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This paper is a report on the research underlying the housing and mortgage market equations used in RDX1, the experimental aggregate model of the Canadian economy developed in the Research Department of the Bank of Canada. The views expressed are the personal views of the author and no responsibility for them should be attributed to the Bank.

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PREFACE

In this study an attempt is made to specify and analyze the structure of, and the forces operating on, housing and mortgage markets in Canada. The structure thus developed is then used to examine the implications of alternative government policies for housing and mortgage lending.

I begin the study by examining the determinants of residential construction expenditure, total housing starts, the stock of housing, housing prices, construction costs, land costs, mortgage interest rates and the volume of mortgage lending undertaken by financial institutions. Housing starts, which play a pivotal role in the housing and mortgage market model, are found to be strongly influenced by the cost and availability of private and government mortgage credit, and also by the relationship between housing prices and construction and land costs. Housing prices are shown to depend upon the existing per family stock of housing, per family real disposable income and the price of alternative goods and services. Construction costs are found to be influenced by land costs, financing costs and labour costs, and by the relationship between the volume of current construction and industrial capacity. The mortgage rate, which is important both as the cost of mortgage credit and as an influence on the availability of mortgage credit, is determined by the interaction of the demand for, and the supply of, mortgage finance.

Often substantial information about the housing market is lost when it is treated on a highly aggregative level. Because the housing sector of RDX1 is based upon aggregative data, a second, more disaggregative housing model was developed in which the single and multiple dwelling segments of the market were treated individually. Several basic differences in the behaviour of these segments were found. The two most important of these differences are, first, the more restrictive effect credit rationing has on the volume of single dwelling construction compared to multiple dwelling construction (although both segments were quite responsive to variations in the cost of mortgage credit), and, second, the opposite effect rising land costs have on both these segments, since rising land costs shift the composition of construction in favour of multiple construction.

Because mortgage credit and mortgage interest rates are so important to the housing market, mortgage investment behaviour of the major financial institutions engaged in the mortgage market and determinants of the inflows of funds into these institutions are examined in some detail. Not surprisingly, preliminary evidence indicates that these financial flows are quite sensitive to alternative interest yields.

Finally, in order to assess the implications of changes in monetary and selective credit policies for the housing market, alternative policy simulations were run. The policies simulated were changes in: the government bond rate, the National Housing Act interest ceiling, and the volume of Central Mortgage and Housing Corporation direct lending.

I wish to thank Professor G.R. Sparks for his valuable comments on this study, and Dr. Ian Stewart and Miss Lynne Orman for their very great computational assistance in its preparation.

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PRÉFACE

Dans cette étude, nous essayons de définir et d'analyser la structure du marché du logement et du crédit hypothécaire au Canada, et les facteurs qui l'affectent. La structure ainsi obtenue sert ensuite à montrer les répercussions possibles des différentes politiques adoptées par les pouvoirs publics en matière de logement et de crédit hypothécaire.

Au début de l'étude nous commençons par définir les facteurs qui conditionnent les divers éléments de ce secteur tels que: dépenses pour la construction d'habitations, total des mises en chantier de logements, total des unités de logement disponibles, prix des logements, coût de la construction, prix des terrains, taux d'intérêt des prêts hypothécaires et total des prêts de ce genre consentis par les institutions financières. Nous constatons que les mises en chantier de logements, qui jouent un rôle capital dans le modèle du marché du logement et du crédit hypothécaire, sont fortement influencées par le coût du crédit, d'origine privée ou publique, et les possibilités de l'obtenir, ainsi que par le rapport entre le prix des habitations et celui des terrains et de la construction. Les prix des logements sont définis comme étant fonction du nombre d'unités de logements existants par rapport au nombre de ménages et du revenu réel disponible par ménage ainsi que du prix des autres biens et services. Nous constatons que le coût de la construction est influencé par le prix des terrains, le coût du financement et celui de la main-d'oeuvre, et par le rapport entre le volume de la construction en cours et la capacité totale du secteur du bâtiment. Le taux d'intérêt des prêts hypothécaires, qui est important à la fois par son influence sur le prix du crédit et sur la possibilité de l'obtenir, est fixé par le jeu de l'offre et de la demande de financement.

On perd souvent une quantité considérable de renseignements sur le marché du logement lorsque l'étude en est faite de manière très sommaire. Comme le secteur du logement du modèle RDX1 avait été établi sur la base de données d'ensemble, nous avons construit un autre modèle détaillé pour le logement dans lequel les données relatives aux maisons unifamiliales et celles concernant les constructions multifamiliales ont été traitées séparément. Nous avons constaté des différences profondes de comportement dans ces deux sections. Parmi ces différences, les deux plus importantes sont: tout d'abord, l'effet plus restrictif produit par le rationnement du crédit sur la construction de maisons unifamiliales que sur les constructions comportant plusieurs logements (bien que les deux sortes d'habitations aient réagi promptement aux variations du coût du crédit immobilier) et, en second lieu, l'effet défavorable de l'augmentation du prix des terrains sur les deux sortes de constructions puisque cette augmentation a pour effet de pousser à la construction d'un plus grand nombre de logements multiples.

Etant donné l'importance particulière du crédit hypothécaire et les taux d'intérêt des prêts hypothécaires pour le marché du logement, nous avons étudié en détail l'évolution des investissements réalisés sur le marché hypothécaire par les principaux établissements financiers qui s'y intéressent et les facteurs qui déterminent le mouvement des fonds vers ces établissements. On n'est pas surpris de constater d'emblée l'extrême sensibilité de ces mouvements de fonds aux divers taux de rendement.

Enfin, pour nous permettre d'évaluer les répercussions possibles des modifications apportées aux politiques monétaires et de crédit sélectif sur le marché du logement, nous avons effectué des simulations de politique. Celles-ci comportaient des modifications aux taux d'intérêt des fonds d'Etat, au plafond de l'intérêt fixé par la Loi nationale sur l'habitation et au volume global des crédits accordés par la Société Centrale d'Hypothèque et de Logement.

Je tiens à remercier M. le Professeur G.R. Sparks pour ses commentaires très utiles sur la présente étude, ainsi que M. Ian Stewart et Mlle Lynne Orman pour la précieuse assistance qu'ils m'ont fournie par leur traitement de l'information.

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INTRODUCTION

Residential construction plays a vital role in the Canadian economy. Providing employment for 5 per cent of the labour force ([8], p. 29 and [17], p. 258), accounting directly for 40 per cent of total new construction, 25 per cent of business gross fixed capital formation, and 4.5 per cent of gross national product (GNP),[1] residential construction also influences indirectly the demand for consumer durables and residential service investment. In addition to its pervasiveness, residential construction is the mechanism for providing more and better housing and is extremely sensitive, with a short response lag, to changes in general economic conditions. Consequently this sector is extremely important for both social and general economic stabilization purposes. Since over 80 per cent of the financing for new residential construction comes from the mortgage market and just under 80 per cent of all mortgage credit goes into housing,[2] the housing and mortgage markets are inexorably intertwined and should be examined together. The purpose of this paper is to discuss in some detail the derivation, structure and implications of the housing and mortgage sectors of RDX1 [24], the experimental econometric model of the Canadian economy developed in the Research Department of the Bank of Canada. In addition, a somewhat more elaborate and sophisticated model, which can be incorporated into the RDX model, is described and discussed.

The paper is divided into six sections and two appendices. In the first section the general structure of a model of the housing and mortgage market is briefly outlined. The RDX1 housing and mortgage market equations are derived and estimated statistically in the second section. Some of the structural relationships underlying the RDX1 mortgage equations are examined in the third section, and the mortgage sector of RDX1 is extended. A disaggregation of the housing sector of RDX1 and the extension of a number of relationships presently combined in that sector are

[1]These figures are based upon the 1948-1967 period.

[2]These percentages were calculated for the 1960-1967 period.

presented in the fourth section. In the fifth section a summary is provided of the functional and statistical relationships developed in the preceding four sections. In the sixth section the existing RDX1 and extended housing and mortgage sectors are simulated, and the impact of alternative policies on the housing market is examined. Two-stage estimates of the basic RDX1 housing model are presented in Appendix A, and estimates updated to the end of 1967 of the basic RDX1 and extended housing models in Appendix B.

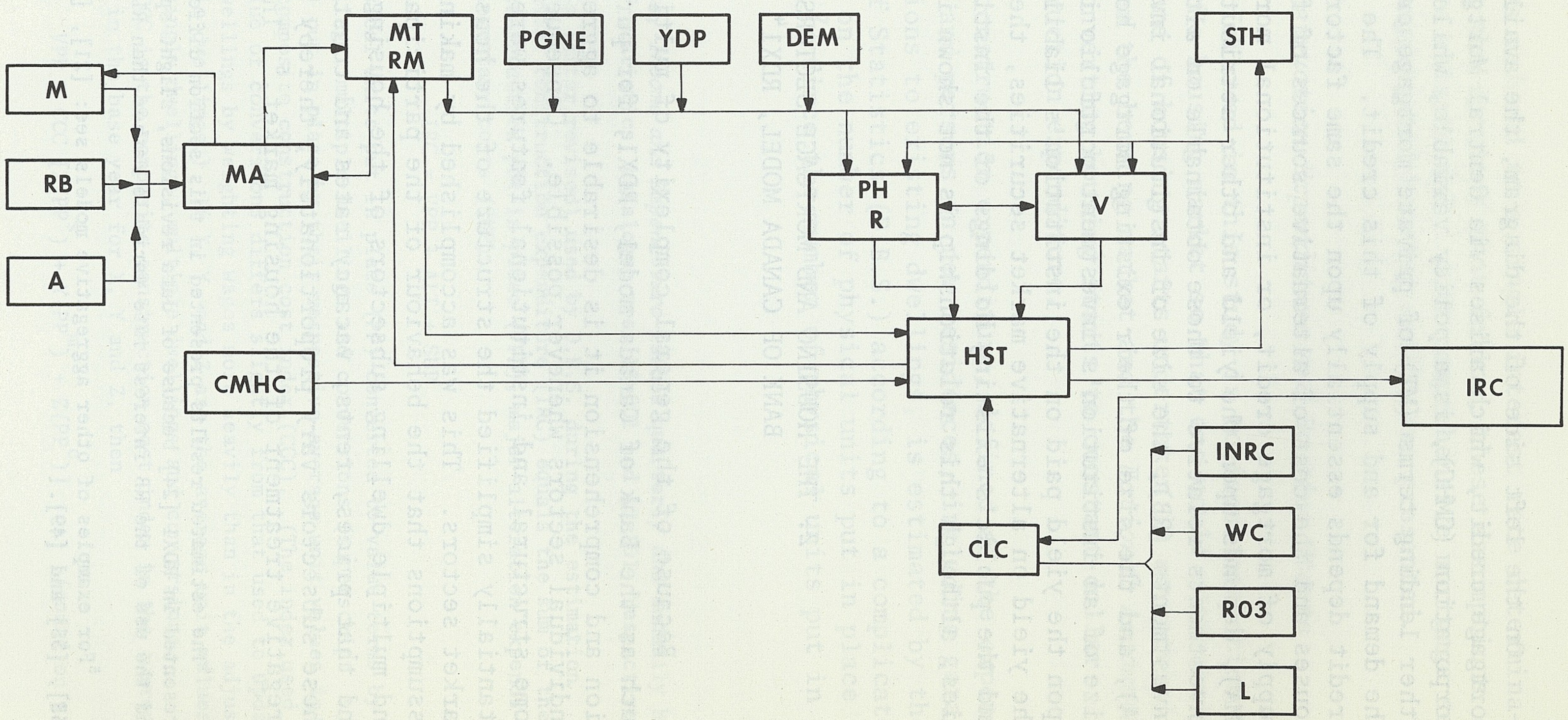
1. THE GENERAL STRUCTURE OF THE MODEL

The general structure of the housing and mortgage market model is presented in flow chart form in Diagram 1, and essentially follows a stock-flow approach.[3] On the right side of the diagram and moving left, residential construction expenditure (IRC) is a function of current and lagged housing starts (HST). The volume of housing starts undertaken in any period depends upon a comparison of housing prices (PH), rent (R), and vacancy rates (V) with construction and land costs (CLC), and financing costs (RM), and upon the availability of public Central Mortgage and Housing Corporation direct lending (CMHC) and private (MT) mortgage credit. Prices and vacancy rates are determined by the price of alternative goods and services (PGNE), permanent real disposable income (YDP), demographic factors (DEM), and the cost and availability of mortgage credit. The current supply of housing units (STH) depends upon the previous supply of housing units and lagged housing starts. Construction costs depend upon the average hourly earnings of labour in the construction industry (WC), the cost of temporary or bridge financing (R03), and the current level of residential (IRC) and non-residential (INRC) construction relative to their respective industrial capacities. Land costs (L) are determined primarily by the demand for residential land. This demand is represented by demographic variables, permanent real disposable income, and the existing stock of housing units, although this relationship is not shown in the flow diagram.

[3]Much of the work in sections 1 and 2 is based upon an earlier paper by the author [44].

Diagram 1

FLOW CHART OF HOUSING AND MORTGAGE MARKETS



On the left side of the diagram, the availability of public mortgage credit, which arises via Central Mortgage and Housing Corporation (CMHC), is a policy variable, while the cost (RM) and other lending terms (MT) of private mortgage credit depend upon the demand for and supply of this credit. The demand for mortgage credit depends essentially upon the same factors as the demand for houses and the cost of alternative sources of funds; while the supply of mortgage credit, or institutional mortgage approvals (MA), depends upon the yield and other attributes of mortgage investments relative to those obtainable on alternative security investments (RB), the size of institutional investment portfolios (A), and the size of their existing mortgage holdings (M). The size of an institution's investment portfolio is taken to depend upon the yield paid on the institution's liabilities relative to the yield on alternative market securities, the public's wealth and the public's existing holdings of the institution's liabilities, although this relationship is not shown in the flow chart.

2. THE HOUSING AND MORTGAGE SECTORS OF THE BANK OF CANADA MODEL, RDX1[4]

Because of the general complexity of multi-sector models, such as the Bank of Canada model, RDX1, for purposes of manipulation and comprehension it is desirable to aggregate and simplify individual sectors whenever possible. Consequently, although some structural and institutional features were blurred, I substantially simplified the structure of the housing and mortgage market sectors. This was accomplished by making the usual heroic assumptions that the behaviour of the participants in the single and multiple dwelling subsectors of the housing market are similar and that prices, rents, vacancy rates and construction costs in these subsectors vary proportionately, thereby justifying an aggregative treatment of the housing market.[5] In addition, the

[4]The estimated results presented in this section differ slightly from those presented in RDX1 [24] because of data revisions, slight specification changes, and the use of the RB interest rate variable rather than RLC.

[5]For examples of other aggregative models see: [21], [23], [30], [31], [32], [33], [35] and [49].

mortgage market was reduced to a single interest rate determination equation. In the sections that follow, these assumptions and constraints are relaxed and a more comprehensive mortgage sector and a more disaggregated housing sector are presented.

A. Residential Construction Expenditure and Housing Starts

The approach followed in this study is to focus attention on the operation of the housing market so that one could ultimately determine the volume of housing starts undertaken in any period. The linkage between the housing market and the *National Accounts*[6] is then made by converting housing starts to constant-dollar residential construction expenditure.

Residential construction expenditure, defined as the expenditures of business and persons on new residences, including garages and major alterations to existing dwellings, is estimated by the Dominion Bureau of Statistics (D.B.S.) according to a complicated formula centering on the number of physical units put in place during any period.[7] Since the number of physical units put in

[6]*National Accounts, Income and Expenditure* issued quarterly and annually by the Dominion Bureau of Statistics, catalogue nos. 13-001 and 13-201, respectively.

[7]The basic formula (later revised) used by D.B.S. during the estimation period is that residential construction expenditure (IRC) equals the sum of the value of residential construction put in place (VPP), major alteration expenditures (ALT), and supplementary costs (SUP).

$$IRC = VPP + ALT + SUP$$

VPP is based upon physical units put in place (PP) converted to value terms by weighting single dwellings, multiple dwellings and conversions (superscript s, m and c, respectively) put in place by their respective average unit values in 1956, updated by the composite construction cost index (CCC). (The index used to update the average value of conversions differs slightly from that used to update single and multiple dwellings by weighting wages more heavily than in the adjustment for single and multiple dwellings.) If X, Y, and Z are the average unit values of the base year for single dwellings, multiple dwellings and conversions, respectively, and if CCC is the composite construction cost index in the current period with CCC = 100 in the base year for X, Y and Z, then

$$VPP = CCC\,[X(PP^{s}) + Y(PP^{m}) + Z(PP^{c})]$$ (contd on p. 6.)

place is estimated from a compilation of the number of dwelling units started, under construction, and completed during a period without making allowance for possible changes in the average quality of a physical unit,[8] and since the number of units under construction and completed during any period is a function of past housing starts, I specified residential construction expenditure (IRC) as a function of current and lagged housing starts (HST).

$$IRC = f\left(\sum_{i=0}^{m} \beta_i HST_{t-i}\right) \quad (1)$$

A preliminary estimate of this relationship using quarterly 1954-1965 data is presented in equation (2), where bracketed values are t values, SEE is the standard error of estimate and D/W is the Durbin/Watson statistic.[9] This regression indicates that lagged housing starts provide a reasonable approximation of resi-

1Q54-4Q65

$$\underset{(6.62)}{IRC = 117.15} + \underset{(16.96)}{4.62\ HST} + \underset{(7.69)}{1.96\ HST_{t-1}} + \underset{(3.32)}{.92\ HST_{t-2}} \quad (2)$$

SEE = 22.06 R^2 = .89 D/W = 1.05

The PP for each category are estimated from the number of units in each category (started (S), under construction (U) and completed (C)) during the period according to the formula PP = .94 [1/3 S + 1/3 C + 1/6 U]. Hence,

$$VPP = .94\ [X(1/3\ S^s + 1/3\ C^s + 1/6\ U^s) + Y(1/3\ S^m + 1/3\ C^m + 1/6\ U^m)$$

$$+ Z(1/3\ S^c + 1/3\ C^c + 1/3\ U^c)]\ CCC$$

Major alterations are estimated from building permits issued and tend to be relatively constant from $20 million to $25 million quarterly.

$$SUP = .024\ VPP^s + .072\ VPP^m$$

Therefore, if ALT is considered to be a constant over the estimation period, and if C and U are considered to be functions of past housing starts, then IRC in constant dollars can be considered to be a function of housing starts.

[8]Except to the extent that shifts occur in the mix of single and multiple dwelling construction, since these categories have different weights.

[9]Estimation procedures and problems are discussed in more detail below.

dential construction expenditure, that the contribution of past housing starts declines with time, and that a housing start generates an average expenditure of $7,510 in constant 1957 dollars. Unfortunately, the Durbin/Watson statistic indicates that the residuals in this regression are serially correlated [16], and therefore an autoregressive transformation using a procedure suggested by Hildreth and Lu [26] was performed. This procedure assumes that the residuals (u) in my regression are generated by a first-order autoregressive scheme

$$u = \rho u_{t-1} + \varepsilon$$

and attempts to select the ρ that minimizes the residual variance of the specified equation. In the work that follows, whenever serial correlation is indicated by the Durbin/Watson statistic or is undetectable because of the inclusion of a lagged dependent variable in a regression [34], an autoregressive transformation will be conducted. The transformed regression and value of the autoregressive parameter are presented below the untransformed regression whenever the autoregressive parameter ρ lies outside the range -.1 to .1 (i.e., whenever $|\rho| > .1$).

The transformed regression of residential construction expenditure is presented in equation (2') and substantiates my previous findings except that the average residential construction expend-

$$\underset{(4.67)}{IRC = 86.27} + \underset{(22.45)}{5.02\ HST} + \underset{(9.88)}{2.13\ HST_{t-1}} + \underset{(5.32)}{1.19\ HST_{t-2}} \qquad (2')$$

$$SEE = 19.18 \qquad \rho = .538 \qquad D/W = 2.27$$

iture generated by a housing start in constant 1957 dollars has increased to a more reasonable $8,340.

Turning now to a discussion of housing starts, it is useful at the outset to distinguish between builders or developers of housing projects and the final demanders of housing units. Builders and developers are of course the entrepreneurial group engaged in the construction of new residential dwellings while the final demanders are the tenants in rental units and owners in owner-occupied dwellings. When the net user demand for dwelling units in either form increases, the number of vacant dwellings declines and pressure is placed on housing prices and rents. Assuming that these variations are not immediately reflected in construction and land costs, rising prices and rents increase the likelihood that new construction projects will be profitable and, hence, lead to an increase in construction activity.

In addition to prices, rents, vacancy rates and construction costs, the volume of building undertaken depends upon the cost and availability of mortgage credit (see [1], [3], [23], and [47]). Higher interest costs and less favourable non-price borrowing terms (lower appraisal values, lower loan-to-value ratios, shorter amortization periods) reduce the desirability and feasibility of rental construction projects by increasing equity requirements and reducing net cash flows. More stringent borrowing terms also discourage construction of owner-occupancy dwellings by making monthly carrying costs and downpayment requirements more difficult for prospective purchasers to absorb.

If one assumes that prices and rents on owner-occupancy and rental dwellings vary proportionately, the volume of new housing starts (HST) may be summarized as a function of the price of houses (PH), the vacancy rate (V), construction and land costs (CLC), and the cost (RM) and availability of private (MT) and public (CMHC) mortgage credit.

$$HST = h\ (PH,\ V,\ CLC,\ RM,\ MT,\ CMHC) \qquad (3)$$

Before this model can be estimated some slight modifications are required in its specification because of data limitations and institutional considerations. These modifications consist of: the deletion of the vacancy variable from the model, the substitution of a proxy credit rationing variable (the yield differential between mortgages and bonds (RM - RB)) for non-price mortgage lending terms to represent the availability of private mortgage credit, and the introduction of a dummy variable (WW) (taking the value 1 in the last quarters of 1963 to 1965 and zero elsewhere) to represent the impact of the government winter house-building incentive programme.

The deletion of the vacancy variable, necessary because a meaningful measure does not exist in Canada,[10] implies that the housing price variable fully represents housing market conditions. Although this is a substantial simplification, serious bias does not arise in the model as long as prices are reasonably good indicators of market conditions. The mortgage to bond yield differential was used to represent private credit rationing effects since the supply of mortgage credit from private financial institutions appears to be quite sensitive to this differential ([43], [48], [51], and section 3 of this paper, p. 33), and since satisfactory loan-to-value ratio data and amortization-term data are not available.[11] Finally, the winter house-building incentive dummy variable was required because of a government programme between 1963 and 1965 that provided a $500 per dwelling subsidy for one- to four-unit dwellings substantially constructed between December 1 and March 31.

The validity of my specification was initially tested by fitting ordinary and two-stage least squares regressions to quarterly data over the 1954-1965 period. The ordinary least squares results are presented in the text and the two-stage least squares estimates,[12] which are very similar to the ordinary least squares estimates, are presented in Appendix A. The equations in my basic model and the extended housing sector were then reestimated over the longer 1954-1967 period and these ordinary least squares results are presented in Appendix B. In order to utilize all the available information and because some statistical series are not available as early as 1954, the estimation period was varied somewhat between regressions with each regression beginning in the first quarter in which data were available after 1954. The esti-

[10]In addition to the unavailability of this variable there are some theoretical reasons for deleting vacancies when constructing a national model. The basic problem may be seen by assuming internal migration from rural to urban areas. If the migrating family abandons, even temporarily, its rural dwelling and 'doubles up' in an urban area, there is an increase in housing demand (since the migrating family now demands a dwelling of its own in an urban area) and an increase in vacancies (in rural areas). An increase in vacancies therefore does not necessarily indicate a lessening of unsatisfied housing demand.

[11]For a further justification of this specification see [23], pp. 275-298.

[12]When making the two-stage estimates I used instrumental variables created for the Bank of Canada model of the Canadian economy, RDX1 [24].

mation period, t ratios, R^2, standard error of estimate and Durbin/Watson statistic are reported for all regressions.[13] In addition, an R^2 adjusted for seasonality, $\bar{\bar{R}}^2$, is presented when appropriate.[14] Q1, Q2 and Q3 are first, second and third quarter seasonal dummy variables, respectively. The estimated housing start regression in untransformed and transformed form is shown in equations (4) and (4').

1Q57-4Q65

$$
\begin{aligned}
HST = {} & \underset{(1.06)}{25.6} - \underset{(9.26)}{20.2\,Q1} + \underset{(3.86)}{7.7\,Q2} + \underset{(4.13)}{7.7\,Q3} + \underset{(2.76)}{9.5\,WW} \\
& + \underset{(3.75)}{76.80\,(PH/CLC)} - \underset{(4.32)}{12.58\,RM_{t-1}} + \underset{(2.35)}{5.20\,(RM - RB)_{t-1}} \\
& + \underset{(1.44)}{.029\left(\frac{CMHC}{PH}\right)} + \underset{(3.93)}{.058\left(\frac{CMHC}{PH}\right)_{t-1}}
\end{aligned}
\tag{4}
$$

SEE = 3.31 $\quad R^2 = .95 \quad \bar{\bar{R}}^2 = .82 \quad$ D/W = 1.95

$$
\begin{aligned}
HST = {} & \underset{(1.75)}{55.6} - \underset{(10.97)}{20.6\,Q1} + \underset{(3.28)}{6.4\,Q2} + \underset{(4.01)}{6.8\,Q3} + \underset{(3.07)}{10.0\,WW} \\
& + \underset{(2.86)}{71.64\,(PH/CLC)} - \underset{(4.03)}{15.96\,RM_{t-1}} + \underset{(2.02)}{5.41\,(RM - RB)_{t-1}} \\
& + \underset{(.81)}{.017\left(\frac{CMHC}{PH}\right)} + \underset{(3.03)}{.044\left(\frac{CMHC}{PH}\right)_{t-1}}
\end{aligned}
\tag{4'}
$$

SEE = 3.23 $\quad \rho = .295 \quad$ D/W = 2.43

[13] The R^2 is not presented for the transformed regressions, but the explanatory power of these regressions may be seen by comparing the SEE of the transformed regression to its corresponding untransformed regression.

[14] $\bar{\bar{R}}^2 = \frac{RSS_1 - RSS_2}{RSS_1}$ where RSS_1 is the residual sum of squares associated with a regression of the dependent variable upon the intercept, Q1, Q2 and Q3, and RSS_2 is the residual sum of squares associated with the final regression.

The regressions in equations (4) and (4') tend to confirm the appropriateness of my specification since the volume of housing starts is significantly influenced by the ratio of housing prices to construction and land costs,[15] the availability of private mortgage credit (represented by the mortgage to bond yield differential (RM - RB)), the availability of public mortgage credit (taken as the constant-dollar volume of CMHC direct lending $(\frac{CMHC}{PH})$), and the cost (RM) of mortgage credit. The sum of the coefficients on the CMHC variable indicates that an additional million dollars of Central Mortgage and Housing Corporation direct lending in constant 1957 dollars will generate between 61 (the sum of the transformed coefficients) and 87 (the sum of the untransformed coefficients) additional housing starts.[16] Finally, the coefficient on the winter house-building incentive dummy variable (WW) indicates that this programme was quite successful in breaking the usual fourth-quarter decline in housing starts.

[15]Since I wrote this paper I have discovered that my profitability variable PH/CLC also reflects variations in the average size of new dwellings. This occurs because the PNHA component of the PH variable is based upon substantially the same data as the CLC variable, and is expressed on a per dwelling basis while CLC is expressed on a per square foot basis. However, the elimination of this influence does not affect any of the parameter estimates in the model. As an illustration, the housing start regression, where the problem is potentially most severe, is presented below over the longer estimation period 1Q57-4Q67 with PMLS/CLC replacing PH/CLC.

1Q57-4Q67

$$HST = \underset{(1.65)}{29.7} - \underset{(7.55)}{17.5}\,Q1 + \underset{(4.48)}{10.1}\,Q2 + \underset{(3.88)}{8.4}\,Q3 + \underset{(3.42)}{9.5}\,WW + \underset{(2.76)}{67.49}\,(PMLS/CLC)$$

$$- \underset{(3.71)}{12.12}\,RM_{t-1} + \underset{(1.67)}{3.87}\,(RM - RB)_{t-1} + \underset{(2.85)}{.038}\,\left(\frac{CMHC}{PH}\right) + \underset{(3.41)}{.044}\,\left(\frac{CMHC}{PH}\right)_{t-1}$$

SEE = 4.22 $\qquad R^2 = .91 \qquad$ D/W = 1.44

[16]This implies an average Central Mortgage and Housing Corporation mortgage loan of between \$11,400 and \$16,400 per unit in constant 1957 dollars was required to generate an additional housing start. This compares with the actual average current-dollar loan of \$11,800 per unit during this period (see [10], p. 41).

B. Housing Prices and Vacancy Rates

The basic forces underlying the demand for housing accommodation are essentially the same as for other goods — population, income, prices, the cost and availability of credit and consumer preferences ([14], p. 138 and [37], p. 5) — with the demographic and income variables being most important in the long run. In the short run, population increases may be accommodated in a relatively fixed housing inventory by varying the intensity of occupancy, but in the long run, especially under conditions of rising real incomes, population growth has been the strategic factor in determining the level of residential construction (see [4], p. 56 and [20], p. 76). However, demographic influences are not confined to population or family growth. The age composition, family size and number of first and second child births also play important roles in housing demand. Unfortunately, despite numerous attempts, I was unable to introduce these variables into the model in a significant manner, and therefore demographic influences are represented solely by family and population variables.

Rising incomes exert a substantial influence on the demand for housing by increasing the quality of accommodation desired and by enabling more families to afford their own homes (see [38], pp. 149-152). Since I am only concerned in this study with the demand for housing units and not with their quality, rising incomes will stimulate demand by facilitating family 'undoubling', net family formation and the formation of non-family households (consisting primarily of single young people who move out of their parents' homes to live in separate dwellings and of middle-aged and elderly widows, widowers, bachelors, spinsters and divorcees). This occurs since higher incomes enable more population units to afford the rents or carrying costs and downpayments required to maintain separate living accommodation.

Credit variables have a strong influence on the demand for housing since for most families this demand is quite sensitive to downpayment and monthly payment requirements ([5], p. 100 and [54], p. 92); and these payments depend upon the nominal purchase price, the mortgage interest rate, the loan-to-value ratio and the amortization term of the mortgage. However, because variations in credit terms have a substantially stronger impact on the quality of housing services demanded, which is ignored in this study, than on the number of housing units demanded,[17] much of the influence of these variations is likely to be missed in this paper.

Family demand for housing units (DH/HH) may, therefore, be thought of as a function of: permanent real family disposable income (YDP/HH), the price of housing (PH), the price of alternative goods and services (PGNE), and (to a slight extent) the cost (RM) and availability (MT) of mortgage credit. The demand for housing is expressed on a family basis because families occupy over 84 per cent of Canadian dwelling units ([10], p. 93 and [28], p. 40), and accurate data on non-family households, occupying the remaining housing units, are not available.

$$DH/HH = g\ (YDP/HH,\ PH,\ PGNE,\ RM,\ MT) \tag{5}$$

Housing prices and vacancies can now be determined by introducing the per family stock of dwelling units (STH/HH) into the model. The stock of dwellings consists of units that are occupied (SHO) and those that are vacant (V). The stock of dwelling units existing in any period is identically equal to the stock of the previous period plus completions (C) and conversions (CON) less removals and demolitions (RD). If conversions, removals and demolitions are considered to be a function of past stock, and completions a function of lagged starts, the supply of housing units is a function of the previous stock and lagged starts, i.e.,

[17] The Consumer Survey prepared for the Royal Commission on Banking and Finance ([6], p. 100) shows that a 10 per cent increase in downpayment requirements would have caused 6 per cent of home purchasers, using mortgage credit during 1957-1962, to purchase cheaper homes; and that a 10 per cent increase in monthly payment requirements would have caused 12 per cent to 15 per cent of home purchasers to purchase cheaper homes. Moreover, these same credit variations would have caused reductions of 9 per cent, and 20 per cent to 25 per cent, respectively, in new home purchases. A significant proportion of these purchases would have occurred to upgrade accommodation, since over a third of home purchases are made by families previously occupying their own dwellings (see [10], p. 68).

if CON = bSTH$_{t-1}$, RD = b'STH$_{t-1}$, and $C = \sum_{i=0}^{n} C_i \, HST_{t-i}$,

$$\text{then } \Delta STH = (b - b') \, STH_{t-1} + \sum_{i=0}^{n} C_i \, HST_{t-i},$$

$$\text{and } STH = (1 + b - b') \, STH_{t-1} + \sum_{i=0}^{n} C_i \, HST_{t-i} .$$

Hence,

$$(STH/HH) \equiv (SHO/HH) + (V/HH) = f[(STH/HH)_{t-1}, \sum_{i=0}^{n} \beta_i \, (HST/HH)_{t-i}] \quad (6)$$

Housing prices and vacancies may now be determined by interacting the demand for and supply of these housing units.

$$PH = p(YDP/HH, PGNE, RM, MT, SHO/HH, V/HH) \quad (7)$$

$$V/HH = v(YDP/HH, PGNE, RM, MT, SHO/HH, PH) \quad (8)$$

Estimates of equations (6) and (7), after modifications necessitated by data limitations, are presented in equations (9), (10) and (11). I did not estimate equation (8) because reliable vacancy data were unavailable. The modifications consist of the use of total housing stock (STH) rather than separate SHO and V variables since vacancy data are lacking, and the proxy for MT is eliminated because of its insignificance. Coefficients on the lagged housing start variable in equation (9) were estimated by the Almon technique using second and third degree Almon variables[18] (see [2], and [50]).

[18] The actual estimated housing stock regression is:

$$STH = \underset{(680.78)}{.9997} \, STH_{t-1} + \underset{(4.29)}{3.70} \, Z_2 - \underset{(3.76)}{2.74} \, Z_3$$

$R^2 = .99$ D/W = 2.03

where Z_2 and Z_3 are second and third degree Almon variables created on housing starts.

$$2Q54\text{-}4Q65$$

$$STH = \underset{(680.78)}{.9997}\ STH_{t-1} + \underset{(2.85)}{.224}\ HST + \underset{(5.07)}{.372}\ HST_{t-1}$$

$$+ \underset{(4.69)}{.275}\ HST_{t-2} + \underset{(4.44)}{.096}\ HST_{t-3} \tag{9}$$

$$SEE = 6.62 \qquad R^2 = .99 \qquad D/W = 2.03$$

Equation (9) indicates that the existing housing stock is determined by the past stock of houses and current housing completions, where housing completions are represented by past housing starts. The lagged housing stock coefficient of less than 1 in the housing stock regression suggests that demolitions and removals exceed conversions (i.e., that $|b'| > b$) since these variables were all assumed to be a function of the lagged stock. The coefficients on the lagged housing start variables indicate an average construction period of just over one and two-thirds quarters assuming housing starts are uniformly distributed within each quarter.[19]

$$1Q57\text{-}4Q65$$

$$PH = \underset{(.87)}{43.8} + \underset{(.83)}{.9}\ Q1 + \underset{(3.30)}{3.6}\ Q2 + \underset{(1.71)}{1.8}\ Q3 + \underset{(1.11)}{32.03}\ (YDP/HH)_{t-1}$$

$$- \underset{(1.33)}{120.96}\ (STH/HH) + \underset{(4.10)}{1.62}\ PGNE_{t-1} - \underset{(1.16)}{2.98}\ RM_{t-1} \tag{10}$$

$$SEE = 2.05 \qquad R^2 = .92 \qquad \bar{\bar{R}}^2 = .90 \qquad D/W = 1.06$$

[19]The average construction period was calculated by assuming that housing starts are uniformly distributed within each quarter. Thus there is an average one-half quarter lag for housing stock changes (which arise from completions) behind housing starts in the current quarter, an average one and one-half quarter lag for changes in stock behind starts in the previous quarter, etc.

$$PH = 23.4 + \underset{(.38)}{.7}\,Q1 + \underset{(.91)}{3.0}\,Q2 + \underset{(3.31)}{1.7}\,Q3 + \underset{(1.46)}{49.16}\,(YDP/HH)_{t-1}$$

$$- \underset{(.57)}{60.05}\,(STH/HH) + \underset{(1.88)}{.79}\,PGNE_{t-1} - \underset{(.24)}{.77}\,RM_{t-1} \qquad (10')$$

$$SEE = 1.70 \qquad \rho = .470 \qquad D/W = 1.24$$

1Q57-4Q65

$$PH = \underset{(1.70)}{74.1} + \underset{(1.10)}{1.1}\,Q1 + \underset{(3.44)}{3.8}\,Q2 + \underset{(2.03)}{2.0}\,Q3 + \underset{(2.95)}{57.13}\,(YDP/HH)_{t-1}$$

$$- \underset{(2.40)}{180.89}\,(STH/HH) + \underset{(3.94)}{1.44}\,PGNE_{t-1} \qquad (11)$$

$$SEE = 2.06 \qquad R^2 = .92 \qquad \bar{\bar{R}}^2 = .90 \qquad D/W = .97$$

$$PH = 21.1 + \underset{(.36)}{.7}\,Q1 + \underset{(.98)}{2.9}\,Q2 + \underset{(3.40)}{1.7}\,Q3 + \underset{(2.60)}{53.64}\,(YDP/HH)_{t-1}$$

(.36) (.98) (3.40) (2.60) (1.98)

$$- \underset{(.61)}{56.15}\,(STH/HH) + \underset{(1.66)}{.66}\,PGNE_{t-1} \qquad (11')$$

$$SEE = 1.65 \qquad \rho = .515 \qquad D/W = 1.25$$

The housing price regressions indicate that housing prices vary directly with permanent real disposable income per family and the price of alternative goods and services, and inversely with the per family size of the existing housing stock. Unfortunately our cost-of-credit and credit-rationing variables failed to perform as anticipated, since the credit-rationing variable had the wrong sign and the cost-of-credit variable was insignificant. One explanation for these failures is the fact that credit variables have a stronger influence on the quality of housing demanded than on the unit or stock demand; and that those stock-demand influences that exist fall primarily on the allocation of housing demand between owner and rental units rather than on the total demand for housing.[20] A further explanation is to be found in the degree of aggregation in, and nature of, the price and interest-cost variables used in this study.

First, the housing-price variable is an average of an index of housing prices compiled by Multiple Listing Service sales (co-operative sales by members of Canadian real estate boards), roughly representing an index of prices of existing houses, and an index of prices of new NHA houses based upon the cost of new NHA houses.[21] Varying interest costs may affect the prices of existing and new houses in opposite ways. Traditionally, rising borrowing costs are expected to reduce housing demand and hence housing prices by increasing monthly carrying costs and leading to more stringent non-price borrowing terms. However, in the case of new houses a different mechanism may be operating, since purchasers of new houses usually assume the mortgage arranged by the builder prior to the commencement of construction. Thus an increase in current mortgage rates would be expected to exert upward pressure on prices since new houses currently for sale are available with financing at the old 'bargain' rate and housing prices, in a sense, become the rationing mechanism for scarce mortgage credit.

Second, the mortgage rate variable is an average of the prime conventional mortgage rate of six life insurance companies and the actual NHA mortgage rate. Since vendors very often 'take back' substantial mortgages on the sale of their houses ([37], pp. 34-36), it is unlikely that my mortgage rate is representative of the rate charged on a large portion of the mortgage financing used in the purchase of existing houses. Similarly, although the RM - RB variable is a satisfactory proxy for the availability of new mortgage credit from financial institutions, RM - RB may be quite an inadequate representation of the tightness in the secondary and vendor mortgage markets.

Since the price and mortgage rate variables used in this study embody these conflicting forces, it is not surprising that the mortgage rate and credit-rationing variables are not signifi-

[20]The factors affecting the allocation of housing demand are discussed more thoroughly in section 4.

[21]See footnote 15.

cant in the housing-price regressions. Consequently, my results should not be interpreted as an indication that no significant relationship exists between housing prices and financial market conditions, but only that my highly aggregative data did not detect any significant relationship.

Finally, in interpreting these results extreme caution must be exercised as a consequence of the presence of serially correlated residuals in the price regressions, indicated by the low Durbin/Watson statistics [16], and the inclusion of a lagged dependent variable in the housing-stock equation. This variable biases the Durbin/Watson statistic toward 2.0 and inhibits the detection of serial correlation [34].

In an effort to eliminate these problems I attempted autoregressive transformations using the procedure suggested by Hildreth and Lu [26]. The results indicate that serial correlation is not a problem in the housing stock regression since the autoregressive parameter, ρ, which minimizes the residual variance of equation (5), is -.032. However, in the price regressions I ran into a further problem because the search procedure indicates that a ρ greater than 1 minimizes the residual variance of equations (10) and (11). This is unsatisfactory because it implies an explosive process and suggests that a first-order autoregressive transformation may not be appropriate. Nevertheless, since the price equations have no lagged dependent variables, I persisted with a Theil/Nagar transformation [52]. The results of these transformations, presented in equation (10') and (11'), indicate some substantial coefficient changes on the (STH/HH), $PGNE_{t-1}$ and RM_{t-1} variables. The low Durbin/Watson statistic indicates that, as expected, the transformations have not eliminated the serial correlation in the residuals.

C. Construction and Land Costs

To complete the housing sector, consideration must be given to the factors affecting construction costs and land costs. The measure of construction costs in this section is an index of the average cost of construction (including land costs) per square foot on new government-insured single detached dwellings. Variations in this index were assumed to be influenced by changes in average hourly earnings in construction (WC), changes in temporary or bridge financing costs (R03),[22] changes in land costs (L), changes in the cost of building materials, and the delays and bottlenecks that arise as current residential construction (IRC) and non-residential construction (INRC) press against their respective industrial capacities. Since changes in the cost of building materials are highly correlated with changes between residential and non-residential construction and their respective industrial capacities, the building material variable was deleted from the model and its impact was assumed to be reflected in the coefficients on the capacity variables and a sales tax dummy variable (DVST). DVST, which has the value 1 from 3Q63 to 4Q65 and zero elsewhere, was included to reflect the influence of the imposition in stages of a sales tax on building materials between June 1963 and December 1965.[23] The degree of capacity utilization in residential and non-residential construction was assumed to be represented by the deviations of residential and non-residential construction expenditure from their seasonally adjusted logarithmic trends.

The estimated regressions in logarithmic form, presented in equations (12) to (14), indicate that all the included variables significantly influence construction costs. The construction cost equation is estimated in terms of annual changes in quarterly form owing to the inclusion of the wage variable and the amount of random noise inherent in the measure of construction costs. Although this procedure does not introduce bias into the estimates it does impair the efficiency of the least squares estimates by building serial correlation into the model and reducing the number of truly independent observations (see [36], pp. 30-31, and [41], pp. 326-327).

[22]The short-term government bond rate (R03) was used as a proxy for the cost of bridge financing or temporary financing because a direct measure of this variable does not exist in Canada.

[23]An 11 per cent federal sales tax was imposed on building materials in 1963, taking effect as follows: 4 per cent after June 1963, 8 per cent after April 1964, and 11 per cent after January 1965.

1Q53-4Q67

$$\ln \hat{IRC}^{24} = \underset{(141.89)}{5.93} - \underset{(8.51)}{.349}\ Q1 - \underset{(2.24)}{.092}\ Q2 - \underset{(.20)}{.008}\ Q3 + \underset{(3.19)}{.0027}\ T \tag{12}$$

SEE = .11 R^2 = .66 D/W = .70

1Q53-4Q67

$$\ln \hat{INRC}^{24} = \underset{(118.65)}{6.25} - \underset{(7.16)}{.370}\ Q1 - \underset{(1.67)}{.086}\ Q2 - \underset{(2.03)}{.105}\ Q3 + \underset{(8.09)}{.0085}\ T \tag{13}$$

SEE = .14 R^2 = .75 D/W = .33

3Q55-4Q65

$$\ln CLC - \ln CLC_{t-4} = \underset{(.51)}{-.0031} + \underset{(1.92)}{.039}\ (\ln INRC - \ln \hat{INRC})_{t-1}$$

$$+ \underset{(3.81)}{.090}\ (\ln IRC - \ln \hat{IRC})_{t-1} + \underset{(1.13)}{.13}\ (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(2.58)}{.11}\ (\ln L - \ln L_{t-4}) + \underset{(3.30)}{.030}\ (\ln R03 - \ln R03_{t-4})$$

$$+ \underset{(5.11)}{.029}\ DVST \tag{14}$$

SEE = .014 R^2 = .78 D/W = 1.56

[24] ln $\hat{INRC}$ and ln $\hat{IRC}$ appear in RDX1 as LINE (11449) and LIRE (11450), respectively. Their corresponding equations were estimated over the sample period, 1953-1965.

$$\ln CLC - \ln CLC_{t-4} = \underset{(.55)}{-.0038} + \underset{(1.70)}{.039} (\ln INRC - \ln \hat{INRC})_{t-1}$$

$$+ \underset{(3.05)}{.076} (\ln IRC - \ln \hat{IRC})_{t-1} + \underset{(1.08)}{.14} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(2.43)}{.12} (\ln L - \ln L_{t-4}) + \underset{(3.07)}{.030} (\ln R03 - \ln R03_{t-4})$$

$$+ \underset{(4.23)}{.029} DVST \qquad (14')$$

SEE = .013 $\qquad \rho = .267 \qquad$ D/W = 1.82

Unfortunately, the CLC equation has a fair amount of multicollinearity so that one cannot place too much reliability on the coefficients of all the variables even though there is a great deal of stability between the transformed and untransformed coefficients. This is particularly true for the average hourly earnings in construction variable (WC). It appears to have a much greater impact on construction costs when the chartered bank day loan rate (RDL) is used, for example, instead of the short-term government bond rate (R03) as a proxy for the cost of temporary construction loans (see equation (15)).

3Q55-4Q65

$$\ln CLC - \ln CLC_{t-4} = \underset{(1.14)}{-.007} + \underset{(1.26)}{.030} (\ln INRC - \ln \hat{INRC})_{t-1}$$

$$+ \underset{(4.83)}{.11} (\ln IRC - \ln \hat{IRC})_{t-1} + \underset{(1.74)}{.21} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(3.04)}{.14} (\ln L - \ln L_{t-4}) + \underset{(1.99)}{.010} (\ln RDL - \ln RDL_{t-4})$$

$$+ \underset{(4.30)}{.026} DVST \qquad (15)$$

SEE = .015 $\qquad R^2 = .74 \qquad$ D/W = 1.48

$$\ln CLC - \ln CLC_{t-4} = \underset{(.80)}{-.006} + \underset{(1.17)}{.030}\ (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(3.25)}{.085}\ (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(1.47)}{.21}\ (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(2.62)}{.14}\ (\ln L - \ln L_{t-4}) + \underset{(1.83)}{.010}\ (\ln RDL - \ln RDL_{t-4})$$

$$+ \underset{(3.38)}{.026}\ DVST \qquad (15')$$

SEE = .014 ρ = .354 D/W = 1.79

Similarly, if construction costs are defined as the average cost of construction per square foot on new government-insured single detached dwellings, excluding land costs, and land costs are deleted as an explanatory variable (see equation (49) in section 4), regardless of what interest rates are used as a proxy for the cost of temporary financing, average hourly earnings exert a much greater influence on construction costs than when construction costs are defined to include land costs (as in equation (14)). However, the coefficients on all the other variables are remarkably similar.

Land costs, measured as an index of the cost of land used in the construction of new NHA single detached dwellings, are assumed to be determined by the demand for residential land.[25] The cost of land, therefore, is thought to vary directly with population (POPT), permanent real disposable income, and expectations as to future land prices (where expectations are extrapolative and represented by past changes in land prices), and inversely with the size of the existing housing stock.

[25] The specification of equation (16) has been greatly simplified by assuming that the supply of residential land is a constant. In fact the supply of usable residential land increases with the availability of transportation, water, electricity and other services and the proclamation of zoning regulations, so that most of these increases in the supply of usable land have been anticipated by developers and speculators and therefore are not increases in the usual sense.

2Q54-4Q65

$$L = -141.5 + .042\ POPT + .030\ YDP - .15\ STH + .59\ \Delta L \quad (16)$$
$$\quad (5.81) \quad (6.55) \quad (4.38) \quad (5.09) \quad (5.08)$$

SEE = 4.11 $\qquad R^2 = .96 \qquad$ D/W = .77

$$L = -123.2 + .036\ POPT + .027\ YDP - .13\ STH + .50\ \Delta L \quad (16')$$
$$\quad (4.05) \quad (4.85) \quad (3.38) \quad (3.79) \quad (6.39)$$

SEE = 3.47 $\qquad \rho = .324 \qquad$ D/W = 1.34

D. The Mortgage Market

The importance of the mortgage market to the housing sector is apparent from the above discussion, since the terms and availability of mortgage credit were shown to have a direct bearing both on user demand for housing and on the willingness and ability of builders and developers to undertake new construction.[26] Because of the multiplicity of sectors in RDX1, the RDX1 mortgage sector has been confined to a single mortgage rate determination equation, which provides the linkage between the real and financial components of the housing market. However, although a complete mortgage sector is not included in RDX1, there is an elaborate mortgage market specification underlying and consistent with the mortgage rate determination equation. This specification, which is partially developed here, will be completed and estimated in section 3.

The demand for mortgage credit for residential construction is directly related to the demand for this construction, and is primarily influenced by the same variables as is the demand for housing (see [25], p. 59 and [27], p. 476). In addition, the demand for mortgage credit depends upon the cost of this credit relative to the cost of alternative sources of funds, including the opportunity cost of equity financing. For estimation purposes

[26]For a further development of these relationships see [29] and [37].

the demand for private mortgage credit (DM)[27] may be summarized as: a function of permanent real family disposable income (YDP/HH), the per family stock of dwelling units (STH/HH), the cost (RM) and non-price borrowing terms (MT) of this credit, and the cost of alternative sources of funds. This last variable is represented by a weighted average of the yields on long-term federal, provincial, municipal, corporate and public utility bonds (RB).[28]

$$DM = d\ (YDP/HH,\ STH/HH,\ RM,\ RB,\ MT) \qquad (17)$$

The supply of mortgage credit for new residential construction in Canada comes from both private financial institutions and Central Mortgage and Housing Corporation (CMHC), a government corporation. Government lending is quite distinct from private lending since the former occurs 'as a last resort' when sufficient private financing is not available. Government lending is considered to be a policy variable in this paper.[29] On the other hand private lending; which originates primarily from life insurance companies, chartered banks, trust companies and mortgage loan companies; responds to market forces and essentially depends upon the desirability of mortgage investments relative to alternative investment opportunities. This desirability, and hence the extent to which institutional flows will be directed toward mortgage investment, depends upon the discrepancy between an institution's actual (M^i) and desired (M^{i*}) stock of mortgage investments; where an institution's desired stock is based upon a comparison of present and expected mortgage yields (RM) and non-price terms (MT) with the present and expected yields (RB) and other terms (BT) of alternative security investments, and upon the size of the institutions investment portfolio (A^i).[30] Since most institutional

[27]Since government lending performs a residual function ([12], p. iv, and [37], p. 100), all demand for mortgage credit is considered initially to be a demand for private mortgage credit.

[28]Weights are in proportion to bonds outstanding, i.e. — .5, .2, .1, .1 and .1, respectively.

[29]For a discussion of the role of Central Mortgage and Housing Corporation see [12], pp. 18-20, [37], pp. 98-103, and [5], pp. 269-284.

[30]For some general examples of financial stock adjustment models see [13] and [19], and for some applications of this approach for the mortgage market see [43], [48] and [51].

mortgages are amortized, a significant proportion (θ) of an institution's mortgage portfolio is returned during each period in the form of principal repayments, and the expected size of these repayments (RE) should be taken into consideration when institutions make their investment decisions.

Hence, factors affecting the volume of mortgage approvals made by the i^{th} institution may be summarized by the following equations:

$$MA^i = \gamma (M^{i*} - M^i_{t-1}) + \delta RE^i,$$

$$M^{i*} = m (RM, RB, A^i, MT, BT),$$

and $$RE^i = \theta (M^i_{t-1}).$$

These equations reduce to

$$MA^i = \gamma m (RM, RB, A^i, MT, BT) - (\gamma - \theta\delta) M^i_{t-1}. \qquad (18)$$

The total supply of private mortgage credit (SM) is then considered to be the sum of the mortgage approvals made by life insurance companies, chartered banks, trust companies and mortgage loan companies.

$$SM \equiv \sum_{i=1}^{4} MA^i, \qquad (19)$$

where i refers to the main institutions engaged in mortgage lending.

Although the interaction of basic demand and supply functions is sufficient to determine security yields and other lending terms in most security markets, the existence of separate government-insured (NHA) and conventional mortgage debt instruments complicates this procedure in the mortgage market. NHA mortgages are government-insured mortgages with lending terms and yields under government supervision, while conventional mortgages are uninsured and essentially free of government controls. Since conventional mortgages have no special features to mitigate their inherent risk they typically carry higher yields and more stringent borrowing terms than NHA mortgages.[31] Up to this point I have largely ignored the distinction between these forms of mortgages, and I have used a mortgage rate (RM) that is the average of the conventional mortgage rate (RC) and the government-insured mortgage rate (RNHA),[32] where (RNHA) is considered to be an exogenous policy variable.[33]

$$RM \equiv (RC + RNHA)/2 \tag{20}$$

The NHA rate should now be introduced explicitly into the demand and supply functions in order to determine the conventional rate, since NHA mortgages are an important alternative source of funds to conventional mortgages for borrowers and an important alternative form of investment to conventional mortgages open to financial institutions (see [45], pp. 420-427). Thus, the demand for (DCM) and supply of (SCM) conventional mortgage credit becomes

$$DCM = d' \,(YDP/HH,\ STH/HH,\ RC,\ RNHA,\ RB,\ MT) \tag{21}$$

and

$$SCM \equiv \sum_{i=1}^{4} C\ MA^{i} = s\,(RC,\ RNHA,\ RB,\ MT,\ BT,\ \sum_{i=1}^{4} \beta_i A^{i},\ \sum_{i=1}^{4} \gamma_i M^{i}). \tag{22}$$

[31]For a more detailed discussion of the difference between NHA and conventional mortgages and government housing legislation see [12], pp. 60-64, [37], pp. 25-32, [5], pp. 269-273, and [55], pp. 10-30.

[32]Since the size of conventional and NHA mortgage flows for new residential construction was approximately equal over the estimation period, an unweighted average was used.

[33]During the period of this study the government set an interest yield ceiling rather than the actual interest yield on NHA mortgages. However, with the exception of a few months in 1955, the actual lending rate was the ceiling rate and, hence, the government may be considered to have set the lending rate.

Hence,

$$RC = r\,(RB,\ RNHA,\ MT,\ BT,\ YDP/HH,\ STH/HH,\ \sum_{i=1}^{4} \beta_i A^i,\ \sum_{i=1}^{4} \gamma_i M^i). \qquad (23)$$

The estimated untransformed and transformed mortgage rate determination regressions are presented in equations (24) and (24'), with MT and BT assumed to be impounded in the disturbance term and with institutional investment portfolios approximated by the total asset holdings of each institution. Because institutions wish to invest different proportions of their investment portfolios in mortgages (see the discussion in section 3), a total institutional investment portfolio variable (ALTM) was created such that each institution's asset holdings are weighted by the coefficient on the institution's portfolio variable in the regressions presented in Table 1 (see pp. 32-33). For consistency, these weights were also applied to the mortgage holdings of each institution to create the institutional mortgage stock variable (MLTM). Since the chartered banks were legally prohibited from participating in the conventional mortgage market prior to 1967, the total institution investment portfolio and mortgage stock variables are the weighted sums of life insurance company (L), trust company ((T) or (T')), and mortgage loan company (M) asset and mortgage holdings only, i.e.,

$$ALTM = .21\ (AL - PL) + .13\ AT + .31\ AM$$

and

$$MLTM = .21\ ML + .13\ MT' + .31\ MM.$$

2Q54-4Q65

$$RC = \underset{(3.20)}{9.7} - \underset{(2.95)}{8.85}\ (STH/HH)_{t-1} + \underset{(3.16)}{3.17}\ (YDP/HH) - \underset{(6.02)}{.0031}\ ALTM$$

$$+ .0045\ MLTM_{t-1} + .38\ RNHA + .32\ RB_{t-1} \qquad (24)$$
$$(5.76) \qquad (4.49) \qquad (4.49)$$

SEE = .092 $\quad R^2 = .96 \quad$ D/W = 1.14

$$RC = 11.5 - 11.21\ (STH/HH)_{t-1} + 3.72\ (YDP/HH) - .0020\ ALTM$$
$$(2.82)\ (2.69) \qquad (3.32) \qquad (3.18)$$

$$+ .0029\ MLTM_{t-1} + .32\ RNHA + .32\ RB_{t-1} \qquad (24')$$
$$(3.21) \qquad (3.42) \qquad (4.33)$$

SEE = .078 $\quad \rho = .564 \quad$ D/W = 2.00

In addition to depending upon the size of institutional total asset and mortgage holdings, the conventional mortgage rate is strongly influenced by the lagged bond rate, the NHA mortgage rate, permanent real family disposable income and the per family housing stock. Although this specification has a rather nice structural rationale and interpretation, for predictive purposes two highly simplified formulations perform almost as well. In these formulations the conventional mortgage rate is solely a function of the lagged bond rate and the change in the bond rate (equation 25), or a function of the lagged bond rate, the change in the bond rate and the current NHA mortgage rate (equation 26).

2Q54-4Q65

$$RC = 4.13 + .54\ RB_{t-1} + .24\ \Delta\ RB \qquad (25)$$
$$(27.88)\ (17.86) \qquad (1.99)$$

SEE = .153 $\quad R^2 = .88 \quad$ D/W = .38

$$RC = 4.22 + .53\ RB_{t-1} + .21\ \Delta\ RB \qquad (25')$$
$$(12.61)\ (8.02) \qquad (2.85)$$

SEE = .089 $\quad \rho = .804 \quad$ D/W = 1.43

2Q54-4Q65

$$RC = \underset{(8.61)}{3.50} + \underset{(1.63)}{.19}\ RNHA + \underset{(5.76)}{.43}\ RB_{t-1} + \underset{(2.31)}{.28}\ \Delta\ RB \quad (26)$$

SEE = .150 $\qquad R^2 = .89 \qquad$ D/W = .44

$$RC = \underset{(7.74)}{4.15} + \underset{(.17)}{.02}\ RNHA + \underset{(6.34)}{.52}\ RB_{t-1} + \underset{(2.74)}{.21}\ \Delta\ RB \quad (26')$$

SEE = .090 $\qquad \rho = .802 \qquad$ D/W = 1.44

3. THE MORTGAGE SECTOR OF RDX1 EXTENDED

Underlying and consistent with the mortgage rate determination equation in the preceding section is a specification of the mortgage lending behaviour of financial institutions. In this specification the volume of an institution's mortgage lending activity depends upon the relative yields available on mortgages and alternative investments, the size of an institution's investment portfolio (represented by the institution's total asset holdings or deposit liabilities), and the size of an institution's existing mortgage holdings (equation (18)). In this section the above relationship is examined for each of the major financial institutions in the mortgage market. In addition, because the size of the investment portfolios or deposit liabilities of these institutions exerts a significant influence on their mortgage investment behaviour, the factors affecting the size of these investment portfolios or deposit liabilities are briefly examined.[34]

[34]For a more elaborate specification and an integration of financial institution inflows of funds and mortgage lending activity see [46].

A. Financial Institutions — Mortgage Lending Behaviour

Because mortgage approvals, rather than mortgage disbursements or net investments that arise out of mortgage approvals, respond to current economic conditions and represent the actual mortgage investment decisions of financial institutions, mortgage approvals are used in this study to represent the mortgage lending behaviour of these institutions. This behaviour is set out in equation (27), which was developed in the previous section. The equation is estimated for the chartered banks, life insurance companies, trust companies and mortgage loan companies. These regression results in untransformed and transformed form are presented in Table 1.

$$MA^i = \gamma m\ (RM, RB, A^i, MT, BT) - (\gamma - \theta\delta)\ M^i_{t-1} \qquad (27)$$

where: γ is the stock-adjustment coefficient,

δ is the proportion of the instution's expected mortgage repayments reinvested (in the approval sense) in mortgages during the current period, and

θ is the proportion of an institution's mortgage portfolio expected to be repaid during the current period.

In order to integrate the mortgage section into the basic RDX1 model and to close the model further by determining the total mortgage stock variable (MLTM), which appears in the conventional mortgage rate determination equation (23), the mortgage approval equation (27) can be transformed into a net mortgage investment equation, equation (28). This can be done by deleting repayments (since the dependent variable is now expressed in net terms) and building a lag structure into the model to reflect the time lag between the commitment and disbursement of funds (see [29], pp. 143-146). Net mortgage investment equations (ΔM) for each financial institution are presented in Table 2. However, no special discussion of these regressions is conducted because of the similarity between them and the regressions for mortgage approvals presented in Table 1.

$$\Delta M^i = \gamma' m'\ (RM, RB, A^i, MT, BT) - \gamma' M^i_{t-1} \qquad (28)$$

Because bonds are the major alternative to mortgage investments for the majority of financial institutions included in this study,[35] a weighted average of the yields on long-term federal, provincial, municipal, corporation and public utility bonds (RB) was used to represent alternative security yields. This rate was combined, in differential form to relieve multicollinearity, with the mortgage rate (RM), an average of the National Housing Act (NHA) rate and the conventional mortgage rate, to represent the relative yield desirability of mortgage investments. In the case of the chartered banks, authorized to initiate only NHA mortgages as opposed to conventional mortgages prior to 1967, the yield differential between NHA mortgages and long-term Government of Canada bonds (RNHA - RLC) rather than the yield differential between all mortgages and bonds (RM - RB) was used to represent relative yield considerations. In order to allow for lagged responses my interest yield variables were introduced currently and in distributed lag form using Almon variables [2].

The chartered bank mortgage regression was estimated from mid-1954 to the end of 1959 because this was the only period prior to 1967 during which banks actively participated in mortgage lending. Since life insurance company policy loans (PL) vary in response to the demands of borrowers rather than the preferences of investors ([7], p. 62), funds invested in policy loans were not considered to form part of life insurance company investment portfolios in the usual sense and were netted out of the life company investment portfolio variable (AL - PL). In order to examine the influence of policy loans on investment decisions of life companies in more detail, a second specification of the model was attempted with life insurance company total assets (AL) and policy loans included separately.

The mortgage lending regressions in Tables 1 and 2 indicate that mortgage lending by financial institutions is significantly influenced by relative interest yields, the size of existing investment portfolios and the size of existing mortgage holdings; and that the strength of these variables varies between institu-

[35]Although loans rather than bonds provide the main investment alternatives to mortgages for the chartered banks, the mortgage yield to bond yield differential probably provides a better indication of the relative desirability of mortgage investments than the mortgage yield to loan yield differential because of the ceiling imposed on bank lending rates during the estimation period.

Table 1

MORTGAGE APPROVAL REGRESSIONS FOR CANADIAN FINANCIAL INSTITUTIONS

	Constant	Q1	Q2	Q3	AL - PL	AL	TBA	AT	AM	PL
Chartered Banks ≠	-517.6	-17.0	40.0	33.1			.054			
	(4.54)	(1.52)	(3.73)	(3.18)			(4.84)			
	-508.1	-16.9	40.0	33.1			.053			
	(4.20)	(1.56)	(3.74)	(3.31)			(4.48)			
Life Insurance Companies	-503.4	-13.4	51.3	16.4	.212					
	(7.38)	(1.49)	(5.67)	(1.82)	(6.00)					
	-543.3	-13.4	50.0	15.3	.248					
	(5.17)	(2.04)	(6.53)	(2.25)	(4.28)					
	-235.2	-13.7	54.1	19.6		.216				-1.61
	(2.99)	(1.89)	(7.37)	(2.68)		(7.57)				(5.47)
	-238.3	-13.8	54.0	19.5		.217				-1.61
	(2.92)	(1.94)	(7.36)	(2.72)		(7.30)				(5.24)
Trust Companies	-93.3	-12.1	23.3	14.7				.132		
	(3.17)	(1.32)	(2.57)	(1.68)				(4.69)		
	-93.4	-9.8	24.2	15.5				.124		
	(3.73)	(.99)	(2.76)	(1.61)				(5.02)		
Mortgage Loan Companies	28.0	1.7	23.3	-1.3					.330	
	(1.00)	(.22)	(2.99)	(.17)					(3.55)	
	18.3	2.3	24.6	.2					.241	
	(.50)	(.36)	(3.41)	(.03)					(2.54)	
	5.8	1.7	23.3	-1.1					.313	
	(.62)	(.23)	(3.01)	(.14)					(3.46)	
	6.6	2.3	24.6	.3					.228	
	(.59)	(.36)	(3.49)	(.05)					(2.46)	
	-29.4	6.5	28.4	6.0						
	(1.37)	(1.06)	(4.61)	(.98)						
	-29.4	6.5	28.3	6.0						
	(1.31)	(1.08)	(4.61)	(1.00)						

≠ The interest variable used in equation (1) is (RNHA - RLC).

* This variable has the wrong sign and is insignificant.

DEP	M_{t-1}	$(RM - RB)_{t-i}$ $i = 0$	$i = 1$	$i = 2$	$i = 3$	R^2	$\bar{\bar{R}}^2$	SEE	D/W	ρ	Estimation Period
	-.154	30.54				.80	.60	18.00	1.78		2Q54-
	(3.77)	(1.94)									4Q59
	-.153	29.35						17.95	1.89	.080	
	(3.51)	(1.76)									
	-.252	23.33	17.50	11.66	5.83	.90	.87	21.94	1.15		1Q54-
	(4.49)	(3.21)	(3.21)	(3.21)	(3.21)						4Q65
	-.311	19.91	14.93	9.95	4.98			19.86	2.11	.449	
	(3.38)	(1.92)	(1.92)	(1.92)	(1.92)						
	-.178	15.04	11.28	7.52	3.76	.93	.91	17.72	1.83		
	(3.73)	(2.45)	(2.45)	(2.45)	(2.45)						
	-.181	14.96	11.22	7.48	3.74			17.71	1.90	.042	
	(3.63)	(2.35)	(2.35)	(2.35)	(2.35)						
	-.106	7.11	5.33	3.56	1.78	.92	.91	20.03	1.82		1Q55-
	(2.01)	(1.29)	(1.29)	(1.29)	(1.29)						4Q65
	-.088	7.39	5.54	3.70	1.85			19.86	1.76	-.190	
	(1.90)	(1.60)	(1.60)	(1.60)	(1.60)						
	-.394	-4.20*	-3.15*	-2.10*	-1.05*	.81	.80	17.56	1.44		1Q55-
	(2.93)	(.84)	(.84)	(.84)	(.84)						4Q65
	-.269	-2.34*	-1.75*	-1.17*	-.58*			17.04	1.99	.327	
	(1.98)	(.34)	(.34)	(.34)	(.34)						
	-.363					.81	.80	17.49	1.38		
	(2.82)										
	-.249							16.84	2.00	.354	
	(1.89)										
.350	-.274	4.05	3.03	2.02	1.01	.87	.86	14.37	1.78		
(6.09)	(4.64)	(1.00)	(1.00)	(1.00)	(1.00)						
.350	-.274	4.11	3.08	2.05	1.03			14.37	1.85	.051	
(5.88)	(4.50)	(.97)	(.97)	(.97)	(.97)						

Table 2

NET MORTGAGE INVESTMENT (ΔM) REGRESSIONS FOR CANADIAN FINANCIAL INSTITUTIONS

	Constant	Q1	Q2	Q3	$(AL - PL)_{t-1}$	AL_{t-1}	TBA_{t-1}	AT_{t-1}	AM_{t-1}
Chartered Banks ≠	-566.8	-30.9	-19.0	2.4			.059		
	(4.35)	(3.15)	(2.06)	(.31)			(5.10)		
	-553.7	-30.4	-20.0	2.3			.058		
	(3.29)	(4.37)	(2.73)	(.37)			(3.87)		
Life Insurance Companies	-159.2	-42.0	-17.2	-.9	.091				
	(3.72)	(7.53)	(3.08)	(.15)	(4.44)				
	-151.3	-41.3	-17.0	-.8	.091				
	(2.62)	(9.17)	(3.38)	(.18)	(3.19)				
	-63.7	-41.5	-18.1	-1.2		.094			
	(1.21)	(8.10)	(3.53)	(.23)		(4.97)			
	-55.7	-41.2	-18.1	-1.2		.095			
	(.86)	(9.25)	(3.71)	(.27)		(3.97)			
Trust Companies	-80.7	9.1	7.9	12.6				.073	
	(4.81)	(1.86)	(1.60)	(2.57)				(3.94)	
	-82.1	10.3	7.7	12.9				.070	
	(6.75)	(1.72)	(1.79)	(2.17)				(5.07)	
Mortgage Loan Companies*	-30.7	.04	6.5	9.7					.067
	(1.28)	(.01)	(1.07)	(1.59)					(.76)
	-19.3	-2.7	5.6	9.4					.054
	(.62)	(.53)	(.98)	(1.85)					(.60)
	-22.8	.2	6.6	9.8					.080
	(3.04)	(.03)	(1.10)	(1.62)					(.99)
	-18.8	-2.7	5.6	9.4					.054
	(2.00)	(.54)	(1.00)	(1.88)					(.64)
	-40.3	-4.9	4.6	7.5					
	(2.60)	(1.09)	(1.02)	(1.68)					
	-40.4	-4.9	4.6	7.5					
	(2.61)	(1.08)	(1.03)	(1.68)					

≠ The interest yield variable used in equation (1) is (RNHA - RLC).

* A second degree Almon variable is used in the first two of these regressions.

PL_{t-2}	DEP_{t-1}	M_{t-2}	$(RM - RB)_{t-i}$ $i = 1$	$i = 2$	$i = 3$	$i = 4$	R^2	$\bar{\bar{R}}^2$	SEE	D/W	ρ	Estimation Period
		-.145	29.70				.75	.69	15.47	1.01		2Q54-
		(4.16)	(1.85)									4Q59
		-.145	29.09						13.22	1.58	.502	
		(3.17)	(1.32)									
		-.121	7.41	5.56	3.71	1.85	.78	.57	13.58	1.32		1Q54-
		(3.77)	(1.71)	(1.71)	(1.71)	(1.71)						4Q65
		-.124	6.04	4.53	3.02	1.51			12.75	2.33	.332	
		(2.74)	(1.06)	(1.06)	(1.06)	(1.06)						
-.70		-.088	6.24	4.68	3.12	1.56	.82	.65	12.48	1.54		
(3.31)		(2.75)	(1.56)	(1.56)	(1.56)	(1.56)						
-.73		-.089	5.42	4.06	2.71	1.35			12.08	2.26	.237	
(2.79)		(2.21)	(1.11)	(1.11)	(1.11)	(1.11)						
		-.046	7.88	5.91	3.94	1.97	.92	.91	11.34	2.45		1Q55-
		(1.27)	(2.65)	(2.65)	(2.65)	(2.65)						4Q65
		-.039	8.22	6.16	4.11	2.05			10.71	1.96	-.367	
		(1.43)	(3.95)	(3.95)	(3.95)	(3.95)						
		-.024	1.90	1.07	.47	.12	.78	.78	14.30	1.26		1Q55-
		(.18)	(.35)	(.35)	(.35)	(.35)						4Q65
		-.012	.11	.06	.03	.01			14.02	1.52	.353	
		(.09)	(.02)	(.02)	(.02)	(.02)						
		.044					.78	.78	14.13	1.27		
		(.38)										
		-.013							13.84	1.52	.354	
		(.11)										
	.28	-.22	4.16	3.12	2.08	1.04	.89	.88	10.41	1.72		
	(5.82)	(4.32)	(1.48)	(1.48)	(1.48)	(1.48)						
	.28	-.22	4.17	3.13	2.08	1.04			10.41	1.72	-.004	
	(5.83)	(4.32)	(1.49)	(1.49)	(1.49)	(1.49)						

tions. For example, relative interest rates exert quite a significant influence on the mortgage approvals and net mortgage investments of life insurance companies, trust companies, and chartered banks,[36] but with different lag patterns. On the other hand, relative interest rates fail to exert any influence on mortgage loan company lending when portfolio targets are expressed in terms of total assets,[37] although interest rates do have some influence when mortgage targets are expressed in terms of total deposit and debenture liabilities (DEP).[38] These findings are not really surprising since they are consistent with the legal, liquidity and traditional constraints governing the investments of all these institutions. Life insurance companies, which are virtually free of all legal and liquidity constraints and traditionally large mortgage and bond purchasers, are likely to be the group most responsive to varying yields; while mortgage loan companies, holding almost 80 per cent of their total investment portfolios in mortgages and virtually confined to this single form of investment, are not likely to be strongly influenced by varying yields. Banks and trust companies, which have considerable investment freedom but which are also subject to considerable liquidity constraint, fall somewhere in between the other two groups. The proportion of an institution's net inflow of funds or net increase in assets that generates mortgage approvals (the marginal propensity to approve mortgages with respect to net asset growth) also varies as expected between institutions; being highest for mortgage loan companies at 31 per cent and lowest for banks at 5 per cent, with life insurance companies at 21 per cent and trust companies at 13 per

[36]With two exceptions, the interest rate variable is significant in these regressions at the 5 per cent confidence level using a one-tailed test. In the trust company mortgage approval regression, the variable is significant at the 10 per cent level, and in the second life company net investment regression the variable is significant at the 7 per cent level.

[37]The interest rate variable is insignificant in the net investment regression and insignificant with the wrong sign in the mortgage approval regression, when mortgage loan company investment targets are specified in terms of total assets (see Tables 1 and 2, equation (31)).

[38]Since mortgage loan companies have quite substantial and volatile short-term borrowings from other financial institutions, and since these borrowings are reflected in the asset positions of the companies but not in their deposit liabilities, it might be more reasonable to express their portfolio targets in terms of deposit and debenture liabilities rather than in terms of total assets.

cent falling in the middle. Consequently, because of the different interest sensitivities and different proportions of investment flows devoted to mortgages, the allocation of funds between institutions will also have a significant influence on total mortgage lending.

If some assumptions are made concerning the proportion of expected repayments that institutions plan to reinvest in mortgages (δ), and the proportion of an institution's mortgage portfolio expected to be repaid in the current period (θ), the stock adjustment coefficients in the mortgage approval regressions can be calculated. If one assumes that institutions plan to reinvest all their mortgage repayments in mortgages (i.e., $\delta = 1$), and that chartered banks receive mortgage repayments each quarter equivalent to 2.2 per cent, life insurance companies receive repayments equivalent to 2.3 per cent, trust companies receive repayments equivalent to 6.4 per cent and mortgage loan companies receive repayments equivalent to 4.4 per cent of their total mortgage portfolios (i.e., that θ = .022, .023, .064 and .044 respectively),[39] then chartered banks have a stock adjustment coefficient (γ) of .176, life insurance companies of .275, trust companies of .170 and mortgage loan companies of .407 using the untransformed coefficients.[40] These figures imply that the chartered banks will require approximately four quarters, life insurance companies approximately two quarters, trust companies approximately four quarters and mortgage loan companies approximately one and one-half quarters to remove half the discrepancy between their desired and actual mortgage holdings. These figures also imply an equilibrium desired proportion of mortgages to total assets of 31 per

[39]Mortgage repayment proportions are the average of each institution's gross annual decrease in mortgages outstanding ([11], Table 9) divided by the average of its initial and year-end mortgage holdings ([11], Table 3) calculated over the estimation period for each institution, and then divided by 4 to arrive at a quarterly basis. The θ's compare with the estimate of the Canadian Life Insurance Officers' Association ([5], p. 44) of 11 per cent annual repayments for life insurance companies (θ = .027) and the estimate of the University of Western Ontario ([53], p. 125) of 36 per cent annual repayments for trust companies (θ = .090). These two estimates imply stock adjustment coefficients of .280 and .196 for life and trust companies, respectively.

[40]If the coefficients from the transformed regressions are used for these calculations the speeds of adjustment become .175 for the banks, .334 for the life insurance companies, .152 for the trust companies and .293 for the mortgage loan companies.

cent for banks and 77 per cent each for life insurance companies, trust companies and mortgage loan companies.[41]

B. Financial Institutions — Portfolio Size

Because the size of the investment portfolios held by financial institutions exerts a very significant influence on the volume of mortgage lending undertaken by the financial institutions examined here, a brief description of the factors affecting the size of these portfolios is in order. This discussion, which is quite cursory, is presented only as an indication of some of the forces affecting asset size and not as a complete specification of these forces.[42]

My model is based upon the premise that the size of an institution's investment portfolio or total asset holdings (A^i) is determined by the public's willingness to hold the obligations of the institution, and that this essentially depends upon the public's wealth (W) (represented as an eight-quarter distributed lag on current-dollar gross national expenditure calculated by a first degree Almon variable), the yield offered by an institution on its obligations (R_i) relative to the yield offered on competing securities (R_j), and the public's existing holdings of the institution's obligations.[43]

$$A^i = f\,(R_i, R_j, W, A^i_{t-1}) \qquad (29)$$

This basic relationship, with the dependent variable expressed in first difference form (ΔA^i), was estimated for the change in asset holdings of the chartered banks, trust companies, mortgage loan companies, and twelve life insurance companies. In addition,

[41]These results are derived by dividing the stock adjustment coefficient (γ) into the coefficient on the total asset variable for each institution.

[42]A more rigorous and comprehensive model is now under development at the Bank of Canada in conjunction with the RDX project.

[43]An important determinant of the asset size of deposit taking institutions, the ease or convenience of dealing with them (i.e., accessibility, hours of operation, staff co-operation, etc. [40], pp. 327-335) has been ignored in this study because of difficulties in specification and data collection.

an insurance policy loan equation was estimated since policy loans arise in response to borrower actions and constitute a drain on life insurance company resources. Because the public's ability to obtain policy loans is a function of their insurance in force, which is assumed to vary with life company assets, life company assets rather than wealth are used in the policy loan regression. These regressions in untransformed and transformed form are presented in Table 3.

The regressions in Table 3 indicate that the model provides a reasonable explanation of the asset size of deposit-taking institutions and of the policy loans of life insurance companies, but unfortunately the model does not explain too well the asset size of life insurance companies. The change in chartered bank asset holdings depends upon the public's wealth and holdings of bank liabilities, the differential between the rate paid on chartered bank personal savings accounts and the short-term government bond rate (RPS - R03), and the differential between the rate paid on 90-day bank deposit receipts and the short-term bond rate (R90 - R03). The change in trust company asset holdings depends upon the public's wealth and holdings of trust company liabilities, the yield differential between the rate paid on trust and mortgage loan company one-year term liabilities and the short-term government bond rate (R1GIC - R03), and the differential between the trust and loan company chequable deposit rate and the chartered bank personal savings deposit rate (RCH - RPS). The change in mortgage loan company asset holdings depends upon the public's wealth, the differential between the rate on trust and mortgage loan company 5-year-term liabilities and the long-term government bond rate (R5GIC - RLC), and the differential between the chequable deposit rate and the chartered bank personal savings rate (RCH - RPS), although these variables are not highly significant. Hence, it appears from these results that the asset size of a deposit-taking institution depends upon the public's wealth, the public's existing holdings of an institution's obligations, and the rate paid on these obligations relative to the rate on alternative securities. However, my model does not provide a completely satisfactory explanation of the asset growth of financial institutions, since important non-price factors are ignored, i.e., location, convenience and services offered by these institutions.

Table 3

CHANGES IN ASSET HOLDINGS (ΔA) OF CANADIAN FINANCIAL INSTITUTIONS

	Constant	Q1	Q2	Q3	W	TBA_{t-1}	AT_{t-1}	AM_{t-1}	AL
Chartered Bank Assets	-147.3	-170.6	70.9	-140.3	.349	-.192			
	(.89)	(2.14)	(.91)	(1.79)	(3.07)	(2.35)			
	-119.5	-188.6	50.2	-165.5	.318	-.171			
	(.94)	(2.04)	(.71)	(1.80)	(3.73)	(2.79)			
Trust Company Assets	-455.6	129.0	53.4	23.4	.047		-.075		
	(3.25)	(6.06)	(2.47)	(1.10)	(2.39)		(1.56)		
	-478.0	128.4	53.9	23.0	.050		-.083		
	(3.21)	(6.25)	(2.49)	(1.12)	(2.38)		(1.64)		
Mortgage Loan Company Assets	-177.1	27.1	9.2	9.9	.018			-.010	
	(1.70)	(1.90)	(.64)	(.69)	(1.18)			(.18)	
	-169.2	27.3	9.1	10.1	.017			-.005	
	(1.67)	(1.89)	(.64)	(.70)	(1.14)			(.09)	
Life Insurance Company Policy Loans	8.0	.6	1.6	1.7					.0029
	(3.15)	(1.25)	(2.77)	(3.00)					(2.82)
	12.2	.7	1.6	1.8					
	(3.34)	(1.91)	(3.92)	(4.94)					

PL_{t-1}	$(RPS - R03)_{t-1}$	(R90 - R03)	(R1GIC - R03)	(R5GIC - RLC)	$(RCH - RPS)_{t-1}$	RLC_{t-1}	R^2	$\bar{R}^2$	SEE	D/W	ρ	Estimation Period
	220.80 (5.07)	565.33 (3.29)					.64	.56	175.34	2.39		1Q55 - 4Q65
	227.69 (6.91)	408.36 (2.88)							168.58	1.92	-.329	
			59.73 (2.83)		206.06 (2.03)		.68	.56	49.22	1.79		1Q55 - 4Q65
			60.15 (2.77)		218.23 (2.09)				49.12	1.90	.073	
				20.36 (.72)	89.89 (1.36)		.57	.56	32.84	1.97		1Q55 - 4Q65
				20.11 (.72)	84.39 (1.29)				32.83	1.90	-.037	
-.129 (3.99)						4.09 (5.57)	.52	.46	1.38	.94		1Q54 - 4Q65
-.184 (4.01)						4.89 (5.18)			1.12	2.04	.553	

The model operates reasonably well in explaining the policy loan holdings of life companies. The change in policy loan holdings varies with the size of life insurance companies' assets, the public's existing policy loans and the long-term government bond rate. Because the policy loan borrowing rate was fixed at 6 per cent it was not included in the specification.

Unfortunately, my stock adjustment model does not provide a good representation of the asset growth of life insurance companies, since the stock adjustment coefficient has the wrong sign, indicating a speed of adjustment exceeding 1. Consequently, a more or less ad hoc specification, presented in equation (30), was adopted for the asset growth of life insurance companies in which their assets vary directly with the public's wealth and inversely with the rate of change of the price level ($\dot{PGNE}$) and the short-term government bond rate (R03).

1Q54-4Q65

$$\underset{(1.86)}{AL = 6138.1} + \underset{(2.19)}{135.5\ Q1} + \underset{(2.35)}{142.9\ Q2} - \underset{(.07)}{3.9\ Q3} + \underset{(54.76)}{.81\ W}$$

$$- \underset{(2.12)}{6991.3\ \dot{PGNE}_{t-1}} - \underset{(2.07)}{57.8\ R03_{t-1}} \qquad (30)$$

$$SEE = 145.2 \qquad R^2 = .99 \qquad \bar{\bar{R}}^2 = .99 \qquad D/W = .31$$

Surprisingly, a Hildreth/Lu autoregressive transformation yields a minimum $\rho = -.028$ despite the presence of serially correlated residuals indicated by an extremely low Durbin/Watson statistic. Therefore, to deal with this problem equation (30) was re-estimated in first-difference form in equation (31).

$$\underset{(8.95)}{\Delta\ AL = 72.2} + \underset{(4.48)}{48.3\ Q1} - \underset{(.46)}{4.0\ Q2} - \underset{(4.46)}{54.9\ Q3} + \underset{(5.79)}{.24\ \Delta\ W}$$

$$- \underset{(.59)}{198.96\ \Delta\ \dot{PGNE}_{t-1}} - \underset{(1.39)}{8.62\ \Delta\ R03_{t-1}} \qquad (31)$$

$$SEE = 21.1 \qquad R^2 = .49 \qquad \bar{\bar{R}}^2 = .45 \qquad D/W = .90$$

4. A DISAGGREGATED HOUSING MARKET MODEL[44]

In this part of the paper the basic RDX1 housing sector is expanded to take account of the fact that the housing market is not really a single market in the classical sense but a series of overlapping submarkets differentiated by location, type, age and quality of dwelling, and kind of tenure (see [14], p. 135). Since each submarket is influenced by different institutional considerations and since the behaviour of the participants in these submarkets often differs substantially, it is desirable to disaggregate the housing market as much as possible. A start toward this disaggregation is made here by recognizing that the housing market is split fundamentally into two basic subsectors — the single dwelling sector primarily owner-occupied and the multiple dwelling sector primarily tenant-occupied — and by examining the behaviour of the participants in each of these sectors separately.

An indication of the differences between single and multiple dwelling sectors may be seen in Table 4, where the number of single and multiple unit housing starts and the percentage change in rents, Multiple Listing Service (MLS) sale prices, and NHA house prices since 1951 are presented. As one can see in Table 4, single and multiple dwelling starts followed distinct patterns over the period, showed different cyclical behaviour and grew at quite different rates. During this time multiple dwelling starts rose from less than 25 per cent of total housing starts in the early 1950's to approximately 50 per cent of total starts in the mid-1960's. Over the same period rents, prices of new NHA houses, and the average price of units sold through the Multiple Listing Service of real estate boards showed quite distinct cyclical patterns. However, after 1956, the period for which data are available for all categories, the average annual rate of inflation in these categories was quite similar, being 4.4 per cent for rents, 4.1 per cent for the prices of new NHA houses, and 5.0 per cent for MLS prices.

[44]Much of the work presented in this section is based upon an earlier paper by the author [42].

Table 4

SINGLE AND MULTIPLE HOUSING STARTS,
AND PERCENTAGE CHANGES IN HOUSING PRICES AND MONTHLY RENTS

Year	Housing starts, in thousands: Single*	Multiple*	Multiple starts as a percentage of total starts	Percentage change in: Average rents**	NHA prices*	MLS prices***
1951	53.0	15.6	22.7	12.1	n.a.	n.a.
1952	60.7	21.5	26.2	8.7	7.1	n.a.
1953	70.8	51.6	42.2	7.2	3.1	n.a.
1954	78.6	34.9	30.7	9.9	6.8	n.a.
1955	99.0	39.3	28.4	3.0	7.1	n.a.
1956	90.6	36.7	28.8	6.1	10.7	3.5
1957	83.0	39.3	32.1	4.4	7.9	8.1
1958	104.5	60.1	36.5	7.1	-.9	5.0
1959	92.9	48.4	34.3	.9	1.7	3.3
1960	67.2	41.7	38.3	3.4	-1.0	1.4
1961	76.4	49.2	39.2	2.1	.7	-2.6
1962	74.4	55.5	42.7	3.7	2.2	3.3
1963	77.2	71.4	48.0	2.3	2.8	-3.1
1964	77.1	88.6	53.5	4.1	4.0	8.2
1965	75.4	91.2	54.7	5.2	4.5	8.5
1966	70.6	63.9	44.2	5.9	8.6	9.5
1967	72.5	91.6	55.8	7.7	8.1	9.9
1968	75.3	121.6	61.8	3.8	4.2	11.0

Sources: * Central Mortgage and Housing Corporation: *Canadian Housing Statistics 1968*. Ottawa, March 1969, pp. 7 and 56.

** Dominion Bureau of Statistics: *Labour Force Survey* worksheets.

*** Canadian Association of Real Estate Boards: *The Canadian Realtor*, Toronto. Monthly.

n.a. — not available.

A. Residential Construction Expenditure and Housing Starts

The first benefits of disaggregation appear in my explanation of residential construction expenditure since I can now explicitly recognize that single and multiple dwelling starts generate different expenditures and different expenditure patterns.[45] This is accomplished by formulating residential construction expenditure as a function of lagged single (HSS) and multiple (HSM) housing starts in equations (32) and (32').

1Q54-4Q65

$$\begin{array}{llllll} IRC = & 55.07 & + 6.55\ HSS & + 2.89\ HSS_{t-1} & + 1.98\ HSS_{t-2} & + 2.72\ HSM \\ & (2.88) & (13.87) & (6.22) & (4.07) & (3.65) \\ & & + 1.39\ HSM_{t-1} & + .95\ HSM_{t-2} & + 1.14\ HSM_{t-3} & \qquad (32) \\ & & (1.66) & (1.19) & (1.82) & \end{array}$$

$$SEE = 15.94 \qquad R^2 = .95 \qquad D/W = 1.55$$

$$\begin{array}{llllll} IRC = & 48.62 & + 6.71\ HSS & + 2.91\ HSS_{t-1} & + 2.06\ HSS_{t-2} & + 2.68\ HSM \\ & (2.20) & (14.05) & (6.62) & (4.39) & (3.86) \\ & & + 1.46\ HSM_{t-1} & + .95\ HSM_{t-2} & + 1.17\ HSM_{t-3} & \qquad (32') \\ & & (1.97) & (1.32) & (1.80) & \end{array}$$

$$SEE = 15.50 \qquad \rho = .228 \qquad D/W = 2.02$$

These equations are statistically superior and economically much more meaningful than the disaggregated equations presented in section 2 since equations (32) and (32') allow for variable expenditure patterns (single dwelling residential construction expenditure is spread over three quarters and multiple dwelling expenditure over four quarters), and for a separate estimate of the expenditures generated by each form of construction. Single dwelling starts are shown to generate construction expenditure

[45]This is recognized in D.B.S. calculations of residential construction expenditure by assigning different weights to single and multiple dwelling units put in place.

of approximately $11,550 per unit start in constant 1957 dollars while multiple dwelling starts are shown to generate expenditure of approximately $6,250 per unit start.[46] These figures compare to an over-all average of $7,500 per unit start indicated by the disaggregated equation. Finally, equations (32) and (32') have the statistical advantages of a substantially reduced standard error of estimate and a much smaller likelihood of serial correlation [16]. Consequently, it can readily be seen that this formulation is much more realistic and conveys substantially more meaningful information than that provided in the aggregate formulation presented in equation (2).

Once differences have been recognized in the price behaviour and pattern of single and multiple housing starts these differences should be incorporated into the model by analyzing the factors influencing the volume of single and multiple housing starts and the determination of prices in each of these sectors separately. In the remainder of this subsection I deal with the forces influencing the volume of housing starts in each sector.

Developers of multiple unit projects plan either to sell their buildings when they have been constructed and rented or to retain them as long-term investments. Thus the desirability of undertaking a multiple dwelling project depends upon the relationship between its expected selling price and its total construction cost, or upon the developer's expected yield on invested capital. Because real estate investments, like other long-term investments, are usually made on a yield basis, the desirability of a project from either the sale or revenue viewpoint is determined by the net cash flow, the amount of mortgage finance obtainable, and the construction and land costs associated with the project. Since the net cash flow depends upon gross rental income, interest costs, taxes and other current expenses and the amortization term of the mortgage, the volume of new multiple dwelling construction will be greatly influenced by existing rent levels, vacancy rates, construction and land costs and the terms and availability of mortgage credit.

An analysis of single unit construction introduces a new complication since these houses are not only speculatively built

[46]The average of the sum of the untransformed and transformed coefficients.

by merchant builders (developers) for subsequent sale but are also custom built by owner builders or contractors on a pre-sale basis (see [39], p. 58). When the demand for owner-occupancy dwellings increases, the price of single family dwellings increases relative to construction costs, assuming that increased building activity does not profoundly affect construction costs in the same period, and the speed at which houses are sold accelerates, thus causing an increase in the volume of new construction by merchant builders. Similarly, the greater the demand for owner-occupancy dwellings the greater will be the volume of construction of new custom-built houses. However, since the increased building of custom-built houses is not a consequence of the selling price to construction cost relationship, the forces influencing the level of this form of construction differ somewhat from those influencing the level of speculative building.

The role of mortgage credit in the single dwelling sector is more complex than in the multiple dwelling sector because mortgage credit has a more direct influence on the final demand for single dwellings. Merchant builders are influenced directly by the availability of mortgage credit since they require these funds for construction and indirectly because their houses will be difficult to sell if the cost and non-price terms of this credit are too stringent for prospective purchasers to absorb. Similarly, more stringent borrowing terms will reduce the volume of custom building by making monthly carrying costs and downpayment requirements or both, too burdensome for some prospective purchasers to absorb. Therefore, the volume of new single dwelling construction will be quite sensitive to the level of housing prices, vacancy rates, construction and land costs, and the terms and availability of mortgage credit.

Finally, when considering factors influencing the volume of single and multiple housing starts one must also take into account the possibility of substituting one type of construction for the other. This is partially done in my model by having single housing starts as a function of housing prices and multiple housing starts as a function of rents so that, ceteris paribus, if rents increase relative to housing prices, multiple housing starts will increase relative to single housing starts. Similarly, if developers think higher borrowing costs can be passed on to purchasers of single family houses more easily than to tenants in multiple dwellings, rising mortgage rates will cause multiple dwelling construction to fall more sharply than single dwelling construction. In addition to these variables, land costs play an important role in determining the form of construction to be undertaken since rising land costs encourage higher density land utilization. This should lead to an increase in the volume of multiple dwelling construction relative to single dwelling construction. Although increasing land costs will also tend to discourage both forms of construction by reducing their profitability,[47] the net impact of rising land costs is likely to be an increase in multiple housing starts and a reduction in single housing starts.

From the above discussion it follows that multiple housing starts (HSM) are a function of rents (R), vacancy rates (V), construction costs (CC), land costs (L), and the cost (RM) and availability of private (MT) and public (CMHC) mortgage credit. Single dwelling housing starts (HSS) are a function of these same variables, except that the price of houses (PH) replaces rents, and land costs have the opposite influence in the single and multiple equations.

$$HSM = f\ (R,\ VM,\ CC,\ L,\ RM,\ MT,\ CMHCM) \qquad (33)$$

$$HSS = g\ (PH,\ VS,\ CC,\ L,\ RM,\ MT,\ CMHCS) \qquad (34)$$

The estimated equations for multiple and single housing starts are presented in equations (35) and (35') after deleting the vacancy variable, substituting a proxy credit rationing variable (RM - RB), and introducing the winter house-building incentive dummy variable (WW), as discussed in section 2.

[47]If prices and rents in period t depend upon the demand for and supply of housing units in t, increased land costs in t will have little or no effect on prices and rents in t. To the extent that increased costs reduce construction in t, they will restrain the increase in housing units in t+1, thereby raising prices and rents in t+1. However, unless prices and rents immediately react strongly to changes in the rate of growth of new housing units and unless the elasticity of demand for housing with respect to prices and rents is considerably less than 1, the profitability of such construction falls.

1Q57-4Q65

$$HSS = \underset{(1.76)}{32.5} - \underset{(7.33)}{12.0}\,Q1 + \underset{(4.72)}{8.3}\,Q2 + \underset{(4.51)}{6.3}\,Q3 + \underset{(2.83)}{7.1}\,WW + \underset{(1.13)}{31.01}\,(PH/CC)_{t-1}$$

$$- \underset{(2.14)}{.21}\,L - \underset{(2.28)}{5.41}\,RM_{t-1} + \underset{(3.63)}{6.18}\,(RM - RB)_{t-1} + \underset{(1.57)}{.028}\left(\frac{CMHCS}{PH}\right)$$

$$+ \underset{(4.34)}{.066}\left(\frac{CMHCS}{PH}\right)_{t-1} \qquad (35)$$

$SEE = 2.48 \qquad R^2 = .93 \qquad \bar{\bar{R}}^2 = .75 \qquad D/W = 2.11$

$$HSS = \underset{(1.74)}{33.4} - \underset{(7.49)}{12.0}\,Q1 + \underset{(4.72)}{8.3}\,Q2 + \underset{(4.56)}{6.3}\,Q3 + \underset{(2.91)}{7.2}\,WW + \underset{(1.21)}{33.10}\,(PH/CC)_{t-1}$$

$$- \underset{(2.23)}{.22}\,L - \underset{(2.29)}{5.67}\,RM_{t-1} + \underset{(3.48)}{6.13}\,(RM - RB)_{t-1} + \underset{(1.51)}{.027}\left(\frac{CMHCS}{PH}\right)$$

$$+ \underset{(4.36)}{.066}\left(\frac{CMHCS}{PH}\right)_{t-1} \qquad (35')$$

$SEE = 2.48 \qquad \rho = .052 \qquad D/W = 2.20$

1Q57-4Q65

$$HSM = \underset{(.59)}{5.3} - \underset{(5.85)}{6.7}\,Q1 + \underset{(1.53)}{1.8}\,Q2 + \underset{(2.91)}{3.1}\,Q3 + \underset{(1.13)}{2.4}\,WW + \underset{(2.37)}{24.09}\,(R/CC)_{t-1}$$

$$+ \underset{(2.38)}{.16}\,L - \underset{(4.48)}{5.77}\,RM_{t-1} + \underset{(.05)}{.08}\,(RM - RB)_{t-1} + \underset{(1.96)}{.112}\left(\frac{CMHCM}{PH}\right)$$

$$+ \underset{(.38)}{.020}\left(\frac{CMHCM}{PH}\right)_{t-1} \qquad (36)$$

$SEE = 2.37 \qquad R^2 = .89 \qquad \bar{\bar{R}}^2 = .83 \qquad D/W = 1.75$

$$HSM = 5.2 - 6.8\ Q1 + 1.7\ Q2 + 3.0\ Q3 + 2.2\ WW + 24.26\ (R/CC)_{t-1}$$
$$(.51)\quad (6.42)\quad (1.44)\quad (2.94)\quad (1.05)\quad (2.23)$$

$$+ .16\ L - 5.70\ RM_{t-1} + .01\ (RM - RB)_{t-1} + .104\ \left(\frac{CMHCM}{PH}\right)$$
$$(2.24)\quad (3.92)\quad (.01)\quad (1.84)$$

$$+ .012\ \left(\frac{CMHCM}{PH}\right)_{t-1} \qquad (36')$$
$$(.23)$$

$$SEE = 2.35 \qquad \rho = .149 \qquad D/W = 1.95$$

These regressions reconfirm the appropriateness of my model and accentuate the distinctions between the single and multiple dwelling sectors. Single housing starts are significantly influenced by both the cost and the availability of private mortgage credit while only the cost of this credit influences the volume of multiple housing starts. Although these results are somewhat more pronounced than I had anticipated, they are consistent with the preceding discussion since developers of multiple dwellings are likely to be quite sensitive to interest costs that substantially affect the profitability and cash flow of their projects. On the other hand, builders of single dwellings are building for home purchasers who are accustomed to the high cost of consumer credit, who are primarily concerned with monthly and downpayment requirements, which are quite sensitive to variations in non-price lending terms (see [18], pp. 69-75), and who can vary the proportion of their budget devoted to housing. Consequently, these builders are less responsive to interest cost variations, as the elasticity measured at the means of -1.56 for single housing starts as opposed to -2.85 for multiple housing starts indicates, and require non-price credit rationing to equilibrate their sector of the market. Moreover, financial institutions are less likely to ration developers of multiple dwelling projects, who can be 'locked in' to financing for a longer period and whose goodwill the institutions covet, than small builders prevalent in the construction of single unit dwellings.[48] The significance of the government direct lending

[48] Individual, as opposed to corporate, borrowers have the legal right to discharge NHA mortgages after three years and conventional mortgages after five years on penalty of paying three months' interest. Corporate borrowers have no such privilege and therefore can be 'locked in' for the full term of their mortgages while individual borrowers cannot. Hence, in periods of high interest rates lending institutions prefer corporate to individual borrowers since corporate borrowers cannot repay their loans in advance if interest rates decline.

variable (CMHC) in the multiple equation is not inconsistent with the lack of private rationing in this sector, since Central Mortgage and Housing Corporation lending occurs at a lower rate than that charged for government insured mortgages.

The larger sum of the coefficients on the multiple variable than on the single government direct lending variable indicates that an additional million dollars of government mortgage lending in constant 1957 dollars for multiple dwellings will generate 40 per cent more dwelling starts than if this lending were for single dwelling construction. Land costs are shown to play a vital role in the mix of single and multiple housing starts as rising land costs significantly increase multiple housing starts at the expense of single housing starts, and have a net negative effect (although this net effect may not be significant). While the rent to construction cost ratio is quite significant in the multiple housing starts equation, the ratio of housing prices to construction costs is only significant at the 13 per cent confidence level (using a one-tailed test) in the single housing starts equation. This lower significance can partially be explained by the inappropriateness of the ratio in explaining housing starts for the large number of custom-built houses included in the single housing starts category. Finally, as expected, the winter housebuilding incentive programme had a much more pronounced effect on single housing starts than on multiple housing starts, where its impact was confined to multiple dwellings of two to four units.[49]

B. Prices and Rents

Although the general forces underlying the demand for rental and owner-occupancy dwellings are essentially the same (see section 2 for an elaboration of these forces), they have somewhat different effects on the participants in these markets. Net family formation, net immigration and net non-family household formation initially tend to generate demand for rental accommodation, while families experiencing first and second child births and families with fathers aged twenty-five to thirty-five often shift their demand from rental to owner-occupancy accommodation (see

[49]In this study multiple dwellings include duplexes, semi-detached and row houses and apartment units.

[9], p. 68). Recently, completing the life-cycle pattern, there has been a tendency for families to move back to rental from owner-occupancy accommodation following the departure of the children from the family home. In determining the demand for single vis-à-vis multiple dwelling units these demographic influences are extremely important. However, they are very elusive to specify, and consequently are reflected in my statistical work simply by expressing the demand for single dwellings on a per family basis (because families are the main occupiers of single dwellings), and by expressing the demand for units in multiple dwellings on a per capita basis (because the occupancy of these units is not confined to families and lack of non-family household data precludes a more structural specification). Numerous attempts were made to introduce child birth, migration and various age composition variables into the model but these attempts were generally unsuccessful despite their theoretical importance.

Variations in incomes also have different sectoral impacts on the demand for housing since variations in income not only influence over-all demand for housing by affecting net family undoubling, net family formation and net new non-family household formation (as discussed in section 2), but they also affect the allocation of demand between different kinds of housing. Ignoring qualitative effects, higher incomes enable more families to afford the monthly carrying costs and downpayments required for home ownership, thereby increasing the demand for single family dwellings. At the same time higher incomes enable more population units to afford the rents required to maintain separate living accommodation, thereby generating a net increase in the demand for rental accommodation despite the fact that rising incomes also enable families to shift some demand from rental to owner-occupancy dwellings. When assessing the relative strengths of these forces for the future it is interesting to note that between 1951 and 1966 the number of doubled families in Canada declined by approximately 140,000 (from 9.8 per cent to 4.0 per cent of all families), while the number of non-family households (60 per cent of which consist of individuals over 55 years) rose by over 382,000 (see [28], p. 40).[50]

[50]For comparative purposes it is interesting to note that the number of family households in Canada rose by approximately 1,230,000 between 1951 and 1966 ([10], p. 73), so that undoubling and net non-family household formation accounted for 30 per cent of the realized increase in housing demand.

As mentioned briefly in section 2, credit variables have a strong influence on the demand for housing accommodation by affecting the downpayment and monthly payment requirements associated with buying a home. However, if one ignores qualitative effects, as is done in this study, the main impact of credit influences is on the allocation of final housing demand between rental and owner accommodation rather than on the over-all user demand for housing. Although more stringent credit terms reduce the demand for owner-occupancy housing there is no corresponding net reduction in the over-all demand for housing since much of this reduced demand for owner-occupancy housing is shifted to rental accommodation. This happens because more stringent credit terms cause families to delay their shift from rental to owner-occupancy dwellings and to undouble into rental rather than into owner-occupancy accommodation causing a net increase in the demand for rental accommodation. Hence, although more stringent credit terms reduce over-all housing demand to some extent, the most pronounced effect is the shifting of demand for owner-occupancy housing to rental housing. Thus, more stringent credit terms are likely to cause a net reduction in the demand for owner-occupancy dwellings and a net increase in the demand for rental accommodation.

This discussion can now be summarized in functional form and its validity tested by regression analysis. Per capita demand for units in multiple dwellings (DHM/POPT) depends upon permanent real per capita disposable income (YDP/POPT), the price of houses (PH) and the rent on multiple dwelling units (R), the price of alternative goods and services (PGNE), and the cost (RM) and availability (MT) of mortgage credit. Family demand for single dwellings (DHS/HH) depends upon these same variables with permanent real family disposable income (YDP/HH) replacing (YDP/POPT), and with the credit, rent and housing price variables exerting an influence on the demand for single family dwellings opposite to the influence of these variables on the demand for multiple accommodation.

$$\text{DHM/POPT} = h\ (\text{YDP/POPT, PH, R, PGNE, RM, MT}) \qquad (37)$$

$$\text{DHS/HH} = k\ (\text{YDP/HH, PH, R, PGNE, RM, MT}) \qquad (38)$$

Rents and housing prices can now be determined by introducing the per family stock of single dwellings (SHS/HH) and per capita stock of multiple dwellings (SHM/POPT), and interacting these stocks with their respective demand functions.

$$R = r\ (YDP/POPT,\ PH,\ PGNE,\ RM,\ MT,\ SHM/POPT) \qquad (39)$$

$$PH = p\ (YDP/HH,\ R,\ PGNE,\ RM,\ MT,\ SHS/HH) \qquad (40)$$

Since the stock of dwelling units existing in any period is equal to the stock of the previous period plus completions and conversions less removals and demolitions; if conversions, removals and demolitions are a function of past stock, and completions a function of lagged housing starts, the supply of each type of housing is a function of the previous stock and lagged starts.

$$(SHM/POPT) = j\ \left[(SHM/POPT)_{t-1},\ \sum_{i=0}^{n} \beta_i\ (HSM/POPT)_{t-i}\right] \qquad (41)$$

$$(SHS/HH) = q\ \left[(SHS/HH)_{t-1},\ \sum_{i=0}^{m} \beta_i\ (HSS/HH)_{t-i}\right] \qquad (42)$$

Estimates of equations (39) to (42), with the stock of rental (SHR) and owner-occupancy (SHO) dwellings replacing the stock of multiple (SHM) and single (SHS) dwellings (because sectoral housing stock estimates are available only in the latter form), are presented in equations (43) to (48). The coefficients of the lagged housing start variables in equations (47) and (48) were estimated by the Almon technique using second and third degree Almon variables.[51]

[51] The actual estimated housing stock regressions are:

$$SHO = \underset{(982.59)}{.9989\ SHO_{t-1}} + \underset{(5.51)}{3.88\ Z_2^s} - \underset{(4.55)}{2.80\ Z_3^s}$$

$R^2 = .99$ $\qquad$ $D/W = 2.23$

$$SHR = \underset{(979.44)}{.9995\ SHR_{t-1}} + \underset{(3.67)}{3.14\ Z_2^m} - \underset{(2.90)}{2.34\ Z_3^m}$$

$R^2 = .99$ $\qquad$ $D/W = 2.06$

where Z_2^s and Z_3^s are second and third degree Almon variables created on single housing starts and Z_2^m and Z_3^m are second and third degree Almon variables created on multiple housing starts.

$$1Q57\text{-}4Q65 \tag{43}$$

$$PH = \underset{(1.84)}{141.5} + \underset{(.90)}{.9}\ Q1 + \underset{(3.58)}{3.5}\ Q2 + \underset{(1.79)}{1.7}\ Q3 + \underset{(.96)}{19.12}\ (YDP/HH)_{t-1}$$

$$- \underset{(2.43)}{305.09}\ (SHO/HH) + \underset{(2.75)}{1.34}\ PGNE_{t-1} + \underset{(.99)}{.29}\ R_{t-1} - \underset{(1.00)}{2.51}\ RM_{t-1}$$

$$SEE = 1.95 \qquad R^2 = .93 \qquad \bar{\bar{R}}^2 = .92 \qquad D/W = 1.15$$

$$PH = \underset{(1.55)}{133.3} + \underset{(.97)}{.7}\ Q1 + \underset{(3.78)}{3.1}\ Q2 + \underset{(2.46)}{1.7}\ Q3 + \underset{(1.43)}{35.32}\ (YDP/HH)_{t-1} \tag{43'}$$

$$- \underset{(1.72)}{255.84}\ (SHO/HH) + \underset{(1.57)}{.71}\ PGNE_{t-1} + \underset{(1.12)}{.35}\ R_{t-1} - \underset{(.32)}{.98}\ RM_{t-1}$$

$$SEE = 1.69 \qquad \rho = .425 \qquad D/W = 1.40$$

$$1Q57\text{-}4Q65$$

$$PH = \underset{(1.95)}{149.4} + \underset{(1.08)}{1.0}\ Q1 + \underset{(3.63)}{3.6}\ Q2 + \underset{(1.97)}{1.8}\ Q3 + \underset{(2.60)}{34.05}\ (YDP/HH)_{t-1}$$

$$- \underset{(2.92)}{346.38}\ (SHO/HH) + \underset{(2.63)}{1.27}\ PGNE_{t-1} + \underset{(.73)}{.22}\ R_{t-1} \tag{44}$$

$$SEE = 1.95 \qquad R^2 = .93 \qquad \bar{\bar{R}}^2 = .92 \qquad D/W = 1.05$$

$$PH = \underset{(1.45)}{123.8} + \underset{(1.04)}{.7}\ Q1 + \underset{(3.86)}{3.0}\ Q2 + \underset{(2.72)}{1.7}\ Q3 + \underset{(2.09)}{41.99}\ (YDP/HH)_{t-1}$$

$$- \underset{(1.70)}{243.42}\ (SHO/HH) + \underset{(1.40)}{.60}\ PGNE_{t-1} + \underset{(1.03)}{.31}\ R_{t-1} \tag{44'}$$

$$SEE = 1.64 \qquad \rho = .475 \qquad D/W = 1.42$$

1Q57-4Q65

$$R = -54.4 + \underset{(1.60)}{} \; \underset{(3.67)}{245.36} \, (YDP/POPT)_{t-1} - \underset{(1.84)}{1096.18} \, (SHR/POPT)_{t-1}$$

$$+ \underset{(3.78)}{1.24} \, PGNE_{t-1} + \underset{(1.61)}{.25} \, PH_{t-1} + \underset{(1.88)}{2.88} \, RM_{t-1} \qquad (45)$$

$$SEE = 1.35 \qquad \bar{R}^2 = .98 \qquad D/W = 1.15$$

$$R = -60.1 + \underset{(1.49)}{} \; \underset{(3.28)}{254.80} \, (YDP/POPT)_{t-1} - \underset{(1.03)}{769.15} \, (SHR/POPT)_{t-1}$$

$$+ \underset{(2.92)}{.90} \, PGNE_{t-1} + \underset{(2.13)}{.32} \, PH_{t-1} + \underset{(1.89)}{3.40} \, RM_{t-1} \qquad (45')$$

$$SEE = 1.21 \qquad \rho = .425 \qquad D/W = 1.44$$

1Q57-4Q65

$$R = -35.9 + \underset{(1.06)}{} \; \underset{(3.10)}{203.36} \, (YDP/POPT)_{t-1} - \underset{(2.30)}{1376.21} \, (SHR/POPT)_{t-1}$$

$$+ \underset{(5.93)}{1.61} \, PGNE_{t-1} + \underset{(1.43)}{.23} \, PH_{t-1} \qquad (46)$$

$$SEE = 1.41 \qquad \bar{R}^2 = .98 \qquad D/W = 1.24$$

$$R = -35.0 + \underset{(.89)}{} \; \underset{(2.92)}{226.02} \, (YDP/POPT)_{t-1} - \underset{(1.45)}{1090.09} \, (SHR/POPT)_{t-1}$$

$$+ \underset{(4.21)}{1.22} \, PGNE_{t-1} + \underset{(1.97)}{.31} \, PH_{t-1} \qquad (46')$$

$$SEE = 1.27 \qquad \rho = .375 \qquad D/W = 1.42$$

These price and rent regressions are quite consistent with those in section 2 and with themselves. (Housing prices and rents vary directly with permanent real disposable income, the price of competing housing, and the price of alternative goods and services; and inversely with the respective stocks of housing.) Housing prices seem to vary inversely with the cost of mortgage credit, and rents seem to vary directly with this cost, which is consistent with the notion that rising financing costs shift demand from owner to rental housing. However, the deletion of the mortgage cost variable in equations (44) and (46) seems to have little or no effect on the explanatory power of the regressions. The R^2's remain the same and the SEE rises slightly in only one case, while the deletion of the mortgage cost variable allows the income variable to become much more significant in the housing price regression. Therefore, although the mortgage rate variable performs as anticipated it does not appear to play a leading role in price and rent determination. On the other hand, it must be remembered that the price, rent and mortgage cost variables are all inexact representations of true market conditions, as previously discussed in section 2, and consequently the likelihood of a strong correlation is diminished in my specification. Demographic influences enter the specification since the variables in the price equation are expressed on a per family basis, and the variables in the rent equation are expressed on a per capita basis. In an effort to introduce more specific demographic variables numerous other specifications were attempted but they were generally unsatisfactory.

Since the Hildreth/Lu search procedure yielded autoregressive parameters greater than 1, a Theil/Nagar autoregressive transformation [52] was used in equations (43') to (46') in an unsuccessful attempt to eliminate serial correlation. These transformed regressions do not indicate any startling changes although they consistently increase the significance of the price of competing dwelling accommodation variables and reduce the significance of the alternative goods and services variable (PGNE). These regressions also tend generally to increase the importance of the effects of income on housing prices and to reduce slightly the effect of the existing housing stock.

2Q54-4Q65

$$SHO = .9989\ SHO_{t-1} + .276\ HSS + .407\ HSS_{t-1}$$
$$\quad (982.59) \qquad (4.14) \qquad (7.43)$$

$$+ .293\ HSS_{t-2} + .101\ HSS_{t-3} \qquad (47)$$
$$(6.36) \qquad (5.81)$$

SEE = 4.31 R^2 = .99 D/W = 2.23

2Q54-4Q65

$$SHR = .9995\ SHR_{t-1} + .132\ HSM + .251\ HSM_{t-1}$$
$$\quad (979.44) \qquad (1.79) \qquad (7.55)$$

$$+ .235\ HSM_{t-2} + .146\ HSM_{t-3} + .047\ HSM_{t-4} \qquad (48)$$
$$(5.15) \qquad (4.28) \qquad (3.89)$$

SEE = 2.46 R^2 = .99 D/W = 2.06

Disaggregative housing stock regressions in equations (47) and (48) are also quite consistent with the total stock regression in section 2. The existing stock of owner-occupied and rental accommodation is determined by the amount of each form of accommodation that existed in the previous period and current housing completions, where current housing completions are represented by past housing starts. The lagged housing stock coefficient of less than 1 indicates that demolitions and removals exceed conversions, since these were all assumed to be a function of lagged stock. Coefficients on the lagged housing start variables indicate an average construction period of approximately two and one-quarter quarters for multiple dwelling projects and one and two-thirds quarters for single housing units.[52] The fact that the sum of the coefficients of the multiple housing start variables is considerably below 1 and that the sum of the coefficients of the single housing start variables is above 1 arises from classification inconsistencies inherent in the use of SHR and SHO as

[52]The average construction period was calculated after adjusting the lagged start coefficients so that all housing starts give rise to housing completions.

approximations for SHM and SHS, respectively. These results indicate that not all multiple dwellings, which include duplexes and row housing, are used for rental purposes. Finally, the Hildreth/Lu transformations confirm the absence of serial correlation, yielding ρ's of -.112 and -.026 in the SHO and SHR regressions, respectively, and transformed coefficients virtually identical to those in the untransformed regressions.

C. Construction Costs

Because land costs enter the disaggregated housing start equations separately, my construction cost variable was redefined in this section to exclude land cost. The measure of construction cost (CC) in this section is an index of the average cost of construction (excluding land cost) per square foot on new government-insured single detached dwellings. Variations in this index were assumed to be influenced by the same variables as in section 2, part C, with the exception of land costs, i.e., by changes in average hourly earnings in construction (WC), changes in temporary or bridge financing costs (R03), changes in the cost of building materials and the cost of delays and bottlenecks that arise as current residential construction (IRC) and non-residential construction (INRC) press against their respective industrial capacities. Changes in the cost of building materials, along with the cost of delays and bottlenecks are represented by deviations of current residential and non-residential construction from their seasonally adjusted logarithmic trends and a sales tax dummy variable (DVST). This estimated construction cost regression in untransformed and transformed form is presented in equations (49) and (49').

3Q55-4Q65

$$\ln CC - \ln CC_{t-4} = \underset{(1.59)}{-.0064} + \underset{(2.74)}{.041} (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(5.27)}{.097} (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(2.61)}{.239} (\ln WC - \ln WC_{t-4})$$

$$+ .027 \underset{(3.78)}{(\ln R03 - \ln R03_{t-4})} + \underset{(7.17)}{.034\ DVST} \quad (49)$$

$$SEE = .011 \qquad R^2 = .86 \qquad D/W = 1.39$$

$$\ln CC - \ln CC_{t-4} = \underset{(.92)}{-.0052} + \underset{(2.28)}{.044} (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(3.43)}{.066} (\ln IRC - \ln \widehat{IRC})_{t-1} + \underset{(1.83)}{.198} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(3.66)}{.028} (\ln R03 - \ln R03_{t-4}) + \underset{(5.48)}{.035\ DVST} \quad (49')$$

$$SEE = .010 \qquad \rho = .466 \qquad D/W = 1.91$$

These equations indicate that construction costs are influenced by the same variables, with the exception of land costs, as construction and land costs in section 2. Moreover, the coefficients on these variables are remarkably similar to those in the construction and land cost equations (14) and (15). The only exception is the variable for average hourly earnings in construction (WC), which has a much stronger impact on construction costs in equations (49) and (49') when multicollinearity is reduced by the exclusion of land costs, than in equations (14) and (15).

5. SUMMARY OF FUNCTIONAL RELATIONSHIPS AND ESTIMATED EQUATIONS

Before turning to the simulations in the next section it is useful for reference purposes to summarize the functional relationships and estimated ordinary least squares equations of the preceding four sections.

A. The Housing and Mortgage Sectors of RDX1

1. Functional Relationships:

$$IRC = f\left(\sum_{i=0}^{m} \beta_i \, HST_{t-i}\right) \tag{50}$$

$$HST = h\ (PH/CLC,\ RM,\ RM - RB,\ CMHC,\ WW) \tag{51}$$

$$PH = p\ (YDP/HH,\ STH/HH,\ PGNE) \tag{52}$$

$$STH = s\left(\sum_{i=0}^{n} \beta_i \, HST_{t-i},\ STH_{t-1}\right) \tag{53}$$

$$\dot{CLC} = c\ (INRC/\hat{INRC},\ IRC/\hat{IRC},\ \dot{WC},\ \dot{L},\ R03,\ DVST) \tag{54}$$

$$L = l\ (POPT,\ YDP,\ STH,\ \Delta\ L) \tag{55}$$

$$RC = r\ (RB,\ RNHA,\ YDP/HH,\ STH/HH,\ ALTM,\ MLTM) \tag{56}$$

$$RM \equiv (RC + RNHA)/2 \tag{57}$$

2. Ordinary Least Squares Estimates:

Investment in residential construction

$$\underset{(6.62)}{IRC = 117.15} + \underset{(16.96)}{4.62\ HST} + \underset{(7.69)}{1.96\ HST_{t-1}} + \underset{(3.32)}{.92\ HST_{t-2}} \tag{58}$$

$$R^2 = .89 \qquad D/W = 1.05$$

Total housing starts (59)

$$HST = \underset{(1.06)}{25.6} - \underset{(9.26)}{20.2\ Q1} + \underset{(3.86)}{7.7\ Q2} + \underset{(4.13)}{7.7\ Q3} + \underset{(2.76)}{9.5\ WW} + \underset{(3.75)}{76.80\ (PH/CLC)}$$

$$- \underset{(4.32)}{12.58\ RM_{t-1}} + \underset{(2.35)}{5.20\ (RM - RB)_{t-1}} + \underset{(1.44)}{.029\ \left(\frac{CMHC}{PH}\right)} + \underset{(3.93)}{.058\ \left(\frac{CMHC}{PH}\right)_{t-1}}$$

$R^2 = .95$ D/W = 1.95

Price of houses

$$PH = \underset{(1.70)}{74.1} + \underset{(1.10)}{1.1\ Q1} + \underset{(3.44)}{3.8\ Q2} + \underset{(2.03)}{2.0\ Q3} + \underset{(2.95)}{57.13\ (YDP/HH)_{t-1}}$$

$$- \underset{(2.40)}{180.89\ (STH/HH)} + \underset{(3.94)}{1.44\ PGNE_{t-1}} \qquad (60)$$

$R^2 = .92$ D/W = .97

Total stock of housing units

$$STH = \underset{(680.78)}{.9997\ STH_{t-1}} + \underset{(2.85)}{.224\ HST} + \underset{(5.07)}{.372\ HST_{t-1}}$$

$$+ \underset{(4.69)}{.275\ HST_{t-2}} + \underset{(4.44)}{.096\ HST_{t-3}} \qquad (61)$$

$R^2 = .99$ D/W = 2.03

Construction costs (including land costs)

$$\ln CLC - \ln CLC_{t-4} = \underset{(.51)}{-.0031} + \underset{(1.92)}{.039\ (\ln INRC - \ln \widehat{INRC})_{t-1}}$$

$$+ \underset{(3.81)}{.090\ (\ln IRC - \ln \widehat{IRC})_{t-1}} + \underset{(1.13)}{.13\ (\ln WC - \ln WC_{t-4})}$$

$$+ .11 \underset{(2.58)}{} (\ln L - \ln L_{t-4}) + \underset{(3.30)}{.030} (\ln RO3 - \ln RO3_{t-4})$$

$$+ \underset{(5.11)}{.029} \, DVST \qquad (62)$$

$$R^2 = .78 \qquad D/W = 1.56$$

Land costs

(63)

$$L = \underset{(5.81)}{-141.5} + \underset{(6.55)}{.042} \, POPT + \underset{(4.38)}{.030} \, YDP - \underset{(5.09)}{.15} \, STH + \underset{(5.08)}{.59} \, \Delta L$$

$$R^2 = .96 \qquad D/W = .77$$

Conventional mortgage rate

$$RC = \underset{(3.20)}{9.7} - \underset{(2.95)}{8.85} \, (STH/HH)_{t-1} + \underset{(3.16)}{3.17} \, (YDP/HH) - \underset{(6.02)}{.0031} \, ALTM$$

$$+ \underset{(5.76)}{.0045} \, MLTM_{t-1} + \underset{(4.49)}{.38} \, RNHA + \underset{(4.49)}{.32} \, RB_{t-1} \qquad (64)$$

$$R^2 = .96 \qquad D/W = 1.14$$

B. The Mortgage Sector of RDX1 Extended

1. Functional Relationships:

$$MA^i = m \, (RM - RB, A^i, M^i_{t-1}) \qquad (65)$$

$$\Delta A^i = a \, (W, A^i_{t-1}, R_i - R_j) \qquad (66)$$

2. Ordinary Least Squares Estimates:

The financial institution mortgage approval regressions are presented together in Table 1 and the net asset growth or inflow regressions are presented in Table 3 and in equation (30).

C. The Disaggregated Housing Model

1. Functional Relationships:

$$IRC = e\left(\sum_{i=0}^{n} \beta_i HSS_{t-i}, \sum_{j=0}^{m} \beta_j HSM_{t-j}\right) \quad (67)$$

$$HSS = n\ (PH/CC,\ L,\ RM,\ RM - RB,\ CMHCS,\ WW) \quad (68)$$

$$HSM = q\ (R/CC,\ L,\ RM,\ RM - RB,\ CMHCM,\ WW) \quad (69)$$

$$PH = b\ (YDP/HH,\ SHO/HH,\ R,\ PGNE,\ RM) \quad (70)$$

$$R = d\ (YDP/POPT,\ SHR/POPT,\ PH,\ PGNE,\ RM) \quad (71)$$

$$SHO = k\left(\sum_{i=0}^{n} \beta_i HSS_{t-i}, SHO_{t-1}\right) \quad (72)$$

$$SHR = g\left(\sum_{j=0}^{m} \beta_j HSM_{t-j}, SHR_{t-1}\right) \quad (73)$$

$$\dot{CC} = z\ (INRC/\widehat{INRC},\ IRC/\widehat{IRC},\ \dot{WC},\ \dot{R03},\ DVST) \quad (74)$$

Other equations are the same as in RDX1 and the extended mortgage market sector.

2. Ordinary Least Squares Estimates:

Investment in residential construction

$$\underset{(2.88)}{IRC = 55.07} + \underset{(13.87)}{6.55\ HSS} + \underset{(6.22)}{2.89\ HSS_{t-1}} + \underset{(4.07)}{1.98\ HSS_{t-2}}$$

$$+ \underset{(3.65)}{2.72}\ HSM + \underset{(1.66)}{1.39}\ HSM_{t-1} + \underset{(1.19)}{.95}\ HSM_{t-2} + \underset{(1.82)}{1.14}\ HSM_{t-3} \quad (75)$$

$R^2 = .95$ $\qquad$ D/W = 1.55

Single housing starts

$$HSS = \underset{(1.76)}{32.5} - \underset{(7.33)}{12.0}\ Q1 + \underset{(4.72)}{8.3}\ Q2 + \underset{(4.51)}{6.3}\ Q3 + \underset{(2.83)}{7.1}\ WW$$

$$+ \underset{(1.13)}{31.01}\ (PH/CC)_{t-1} - \underset{(2.14)}{.21}\ L - \underset{(2.28)}{5.41}\ RM_{t-1}$$

$$+ \underset{(3.63)}{6.18}\ (RM - RB)_{t-1} + \underset{(1.57)}{.028}\ \left(\frac{CMHCS}{PH}\right)$$

$$+ \underset{(4.34)}{.066}\ \left(\frac{CMHCS}{PH}\right)_{t-1} \quad (76)$$

$R^2 = .93$ $\qquad$ D/W = 2.11

Multiple housing starts

$$HSM = \underset{(.59)}{5.3} - \underset{(5.85)}{6.7}\ Q1 + \underset{(1.53)}{1.8}\ Q2 + \underset{(2.91)}{3.1}\ Q3 + \underset{(1.13)}{2.4}\ WW + \underset{(2.37)}{24.09}\ (R/CC)_{t-1}$$

$$+ \underset{(2.38)}{.16}\ L - \underset{(4.48)}{5.77}\ RM_{t-1} + \underset{(.05)}{.08}\ (RM - RB)_{t-1}$$

$$+ \underset{(1.96)}{.112}\ \left(\frac{CMHCM}{PH}\right) + \underset{(.38)}{.020}\ \left(\frac{CMHCM}{PH}\right)_{t-1} \quad (77)$$

$R^2 = .89$ $\qquad$ D/W = 1.75

Price of houses

$$PH = \underset{(1.84)}{141.5} + \underset{(.90)}{.9}\ Q1 + \underset{(3.58)}{3.5}\ Q2 + \underset{(1.79)}{1.7}\ Q3 + \underset{(.96)}{19.12}\ (YDP/HH)_{t-1} \quad (78)$$

$$- 305.09\,(SHO/HH) + 1.34\,PGNE_{t-1} + .29\,R_{t-1} - 2.51\,RM_{t-1}$$
$$(2.43) \quad (2.75) \quad (.99) \quad (1.00)$$

$$R^2 = .93 \qquad D/W = 1.15$$

Rent

$$R = -54.4 + 245.36\,(YDP/POPT)_{t-1} - 1096.18\,(SHR/POPT)_{t-1}$$
$$(1.60) \quad (3.67) \quad (1.84)$$

$$+ 1.24\,PGNE_{t-1} + .25\,PH_{t-1} + 2.88\,RM_{t-1} \tag{79}$$
$$(3.78) \quad (1.61) \quad (1.88)$$

$$R^2 = .98 \qquad D/W = 1.15$$

Stock of owner-occupied housing units

$$SHO = .9989\,SHO_{t-1} + .276\,HSS + .407\,HSS_{t-1}$$
$$(982.59) \quad (4.14) \quad (7.43)$$

$$+ .293\,HSS_{t-2} + .101\,HSS_{t-3} \tag{80}$$
$$(6.36) \quad (5.81)$$

$$R^2 = .99 \qquad D/W = 2.23$$

Stock of renter-occupied housing units

$$SHR = .9999\,SHR_{t-1} + .132\,HSM + .251\,HSM_{t-1}$$
$$(979.44) \quad (1.79) \quad (7.55)$$

$$+ .235\,HSM_{t-2} + .146\,HSM_{t-3} + .047\,HSM_{t-4} \tag{81}$$
$$(5.15) \quad (4.28) \quad (3.89)$$

$$R^2 = .99 \qquad D/W = 2.06$$

Construction costs

$$\ln CC - \ln CC_{t-4} = -.0064 + .041\,(\ln INRC - \ln \hat{INRC})_{t-1}$$
$$(1.59) \quad (2.74)$$

$$+ .097\,(\ln IRC - \ln \hat{IRC})_{t-1} + .239\,(\ln WC - \ln WC_{t-4})$$
$$(5.27) \quad (2.61)$$

$$+ .027 \underset{(3.78)}{(\ln RO3 - \ln RO3_{t-4})} + \underset{(7.17)}{.034} DVST \tag{82}$$

$$R^2 = .86 \qquad D/W = 1.39$$

6. SIMULATIONS OF THE RDX1 HOUSING AND EXTENDED HOUSING MODELS

In order to examine the stability and predictability of my models and to explore the impact of alternative policy measures on the housing market, a number of simulations of the RDX1 housing and extended housing models were conducted. These simulations consist of first: solutions for both models over the twelve-quarter period 1963-1965 within the estimation period, and over the eight-quarter period 1966-1967 beyond the estimation period, and second: solutions for both models over the twelve-quarter period 1963-1965 after introducing various policy changes such as a 1 per cent increase in the long-term government bond rate, a 1 per cent increase in the NHA mortgage rate, and a $100 million increase in CMHC direct mortgage lending.

A. The Basic Simulations

The first simulations were solutions for the RDX1 housing and extended housing sector models over the twelve-quarter period 1Q63-4Q65, initializing in 4Q62; and solutions for these models for the eight quarters immediately beyond the estimation period 1Q66-4Q67, initializing in 4Q65. Thus simulations were begun in 4Q62 and 4Q65, respectively, with the actual values of the lagged endogenous variables. Thereafter internally generated values were used.

The endogenous variables in the RDX1 version simulations are housing starts (HST), residential construction expenditure (IRC), construction and land costs (CLC), housing prices (PH), the stock of housing units (STH), and the conventional mortgage rate (RC). These variables are determined by equations (50) to (54), and (56).

The endogenous variables in the extended housing model simulations are: single housing starts (HSS), multiple housing starts (HSM), residential construction expenditure (IRC), construction costs (CC), housing prices (PH), rents (R), the stock of owner-occupied houses (SHO) and renter-occupied houses (SHR) and the conventional mortgage rate (RC). These variables are determined by equations (67) to (73), and (56). The exogenous variables in the simulations of both models are: families (HH), population (POPT), permanent real disposable income (YDP), the size of financial institutions' assets (ALTM), financial institutions' mortgage holdings (MLTM), the implicit private gross national expenditure deflator (PGNE), non-residential construction expenditure (INRC), average hourly earnings in construction (WC), and land costs (L). The exogenous policy variables in both models are: the long-term government bond rate (RLC), the short-term government bond rate (R03), the NHA mortgage rate (RNHA), and the volume of Central Mortgage and Housing Corporation direct lending (CMHC). In the disaggregate model the latter variable is replaced by two variables, the volume of Central Mortgage and Housing Corporation lending on single dwellings (CMHCS) and the volume of CMHC lending on multiple dwellings (CMHCM).[53]

In Table 5 I present the results of the twelve-quarter simulation within, and the eight-quarter simulation beyond, the estimation period in terms of the percentage error of the predictions for each of the endogenous variables in the RDX1 housing model. The results for the endogenous variables in the extended housing model are presented in Table 6. The two solutions are compared with the actual values for residential construction expenditure and total housing starts (single and multiple unit starts are combined) in Diagram 2 and Diagram 3.

These simulation results demonstrate the stability of my specification within the estimation period, as only residential construction expenditure and housing starts have average percentage errors exceeding 2 per cent for the twelve-quarter simulation. Residential construction expenditure has an average percentage error of 4.7 per cent in the aggregate RDX1 model and of only 3.3 per cent in the extended disaggregated model. Housing starts have

[53]Because the simulations were conducted within the framework of the over-all RDX1 model [24] and because RLC rather than RB was used in RDX1, RLC was used in place of RB in my simulations.

Table 5

RESULTS OF SIMULATIONS IN TERMS OF PERCENTAGE ERRORS*
FOR TWELVE QUARTERS (1Q63-4Q65) WITHIN, AND EIGHT QUARTERS
(1Q66-4Q67) BEYOND, THE ESTIMATION PERIOD USING THE RDX1 HOUSING MODEL

Period 1963-1965	IRC %	HST %	PH %	CLC %	STH %	RC %
1	-11.3	11.5	-4.0	1.8	-.1	.8
2	-4.5	-4.5	-2.8	.2	-.1	1.0
3	.6	6.0	-1.3	-.4	—	1.2
4	-6.7	-4.6	-3.5	—	-.1	-.5
5	6.4	-.3	-.6	.4	—	-.3
6	-8.7	-4.5	1.7	-.4	-.1	-1.7
7	-1.8	7.9	.7	-.4	-.1	-2.5
8	-.8	6.8	-1.1	.3	-.2	-3.8
9	.7	-5.3	.5	.8	-.1	.3
10	-3.5	7.1	2.9	-1.1	-.2	1.0
11	-2.8	7.3	2.4	-.3	-.3	3.4
12	-8.7	-10.7	1.8	.8	-.4	1.0
Average Twelve Quarters	4.7	6.4	1.9	.6	.1	1.5
1966-1967						
1	6.0	2.5	2.7	.5	-.1	.4
2	8.2	-9.1	1.4	-1.3	.1	-.5
3	-8.6	-20.7	2.3	3.1	.2	1.3
4	-11.8	-13.1	1.0	6.3	.1	-.4
5	-5.4	31.3	2.6	1.8	—	-1.5
6	6.6	15.8	1.0	2.6	.1	3.2
7	-7.5	-11.5	1.4	6.6	.1	6.1
8	-2.9	5.1	1.1	9.3	.1	4.2
Average Eight Quarters	7.1	13.6	1.7	3.9	.1	2.2

* -indicates that simulation estimate exceeds actual value.

Table 6

RESULTS OF SIMULATIONS IN TERMS OF PERCENTAGE ERRORS*
FOR TWELVE QUARTERS (1Q63-4Q65) WITHIN, AND EIGHT QUARTERS
(1Q66-4Q67) BEYOND, THE ESTIMATION PERIOD USING THE EXTENDED HOUSING MODEL

Period	IRC %	HSS %	HSM %	PH %	R %	CC %	SHO %	SHR %	RC %
1963-1965									
1	.3	63.0	-35.2	-3.3	1.0	1.3	-.1	-.2	.8
2	3.1	-2.7	-11.0	-2.6	1.1	.6	-	-.3	1.0
3	3.1	-4.0	2.2	-1.0	1.5	-	.1	-.4	1.2
4	-4.6	-.2	-4.4	-2.6	-.8	-	-	-.5	-.5
5	6.8	1.5	-3.2	-.2	-.9	1.0	-.1	-.3	-.2
6	-7.0	-7.2	-10.0	1.6	-.6	.5	-	-.5	-1.5
7	1.6	-4.1	13.1	.7	.3	-.2	-	-.6	-2.3
8	2.8	2.2	14.9	-1.0	-.7	.3	-.1	-.7	-3.5
9	1.7	-3.6	-16.4	.1	.9	.5	-	-.4	.5
10	-5.2	-21.9	17.9	2.0	2.1	.1	-	-.3	1.0
11	.9	-1.3	17.6	1.9	1.5	.3	-	-.2	3.2
12	-2.7	.3	-12.2	1.7	-.6	1.3	-.1	-.1	.7
Average Twelve Quarters	3.3	9.3	13.1	1.6	1.0	.5	.1	.4	1.4
Average Eleven Quarters (2Q63-4Q65)		4.5	11.1						
1966-1967									
1	9.5	41.7	-38.3	3.0	-.7	-.1	-.1	.1	.3
2	12.9	7.9	-23.8	1.4	-1.5	-1.3	.1	.6	-.2
3	8.9	19.6	-35.8	2.2	-1.6	2.4	.3	.9	1.1
4	7.4	32.2	-45.1	1.0	-3.6	3.7	.4	1.2	-.8
5	15.3	124.2	-62.3	1.9	-2.2	2.0	.5	1.0	-2.4
6	13.6	11.8	12.7	-.1	-1.9	3.1	.7	1.0	2.3
7	-.2	-10.9	-14.8	-.1	-1.2	9.2	.8	.9	5.0
8	16.5	63.4	-4.6	-.4	-2.3	10.3	1.0	.9	3.2
Average Eight Quarters	10.5	38.9	29.7	1.3	1.9	4.0	.5	.8	1.9
Average Seven Quarters (ex. 1Q67)	9.9	26.7	25.0						

* - indicates that simulation exceeds actual value.

Diagram 2

SIMULATION RESULTS — RESIDENTIAL CONSTRUCTION EXPENDITURE

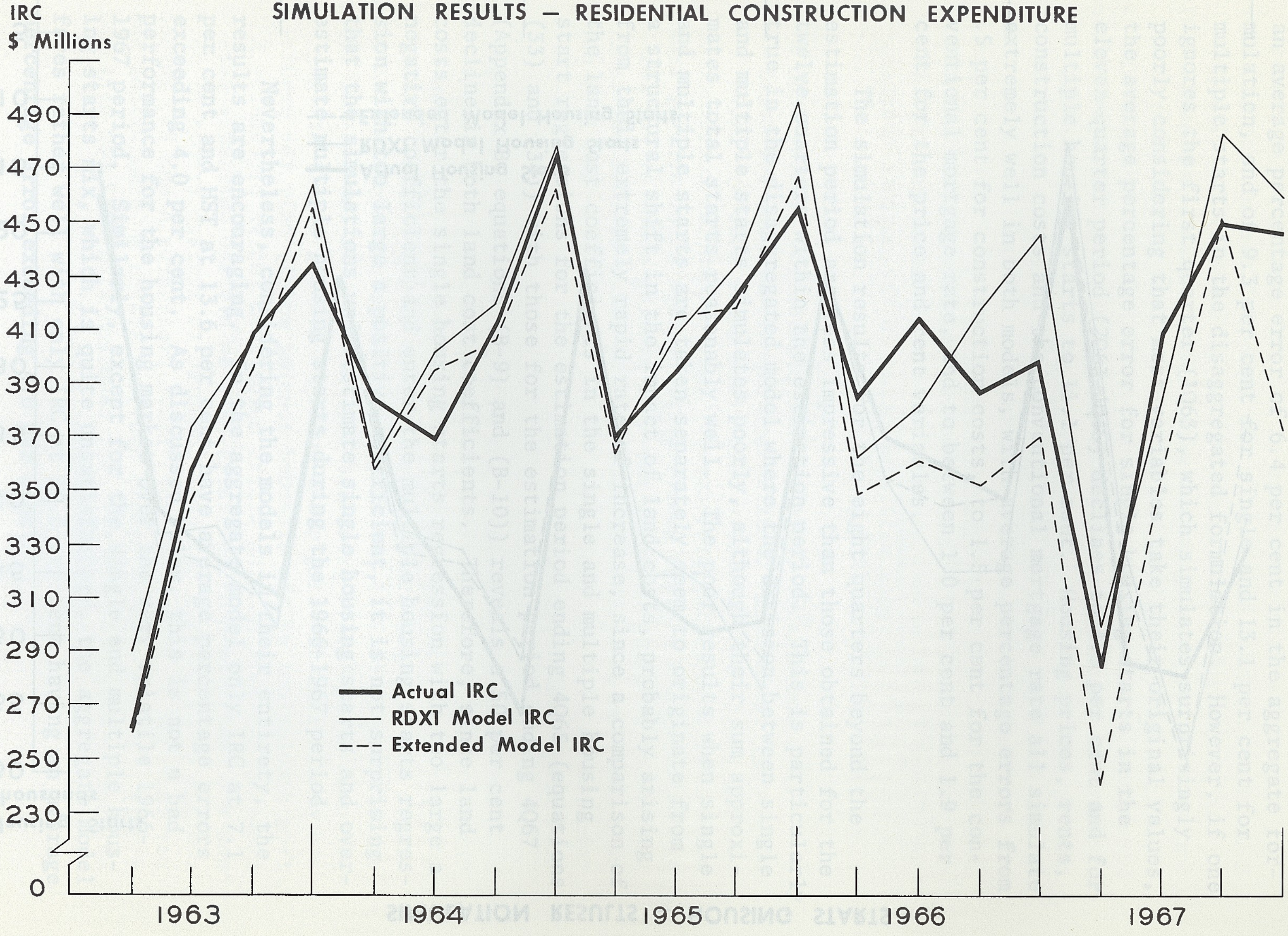
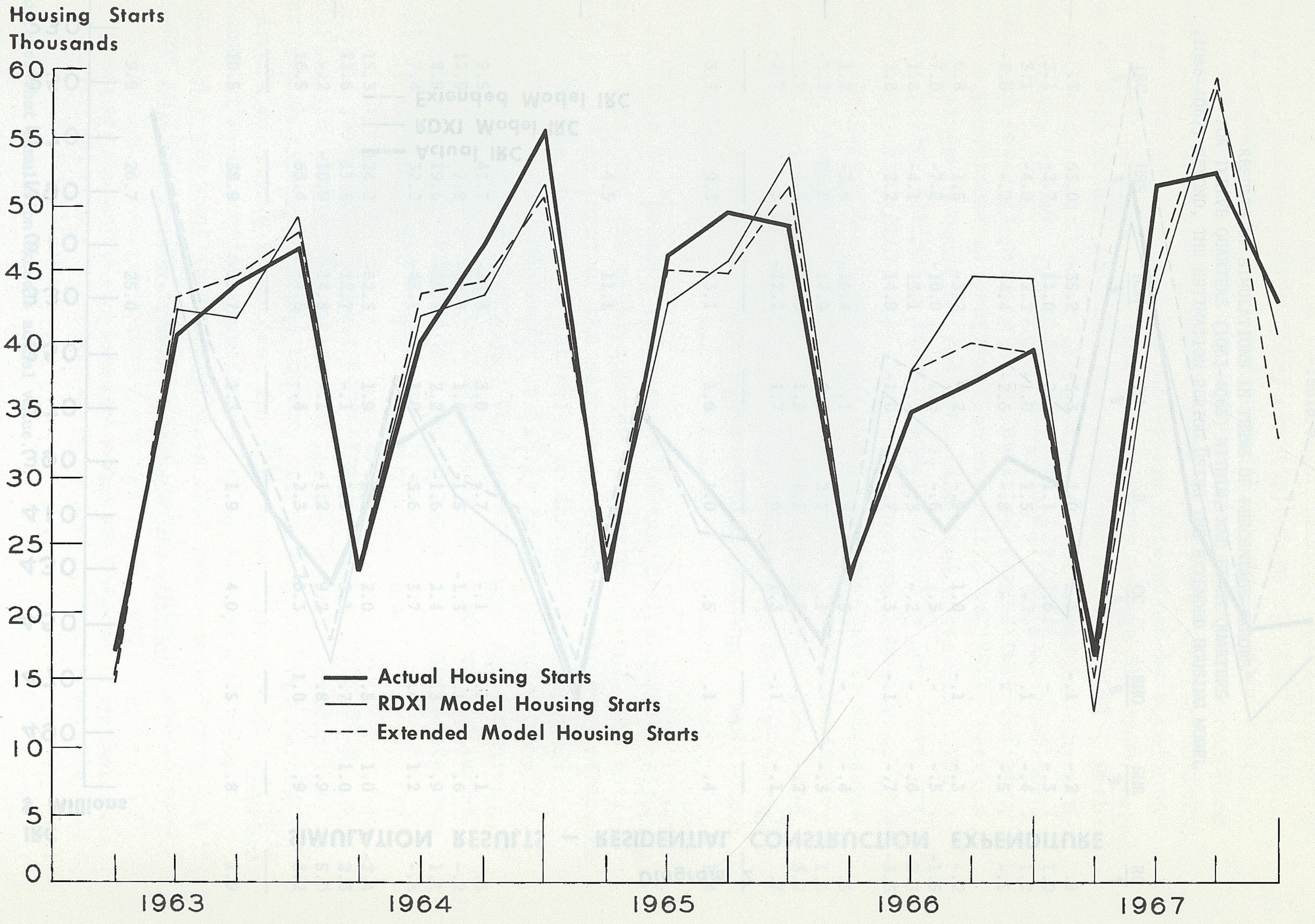


Diagram 3

SIMULATION RESULTS — HOUSING STARTS



an average percentage error of 6.4 per cent in the aggregate formulation, and of 9.3 per cent for single and 13.1 per cent for multiple starts in the disaggregated formulation. However, if one ignores the first quarter (1Q63), which simulates surprisingly poorly considering that most variables take their original values, the average percentage error for single housing starts in the eleven-quarter period (2Q63-4Q65) declines to 4.5 per cent and for multiple housing starts to 11.1 per cent. Housing prices, rents, construction costs and the conventional mortgage rate all simulate extremely well in both models, with average percentage errors from .5 per cent for construction costs, to 1.5 per cent for the conventional mortgage rate, and to between 1.0 per cent and 1.9 per cent for the price and rent variables.

The simulation results for the eight quarters beyond the estimation period are less impressive than those obtained for the twelve quarters within the estimation period. This is particularly true in the disaggregated model where the division between single and multiple starts simulates poorly, although their sum approximates total starts reasonably well. The poor results when single and multiple starts are taken separately seem to originate from a structural shift in the impact of land costs, probably arising from their extremely rapid rate of increase, since a comparison of the land cost coefficients in the single and multiple housing start regressions for the estimation period ending 4Q65 (equations (33) and (34)) with those for the estimation period ending 4Q67 (Appendix B, equations (B-9) and (B-10)) reveals a 50 per cent decline in both land cost coefficients. Therefore, since land costs enter the single housing starts regression with too large a negative coefficient and enter the multiple housing starts regression with too large a positive coefficient, it is not surprising that the simulations underestimate single housing starts and overestimate multiple housing starts during the 1966-1967 period.

Nevertheless, considering the models in their entirety, the results are encouraging. In the aggregate model only IRC at 7.1 per cent and HST at 13.6 per cent have average percentage errors exceeding 4.0 per cent. As discussed below, this is not a bad performance for the housing market over the very volatile 1966-1967 period. Similarly, except for the single and multiple housing starts mix, which is quite unsatisfactory, the aggregate model fares rather well with only IRC at 10.5 per cent having an average percentage error exceeding 4.0 per cent.

However, a fair assessment of IRC and housing start simulation results cannot be made for the 1966-1967 period from the size of our percentage errors alone because of the very volatile performance of the housing market after 1965. Rather, any assessment should be made in conjunction with predictions generated by other procedures. Consequently, in order to facilitate such comparisons, residential construction expenditures and housing starts were forecast by two 'naive' mechanical procedures and their percentage errors compared with the simulated percentage errors in Tables 7 and 8. 'Naive procedure A' predicts that IRC and HST in any quarter will be the same as in the corresponding quarter of the previous year, i.e., $\hat{IRC} = IRC_{t-4}$. 'Naive procedure B' predicts that any change in IRC or HST between the corresponding quarters of the preceding two years will also occur in the current quarter, i.e., $\hat{IRC} = IRC_{t-4} + (IRC_{t-4} - IRC_{t-8})$.

These comparisons indicate that predictions arising from my models for residential construction expenditure and for total housing starts substantially outperform those made by 'naive' mechanical forecasting procedures. For residential construction expenditure, the average quarterly percentage error arising from simulation predictions using the RDX1 housing model is 7.1 per cent and from using the extended housing model is 10.5 per cent, compared to 11.7 per cent using 'naive procedure A' and 15.3 per cent using 'naive procedure B'.

For total housing starts the average quarterly percentage error arising from simulation predictions using the RDX1 model is 14.4 per cent. In the extended housing model, using the sum of single and multiple starts, the error is 11.0 per cent. These errors compare to 24.5 per cent using 'naive procedure A' and 34.6 per cent using 'naive procedure B'. However, in the case of separate predictions for single and multiple housing starts arising from simulations of the extended housing model, only the predictions of multiple housing starts outperform 'naive procedures A and B'. Multiple housing starts have an average quarterly percentage error of 29.7 per cent compared to average errors of 35.7 per cent and 47.8 per cent for 'naive procedures A and B', respectively. In the case of single dwelling starts my simulations have an average error of 39.0 per cent compared with 24.2 per cent and 28.5 per cent for 'naive procedures A and B'.

Table 7

COMPARISON OF PERCENTAGE ERRORS* IN
PREDICTIONS OF RESIDENTIAL CONSTRUCTION EXPENDITURE

		Predictions Arising From:			
Quarter		Procedure A	Procedure B	RDX1 Housing Sector Simulations	RDX1 Extended Housing Sector Simulations
		%	%	%	%
1966	1	3.9	7.5	6.0	9.5
	2	4.8	-1.4	8.2	12.9
	3	-9.6	-12.2	-8.6	8.9
	4	-14.0	-9.0	-11.8	7.4
1967	1	-35.1	-40.4	-5.4	15.3
	2	1.5	-6.4	6.6	13.6
	3	14.2	22.4	-7.5	-.2
	4	10.7	23.3	-2.9	16.5
Average		11.7	15.3	7.1	10.5

* - indicates that simulation exceeds actual value.

Table 8

COMPARISON OF PERCENTAGE ERRORS* IN PREDICTIONS OF HOUSING STARTS

		Predictions Arising From:			
Quarter		Procedure A	Procedure B	RDX1 Housing Sector Simulations	RDX1 Extended Housing Sector Simulations**
		%	%	%	%
1966	1	2.7	6.3	3.6	3.5
	2	-32.5	-50.0	-16.8	-8.6
	3	-33.4	-40.3	-23.8	-7.8
	4	-22.8	-5.4	-16.9	.5
1967	1	-35.0	-38.7	24.1	18.7
	2	32.6	54.5	13.2	12.4
	3	29.4	53.0	-10.6	-13.1
	4	7.8	28.8	5.9	23.1
Average		24.5	34.6	14.4	11.0

* - indicates that simulation exceeds actual value.

** Calculations based on sum of single and multiple starts.

B. Alternative Policy Simulations

In order to assess the implications of various policies designed to influence the volume of residential construction and other aspects of the housing market, my models were re-simulated over the 1963-1965 period after introducing separate one-shot changes in the NHA mortgage rate (up 1 per cent), in the long-term government bond rate (up 1 per cent), in both the NHA mortgage and long-term government bond rates (both up 1 per cent), and in the volume of Central Mortgage and Housing Corporation direct lending (up $100 million) during 1Q63. The percentage changes in housing starts and prices resulting from the introduction of each of these alternative policies into the housing sector of RDX1 are presented in Table 9. The percentage changes in single and multiple housing starts and prices and rents resulting from each of these policies in my disaggregate housing model are presented in Tables 10 and 11. The increase in CMHC direct lending in the disaggregate model was $50 million for both single and multiple housing.

These simulations have a number of interesting implications. According to the aggregate model, a 1 per cent increase in the long-term bond rate will cause a 6.6 per cent decline in housing starts in the first year (even though the increase in RLC has no effect on housing starts in the quarter in which the 1 per cent increase is introduced),[54] a 7.7 per cent decline in the second year and a 6.3 per cent decline in the third year. According to the disaggregate model a 1 per cent increase in RLC will generate a smaller reduction in housing starts than the aggregate model indicates and will shift the mix between single and multiple starts because single starts remain relatively constant (increasing slightly) while multiple starts decline by approximately 2.8 per cent each year. Housing prices are also affected by the change in RLC. The aggregate model indicates a 1.1 per cent increase after twelve quarters. The disaggregate model shows that this is the consequence of a slight increase in rents and a very slight reduction in house prices.

[54]The increases in interest rates referred to in this section are in absolute terms — i.e., an increase from 5.50 per cent to 6.50 per cent is a 1.0 per cent increase in interest rates, while the percentage changes in housing starts and rents in this section are in relative terms, i.e., an increase from 20,000 HST to 21,000 HST is a 5 per cent increase in housing starts.

Table 9

RESULTS OF SIMULATIONS UNDER ALTERNATIVE POLICIES USING THE RDX1 HOUSING MODEL

		Change in housing starts, in thousands, arising from an increase in:				Percentage change in housing prices arising from an increase in:			
Quarter		RNHA	RLC	RNHA & RLC	CMHC	RNHA	RLC	RNHA & RLC	CMHC
1963	1	—	—	—	2.6	—	—	—	—
	2	-9.1	-2.6	-9.3	5.0	.1	—	.1	.1
	3	-6.3	-3.7	-10.2	-.6	.3	.1	.4	-.2
	4	-5.6	-3.4	-9.1	-.3	.5	.2	.6	-.3
1964	1	-5.6	-3.4	-8.9	-.2	.8	.4	1.1	-.3
	2	-7.7	-3.2	-8.4	-.4	1.0	.5	1.2	-.3
	3	-4.4	-3.0	-7.8	-.5	1.2	.5	1.7	-.3
	4	-4.5	-2.8	-7.4	-.2	1.4	.7	1.9	-.3
1965	1	-4.8	-2.9	-7.7	-.1	1.6	.8	2.2	-.2
	2	-6.8	-2.6	-6.9	-.3	1.8	.8	2.4	-.2
	3	-3.2	-2.5	-6.3	-.5	1.8	.9	2.7	-.2
	4	-3.8	-2.4	-6.3	—	2.0	.11	2.9	-.2

Table 10

RESULTS OF SIMULATIONS FOR HOUSING STARTS UNDER ALTERNATIVE POLICIES USING THE DISAGGREGATE HOUSING MODEL

Quarter		Change in single housing starts, in thousands, arising from an increase in: RNHA	RLC	RNHA & RLC	CMHC	Change in multiple housing starts, in thousands, arising from an increase in: RNHA	RLC	RNHA & RLC	CMHC
1963	1	—	—	—	1.3	—	—	—	5.3
	2	—	—	.5	3.2	-4.6	-.1	-4.2	1.0
	3	—	.1	.2	-.3	-4.0	-.6	-4.7	-.3
	4	.3	—	.2	-.4	-3.6	-.7	-4.3	-.3
1964	1	.3	—	.3	-.2	-3.5	-.7	-4.3	-.1
	2	.3	—	.3	-.2	-3.5	-.6	-4.2	—
	3	.4	—	.4	-.4	-3.4	-.7	-4.1	-.2
	4	.5	—	.4	-.4	-3.4	-.7	-4.2	-.3
1965	1	.5	—	.5	-.2	-3.4	-.7	-4.1	-.2
	2	.4	—	.5	-.2	-3.3	-.6	-4.0	—
	3	.6	.1	.7	-.3	-3.3	-.7	-4.0	-.2
	4	.6	—	.6	-.4	-3.2	-.7	-3.9	-.3

Table 11

RESULTS OF SIMULATIONS FOR HOUSING PRICES AND RENTS UNDER ALTERNATIVE POLICIES USING THE DISAGGREGATE HOUSING MODEL

Quarter		Percentage change in housing prices arising from an increase in: RNHA	RLC	RNHA & RLC	CMHC	Percentage change in rents arising from an increase in: RNHA	RLC	RNHA & RLC	CMHC
1963	1	—	—	—	-.1	—	—	—	—
	2	-1.6	—	-1.8	-.1	1.8	—	2.1	—
	3	-1.3	-.4	-1.7	-.3	1.6	.4	2.2	-.1
	4	-1.2	-.3	-1.6	-.3	1.5	.3	2.1	-.2
1964	1	-1.2	-.3	-1.4	-.4	1.6	.3	2.3	-.3
	2	-1.1	-.3	-1.6	-.3	1.8	.3	2.5	-.3
	3	-1.0	-.3	-1.6	-.3	1.9	.4	2.7	-.3
	4	-1.0	-.3	-1.6	-.3	2.0	.4	2.9	-.3
965	1	-1.0	-.2	-1.5	-.3	2.2	.4	3.2	-.2
	2	-1.0	-.3	-1.5	-.3	2.3	.5	3.3	-.2
	3	-1.0	-.3	-1.5	-.2	2.3	.4	3.5	-.2
	4	-1.0	-.3	-1.5	-.2	2.4	.5	3.7	-.2

A 1 per cent increase in the NHA mortgage rate appears to have a more pronounced impact on the housing market than does a 1 per cent increase in the long-term bond rate. The aggregate model indicates that a 1 per cent increase in RNHA will cause a 14.2 per cent reduction in housing starts in the first year (even though the increase has no effect on housing starts during the quarter in which this increase is introduced), a 13.9 per cent reduction in the second year and an 11.1 per cent reduction in the third year. The disaggregated model indicates a 15.8 per cent reduction in multiple housing starts in the first year, a 16.6 per cent reduction in the second year and a 15.3 per cent reduction in the third year, compared to a .4 per cent increase in single housing starts in the first year, a 1.9 per cent increase in the second year and a 2.6 per cent increase in the third year arising from a 1 per cent increase in RNHA. Thus, once again, the disaggregate model indicates a smaller net reduction in housing starts than does the aggregate model. Prices are also more significantly influenced by a change in RNHA than by a change in RLC. The aggregate model shows a 2 per cent increase in housing prices after twelve quarters arising from a 1 per cent increase in RNHA compared to a 1.1 per cent increase in housing prices resulting from a 1 per cent increase in RLC. Once again this mortgage rate increase works to the detriment of tenants, as rents rise 2.4 per cent after twelve quarters, and to the benefit of home purchasers, as prices fall 1.0 per cent after twelve quarters.

An increase of $100 million in Central Mortgage and Housing Corporation direct lending generates an increase in housing starts in the first two quarters after this injection of additional funds and a slight reduction in housing starts thereafter. According to the aggregate model this increased lending will generate an additional 7,600 housing starts in the first two quarters but only an additional 4,400 starts over the first three years, since this government financed construction is partially offset by reduced privately financed activity. According to the disaggregate model an additional $50 million of single and multiple dwelling direct lending will generate an additional 4,500 single dwelling starts and 6,300 multiple dwelling starts in the first two quarters but only an additional 1,500 single starts and 4,400 multiple starts after three years. The total number of housing starts is higher in the disaggregate model because the lending mix has a larger multiple component than that implied by the coefficients in the aggregate model. Both models indicate a very slight reduction in housing prices and rents. These simulation results are only partial, however, because no allowance is made for the impact an additional $100 million of government funding will have on the capital markets.

The highlights of the various policy alternatives are summarized in terms of annual elasticities in Tables 12 and 13, and in terms of their influence on residential construction expenditure in Diagrams 4 and 5. These summaries clearly demonstrate that variations in the NHA mortgage rate will more profoundly affect residential construction and housing prices than equivalent variations in the long-term government bond rate, although variations in both these rates will have a substantial impact on the volume and mix of residential construction and a minor impact on housing prices and rents. Variations in government direct mortgage lending activity will also have a significant effect on residential construction, initially stimulating and subsequently retarding slightly the volume of building activity.

CONCLUSION

In this paper I have attempted to specify and analyze the structure of, and the forces operating on and within, the housing and mortgage markets, and then to use the developed structure to examine the implications of alternative government policies. In a number of areas, however, this study is rudimentary raising many more questions than it answers, especially concerning the structure and interrelationships of the various components or subsectors of these markets.

A further cautionary word about using my results today (April 1970) must be issued because of the structural changes that have occurred since the study was started in 1967. Complete data were then available only to the end of 1965 and consequently the basic specification was determined on the basis of these data, although the model was later re-estimated making use of data to the end of 1967. Unfortunately for my purposes, the housing and mortgage markets have undergone profound structural changes since 1965

Table 12

A COMPARISON OF HOUSING START ELASTICITIES OVER TIME WITH RESPECT TO CHANGES IN THE NHA MORTGAGE RATE AND THE LONG-TERM GOVERNMENT BOND RATE

	RDX1 Model		Disaggregate Model			
	Total Housing Starts		Single Housing Starts		Multiple Housing Starts	
Year	RNHA	RLC	RNHA	RLC	RNHA	RLC
1	-.90	-.34	.03	.01	-1.00	-.09
2	-.87	-.40	.12	—	-1.04	-.17
3	-.69	-.33	.16	.01	-.96	-.16

Table 13

A COMPARISON OF PRICE AND RENT ELASTICITIES OVER TIME WITH RESPECT TO CHANGES IN THE NHA MORTGAGE RATE AND THE LONG-TERM GOVERNMENT BOND RATE

	RDX1 Model		Disaggregate Model			
	Housing Prices		Housing Prices		Rents	
Year	RNHA	RLC	RNHA	RLC	RNHA	RLC
1	.01	.01	-.08	-.01	.08	.01
2	.07	.03	-.07	-.02	.11	.02
3	.11	.05	-.06	-.02	.14	.02

Diagram 4

RESIDENTIAL CONSTRUCTION EXPENDITURE SIMULATIONS (AGGREGATE MODEL) UNDER ALTERNATIVE POLICY ASSUMPTIONS

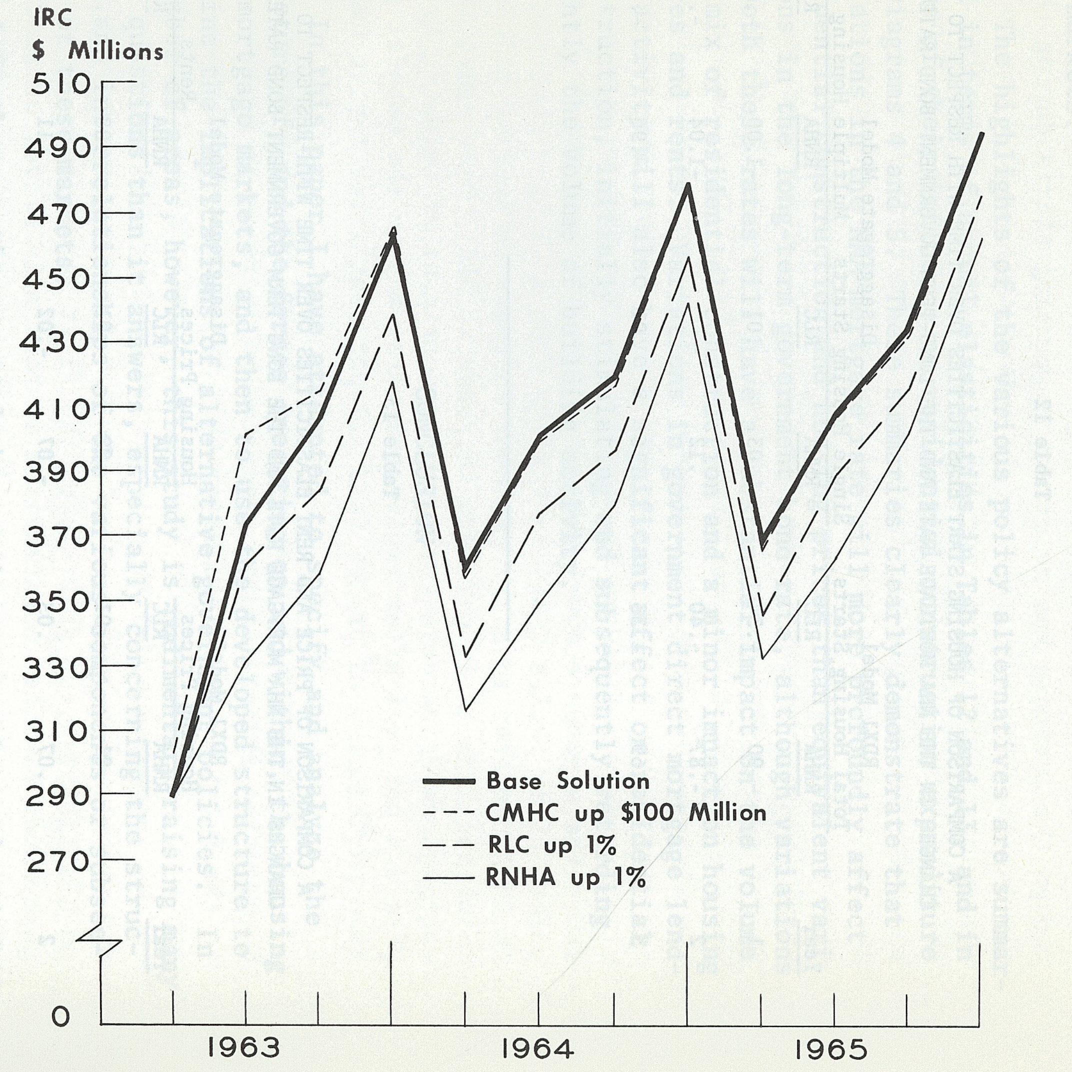
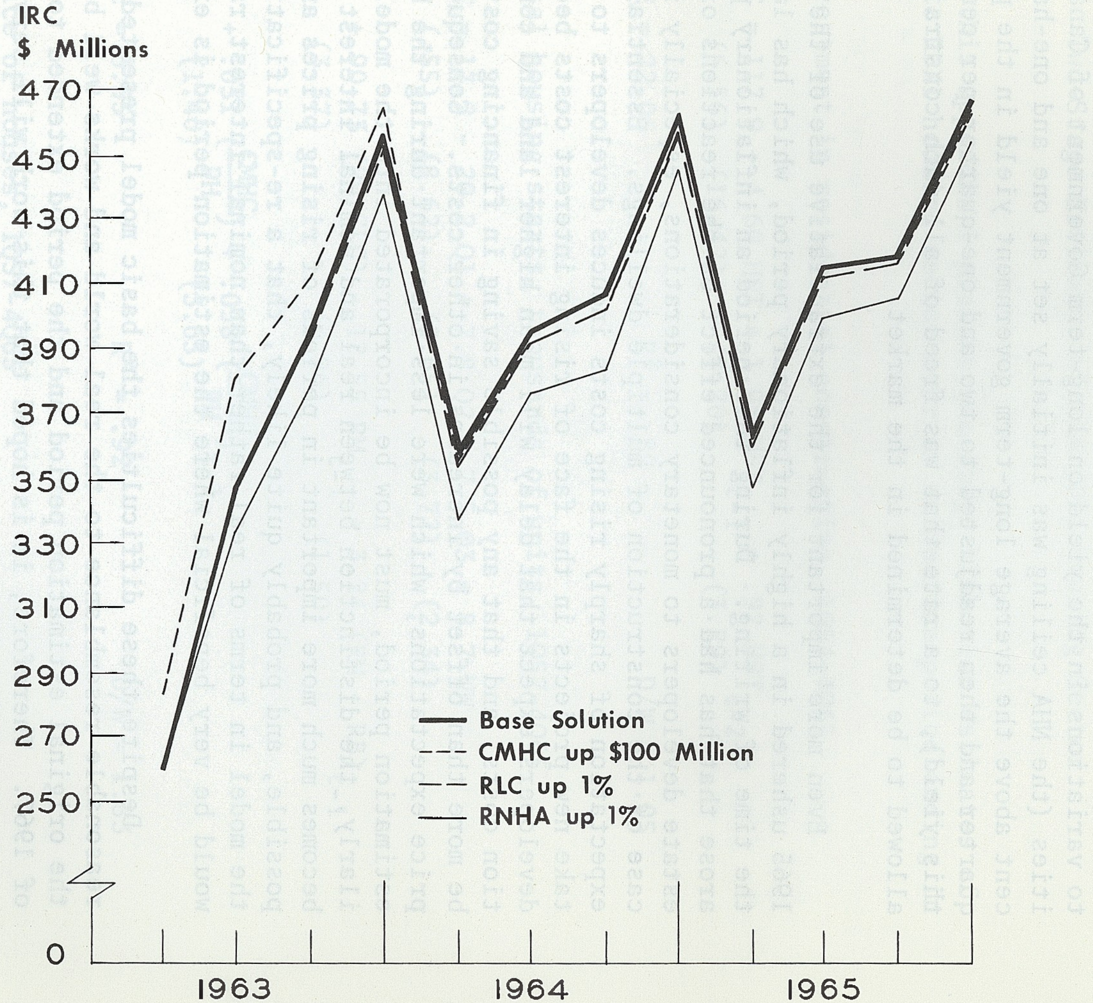


Diagram 5

RESIDENTIAL CONSTRUCTION EXPENDITURE SIMULATIONS (DISAGGREGATE MODEL) UNDER ALTERNATIVE POLICY ASSUMPTIONS



necessitating a reformulation of some of my specifications. For example, since 1965 the NHA mortgage interest rate evolved from a rate constrained by an arbitrarily set and seldom adjusted ceiling, to a rate constrained by a ceiling adjusted quarterly in relation to variations in the yield on long-term Government of Canada securities (the NHA ceiling was initially set at one and one-half per cent above the average long-term government yield in the previous quarter and then readjusted to two and one-quarter per cent above this yield), to a rate that was freed of all such constraints, and allowed to be determined in the market.

Even more important for the extrapolative use of the models, 1965 ushered in a highly inflationary period, which has lasted to the time of writing. During this period an inflationary psychology arose that has had a pronounced effect on the reactions of real estate developers to monetary considerations, especially in the case of the construction of multiple dwellings. Essentially, the expectation of sharply rising costs induces developers to undertake new projects in the face of rising interest costs because developers expect that delay will mean higher land and construction costs, and that any possible saving in financing costs will be more than offset by increases in other costs. Consequently, price expectations, which were less important during the basic estimation period, must now be incorporated into the model. Similarly, the distinction between real and nominal interest rates becomes much more important in periods of rising prices and it is possible, and probably quite likely, that a re-specification of the model in terms of real rather than nominal interest rates would be very beneficial where the estimation period is extended.

Despite these difficulties the basic model presented bears a reasonable resemblance to the real world and works well both over the original estimation period and the period extended to the end of 1967. Therefore, it is hoped that this work will serve as a guide to, and a framework for, further explorations in these most diverse and complex markets.

APPENDIX A

Two-Stage Estimates of the RDX1 Housing Sector

In this appendix I present two-stage Fisherian estimates of the basic RDX1 housing sector over an estimation period ending in 4Q65.

A-1 Investment in residential construction, 1Q54-4Q65

$$IRC = \underset{(6.56)}{117.9} + \underset{(16.42)}{4.60}\ HST + \underset{(7.70)}{1.96}\ HST_{t-1} + \underset{(3.29)}{.92}\ HST_{t-2}$$

SEE = 22.06 $\quad$ R^2 = .89 $\quad$ D/W = 1.05

A-2 Total housing starts, thousands of units, 1Q57-4Q65

$$HST = \underset{(.55)}{17.2} - \underset{(8.62)}{20.2}\ Q1 + \underset{(3.65)}{7.8}\ Q2 + \underset{(3.72)}{7.5}\ Q3 + \underset{(2.34)}{8.7}\ WW$$

$$+ \underset{(3.37)}{90.73}\ (PH/CLC) - \underset{(3.96)}{12.55}\ RM_{t-1} + \underset{(1.50)}{3.24}\ (RM - RB)_{t-1}$$

$$+ \underset{(1.40)}{.031}\ \left(\frac{CMHC}{PH}\right) + \underset{(3.65)}{.058}\ \left(\frac{CMHC}{PH}\right)_{t-1}$$

SEE = 3.55 $\quad$ R^2 = .92 $\quad$ D/W = 1.83

A-3 Price of houses, 1Q57-4Q65

$$PH = \underset{(1.95)}{79.1} + \underset{(1.49)}{1.5}\ Q1 + \underset{(3.98)}{4.1}\ Q2 + \underset{(2.22)}{2.1}\ Q3 + \underset{(3.05)}{55.62}\ (YDP/HH)_{t-1}$$

$$- \underset{(2.99)}{212.3}\ (STH/HH) + \underset{(4.82)}{1.74}\ PGNE_{t-1}$$

SEE = 1.92 $\quad$ R^2 = .91 $\quad$ D/W = 1.14

A-4 Total stock of housing units, 2Q54-4Q65

$$STH = \underset{(651.6)}{.9993}\ STH_{t-1} + \underset{(2.49)}{.202}\ HST + \underset{(5.25)}{.406}\ HST_{t-1} + \underset{(4.99)}{.310}\ HST_{t-2}$$

$$+ \underset{(4.78)}{.110}\ HST_{t-3}$$

SEE = 6.66 $\quad R^2 = .999 \quad$ D/W = 2.02

A-5 Construction costs (including land costs), 3Q55-4Q65

$$\ln CLC - \ln CLC_{t-4} = \underset{(.49)}{-.0032} + \underset{(1.90)}{.045}\ (\ln INRC - \ln \widehat{INRC})_{t-1}$$

$$+ \underset{(3.45)}{.085}\ (\ln IRC - \ln \widehat{IRC})_{t-1}$$

$$+ \underset{(.63)}{.078}\ (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(2.26)}{.125}\ (\ln L - \ln L_{t-4})$$

$$+ \underset{(3.40)}{.038}\ (\ln R03 - \ln R03_{t-4}) + \underset{(5.15)}{.030}\ DVST$$

SEE = .014 $\quad R^2 = .74 \quad$ D/W = 1.52

APPENDIX B

Ordinary Least Squares Regressions of the RDX1 Housing and the Extended Housing Models — Estimation Period Extended to the End of 1967

In this appendix I present ordinary least squares re-estimates, untransformed and transformed, of the basic and extended RDX1 models over an estimation period extended to the end of 1967.

A. The RDX1 Housing Model

B-1 Investment in residential construction, 1Q54-4Q67

$$IRC = \underset{(7.11)}{119.28} + \underset{(17.91)}{4.56}\ HST + \underset{(7.83)}{1.86}\ HST_{t-1} + \underset{(3.91)}{1.01}\ HST_{t-2}$$

SEE = 22.28 $\qquad R^2 = .88 \qquad$ D/W = 1.06

B-1'

$$IRC = \underset{(5.42)}{95.39} + \underset{(22.98)}{4.90}\ HST + \underset{(9.66)}{2.00}\ HST_{t-1} + \underset{(5.56)}{1.18}\ HST_{t-2}$$

SEE = 19.60 $\qquad \rho = .499 \qquad$ D/W = 2.04

B-2 Total housing starts, 1Q57-4Q67

$$HST = \underset{(.50)}{9.7} - \underset{(9.93)}{20.7}\ Q1 + \underset{(3.21)}{6.7}\ Q2 + \underset{(2.96)}{6.0}\ Q3 + \underset{(2.53)}{8.75}\ WW$$

$$+ \underset{(2.92)}{64.41}\ (PH/CLC) - \underset{(3.17)}{8.78}\ RM_{t-1} + \underset{(2.02)}{5.41}\ (RM - RB)_{t-1}$$

$$+ \underset{(2.33)}{.032} \left(\frac{CMHC}{PH}\right) + \underset{(4.27)}{.054} \left(\frac{CMHC}{PH}\right)_{t-1}$$

SEE = 4.05 R^2 = .92 D/W = 1.59

B-2'

$$HST = \underset{(.43)}{10.6} - \underset{(11.43)}{20.2}\ Q1 + \underset{(2.91)}{5.8}\ Q2 + \underset{(3.00)}{5.3}\ Q3 + \underset{(2.24)}{6.91}\ WW$$

$$+ \underset{(2.33)}{68.42}\ (PH/CLC) - \underset{(2.51)}{8.58}\ RM_{t-1} + \underset{(1.54)}{4.97}\ (RM - RB)_{t-1}$$

$$+ \underset{(2.43)}{.032} \left(\frac{CMHC}{PH}\right) + \underset{(3.38)}{.041} \left(\frac{CMHC}{PH}\right)_{t-1}$$

SEE = 3.92 ρ = .312 D/W = 1.96

B-3 Price of houses, 1Q57-4Q67

$$PH = \underset{(4.16)}{121.7} + \underset{(2.12)}{1.9}\ Q1 + \underset{(5.22)}{4.6}\ Q2 + \underset{(3.03)}{2.6}\ Q3 + \underset{(5.20)}{77.72}\ (YDP/HH)_{t-1}$$

$$- \underset{(7.89)}{274.23}\ (STH/HH) + \underset{(7.76)}{1.44}\ PGNE_{t-1}$$

SEE = 2.02 R^2 = .98 D/W = 1.11

B-3'

$$PH = \underset{(2.99)}{118.9} + \underset{(2.29)}{1.4}\ Q1 + \underset{(5.91)}{4.2}\ Q2 + \underset{(4.16)}{2.5}\ Q3 + \underset{(5.03)}{91.36}\ (YDP/HH)_{t-1}$$

$$- \underset{(5.24)}{254.18}\ (STH/HH) + \underset{(5.24)}{1.32}\ PGNE_{t-1}$$

SEE = 1.73 ρ = .450 D/W = 1.62

B-4 Total stock of housing units, 2Q54-4Q67

$$STH^{*} = \underset{(776.94)}{1.000}\ STH_{t-1} + \underset{(3.01)}{.213}\ HST + \underset{(5.19)}{.339}\ HST_{t-1} + \underset{(4.74)}{.248}\ HST_{t-2}$$

$$+ \underset{(4.46)}{.086}\ HST_{t-3}$$

SEE = 6.44 $\quad$ R^2 = .999 $\quad$ D/W = 2.03

B-4'

$$STH^{*} = \underset{(784.50)}{1.000}\ STH_{t-1} + \underset{(3.01)}{.212}\ HST + \underset{(5.23)}{.339}\ HST_{t-1} + \underset{(4.77)}{.248}\ HST_{t-2}$$

$$+ \underset{(4.49)}{.086}\ HST_{t-3}$$

SEE = 6.44 $\quad$ ρ = -.015 $\quad$ D/W = 2.00

B-5 Construction costs (including land costs), 3Q55-4Q67

$$\ln CLC - \ln CLC_{t-4} = \underset{(1.20)}{-.006} + \underset{(1.67)}{.037}\ (\ln INRC - \ln \widehat{INRC})_{t-1}$$

* These equations were estimated using second (Z_2) and third (Z_3) degree Almon variables created on housing starts. The actual regressions are:

$$STH = \underset{(776.94)}{1.000}\ STH_{t-1} + \underset{(4.30)}{3.33}\ Z_2 - \underset{(3.73)}{2.44}\ Z_3$$

R^2 = .99 $\quad$ D/W = 2.03

$$STH = \underset{(784.50)}{1.000}\ STH_{t-1} + \underset{(4.32)}{3.33}\ Z_2 - \underset{(3.75)}{2.44}\ Z_3$$

ρ = -.015

$$+ \underset{(2.73)}{.070} (\ln IRC - \ln \hat{IRC})_{t-1}$$

$$+ \underset{(5.24)}{.36} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(1.59)}{.07} (\ln L - \ln L_{t-4})$$

$$+ \underset{(2.07)}{.020} (\ln R03 - \ln R03_{t-4}) + \underset{(2.72)}{.017} DVST$$

SEE = .017 R^2 = .73 D/W = 1.16

B-5'

$$\ln CLC - \ln CLC_{t-4} = \underset{(.49)}{-.004} + \underset{(.53)}{.015} (\ln INRC - \ln \hat{INRC})_{t-1}$$

$$+ \underset{(.92)}{.024} (\ln IRC - \ln \hat{IRC})_{t-1}$$

$$+ \underset{(3.55)}{.33} (\ln WC - \ln WC_{t-4})$$

$$+ \underset{(1.82)}{.10} (\ln L - \ln L_{t-4})$$

$$+ \underset{(1.92)}{.021} (\ln R03 - \ln R03_{t-4}) + \underset{(1.52)}{.014} DVST$$

SEE = .015 ρ = .606 D/W = 1.89

B-6 Land costs, 2Q54-4Q67

$$L = \underset{(4.16)}{-84.1} + \underset{(4.38)}{.022} POPT + \underset{(4.93)}{.028} YDP - \underset{(3.29)}{.081} STH + \underset{(5.43)}{.65} \Delta L$$

SEE = 4.70 R^2 = .96 D/W = .98

B-6'

$$L = -42.0 + .009\ POPT + .020\ YDP - .026\ STH + .45\ \Delta\ L$$
$$(1.43)\quad (1.74)\quad (2.93)\quad (1.06)\quad (6.21)$$

SEE = 3.92 ρ = .441 D/W = 1.31

B-7 Conventional mortgage rate, 2Q54-4Q67

$$RC = 12.9 - 13.07\ (STH/HH)_{t-1} + 3.82\ (YDP/HH) - .0027\ ALTM$$
$$(6.07)\quad (6.70)\quad (3.83)\quad (5.49)$$

$$+ .0041\ MLTM_{t-1} + .45\ RNHA + .28\ RB_{t-1}$$
$$(6.00)\quad (6.22)\quad (4.00)$$

SEE = .100 R^2 = .97 D/W = 1.26

B-7'

$$RC = 13.6 - 14.49\ (STH/HH)_{t-1} + 4.50\ (YDP/HH) - .0020\ ALTM$$
$$(4.89)\quad (5.47)\quad (3.94)\quad (3.27)$$

$$+ .0029\ MLTM_{t-1} + .38\ RNHA + .29\ RB_{t-1}$$
$$(3.35)\quad (5.26)\quad (3.86)$$

SEE = .088 ρ = .486 D/W = 2.05

B. The Extended Housing Model

B-8 Investment in residential construction, 1Q54-4Q67

$$IRC = 45.02 + 6.56\ HSS + 3.00\ HSS_{t-1} + 2.00\ HSS_{t-2}$$
$$(2.42)\quad (14.55)\quad (6.84)\quad (4.34)$$

$$+ 2.89\ HSM + 1.19\ HSM_{t-1} + 1.15\ HSM_{t-2} + 1.64\ HSM_{t-3}$$
$$(4.69)\quad (1.59)\quad (1.78)\quad (3.18)$$

SEE = 16.46 R^2 = .94 D/W = 1.44

B-8'

$$IRC = 32.93 + 6.77\ HSS + 3.06\ HSS_{t-1} + 2.18\ HSS_{t-2}$$
$$\quad (1.52) \quad (14.95) \quad (7.64) \quad (4.89)$$

$$+ 2.96\ HSM + 1.29\ HSM_{t-1} + 1.10\ HSM_{t-2} + 1.70\ HSM_{t-3}$$
$$\quad (5.17) \quad (2.03) \quad (1.92) \quad (3.17)$$

$SEE = 15.74$ $\qquad \rho = .294$ $\qquad D/W = 1.97$

B-9 Single housing starts, 1Q57-4Q67

$$HSS = 21.4 - 12.6\ Q1 + 5.3\ Q2 + 4.2\ Q3 + 5.20\ WW$$
$$\quad (1.14) \quad (8.50) \quad (3.24) \quad (2.95) \quad (2.19)$$

$$+ 13.02\ (PH/CC)_{t-1} - .11\ L - 1.98\ RM_{t-1}$$
$$(.56) \quad (1.55) \quad (1.07)$$

$$+ 5.63\ (RM - RB)_{t-1} + .022\ \left(\frac{CMHCS}{PH}\right) + .051\ \left(\frac{CMHCS}{PH}\right)_{t-1}$$
$$(2.87) \quad (1.95) \quad (4.42)$$

$SEE = 2.91$ $\qquad R^2 = .89$ $\qquad D/W = 2.05$

B-10 Multiple housing starts, 1Q57-4Q67

$$HSM = -1.9 - 7.3\ Q1 + 2.7\ Q2 + 3.0\ Q3 + 3.22\ WW$$
$$\quad (.19) \quad (6.15) \quad (2.08) \quad (2.57) \quad (1.49)$$

$$+ 34.94\ (R/CC)_{t-1} + .07\ L - 4.97\ RM_{t-1} + .17\ (RM - RB)_{t-1}$$
$$(3.63) \quad (1.20) \quad (3.56) \quad (.10)$$

$$+ .114\ \left(\frac{CMHCM}{PH}\right) + .062\ \left(\frac{CMHCM}{PH}\right)_{t-1}$$
$$(2.60) \quad (1.63)$$

$SEE = 2.75$ $\qquad R^2 = .86$ $\qquad D/W = 1.55$

B-10'

$$HSM = \underset{(.44)}{-5.6} - \underset{(7.48)}{7.4}\,Q1 + \underset{(1.61)}{2.0}\,Q2 + \underset{(2.64)}{2.6}\,Q3 + \underset{(1.63)}{3.10}\,WW$$

$$+ \underset{(2.58)}{29.97}\,(R/CC)_{t-1} + \underset{(1.55)}{.10}\,L - \underset{(2.28)}{4.10}\,RM_{t-1} + \underset{(.35)}{.70}\,(RM - RB)_{t-1}$$

$$+ \underset{(1.80)}{.074}\left(\frac{CMHCM}{PH}\right) + \underset{(1.09)}{.040}\left(\frac{CMHCM}{PH}\right)_{t-1}$$

SEE = 2.67 $\qquad\rho$ = .331 $\qquad$ D/W = 1.91

B-11 Price of houses, 1Q57-4Q67

$$PH = \underset{(3.82)}{178.5} + \underset{(1.55)}{1.3}\,Q1 + \underset{(4.41)}{3.9}\,Q2 + \underset{(2.49)}{2.0}\,Q3 + \underset{(2.07)}{34.44}\,(YDP/HH)_{t-1}$$

$$- \underset{(7.93)}{392.58}\,(STHO/HH) + \underset{(3.33)}{1.29}\,PGNE_{t-1} + \underset{(1.21)}{.29}\,R_{t-1} - \underset{(.50)}{1.01}\,RM_{t-1}$$

SEE = 1.89 $\qquad R^2$ = .98 $\qquad$ D/W = 1.11

B-11'

$$PH = \underset{(3.41)}{174.9} + \underset{(1.36)}{.8}\,Q1 + \underset{(4.67)}{3.3}\,Q2 + \underset{(3.43)}{2.0}\,Q3 + \underset{(2.42)}{50.19}\,(YDP/HH)_{t-1}$$

$$- \underset{(5.69)}{365.47}\,(STHO/HH) + \underset{(2.20)}{.73}\,PGNE_{t-1} + \underset{(1.39)}{.35}\,R_{t-1} + \underset{(.46)}{1.10}\,RM^{\dagger}_{t-1}$$

SEE = 1.60 $\qquad\rho$ = .450 $\qquad$ D/W = 1.53

(† This variable has the wrong sign and is insignificant)

B-12 Rent, 1Q57-4Q67

$$R = \underset{(.63)}{-17.7} + \underset{(4.92)}{303.14}\,(YDP/POPT)_{t-1} - \underset{(3.34)}{1636.10}\,(SHR/POPT)_{t-1}$$

$$+\ 1.17\ PGNE_{t-1} + .26\ PH_{t-1} + 2.11\ RM_{t-1}$$
$$(4.67) \qquad (1.88) \qquad (1.84)$$

SEE = 1.39 R^2 = .99 D/W = 1.26

B-12'

$$R = .82 + 335.48\ (YDP/POPT)_{t-1} - 1707.80\ (SHR/POPT)_{t-1}$$
$$(.03)\ (4.92) \qquad (3.20)$$

$$+\ .82\ PGNE_{t-1} + .39\ PH_{t-1} + 2.02\ RM_{t-1}$$
$$(3.46) \qquad (3.05) \qquad (1.44)$$

SEE = 1.25 ρ = .380 D/W = 1.51

B-13 Stock of owner-occupied housing units, 2Q54-4Q67

$$SHO^* = .9989\ SHO_{t-1} + .281\ HSS + .400\ HSS_{t-1} + .285\ HSS_{t-2}$$
$$(1172.57) \qquad (4.63) \qquad (8.27) \qquad (6.88)$$

$$+\ .098\ HSS_{t-3}$$
$$(6.21)$$

SEE = 4.16 R^2 = .999 D/W = 2.23

* These equations were estimated using second (Z_2) and third (Z_3) degree Almon variables created on single unit housing starts. The actual regressions are:

$$SHO = .9989\ SHO_{t-1} + 3.75\ Z_2 - 2.69\ Z_3$$
$$(1172.57) \qquad (5.85) \qquad (4.75)$$

R^2 = .99 D/W = 2.23

$$SHO = .9989\ SHO_{t-1} + 3.77\ Z_2 - 2.71\ Z_3$$
$$(1297.99) \qquad (6.18) \qquad (4.95)$$

ρ = -.123

B-13'

$$SHO^{*} = \underset{(1297.99)}{.9989}\ SHO_{t-1} + \underset{(4.77)}{.280}\ HSS + \underset{(9.11)}{.401}\ HSS_{t-1} + \underset{(7.38)}{.287}\ HSS_{t-2}$$

$$+ \underset{(6.59)}{.099}\ HSS_{t-3}$$

SEE = 4.13 $\qquad \rho = -.123 \qquad$ D/W = 2.05

B-14 Stock of renter-occupied housing units, 2Q54-4Q67

$$SHR^{**} = \underset{(809.86)}{.9998}\ SHR_{t-1} + \underset{(1.18)}{.090}\ HSM + \underset{(7.18)}{.277}\ HSM_{t-1} + \underset{(5.82)}{.279}\ HSM_{t-2}$$

$$+ \underset{(5.10)}{.179}\ HSM_{t-3} + \underset{(4.75)}{.058}\ HSM_{t-4}$$

SEE = 3.14 $\qquad R^2 = .999 \qquad$ D/W = 1.38

*See footnote on the previous page.

** These equations were estimated using second (Z_2) and third (Z_3) degree Almon variables created on multiple dwelling unit housing starts. The actual regressions are:

$$SHR = \underset{(809.86)}{.9998}\ SHR_{t-1} + \underset{(4.54)}{3.97}\ Z_2 - \underset{(3.80)}{3.09}\ Z_3$$

$R^2 = .99 \qquad$ D/W = 1.38

$$SHR = \underset{(587.45)}{.9997}\ SHR_{t-1} + \underset{(3.66)}{3.42}\ Z_2 - \underset{(3.05)}{2.52}\ Z_3$$

$\rho = .350$

B-14'

$$SHR^{**} = .9997\ SHR_{t-1} + .154\ HSM + .277\ HSM_{t-1} + .257\ HSM_{t-2}$$
$$\quad (587.45) \qquad (2.08) \qquad (5.29) \qquad (4.53)$$

$$+ .159\ HSM_{t-3} + .051\ HSM_{t-4}$$
$$(4.07) \qquad (3.82)$$

SEE = 2.96 $\qquad \rho = .350 \qquad$ D/W = 2.02

B-15 Construction costs, 3Q55-4Q67

$$\ln CC - \ln CC_{t-4} = -.0090 + .015\ (\ln INRC - \ln \widehat{INRC})_{t-1}$$
$$(2.13)\ (.76)$$

$$+ .104\ (\ln IRC - \ln \widehat{IRC})_{t-1}$$
$$(4.22)$$

$$+ .425\ (\ln WC - \ln WC_{t-4})$$
$$(6.36)$$

$$+ .013\ (\ln R03 - \ln R03_{t-4}) + .021\ DVST$$
$$(1.39) \qquad (3.38)$$

SEE = .016 $\qquad R^2 = .76 \qquad$ D/W = .83

**See footnote on the previous page.

B-15'

$$
\begin{aligned}
\ln CC - \ln CC_{t-4} = {} & \underset{(.53)}{.0096} - \underset{(.55)}{.013}\,(\ln INRC - \ln \widehat{INRC})^{\dagger}_{t-1} \\
& + \underset{(2.09)}{.041}\,(\ln IRC - \ln \widehat{IRC})_{t-1} \\
& + \underset{(2.86)}{.235}\,(\ln WC - \ln WC_{t-4}) \\
& + \underset{(1.98)}{.017}\,(\ln R03 - \ln R03_{t-4}) + \underset{(2.29)}{.021}\, DVST
\end{aligned}
$$

$SEE = .012 \qquad \rho = .900 \qquad D/W = 2.02$

(† This variable has the wrong sign and is insignificant)

LIST OF VARIABLES AND SOURCES

AL — Total assets of twelve life insurance companies. Millions. Bank of Canada: *Statistical Summary*, year-end values interpolated by net investment transactions.

ALTM — Total assets (weighted) of trust and mortgage companies plus total assets less policy loans of twelve life insurance companies. Millions. (11240)

AM — Total assets of mortgage loan companies. Millions. (1112)

AT — Total assets of trust companies. Millions. (1100)

CC — Index of average construction costs per square foot on new single detached NHA dwellings. 1957=100. Central Mortgage and Housing Corporation: *Canadian Housing Statistics, 1966*, Table 94.

CLC — Index of average cost of construction per square foot (including land) of new single detached NHA dwellings. 1957=100. (Constructed from 11369)

CMHC — Central Mortgage and Housing Corporation direct mortgage approvals. Millions. (11440)

CMHCM — Central Mortgage and Housing Corporation direct mortgage approvals for multiple dwellings. Millions. (11371)

CMHCS — Central Mortgage and Housing Corporation direct mortgage approvals for single dwellings. Millions. (11370)

DVST — Dummy variable for sales tax on building materials; equals 1 from third quarter 1963 to the end of 1965, zero elsewhere. (11027)

HH — Number of families in Canada. Thousands. (3054)

HSM Multiple housing starts. Thousands. (3064 - 3068)

HSS Single housing starts. Thousands. (3068)

HST Total housing starts. Thousands. (3064)

INRC Investment in non-residential construction. Millions of 1957 dollars. (11307)

IRC Investment in new residential construction. Millions of 1957 dollars. (145)

L Index of land costs on new single detached NHA dwellings. 1957=100. (11372)

MAB Mortgage approvals of chartered banks. Millions. (622)

MAL Mortgage approvals of all life insurance companies. Millions. (626)

MAM Mortgage approvals of mortgage loan companies. Millions. Supplied by Central Mortgage and Housing Corporation.

MAT Mortgage approvals of trust companies. Millions. Supplied by Central Mortgage and Housing Corporation.

MB Mortgage holdings of chartered banks. Millions. Bank of Canada: *Statistical Summary*.

ML Mortgage holdings of twelve life insurance companies. Millions. (1138)

MLTM Weighted sum of total mortgage holdings of trust, mortgage and twelve life insurance companies. Millions. (11645)

MM Mortgage holdings of mortgage loan companies. Millions. (1104)

MT Non-interest rate attributes of mortgages.

MT' Mortgage holdings of trust companies. Millions. (1097)

PGNE Deflator of gross national expenditure, less government expenditure and less farm inventories. 1957=100. (Adjusted from 9153)

PH Index of housing prices. 1957=100. (11070)

PL Policy loans of twelve life insurance companies. Millions. (1137)

PMLS Housing price index of Multiple Listing Service sales. 1957=100. A four-quarter moving average centered on the third quarter of the average monthly value of real estate sales. The Canadian Association of Real Estate Boards: *The Canadian Realtor*.

PNHA Index of the cost of new single detached NHA dwellings. 1957=100. Central Mortgage and Housing Corporation: *Canadian Housing Statistics 1966*, Table 94.

POPT Total Canadian population. Millions of persons. (3032)

Q1 First-quarter seasonal dummy. 1 in first quarter, zero elsewhere. (11073)

Q2 Second-quarter seasonal dummy. 1 in second quarter, zero elsewhere. (11074)

Q3 Third-quarter seasonal dummy. 1 in third quarter, zero elsewhere. (11075)

R03 Average yield on short-term Government of Canada bonds, zero to three years. (1365)

R1GIC Interest rate paid on trust and mortgage loan company one-year term liabilities. (2779)

R5GIC Interest rate paid on trust and mortgage loan company five-year term liabilities. (2780)

R40 McLeod, Young, Weir average yield on forty industrial bonds. (1162)

R90	Interest rate paid by chartered banks on 90-day deposit receipts. (1164)
R	Index of average monthly rents. 1957=100. (11368)
RB	Average bond interest yield. Weighted average of ten industrial, ten public utility, ten municipal, ten provincial bond rates; and the average yield on long-term Government of Canada bonds, ten or more years to maturity.
RC	Conventional mortgage rate. (1096)
RCH	Interest rate paid on trust and mortgage loan company chequable deposits. (1127)
RDL	Chartered banks' day-loan rate. (2781)
RLC	Average yield on long-term Government of Canada bonds, ten or more years to maturity. (2764)
RM	Average mortgage rate. (11318)
RNHA	Average of actual month-end NHA rates: maximum NHA rates (245) adjusted in second quarter of 1954 to fourth quarter of 1954 according to [37], pp. 159-160.
RPS	Interest rate paid on chartered banks' personal savings deposits. (2778)
SHO	Stock of owner-occupied housing units. Thousands. (11366)
SHR	Stock of renter-occupied housing units. Thousands. (11367)
STH	Total stock of housing units. Thousands. (3057)
T	Time trend, equals 1 in first quarter of 1952.
TBA	Total major assets of chartered banks. Millions. (383)

W	A wealth variable represented by an eight-quarter distributed (Almon) lag on current-dollar gross national expenditure.
WC	Index of average hourly earnings of hourly-rated construction workers. 1957=100. (Constructed from 2486)
WW	Dummy winter works variable; equals 1 in fourth quarters of 1963, 1964 and 1965, zero elsewhere. (11320)
YDP	Permanent real disposable income. Millions of 1957 dollars. (3052)

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