relation to the U.S. time deposit market. In addition, further weight is attached to the Euro-dollar rate when it is high relative to the U.S. Certificate of Deposit rate (RCD2), i.e. when Regulation Q starts to hinder seriously the ability of U.S. banks to bid for domestic deposits. This very complex interest rate does not explain the sample period data any better than a simple Canadian-U.S. covered interest rate differential, but the complex rate is much better suited to explain the massive 1969 flows out of Canada to the Euro-dollar market.

To capture the influence of trade and long-term capital flows, the equation contains a two-quarter average of the trade and long-term capital balance and also the average of net short-term liabilities outstanding between Canada and the rest of the

world at the end of the two preceding quarters. The coefficients of -.22 on the trade balance variable and .13 on the cumulated short-term liabilities imply that any change in the trade balance will be half cleared through the foreign exchange market by the time one year has passed. The significant positive coefficient on the stock of short-term liabilities implies that any change in the trade balance will eventually lead to a corresponding purchase or sale of foreign exchange.

Since the long-term capital flow equations of RDX2 are based on the assumption that neither pure flow nor pure stock theories of capital movements can be correct in conditions of general portfolio growth, one may ask why the desired stock of short-term liabilities is not affected, in the FXP equation, by portfolio growth. The reason for the different approach in the foreign exchange market is that our short-term indebtedness figures are, unfortunately, net rather than gross. Gross claims, whether short- or long-term, of the residents of one country on residents of another country might well be a function of portfolio growth, but net claims are a different matter. The desired net short-term liability of one country to others is the linear difference between two growing series. This difference may or may not itself be growing, depending on the size, the rate of growth, and the equilibrium portfolio proportions in each of the countries. There is no presumption that the desired net short-term foreign liabilities should either grow or decline with growth of Canadian or foreign population, wealth, income, or trade.

The interest rate coefficients in the FXP equation suggest an inflow, in response to an increase of 1 percentage point in

the covered interest rate differential, of about $135 million in the first quarter, $220 million in the second quarter, $200 million in the third quarter, $170 million in the fourth quarter, and so on in diminishing amounts until the stock of short-term liabilities reaches a new equilibrium about $1,750 million higher than its initial position.

All one can tell from these single equation results is what the response would be to a given increase in the covered interest rate differential. To investigate the effects of an initial change in the uncovered interest rate differential, one must take account of induced changes in the forward exchange rate and the spot exchange rate. The effect on the forward rate can be deduced from its own equation, whereas the net impact on the spot rate can only be discovered when all the equations of the model are jointly solved.

PFXF The 90-day forward exchange rate (Equation 21.3)

This is a reduced-form equation, so it ought to include the determinants of both the private and official demand for forward exchange. The private demand is represented by a four-quarter moving average of the balance of trade and long-term capital flows, the interest rate differential, and variables reflecting the surge of speculative purchases in 1Q68. Since the official strategy of forward market operations is not governed by any easily specified rules, we have used instead the actual level of official purchases in the forward market as the measure of official demand. Assuming that the policy itself does not depend directly on the price (consistent estimation should reveal the

extent of this reverse influence), the coefficient tells how much the forward rate will alter as a result of a given quantity of official forward purchases in the current quarter.

The coefficient on the interest rate differential indicates that induced forward rate movements will directly offset slightly less than 60% of any increase in the covered interest rate differential induced by a change in interest rates. This is a partial effect, ignoring any repercussions through the spot exchange rate.

PFX Equilibrium condition in the foreign exchange market, used to determine the spot exchange rate, PFX (Canadian dollars per U.S. dollar) (Equation 21.4)

We postulate that the foreign exchange market clears continuously, and hence that the sum of private and official demand for foreign exchange equals zero. This assumption permits us to use the measured and adjusted series for the change in reserves as the dependent variable for both the private and official demand equations. The private demand equation implicitly 'explains' the behaviour of all private participants plus any governments outside Canada entering the Canadian foreign exchange market.

FIS Balance of payments identity used to determine short-term capital flows as a residual (Equation 21.5)

ULS Net international short-term liabilities outstanding between Canada and the rest of the world (Equation 21.9)

In equation 21.5 we apply the balance of payments identity to determine short-term capital flows (in millions of Canadian dollars) as the Canadian dollar equivalent of the official purchases of foreign exchange minus the balance on trade and long-term capital accounts.

Short-term capital flows (in millions of U.S. dollars) are accumulated in equation 21.9 for ULS.

URES Canadian foreign exchange reserves (Equation 21.8)

Here official reserves are shown as the cumulant of official purchases plus two variables (ERES1ADJ and ERES2ADJ) adjusting for some transactions that altered the level of reserves without influencing the foreign exchange market. (See [31] for a description of ERES1ADJ and ERES2ADJ.)

Forecasts and policy simulations using the model described above, and an alternative model based on a pure flow theory of private short-term capital movements, are reported in [31]. Both versions give fairly accurate solutions for both exchange rates and for the change in reserves during the twenty-four quarter fitting period. The version used in RDX2 has a root mean square error of the solution values for the spot exchange rate of .153 cents, about half the standard deviation of PFX during that period. Outside the fitting period, the stock-adjustment version used in RDX2 fares much better than the alternative pure flow version.

C The Foreign Exchange Market under Flexible Exchange Rates

The model described above is appropriate only for the period during which Canada was on a pegged exchange rate, 3Q62-1Q70. When using RDX2 for simulation in the adjacent periods of floating exchange rates, some alternative procedure must be developed.

Our theoretical model is equally applicable to fixed and floating exchange rate regimes (as shown in [27]), but empirical implementation is more difficult under a flexible exchange rate system. The fact that trade and long-term capital flows are influenced by the larger movements of a flexible rate raises no problems. It is merely necessary to solve the trade and long-term capital flow equations jointly with the private and official demand for foreign exchange. The main problem arises from the likelihood that the foreign exchange authorities are not very systematic traders in foreign exchange under a flexible rate system. As we have already noted, if little or no systematic official trading takes place, no suitable data exist on which to base our FXO and FXP equations.

In RDX1 we had an explicit equation for short-term capital flows, and treated the foreign exchange rate as exogenous. To leave a floating exchange rate unexplained is not desirable in a model designed to capture external influences. So we prefer to have a reduced-form equation for the exchange rate and to treat the change in foreign exchange reserves as an exogenous policy variable. This means that short-term capital flows would be obtained as a residual from the balance of payments identity.

CHAPTER 12

HOW THE MODEL WORKS

A Introduction

In this chapter we hope to make the model as a whole come to life by tracing a few of its main chains of causation, presenting the results from some preliminary simulations, and outlining the broader range of experiments now planned. We have developed programmes for data assembly, model estimation, and simulation that allow models as large as RDX2 to be handled with some facility. A substantial problem remains in grasping the extent and relative importance of the various interactions within the model. Lacking such a grasp, the user will work for the model rather than have the model work for him. All the benefits to be derived from a large quantitative model can only be realized when its basic mechanisms are understood and their relative importance is clearly established.

In section B we discuss a few of the model's mechanisms, and in section C we present some preliminary evidence of their relative importance. We outline in section D our plans for a more complete set of experiments designed to tell us about the model so that it can then tell us about the real economy.

B Some Chains of Influence

We shall use an increase in government expenditure to illustrate certain interesting features of RDX2. Some of the chains of influence mentioned here will be quantified by the results reported in the next section. Consider the effects of a sustained increase in federal government current nonwage expenditure (GCNWF). The lack of a specific assumption about how this expenditure will be financed implies that any resulting net use of funds will be met by increasing the supply of treasury bills (LGFTB). The immediate effect of such expenditure is to increase the aggregate demand variable UGPPA. Part of this increase in demand will be met by running down inventories (via their buffer-stock role), and the degree of utilization of capital and labour will increase (via increases in average weekly hours). There will also be some increase in employment. This increase in employment will lead to increases in total wages, partly because of small increases in the quarterly wage rate. The increase in UGPPA will produce upward pressure on various final demand prices, while the increase in short-term labour productivity will push in the opposite direction. Increases in UGPP and PGPP comprise an increase in their product YGPP. This causes corporate profits to increase, offset to some extent by the increase in business wage payments.

Increases in domestic prices and the rate of domestic capacity utilization cause imports to rise and exports to drop.

The supply price of capital (RHO) is subject to a number of conflicting forces. Both the increase in the supply of

government debt relative to real assets and the increase in profits cause the value of the business capital stock (VKB) to rise; the higher interest rate causes VKB to fall. RHO will fall if the value of the business capital stock rises proportionately more than after-tax profits. This condition is not exact, for it depends on induced changes in PCPICE.

In the government sector there will be increases in personal and corporate income taxes, along with increased revenues from other taxes and from the Unemployment Insurance Fund. Federal government employment in administration is decreased in the light of the decrease in the general unemployment rate, but offsetting upward pressures are generated by increases in real personal income. The net impact of these changes is likely to offset currently only a small part of the cost of the initial expenditure.

As for the initial increase in government debt, it will be lodged in private portfolios only if short-term and long-term interest rates on government debt increase, or if there is an expansion of the banking system. If we suppress the central bank reaction function, and suppose the monetary base to be constant, then higher interest rates on government debt will lead to higher interest rates on other liquid assets that are substitutes in private portfolios. Higher domestic interest rates will lead to short-term and possibly net long-term capital inflows (depending on whether RHO goes up or down), probably smaller in size than the induced trade deficit. If there is a net deficit on current and long-term capital account, the interaction of private and official demand for foreign exchange will lead to a higher price

of foreign exchange and a reduction of foreign exchange reserves. The latter development will further reduce net federal government borrowing requirements. The permanent income flowing from the increased market value of business capital may or may not increase depending on movements in the relevant rate of return (RHOR). Permanent income streams from stocks of durables and bonds will increase, however, as prices and interest rates rise, and YPDNWP will probably increase. Capital gains on equities will be offset by capital losses on bonds and it is not clear in what direction YKGP will move. Disposable wage income will increase, and we expect, on balance, to see some net induced increase in consumption which will amplify most of the reactions already mentioned.

During the second quarter of increased expenditure a number of the induced changes start to impinge on investment behaviour. Increases in prices and wages may lead to increases in the incentive to substitute capital for labour. This will be so if wage rates and investment goods prices increase by corresponding proportions in the first quarter because the expectations process for wage rates extrapolates further into the future than does the expectations process for capital goods prices. The incentive to substitute capital for labour will be sharpened if RHO has fallen or dulled if RHO has risen. At this point the increase in UGPPA finds its way into the investment process defining expected future output, and thus increasing investment via the flexible accelerator mechanism.

As sales continue to increase, the flexible accelerator mechanism in the inventory equation starts to play a stronger

role opposing the buffer-stock reduction, especially as greater employment and average weekly hours increase UGPPS, thereby reducing the incentive to draw down inventories. Furthermore, successive inventory reductions decrease the lagged stock of inventories below the desired level and thus make additional inventory cuts less likely.

Increases in non-residential construction lead to increases in employment, average hours, and the quarterly wage rate in construction. These cost increases in turn lead to upward pressure on the price deflators for residential and non-residential construction.

The combination of a lower unemployment rate and a higher real wage results in more immigration, less emigration, and a higher rate of labour force participation. All these factors reduce the cost and price pressures that are a consequence of the initial increase in aggregate demand.

By now we have followed the ripples out so far from the original splash that the size and direction of the resulting movement is difficult to trace. At this stage, there is little substitute for a direct examination of simulation evidence.

C Preliminary Simulation Results

1 Historical tracking within the sample period and ex post forecasts for 1969 and 1970.

In Tables 12.1 and 12.2 at the end of this chapter we present a record of the tracking qualities of the model. Two simulations are reported. The first is a twenty-one-quarter simulation (4Q63-4Q68) within the estimation period of the structural equations of the model. The second is an eight-quarter simulation initiated in 1Q69 and running to 4Q70, an 'ex post' forecast outside the sample period, employing historical values for all exogenous variables. The historical mean, the root mean squared error, and, where applicable, the root mean squared error as a percentage of the mean are reported for each variable in the two tables. Table 12.1 is composed of gross national expenditure and its principal components, in constant and in current dollars. Table 12.2 is made up of a selection of important variables from elsewhere in the model grouped under several sector-related headings.

Some rough measures of the goodness of fit of RDX2 in simulation can be adduced from these statistics. Looking at root mean squared errors as a percentage of the mean and at the 42 variables or aggregates of variables for which this measure has meaning, 25 in the intra-sample period and 15 in the post-sample period have values of less than 2%. A further 4 variables in the intra-sample period and 11 in the post-sample period have values of less than 3%. The average of the percentage errors for all 42

variables is 3.1% intra-sample and 4.05% post-sample. If one excludes the unemployment rate, which is notoriously difficult to predict accurately and in the prediction of which we fare little better than others, the average of the percentage errors falls to 2.63% within the sample period and to 3.48% in the post-sample period.

As has been found with most other large models, errors among components of aggregates tend to be offsetting. Thus our errors in constant- and current-dollar GNE are 1.07% and 1.01%, respectively, in the intra-sample simulation and 1.27% and 1.06%, respectively, in the post-sample period of eight quarters. A major exception in RDX2 is the absolute level of unemployment (NU). Labour force participation tends to be overstated when employment is understated and vice versa leading to uncomfortably large errors in the number unemployed and hence in the unemployment rate.

It can be seen that, with the notable exception of private investment expenditure, which remains remarkably well on track, most percentage errors are modestly larger in the post-sample simulation. This is to be expected. We are just beginning the examination of the sources of these errors and will have more to report later about the relative contribution to them of inadequate or shifting structure, measurement errors in variables, or the apparent emergence of new forces of which we have failed to take sufficient account. Given the slowdown of economic growth in early 1969 and the downturn of late 1969 and 1970, and given that we have made no effort as yet (with a single exception) to adjust the equations for some of the extraordinary

events of that period, we are not unhappy with the performance of RDX2. The single case in which we have felt compelled to adjust the structural equations of RDX2 arises because of our need to substitute in 1970 some alternative mechanism for our model of the foreign exchange market. For the purpose of this report we have simply exogenized the spot and forward exchange rates and the official and private demand for foreign exchange, and have used their actual 1970 values in our simulations.

2 Some representative shocks

In order to present an early report on some other dynamic properties of RDX2 we have conducted four simulation experiments of a straightforward character. With a twenty-nine-quarter control solution of the model (4Q63-4Q70) as a reference, we have examined the effects of the following four shocks.

(a) A fiscal policy

Federal government current nonwage expenditure (GCNWF) is raised by $100 million in 4Q63 by shifting the constant term of this equation and the shift is maintained until the end of the period. With no explicit assumption of alternative means of financing, the induced net use of funds is financed by the issue of additional treasury bills (LGFTB).

(b) A monetary policy

The Bank of Canada pursues an easier monetary policy through a lower interest rate target and the implicit provision of reserves to support this policy. We have lowered the constant term in the reaction function determining the short-term rate of interest (RS) by 50 basis points and maintained this shift throughout the period.

(c) A fiscal policy with restrictive monetary policy

Under the assumptions of our fiscal policy experiment, the central bank is willing to provide the reserves necessary to have the additional treasury bills absorbed in private or bank portfolios at the level of short-term interest rates yielded by the policy reaction equation. In order to examine fiscal multipliers under the assumption that the Bank of Canada is unwilling to provide such support but is determined to maintain the size of the banking system approximately unchanged (i.e. at its control solution) we have combined the two shocks above but have reversed the direction of the interest rate shift by raising the intercept of the reaction function by 50 basis points. This is a crude approximation to the action necessary to keep the banking system at its control solution size.

(d) An appreciation of the Canadian dollar

The Canadian dollar is assumed to appreciate by approximately 5% for one quarter and by approximately 7% thereafter. The Canadian price of a U.S. dollar (PFX) is

lowered to $1.03 in 4Q63, to $1.01 in 1Q64, and maintained at $1.01 until 2Q70 when it is lowered to $.97 and then in 3Q70 and 4Q70 to $.95. Throughout the period the private and official demand for foreign exchange (FXP and FXO) are set equal to their historical values.

Under the headings Fiscal, Monetary, Fiscal plus Monetary, and Appreciation, Table 12.3 (see pp.258-262) contains values of the induced effects of these shocks in the fourth quarter of seven successive years (i.e. 4Q64 to 4Q70). These values are reported for each variable or aggregate of variables that appears in Tables 12.1 and 12.2. Table 12.3 is organized similarly to Tables 12.1 and 12.2, with GNE and its components in constant dollars and current dollars followed by a selected set of variables grouped under several sectoral headings.

What, in general, can be said about these results? First, and rather unnerving for policy makers, there is the strong cyclical character of response. The combination of both capital and labour supply constraints and strong accelerator mechanisms in the model leads to rather sharp reductions in effect once the peak is passed. Indeed, ignoring timing differences between policies and between variables for the moment, peaks in effect are observable in the third to fourth years followed by substantial declines into the seventh year. Subsequent investigation leads us to believe that the trough of this cyclical process occurs in about the seventh year and that succeeding cycles of roughly the same periodicity slowly damp. Our early experimentation with the stationary state properties of

the model also leads us to believe that one may take the mean of the peak and trough over the first cycle as a very rough measure of the equilibrium effect. At the moment, however, this must be a very tentative guess.

Our practice of reporting fourth quarter values obscures somewhat the precise turning points and peak effects. In addition the tendency of peak effects on prices and wages to lag the peak effects on constant-dollar expenditure by approximately a year implies that peaks in current-dollar expenditure equations generally lag their real counterparts. If we focus upon real quantities, fiscal policy multipliers peak during the third year or in approximately twelve quarters, whereas monetary policy has its largest impact after about sixteen quarters of application. The combined policies not surprisingly are intermediate in timing. Appreciation has its maximum effect on reducing Canadian real income in the twelfth quarter. Fifty to seventy-five per cent of the short-run impact of these policies is felt in six quarters for fiscal policy, seven to eight quarters for monetary policy, and six quarters for the combined policies.

The impacts of these various policies appear uniformly stronger than those reported for RDX1 [32]. However several important differences in the structure of the two models should be noted. A very substantial proportion of government expenditure, exogenous to RDX1, has been endogenized in RDX2. More importantly, in RDX2 we go much further than RDX1 in integrating the real and financial sectors of the model and in spelling out the portfolio consequences of various spending decisions. Thus our fiscal policy entails substantial support on

the part of the monetary authorities and is therefore associated with substantial growth in the banking system accompanying the limited interest rate effects. Peak multipliers in the neighbourhood of 3 and 5.5 on constant- and current-dollar GNE, respectively, are accompanied by a banking system that is some 4% larger than control and a short-term interest rate (RS) that peaks only some 40 basis points above control. When this simulation is repeated in our fiscal plus monetary policy case, with the banking system restricted, RS rises by 95 basis points and the multipliers on constant- and current-dollar GNE are reduced to approximately 2.25 and 4, respectively. These multipliers are somewhat larger than those reported for RDX1, using a roughly comparable method of financing a fiscal policy change. (See Tables 1-3 in [32] or [33].)

The reader can pursue, through the vehicle of Table 12.3, additional analysis of the consequences of the policies we have chosen. It is our purpose to present here only an early indication of some of the emerging properties of RDX2. We shall be discussing these properties in greater length and detail in our forthcoming study, The Dynamics of RDX2.

We conclude with a few words about the appreciation simulation. An extensive analysis of this case has been presented elsewhere [26] and need not be elaborated here. We have made a modification to RDX2, not incorporated in the earlier experiments reported in [26]. We now take explicit account of the effects of exchange rate appreciation on the price of Canadian imports of goods from countries other than the United States (PMNTE13). Since the earlier experiments were primarily

concerned with the effects of appreciation on the Canadian bilateral balance with the United States this change is of small consequence to that paper. However, the change does modify the total consequences reported there.

The maximum reduction in real income occurs in the third year. Prices and wages move downward with a lag and do not reach their trough until the fifth year. As a result current-dollar GNE bottoms out in the fourth year. The appreciation leads to a first year fall in real exports of approximately $300 million, which remains relatively constant throughout the seven year period. The resulting current account deficit (XBAL$) is gradually offset until the third year by declining imports, and then is rapidly increased as imports rise with rising real income toward the end of the period. The net balance on current and long-term capital account (UBAL) diverges little from the current account deficit in the first year but then the deficit increases steadily as, in the early years, net capital inflows fall off in response to falling interest rates and borrowing requirements. In the later years some resumed net capital inflows serve to offset partially the growing current account deficit. It is noteworthy that, if our inference about equilibrium effects should be substantiated, the long-term consequence of Canadian dollar appreciation will be little change in Canadian real income and employment because of roughly equal proportionate reductions in domestic prices and money incomes.

D Further Simulation Plans

1 Policy simulation

RDX2 is loaded with policy instruments and various government reaction functions, and we plan to test the effectiveness of most of them both inside and outside the sample period. There are three basic model environments that can be used for these simulations, and we would like to try all three.

1.1 Historical context

This framework, which is the one we used for all our RDX1 simulations, is relatively easy to employ, since actual values are available for all the exogenous variables. However, as we found with our tests of the dynamic efficiency of automatic stabilizers [30], the simulation consequences of a policy change depend heavily on the values taken by various other exogenous variables. Thus it is difficult to disentangle the consequences over time of a hypothetical policy change from the particular features of the historical data underlying the simulation. The other two types of simulation get around this problem in different ways.

1.2 Forecasting context

If one wishes to assess the likely consequences of policy choices made at the present time, and if those consequences

depend heavily on the values of the exogenous variables, the simulations are best performed within a genuine forecasting context. This requires that 'best guesses' be used for all the exogenous variables. For longer run simulations, most of the exogenous variables will have fairly smooth profiles in the absence of specific information.

1.3 Stationary context

The best way to abstract the policy simulations from a particular period of history is to define a set of exogenous variables from which all variance has been removed. The dynamic consequences of either cyclical or sustained shocks applied to RDX2 could be assessed much more precisely by using a special set of exogenous variables constructed for the purpose. Such a procedure would not work in a model with important nonhomogeneities, so we hope that our emphasis on both stock and flow disequilibrium adjustment processes has made RDX2 a suitable vehicle for this kind of simulation.

We would also like to run stochastic simulations of the three varieties described above, taking account of uncertainty about exogenous variables, parameter estimates, and equation residuals. Although we recognize that the size of RDX2 will severely limit the feasible scope of stochastic simulations, we shall do what we can.

2 Linked simulations

RDX2 has been designed so that it can be linked with models of other countries, particularly with a U.S. model. Thus we are able and anxious to undertake a variety of simulations of RDX2 with the MPS model, a recent variant of the FRB-MIT-Penn model ([1], [14], [50]). These simulations will be described in detail elsewhere, as they are part of a separate project (see [36]). Such experiments may provide the most accurate measures of the results attainable from various Canadian policies. At the very least, they will allow some precise assessment of the effects on Canada of alternative economic developments abroad. By fitting both Canadian and U.S. models with policy reaction functions that take the balance of payments into account, we should be able to get a better idea of what sets of national decisions are mutually consistent within a world environment.

To say much more at this stage might take us too far beyond where we are now. Here is RDX2. We expect to report again on its progress before too many months have passed.

TABLE 12.1

INTRA-SAMPLE AND POST-SAMPLE MEANS, ROOT MEAN SQUARED ERRORS AND ROOT MEAN SQUARED ERROR AS PER CENT OF MEAN OF GROSS NATIONAL EXPENDITURE AND COMPONENTS

(CONSTANT 1961 DOLLARS)

	INTRA SAMPLE 4Q63-4Q68 MEAN	RMSE	%RMSE	POST-SAMPLE 1Q69-4Q70 MEAN	RMSE	%RMSE
Personal Consumption Expenditure C = (CNDSD+CS+CMV+CDO)	8144.0	70.4	.86	9857.1	228.1	2.39
Government Current Expenditure GC = [(GCNSF+GCNAPM+GCGSH)/PGCN&G+E861MPF+1434.0265 NTS+1207.1399 NGPAF+ 921.25014 NGPAPM+603.68732 (GW1F+GW1PM)/WQIOS]	1927.0	24.1	1.24	2309.6	104.9	4.54
Gross Investment						
Government IG = [IR+IIG+INRCGF+INRCGPM+INRCSM+IMEGF+IMEGPM]	556.7	22.5	4.0	614.6	23.2	3.78
Private Fixed I = (IME+INRC+IRC)	2498.7	138.2	5.5	2847.0	46.1	1.62
Business Inventories IIB	-	104.9	-	-	191.5	-
Exports of Goods and Services X	2942.9	36.7	1.25	4112.3	126.4	3.07
Imports of Goods and Services M	3129.6	84.0	2.69	4150.9	105.6	2.54
Gross National Expenditure HGNE	13341.0	140.2	1.07	15553.0	197.3	1.27
	(CURRENT DOLLARS)					
Personal Consumption Expenditure C$ = (CNDSB)(PCNDSD)+(CS)(PCS)+(CMV)(PCMV)+(CDO)(PCDO)	9002.8	88.4	.98	11949.7	332.3	2.78
Government Current Expenditure GC$ = [GCNWF+GCNAPM+GCGSH+GMPR+(NTS)(WQISM)+(NGPAF)(WQGPAF)+ (NGPAPM)(WQGPAPM)+GWSSM+GWPASPM+GWSF+GW1F+GW1PM]	2417.5	34.9	1.44	3685.2	89.7	2.43
Gross Investment						
Government IG$ = [IR(PIR)+IIG$+(INRCGF+INRCGPM+INRCSM)(PINRCG)+ (IMEGF+IMEGPM)(PIMEG)]	657.6	64.2	9.77	788.0	101.7	12.9
Private Fixed I$ = (IME)(PIME)+(INRC)(PINRC)+(IRC)(PIRC)	2862.7	145.3	5.08	3612.4	60.7	1.68
Business Inventories IIB$ = JID[(PKIB)(KIB)]+YIVA	-	112.1	-	-	239.1	-
Exports of Goods and Services X$ = X$12+X$13-XIHS-XTRP$	3276.6	46.3	1.41	4967.0	219.5	4.42
Imports of Goods and Services M$ = M$12+M$13-MIHS-MTRP$-GTNRF+TWF	3446.7	92.3	2.68	4940.9	137.4	2.78
Gross National Expenditure YGNE	15004.1	151.7	1.01	20376.5	215.9	1.06

TABLE 12.2

INTRA-SAMPLE AND POST-SAMPLE MEANS, ROOT MEAN SQUARED ERRORS AND ROOT MEAN SQUARED ERROR AS PER CENT OF MEAN OF SELECTED VARIABLES

	INTRA-SAMPLE 4Q63-4Q68 MEAN	RMSE	%RMSE	POST-SAMPLE 1Q69-4Q70 MEAN	RMSE	%RMSE
Components of Gross National Product						
YW	7860.3	74.6	0.95	11280.8	201.2	1.78
YC	1676.6	135.6	8.09	1902.0	240.3	12.63
TILCS	1987.8	41.8	2.10	2737.3	60.6	2.22
Monetary Sector and Interest Rates						
ABT	19782.5	634.9	3.21	27955.4	1871.9	6.70
ANFCUR+DDB	7397.1	290.9	3.93	8736.8	275.2	3.15
ANFLIQ	50819.1	678.2	1.34	65705.1	1466.4	2.23
RS	5.14	0.40	7.73	7.07	0.74	10.52
RL	5.71	0.18	3.20	7.76	0.38	4.89
RIOR	6.60	0.29	4.33	6.63	0.32	4.82
V	172162.2	2911.5	1.69	218549.2	5217.9	2.39
Government Sector						
GBALF	-	68.8	-	-	95.4	-
GBALPM	-	42.9	-	-	79.1	-
LGFTB	1840.6	203.9	11.08	2638.5	511.5	19.39
LGBPM	17413.1	127.3	0.73	22875.0	182.0	0.80
External Trade and Balance of Payments						
XBAL$	-	117.8	-	-	234.6	-
X$12	2094.0	21.2	1.01	3405.6	174.5	5.13
M$12	2482.1	69.6	2.81	3493.1	97.2	2.78
UBAL	-	142.8	-	-	440.8	-
UBAL12	-	121.1	-	-	232.5	-
EXO	-	79.3	-	-	98.8	-
PEX	1.078	.002	0.22	-	-	-
Employment and Labour Force						
NMMOB	4.092	.033	0.82	4.626	.097	2.11
NE	7.079	.053	0.75	7.850	.078	1.00
NL	7.393	.033	0.44	8.268	.082	1.00
NPOP	15.470	.029	0.22	14.827	.035	0.23
RNU	4.26	.84	19.75	5.31	1.31	24.61
Wages and Prices						
WQMMOB	1289.0	9.91	0.77	1602.3	5.0	0.31
PGNE	1.136	.008	0.72	1.310	.014	1.11
PGPT	1.114	.007	0.62	1.276	.014	1.10
PCPICE	2.007	.223	11.09	3.454	.214	6.20
Output Measures						
UCPP	11497.2	134.2	1.17	13787.8	188.6	1.37
UCPPA	11475.9	130.9	1.32	13638.7	281.7	2.07
UCPPS	11457.8	84.6	0.74	14111.7	136.0	0.96
UCPPD	11382.7	61.0	0.54	14275.5	177.4	1.24

TABLE 12.3

EFFECTS IN SUCCESSIVE FOURTH QUARTERS
OF FOUR REPRESENTATIVE SHOCKS ON
GROSS NATIONAL EXPENDITURE AND COMPONENTS

(CONSTANT 1961 DOLLARS)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
C	Millions'61$							
Fiscal		74.6	124.1	141.2	110.0	47.0	-19.8	-40.3
Monetary		28.8	44.5	54.9	48.8	28.1	-12.2	-36.1
Fiscal + Monetary		47.1	84.3	96.4	76.6	41.0	27.4	40.8
Appreciation		.6	-24.2	-10.2	51.8	119.4	210.3	267.4
GC	Millions'61$							
Fiscal		92.0	88.4	87.2	84.7	82.9	81.8	80.6
Monetary		1.5	.2	-	1.3	.1	-.5	-1.1
Fiscal + Monetary		90.4	88.5	88.2	85.4	86.1	87.2	87.2
Appreciation		8.2	15.8	23.0	26.1	28.7	27.5	29.8
IG	Millions'61$							
Fiscal		4.4	5.6	11.6	13.0	8.3	.2	-4.0
Monetary		3.9	4.9	8.6	10.8	5.7	-.6	-2.9
Fiscal + Monetary		0.7	1.7	4.1	3.3	4.3	4.1	2.8
Appreciation		-2.2	-2.5	-7.2	-2.4	-.8	2.9	9.1
I	Millions'61$							
Fiscal		64.4	128.9	170.4	127.0	17.8	-108.5	-169.8
Monetary		44.4	61.4	71.3	62.5	9.4	-52.1	-84.3
Fiscal + Monetary		22.4	70.7	105.5	71.4	20.2	-37.9	-61.2
Appreciation		-19.6	-78.1	-145.9	-124.4	-8.6	134.9	241.7
IIB	Millions'61$							
Fiscal		16.6	21.4	22.5	-3.5	-16.4	-16.1	4.9
Monetary		2.2	5.9	2.7	0.7	-6.7	-8.3	1.7
Fiscal + Monetary		14.5	16.4	20.8	-4.0	-8.3	-7.7	3.6
Appreciation		2.7	-43.9	-34.7	-13.0	5.8	21.7	-8.8
X	Millions'61$							
Fiscal		-4.8	-9.0	-9.5	-7.9	-4.5	1.2	5.4
Monetary		-	-1.8	-1.3	-0.7	0.8	3.3	4.6
Fiscal + Monetary		-4.9	-7.3	-8.2	-7.0	-4.1	-0.7	0.5
Appreciation		-72.8	-71.2	-64.7	-64.5	-70.2	-76.2	-95.0
M	Millions'61$							
Fiscal		62.2	101.9	130.9	92.8	19.0	-47.4	-46.0
Monetary		15.7	26.9	33.1	22.8	-7.9	-47.9	-54.2
Fiscal + Monetary		46.7	75.5	100.8	75.1	37.0	14.6	28.0
Appreciation		37.5	-.9	-11.7	12.6	93.4	190.1	208.6
YGNE	Millions'61$							
Fiscal		185.1	257.4	292.3	230.6	116.0	-13.9	-80.5
Monetary		65.1	86.1	102.7	100.6	45.3	-22.6	-64.0
Fiscal + Monetary		125.4	178.7	206.0	150.5	102.4	57.9	45.6
Appreciation		-120.5	-205.2	-218.0	-159.0	-19.0	131.0	235.7

(CURRENT DOLLARS)

C$	Millions$							
Fiscal		86.3	181.8	258.9	281.1	258.7	145.6	76.6
Monetary		32.4	63.6	97.5	113.2	108.7	63.4	16.1
Fiscal + Monetary		54.5	119.4	165.9	177.7	150.5	122.8	118.1
Appreciation		-46.8	-120.3	-177.5	-205.7	-153.4	-41.9	69.8
GC$	Millions$							
Fiscal		113.8	126.1	137.6	144.2	141.6	135.5	127.8
Monetary		3.4	6.5	10.2	15.6	15.1	11.8	6.6
Fiscal + Monetary		110.0	118.4	126.6	129.7	130.8	130.2	128.8
Appreciation		-.5	-3.7	-4.9	-10.6	-7.7	-.5	15.8
IG$	Millions$							
Fiscal		5.7	7.8	14.7	15.4	9.3	-.1	-4.9
Monetary		4.6	6.0	10.2	12.5	6.5	-.2	-3.5
Fiscal + Monetary		1.4	2.7	5.7	4.1	4.7	4.2	3.0
Appreciation		-9.3	-11.7	-18.9	-12.7	-9.5	-5.2	.1

TABLE 12.3 (cont'd.)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
I$	Millions$							
Fiscal		84.2	178.2	245.4	203.6	66.7	-95.2	-180.3
Monetary		52.6	80.8	98.7	94.6	29.6	49.0	-94.5
Fiscal + Monetary		33.6	99.0	151.5	114.6	50.3	-21.4	-53.0
Appreciation		-53.1	-145.0	-235.9	-231.5	-86.8	90.0	226.3
IIB$	Millions$							
Fiscal		28.5	35.8	34.9	-4.0	-27.7	-28.7	1.0
Monetary		8.8	8.2	6.7	3.5	-10.6	-13.7	-1.7
Fiscal + Monetary		19.5	25.8	28.6	-7.0	-14.6	15.1	4.4
Appreciation		-15.9	-63.6	-51.7	-19.0	15.4	32.5	-7.0
X$	Millions$							
Fiscal		-2.8	-2.6	-.7	4.6	9.4	14.7	17.1
Monetary		2.1	2.2	3.6	6.6	8.0	13.2	11.3
Fiscal + Monetary		-4.7	-5.3	-4.2	1.8	2.6	4.8	5.6
Appreciation		-124.1	-134.3	-138.2	-146.4	-164.2	-179.3	-214.5
M$	Millions$							
Fiscal		68.0	112.6	146.4	106.9	24.0	-53.7	-49.1
Monetary		18.9	32.1	38.5	28.5	-9.7	-52.9	-67.5
Fiscal + Monetary		49.8	81.5	111.3	84.6	45.2	19.7	38.0
Appreciation		-53.4	-106.0	-136.0	-110.1	-19.3	82.9	81.0
YGNE	Millions$							
Fiscal		250.5	421.1	557.9	554.6	428.9	237.3	95.2
Monetary		85.7	137.7	192.4	223.6	172.7	84.0	4.1
Fiscal + Monetary		166.3	283.4	370.6	342.3	287.9	216.2	176.2
Appreciation		-193.8	-371.4	-496.6	-524.8	-395.6	-192.9	10.0

EFFECTS OF SHOCKS ON SELECTED OTHER VARIABLES

Components of Gross National Product								
YW	Millions$							
Fiscal		95.6	197.2	287.0	327.4	273.2	163.8	57.1
Monetary		29.6	62.7	101.0	129.7	118.7	72.6	16.4
Fiscal + Monetary		64.4	125.5	183.4	200.1	165.6	114.5	76.3
Appreciation		-69.3	-169.0	-265.9	-318.6	-273.7	-158.5	-26.3
YC	Millions$							
Fiscal		132.9	183.1	214.0	173.7	115.2	55.1	31.1
Monetary		47.2	55.0	69.5	69.6	53.7	-.5	-18.0
Fiscal + Monetary		88.5	131.7	151.3	111.3	98.4	85.6	86.6
Appreciation		-108.4	-169.2	-183.7	-161.9	-92.8	-28.7	20.3
FIGS	Millions$							
Fiscal		13.5	28.5	42.1	40.5	31.4	15.9	4.7
Monetary		5.9	11.2	17.0	19.2	17.3	11.1	4.6
Fiscal + Monetary		7.7	17.4	25.6	22.5	16.8	10.1	7.6
Appreciation		-9.2	-21.9	-33.8	-32.0	-21.1	-2.6	15.2
Monetary Sector and Interest Rates								
A87	Millions$							
Fiscal		382.5	489.1	645.1	797.7	746.1	645.5	479.5
Monetary		532.5	628.0	756.5	972.0	886.0	1020.5	845.1
Fiscal + Monetary		-155.2	-89.5	-73.9	-121.4	-48.7	-65.5	-227.0
Appreciation		-33.4	-122.3	-471.5	-450.4	-180.2	-344.1	465.0
AXFCUR+DDB	Millions$							
Fiscal		170.7	142.3	157.5	186.4	157.1	139.8	167.6
Monetary		323.5	357.4	418.2	527.6	509.5	557.5	717.1
Fiscal + Monetary		-155.1	-190.6	-243.3	-323.9	-341.1	-381.5	-564.9
Appreciation		-40.6	-34.6	-120.3	-222.8	-146.2	-183.6	-512.6
ANETIQ	Millions$							
Fiscal		559.2	873.4	1072.5	1210.1	1334.1	1492.0	1946.0
Monetary		296.1	429.9	456.2	461.2	376.1	114.7	618.6
Fiscal + Monetary		321.8	495.6	660.6	817.4	1185.5	1815.2	2016.5
Appreciation		-61.3	401.2	691.1	700.0	1425.2	2247.5	2566.9

TABLE 12.3 (cont'd.)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
RS	Percentage Points							
Fiscal		.13	.30	.25	.18	.07	-.16	-.24
Monetary		-.64	-.58	-.71	-.76	-.73	-.90	-.93
Fiscal + Monetary		.78	.87	.97	.93	.81	.76	.72
Appreciation		-.14	-.20	-.36	-.34	.00	.11	.16
RL	Percentage Points							
Fiscal		.04	.10	.15	.22	.23	.14	.02
Monetary		-.18	-.27	-.39	-.50	-.56	-.62	-.68
Fiscal + Monetary		.22	.37	.54	.71	.78	.77	.72
Appreciation		-.06	-.10	-.22	-.28	-.25	-.20	-.09
RHOR	Percentage Points							
Fiscal		.23	.30	.34	.24	.10	-.04	-.10
Monetary		-.04	-.07	-.15	-.21	-.32	-.41	-.48
Fiscal + Monetary		.27	.37	.49	.45	.42	.36	.37
Appreciation		-.16	-.36	-.43	-.42	-.30	-.15	-.15
V	Millions$							
Fiscal		1774.2	3254.7	4433.7	4768.3	4168.9	3332.3	3270.6
Monetary		1371.7	2569.0	3621.1	4645.8	5188.5	4869.4	5462.6
Fiscal + Monetary		469.2	879.0	1119.7	605.1	-97.5	40.2	-114.8
Appreciation		-630.5	-1206.0	-1458.6	-876.9	883.9	3071.6	4993.0

Government Sector

GBALF	Millions$							
Fiscal		-47.0	-12.9	.5	-17.0	-52.0	-101.8	-136.7
Monetary		25.7	38.2	48.7	53.1	43.2	29.5	12.9
Fiscal + Monetary		-72.7	-51.8	-48.3	-70.9	-97.5	-131.7	-151.8
Appreciation		-53.9	-105.6	-133.3	-129.4	-102.7	-54.6	-22.5
GBALPM	Millions$							
Fiscal		-5.7	-10.8	-11.8	-7.0	6.1	19.5	23.6
Monetary		-4.6	-9.0	-11.0	-12.8	-6.4	2.7	4.8
Fiscal + Monetary		-.7	-1.7	-.8	4.8	11.6	17.3	19.8
Appreciation		2.8	7.4	13.4	.6	-8.1	-19.5	-24.8
LGF1B	Millions$							
Fiscal		317.5	344.6	357.2	344.1	450.1	764.5	1188.6
Monetary		-145.9	-313.9	-493.1	-729.3	-1075.0	-1227.2	-1354.4
Fiscal + Monetary		465.9	667.3	853.3	1105.2	1721.3	2413.1	2949.3
Appreciation		46.2	374.1	632.1	996.6	1370.1	1498.5	1587.0
LGBPM	Millions$							
Fiscal		5.8	41.2	84.4	117.7	111.2	48.1	-42.7
Monetary		20.6	50.3	91.1	141.5	177.0	178.8	164.4
Fiscal + Monetary		-15.1	-10.1	-7.9	-22.6	-61.3	-126.9	-207.0
Appreciation		-5.5	-25.0	-71.2	-93.1	-65.7	-7.4	88.3

External Trade and Balance of Payments

XSAL$	Millions$							
Fiscal		-69.4	-113.3	-143.6	-99.0	-11.2	71.3	68.4
Monetary		-16.8	-29.8	-35.1	-22.7	15.9	65.2	74.0
Fiscal + Monetary		-53.1	-84.3	-112.2	-82.3	-37.2	-8.8	-25.3
Appreciation		-72.5	-31.2	-5.9	-40.2	-149.7	-266.5	-298.9
X$12	Millions$							
Fiscal		1.1	2.8	3.7	3.0	.2	-1.7	-1.6
Monetary		1.9	3.0	4.0	4.8	1.3	4.8	1.3
Fiscal + Monetary		-.8	-.2	-.1	-1.3	-2.4	-3.0	-2.2
Appreciation		-91.4	-93.7	-95.7	-97.8	-100.3	-98.3	-112.8
M$12	Millions$							
Fiscal		51.3	84.8	108.6	72.9	3.1	-59.8	-50.3
Monetary		14.7	24.9	29.1	20.2	-11.4	-46.4	-54.4
Fiscal + Monetary		37.2	60.4	82.4	58.0	23.9	3.0	19.0
Appreciation		-34.6	-76.4	-95.3	-72.0	5.2	90.3	81.6

TABLE 12.3 (cont'd.)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
UBAL	Millions$							
Fiscal		-81.4	-82.9	-63.6	2.6	76.9	78.2	13.7
Monetary		-49.1	-49.7	-47.5	-68.9	-11.4	9.9	12.9
Fiscal + Monetary		-31.4	-37.0	-21.8	56.1	70.2	41.9	8.2
Appreciation		-85.0	-73.2	-84.9	-183.0	-326.0	271.2	254.2
UBAL12	Millions$							
Fiscal		-64.1	-58.8	-40.1	8.9	64.2	59.5	7.4
Monetary		-41.6	-37.8	-42.9	-48.3	-4.3	8.5	-10.9
Fiscal + Monetary		-22.5	-24.2	-11.5	51.8	53.7	27.7	6.4
Appreciation		-56.4	-51.0	-57.7	-137.4	-244.5	-174.4	-152.3
FXO	Millions.US$							
Fiscal		5.1	16.5	-4.9	-4.9	7.8	15.0	0
Monetary		15.5	25.8	-6.5	-11.0	-58.5	326.4	0
Fiscal + Monetary		-1.5	-6.2	1.5	20.6	93.4	30.0	0
Appreciation		91.8	-18.0	54.2	45.5	-71.8	339.1	0
PFX	$C/$US							
Fiscal		.001	.002	.002	.002	.000	.000	.000
Monetary		.002	.005	.002	.003	.001	.004	.001
Fiscal + Monetary		-.001	-.001	-.000	-.001	.000	-.001	.000
Appreciation		-.066	-.066	-.066	-.065	-.063	-.063	-.070

Employment and Labour Force

NMMOB	Millions							
Fiscal		.046	.081	.100	.087	.049	.001	-.030
Monetary		.013	.027	.033	.033	.020	.002	-.020
Fiscal + Monetary		.034	.056	.071	.060	.037	.016	.007
Appreciation		-.030	-.068	.084	-.071	.029	.029	069
NE	Millions							
Fiscal		.056	.094	.115	.099	.054	-.003	.042
Monetary		.018	.034	.042	.043	.026	.001	-.024
Fiscal + Monetary		.038	.062	.079	.065	.039	.015	.004
Appreciation		-.035	-.076	-.095	-.077	-.024	.043	.092
NL	Millions							
Fiscal		.013	.038	.069	.096	.103	.083	.040
Monetary		.002	.011	.022	.033	.039	.032	.015
Fiscal + Monetary		.010	.027	.048	.066	.071	.061	
Appreciation		.002	-.018	-.042	.066	-.073	-.052	-.036
NPOP	Millions							
Fiscal		.001	.015	.041	.071	.092	.090	.064
Monetary		.000	.001	.014	.026	.036	.038	.031
Fiscal + Monetary		.001	.011	.027	.047	.060	.057	.042
Appreciation		.000	-.008	-.028	.058	.080	-.079	-.051
RNU	Percentage Points							
Fiscal		-.624	-.794	-.647	-.088	.559	.995	.980
Monetary		-.230	-.527	-.277	-.134	.140	.395	.477
Fiscal + Monetary		-.406	-.503	-.434	-.014	.370	.528	.409
Appreciation		.466	.822	.740	.166	-.590	-1.154	-1.170

Wages and Prices

WQMMOB	Dollars							
Fiscal		5.2	9.1	16.4	24.6	28.1	26.7	20.9
Monetary		.8	2.8	5.6	9.2	11.6	12.0	10.3
Fiscal + Monetary		2.0	5.4	9.6	14.2	15.7	14.1	10.6
Appreciation		-5.0	-12.2	-23.2	-34.5	-41.3	-41.8	-36.7
PGNE	1961 = 1.000							
Fiscal		.004	.010	.016	.019	.019	.016	.013
Monetary		.001	.003	.005	.007	008	.007	.006
Fiscal + Monetary		.003	.006	.009	.011	.011	.009	.007
Appreciation		-.005	-.011	-.018	-.024	-.025	-.023	-.019

TABLE 12.3 (cont'd.)

VARIABLE/YEAR	UNITS	1	2	3	4	5	6	7
PCPI	1961 = 1.000							
Fiscal		.001	.007	.013	.018	.020	.018	.013
Monetary		.000	.002	.005	.007	.008	.008	.007
Fiscal + Monetary		001	.004	.007	.010	.011	.009	.007
Appreciation		-.006	-.012	-.020	-.027	-.031	-.030	-.026
PCPICE	Percentage Points							
Fiscal		.026	.107	.204	.376	.383	.232	.017
Monetary		.007	.037	.073	.137	.164	.117	.047
Fiscal + Monetary		.016	.063	.119	.221	.208	.120	-.011
Appreciation		-.006	-.012	-.020	-.027	-.031	-.030	.026
Output Measures								
JGPP	Millions'61$							
Fiscal		183.2	299.2	294.0	229.4	111.7	-20.6	-85.7
Monetary		63.6	86.0	102.4	98.5	42.6	-26.5	67.7
Fiscal + Monetary		123.0	180.1	206.9	156.9	100.0	53.6	42.2
Appreciation		-120.6	-208.3	-221.9	-164.3	-24.4	130.0	233.5
UGPPA	Millions'61$							
Fiscal		210.3	276.4	294.1	208.6	73.6	-61.8	-183.7
Monetary		77.9	94.3	106.5	96.4	29.4	-44.6	-4.7
Fiscal + Monetary		137.0	192.8	205.1	134.5	77.8	35.9	35.8
Appreciation		-149.4	-218.7	-214.4	-133.7	30.4	182.4	378.5
JGPPS	Millions'61$							
Fiscal		108.1	196.5	270.9	279.1	210.8	84.8	-29.8
Monetary		31.5	64.5	91.0	105.6	77.8	21.2	-36.8
Fiscal + Monetary		78.4	136.1	189.7	191.5	156.5	100.2	57.0
Appreciation		-60.4	-141.6	-204.8	-216.3	-149.3	-3.5	143.7
UGPPD	Millions'61$							
Fiscal		49.7	123.7	213.0	280.7	285.4	210.4	85.1
Monetary		8.9	39.1	65.7	91.8	93.3	71.5	19.6
Fiscal + Monetary		41.3	89.5	151.1	198.1	203.8	165.5	105.3
Appreciation		-15.1	-67.6	-142.2	-212.9	-229.6	-145.9	2.8

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