Economic Impacts of Residential Construction

Prepared by
DRI Canada
Toronto, Ontario

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Helping to house Canadians

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Prepared for Canada Mortgage and Housing Corporation

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Cette publication est aussi disponible en français sous le titre *Les retombées économiques de la construction résidentielle*.

Table of Contents

Preface

The Market Analysis Centre is pleased to present this study as a contribution to the stock of knowledge about housing in Canada. The study, carried out using the services of DRI/McGraw-Hill, provides an update on the employment and value-added impacts of housing investment. The final version of this report benefitted from comments of reviewers from CMHC. However, the authors bear sole responsibility for its contents.

Summary findings include:

1) About 30 person-years of employment are created for each million dollars of new residential investment. Of these 30 person-years, only 5.4 are created directly on-site. Much of the employment is created indirectly off-site (18.3) or induced through income spending (6.2).

2) 1.5 million dollars of Gross Domestic Product (mostly in wages and profits) are also created for each million dollars of new residential spending.

Introduction

DRI/McGraw-Hill is pleased to respond to the Request for Proposal from Canada Mortgage and Housing Corporation (CMHC) on "Economic Impacts of Residential Construction." DRI/McGraw-Hill is uniquely qualified to assist the CMHC to meet the objectives of this study and has submitted a proposal that describes the approach the study team would employ.

I Study Purpose

Residential investment is a key component of the Canadian economy. In 1992, real residential investment expenditures was $32.8 billion at 1986 prices, which represented 5.9% of real GDP. Total residential investment is comprised of new residential construction, alterations and improvements, and residential transfer costs. Real expenditures for these components were $15.6 billion, $10.2 billion and $7.1 billion respectively in 1992. Not only is direct expenditure on residential investment large in relation to the economy, but each dollar of residential investment expenditure supports business activity in a host of supplying industries.

The primary objective of the study is to quantify the total contribution of residential construction investment to the Canadian economy, reflecting the level of national spending in 1992. The contribution of residential construction investment will be quantified in terms of employment and value added by industry. This research will include an examination of the major components of residential construction: New residential construction spending, alterations and improvements spending, and residential transfer costs. The contribution of these residential construction spending categories will be differentiated by the stage of impact and on a disaggregated industrial basis.

II Study Scope

The study will identify and express the contribution of residential construction expenditures and its major components at their 1992 level of activity in terms of person years of employment and billions of 1986 dollars of value added by stage of impact and by industry.

The major residential investment components are: New residential construction spending, alterations and improvements spending, and residential transfer costs. Estimates will be provided to quantify the contribution of each residential construction investment category by stage of impact: Direct, indirect and induced. The direct impact will include all contributions that residential construction

expenditures directly makes to an industry's value added and employment. The indirect stage will indicate the extent to which output for a particular industry is demanded as an intermediate input in the production processes of all other industries directly affected by residential construction investment expenditures, will indicate the corresponding change in employment which results. The induced impact stage results from there being a change in the level of general employment and income in the economy. These changes in aggregate demand cause additional changes in output and employment through the economy.

For each residential investment component, and each stage of impact, a summary table will be created for key industries: Agriculture, Forestry, Fishing, Hunting and Trapping, Mining, Construction, Manufacturing, Transportation, Communication & Utilities, Trade, Finance, Insurance and Real Estate, Service.

Results

The I/O model shows that the expenditure multiplier for total residential construction is in the range of 1.5. The multiplier for new construction expenditures is slightly below 1.5 and alterations and improvements is slightly below 1.6. The expenditure multiplier for transactions cost is slightly higher than 1.6. The reason for the large expenditure multiplier for transaction costs is that this industry has a high degree of value added. Its gross output multiplier is significant lower than that for either alternations and improvements or new construction investment, but this is more than compensated by its high level of value added relative to gross output.

This relationship can be seen through the composition of the impact results across the various stages. The largest impact for new and alterations and improvement expenditures was in direct supply. New expenditures second largest impact was for the indirect stage, while for alterations and improvements the indirect and induced stages were roughly of equal importance. For transaction costs, the direct supply and the indirect stages were the least important. It had the largest induced stage because of the higher level of value added in this sector.

In general, for new construction expenditure and alterations and improvements most of the aggregate impact is constrained in the goods producing sector. The Construction Industry and Manufacturing Industry account for over half of the impact for these two types of expenditures. Most of the impact for transactions costs, however, are contained in the service sector, with the Finance, Insurance and Real Estate Industry accounting for over half of the total impact.

The model shows that the employment multiplier for the residential construction industry (direct output) is in the range of 5.9. This multiplier is slightly higher than is normally calculated for a number of reasons. First the model was not constrained in any way, so that the direct output effect are simply those calculated by the model. Other studies will use the actual number of employees in the industry. Second, the industries contained at the work sheet level of aggregation are not detailed enough to distinguish the pertinent employment categories. For example, it is impossible to differentiate between real estate agents and others in the Other Finance and Real Estate Industry. The non-real estate agents in this industry include those who are stock brokers. Since stock brokers on average earn more than the average in the real estate industry, this will depress the calculated direct output employment effect. Total employment in this broader aggregate was in the range of 100,000 employees in 1992 according to SEPH. Employment from SEPH is not perfect delineated in the same way as the I/O information at the worksheet level of aggregation for construction. SEPH indicates that total construction employment was roughly 420,000 in 1992, so 130.6 thousand represents 31%.

Methodology

I Direct/Indirect Value Added Impacts

In order to estimate the total direct and indirect impacts for all components of residential investment expenditure, a detailed Input/Output model of the Canadian economy was used. The results from this model formed the basis of the first two segments of the analysis, that is the direct and indirect impact results in terms of value added.

The direct impact can be divided into two different components. These components are called direct output and direct supply in this report. The direct output impact result was determined by multiplying the final demand matrix for each residential construction investment category (column) across a normalized make matrix at the work sheet level of aggregation. This permits a determination of the industries which produce the commodities purchased under residential investment expenditure. The direct output industries will be dominated by the Residential Construction industry for new residential investment and alterations and improvements. The Other Finance and Real Estate industry, and Banks and Other Deposit Accepting Institutions will be the most affected by transaction costs. This approach also shows the magnitude of output change each relevant industry experiences for changes in residential investment expenditure.

The second component of the direct impact is the effect on those industries which directly supply the industries found in the direct output round. This component of the direct effect is listed under the direct supply column in the tables. This effect is often included as part of the direct effect in industry specific studies, but is not always included in expenditure studies. It has been separated to underscore the difference between those who produce for residential investment expenditures and those industries that directly supply these industries. The direct supply impact was determined by using the technical coefficients matrix (product of normalized Make matrix, with the normalized Use matrix) for those industries found in the direct output effect.

In order to determine the direct and indirect impact (the first two stages together) the full interindustry total requirements matrix was used in conjunction with the final demand matrix. Changes to final demand categories are translated into industry output changes through this method. This captures all the interindustry impacts from the change emanating from each residential investment category. The indirect impact is determined by removing the direct impact result from the total direct and indirect impact result.

The input/output information from Statistics Canada, even at the work sheet level does not differentiate between new residential construction and alterations and

improvements. Therefore, any estimate of the importance of alternations and improvements across industries will be proportionate with new residential construction. In order to help differentiate between these two different forms of construction expenditures, the available Statistics Canada information was supplemented with information from DRI/McGraw-Hill for the input/output relationship that has been reported for the United States. Given the similarities in the industrial structure of the supplying industries in Canada and the United States, this additional information can be used to successfully augment the Canadian information. Essentially, this step entails replacing the appropriate column in the interindustry technical coefficients matrix and solving the system with this new interindustry linkage.

II Employment Impacts

The primary input portion of the use matrix was used to determine the impact on the total value of wages and salaries. This information was translated into employment via the average wages and salaries for that industry. The input/output information is not available for 1992. In order to make the impact effects relevant for 1992, the results were generally applied to the level of employment as contained in the Survey of Employment, Payrolls and Hours (SEPH). This survey information was used to provide the level of disaggregation needed. The major exceptions to this approach were for agriculture and fishing, hunting and trapping. Employment data for these industries is not available from SEPH. Agriculture employment is from the Labour Force Survey (LFS), and fishing, hunting and trapping employment was calculated by combining the LFS information for other primary, with the SEPH primary sector information.

III Induced Impacts

Once the relevant employment and labour income effects were determined, these results were aggregated and put into the macro modelling system to determine the induced impact results. Since, some of the residential construction expenditure include taxes, such as land transfer costs, it will be assumed that government expenditure will be lowered by an equal amount to the direct impact on revenues. This approach will be taken because the government sector was in considerable deficit during 1992, and any change in tax revenues would have resulted in cutbacks elsewhere. In 1989, the value of indirect taxes from new residential construction and alternations and improvement expenditures was $9 million. The value of indirect taxes from transaction costs was $1130 million. From these values an implicit tax rate can be constructed. The value of direct tax revenue can therefore be calculated by adjusting the results to reflect the change activity between 1989 and 1992. No attempt was made to adjust these numbers for changes in tax rates over this time period.

The Modelling System

The DRI Canadian modelling system is based on an integration of econometric modelling and input-output analysis. This structure facilitates the incorporation of final demand changes into the model framework. The present section provides a general overview of the Canadian modelling system.

I Overview of the DRI Canadian Modelling System

DRI's Canadian Models are fully integrated within the family of DRI economic models so that a particular simulation is based upon DRI's most current forecasts of the U.S., Japanese and European economies with consistent outlooks for trade, exchange rates and world energy and commodity prices. As a result, the model provides a comprehensive view of economic activity in Canada that reflects and is consistent with economic activity in the United States and around the world.

The DRI modelling system for Canada is used extensively for forecasting, impact analysis and for the examination of policy alternatives. DRI produces short-term (three year) forecasts eight times per year and long-term forecasts covering the next 10 or 25 years four times per year. In addition, Canadian and foreign government agencies and a wide variety of private-sector clients use DRI's models either to produce their own forecast scenarios, or for policy analysis, or simply to provide "economic intelligence" for their business or policy decisions.

The DRI Canadian Modelling System is itself a highly integrated system of models that were designed to function together to describe and simulate Canadian economic activity in detail. The macro model provides detailed solutions at the national level for expenditures, incomes, housing, employment, interest rates. The interindustry model provides industry output given the fiscal and monetary policy environment.

II The DRI Macroeconomic Model of the Canadian Economy

The DRI quarterly econometric model of the Canadian economy is the centrepiece of the Canadian Modelling System, and an integral part of DRI's broader international economic information system. Originally developed in 1977, the current version of the model was re-specified and re-estimated using the 1986-based National Income and Expenditure accounts and released for use in the spring of 1991. The model is a comprehensive representation of a small open economy with strong links to the rest of the world particularly the United States. The model (1991A version) consists of 781 variables and 528 equations, 256 of which are identities or technical equations.

The model follows a pragmatic Keynesian approach with national income determined by national expenditure. National output is, however, constrained in the long-run by the economy's productive capacity. The model includes a detailed disaggregation of the National Income and Expenditure Accounts, consumer and industrial prices, interest rates, investment, trade flows and financial sector activity.

From a structural perspective, the model resembles other quarterly Canadian econometric models. In concept, however, it is a hybrid of the DRI U.S. macro model adapted to reflect the greater openness of the Canadian economy, and differences in the industrial base and institutional structure. A brief overview of the model is provided in Appendix I.

III The Integrated Canadian Inter-Industry Model

Industrial output related to any macroeconomic forecast is calculated by DRI's Canadian Inter-Industry Model. This model covers 43 industries at the Canadian 1980 SIC 2-digit level and includes 10 industry aggregations.

Real output for each industry is calculated based upon the mix of final demand determined by the macro model and the extent to which output for a particular industry is demanded as intermediate inputs in the production processes of all other industries. The model generates industry demand using an input-output block of 50 industries based on the medium level aggregation of Statistics Canada's input-output matrices. The most important innovation of the DRI inter-industry model is that the input-output technical coefficients are endogenously determined in the technology sub-model and as a result reflect relative prices and disembodied technological improvement. As a result, the Industry Model captures both the complex inter-related nature of the Canadian industrial sector and the importance of technology on the production process of the economy.

Using the input-output framework, the inter-industry model also delineates final demand detail including imports and exports for each of the 43 industries.

IV Disaggregated Input/Output Modelling System of the Canadian Economy

Input/Output Accounts present the most detailed accounting of the Canadian economy. The Input/Output Accounts for Canada contain two sets of interrelated accounts, the Commodity Accounts and the Industry Accounts. The former details the supply and disposition of individual commodities. The latter details the commodity composition of output of industries and the complete costs of production of industries. Gross Domestic Product by industry is an integral part of the Input/Output Accounts. This measure represents the contribution of each

industry to the total value of production in the economy; it is the value added by the industry's labour and capital to the intermediate inputs used in production.[1]

DRI has a detail Input/Output modelling system available. This system uses the worksheet level input/output structure of the Canadian economy, with 627 commodities and 216 industries in the interindustry block, and is supplemented by 136 final demand categories. The 1989 input/output information at the core of this model is the most up to date final form data currently available from Statistics Canada. At this level of detail, final demand is differentiated between housing investment and real estate commissions, while the commodity detail differentiates between repair construction, residential construction, and other financial & real estate services (including real estate brokers commissions).

This modelling approach is very useful since it supports a very detailed analysis, known as comparative statics, of the inter-industry impacts of a shock. Comparative statics involves describing the current economy and then changing some of the underlying assumptions to see what the economy would like if these new assumptions were true. This type of analysis is well suited to the problem of determining the importance of residential construction investment to the Canadian economy.

[1] Statistics Canada, Catalogue 15-511, "The Input-Output Structure of the Canadian economy in Constant Prices"

Areas of Further Research

I Base Year Different from Target Year

The I/O base year used was 1989, which is the most recently available final form information from Statistics Canada. Unfortunately, the base year, 1989 and the expenditure target year, 1992, represent the peak and the trough of the most recent business cycle. Consequently, the level and mix of residential construction changed dramatically over this time period. With such a large shift in residential investment combined with other forces in the economy, there was a large degree of structural change for the industries which supply and produce residential construction activity. The compositional mix of Canada's new residential construction could be taken into consideration when calculating the supply linkages, based on U.S. data. The U.S. I/O information differentiates between the industries which supply single detached housing and multi-family housing. But given the extent of the change in level and composition, this adjustment was not enough. This may be the case, since the marginal builders or suppliers who went out of business may have utilized a different mix of inputs than the firms which survived. Consequently, further research into the degree of and implications from structural change is warranted. It may also be prudent to examine in more detail the compositional shift in expenditures that occurred from 1989 and 1992. It is also possible to redo the analysis for a different base and target year when the data becomes available.

II Input/Output Model Assumptions

An input/output model is built on three basic assumptions. First, each industry uses a fixed input ratio or factor combination for the production of its output. Second, it is assumed that each industry maintains its market share for each commodity it produces. Third, production in every industry is subject to constant returns to scale. These assumptions are taken to minimize the computationally difficult of deriving industry demand. In terms of the current exercise these assumptions clearly will distort the determination of the true importance of residential construction. Some of the limitations of these assumptions, however, can be overcome by using a flexible functional form, and multiple year data. The worksheet level of aggregation, however, makes this computational difficult. This approach, however, enables many additional questions to be answered in terms of the importance of residential construction to the economy. Given the large change in residential expenditure implied by the terms of the report a flexible functional form would provide a better estimate of the importance of the residential construction to the economy.

It should be also noted that there are a variety of input/output models. The one used for this report was constructed as follows:

$(I-DB)^{-1}*DY=X$

Where:

D is the normalize Make matrix

B is the normalize Use matrix

I is the Identity matrix

Y is the Final Demand matrix

X is the Output matrix

DB is the Technology matrix

$(I-DB)^{-1}$ is the Total Requirements matrix

Other models will alter the DB matrix by including leakages, such as imports and the government sector. These models will give impact results smaller than the model used. Closed I/O models include the consumer (labour) sector as an additional industry. This type of model results in a large induced impact. Statistics Canada has warned that closing an I/O model in such a way is not only incomplete, but the model itself, by virtue of its construction, does not take into account important macro-economic equilibrium relationships.[2] In the current study, a macro model was used to construct the induced impact round which does take into account the important macro-economic equilibrium relationships.

III Definitional Data Differences

Canadian I/O and other data sources define industry aggregations in different ways which are not perfectly comparable.

Translating U.S. I/O data into Canadian I/O terms will necessarily cause some problems because there is not a perfect one-to-one concordance between the U.S. and Canadian information. For this report, there were multiple category concordances. Among these categories some were clearly not appropriate for residential construction, and were excluded. In other instances of multiple choice, the relevant concordance and the appropriate weight were ambiguous. When examining the U.S. input coefficient vector for building construction compared with the total new construction column in the Canadian data, the profile for these two

[2] Statistics Canada, Statistics Canada's Input-Output Model: General Description, Critical Analysis of Partially Closed Version and Alternative Solutions, June 1991.

were similar for most industries, but there were some differences. This will cause some distortions at the most detailed level of aggregation, but should have less effect at the higher levels of aggregation used in this report.

A concordance is available between Canadian SIC and I/O, but there is not a unique one-to-one mapping. Consequently, the industry employment numbers from SEPH and the labour force survey information will not be perfectly consistent with the I/O definitions. The employment data which is consistent with the I/O categories are released at the time of the general I/O release and are not available for 1992. One way to minimize the concordance problem would be to spend more time on the concordance methodology in conjunction with Statistics Canada officials to determine in greater detail which of the multiple category choices is not relevant for the residential construction sector.

IV Confidentiality of Data

Due to confidentiality, some of the data along the rows and columns at the work sheet level of aggregation were not available. For the current I/O model there was no attempt was made to determine the values of the missing I/O coefficients. This could be done in one of three ways. First, the Canadian I/O information could be supplemented with U.S. data. Second, the gaps in the Canadian data could be imputed through mathematical means. Third, the gaps could be filled through use of other data sources and educated guesses.

V Other Approaches

It may be possible to examine the importance of residential investment expenditure to the economy by using a general equilibrium model. These models are usually used to analyse policy changes, but have also been used to analyse changes in energy supply, and changes in energy demand.

A general equilibrium model is characterized by a set prices and levels of production in each industry such that market demand equals supply for all commodities. Since producers are assumed to maximize profits, this implies that in the constant-returns-to-scale case no activity (or cost minimizing techniques for production functions) does any better than break even at the equilibrium prices.[3]

[3] Shoven, J. and Whalley, J. Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey, Journal of Economic Literature, vol. XXII, (Sept. 1984), pp 1007-1051.

Table 1

Employment Impacts of Total Expenditures on Residential Construction by Industry Canada, 1992

Thousands of Person-years

Industry	Direct Output	Direct Supply	Indirect	Induced	Total
Agriculture	0.0	0.0	-9.4	-14.2	-23.6
Fishing & Trapping	0.0	0.0	-0.9	-1.2	-2.1
Forestry	0.0	-0.2	-9.3	-5.2	-14.8
Mining	-0.2	-0.6	-4.2	-4.0	-9.1
Manufacturing	-0.4	-105.8	-59.7	-34.8	-200.6
Construction	-130.6	-1.6	-1.8	-11.0	-145.1
Transp., Comm., & Utilities	-0.2	-15.2	-30.4	-28.6	-74.5
Wholesale & Retail Trade	-1.1	-95.0	-58.3	-65.1	-219.5
Finance, Insurance & Real Estate	-24.9	-4.6	-7.1	-7.7	-44.4
Com., Bus. & Pers. Services	-1.0	-43.0	-54.9	-100.6	-199.5
Total	-158.4	-266.2	-236.2	-272.4	-933.2

Table 2

Employment Impacts of Total Expenditures on Residential New Construction by Industry Canada, 1992

Thousands of Person-years

Industry	Direct Output	Direct Supply	Indirect	Induced	Total
Agriculture	0.0	0.0	-5.3	-5.3	-10.6
Fishing & Trapping	0.0	0.0	-0.5	-0.4	-1.0
Forestry	0.0	-0.1	-6.5	-2.0	-8.7
Mining	0.0	-0.3	-2.3	-1.5	-4.1
Manufacturing	-0.1	-68.0	-34.6	-3.5	-106.2
Construction	-84.0	-0.1	-0.9	-4.4	-89.5
Transp., Comm., & Utilities	0.0	-6.5	-16.2	-10.7	-33.5
Wholesale & Retail Trade	-0.2	-58.1	-33.0	-24.9	-116.2
Finance, Insurance & Real Estate	0.0	-1.1	-3.6	-3.0	-7.8
Com., Bus. & Pers. Services	0.0	-19.4	-29.2	-40.0	-88.7
Total	-84.3	-153.6	-132.3	-95.9	-466.2

Table 3

Employment Impacts of Total Expenditures on Residential Alterations and Improvements by Industry Canada, 1992

Thousands of Person-years

Industry	Direct Output	Direct Supply	Indirect	Induced	Total
Agriculture	0.0	0.0	-3.7	-4.8	-8.5
Fishing & Trapping	0.0	0.0	-0.3	-0.4	-0.7
Forestry	0.0	-0.1	-2.7	-1.8	-4.5
Mining	0.0	-0.3	-1.5	-1.4	-3.1
Manufacturing	-0.1	-37.0	-20.3	-11.6	-69.0
Construction	-46.6	-0.1	-0.6	-3.7	-51.0
Transp., Comm., & Utilities	0.0	-3.5	-9.9	-9.6	-23.0
Wholesale & Retail Trade	-0.1	-34.4	-19.3	-21.9	-75.7
Finance, Insurance & Real Estate	0.0	-0.4	-2.2	-2.6	-5.2
Com., Bus. & Pers. Services	0.0	-11.9	-16.6	-34.0	-62.5
Total	-46.8	-87.8	-77.1	-91.7	-303.3

Table 4

Employment Impacts of Total Expenditures on Residential Transfer Costs by Industry Canada, 1992

Thousands of Person-years

Industry	Direct Output	Direct Supply	Indirect	Induced	Total
Agriculture	0.0	0.0	-0.4	-4.2	-4.6
Fishing & Trapping	0.0	0.0	-0.1	-0.4	-0.5
Forestry	0.0	0.0	-0.1	-1.4	-1.6
Mining	-0.2	-0.1	-0.4	-1.2	-1.9
Manufacturing	-0.1	-0.8	-4.8	-19.6	-25.4
Construction	0.0	-1.5	-0.3	-2.9	-4.7
Transp., Comm., & Utilities	-0.2	-5.2	-4.3	-8.2	-18.0
Wholesale & Retail Trade	-0.8	-2.5	-6.0	-18.4	-27.6
Finance, Insurance & Real Estate	-24.9	-3.1	-1.3	-2.1	-31.3
Com., Bus. & Pers. Services	-1.0	-11.7	-9.1	-26.5	-48.3
Total	-27.3	-24.8	-26.8	-84.9	-163.8

Table 5

Value Added Impacts of Total Expenditures on Residential Construction by Industry Canada, 1992

Billions of 1986 $

Industry	Direct Output	Direct Supply	Indirect	Induced	Total
Agriculture	0.0	0.0	-0.2	-0.4	-0.6
Fishing & Trapping	0.0	0.0	0.0	0.0	0.0
Forestry	0.0	0.0	-0.1	-0.1	-0.2
Mining	-0.1	-0.1	-0.8	-0.7	-1.6
Manufacturing	0.0	-6.9	-3.6	-1.9	-12.5
Construction	-9.1	-0.1	-0.1	-0.8	-10.1
Transp., Comm., & Utilities	0.0	-1.0	-2.0	-1.9	-5.0
Wholesale & Retail Trade	0.0	-2.8	-1.2	-2.0	-5.9
Finance, Insurance & Real Estate	-4.9	-0.6	-1.4	-2.2	-9.1
Com., Bus. & Pers. Services	0.0	-1.7	-1.6	-1.5	-4.8
Total	-14.1	-13.2	-11.2	-11.4	-49.8

Table 6

Value Added Impacts of Total Expenditures on Residential New Construction by Industry Canada, 1992

Billions of 1986 $

Industry	Direct Output	Direct Supply	Indirect	Induced	Total
Agriculture	0.0	0.0	-0.1	-0.1	-0.3
Fishing & Trapping	0.0	0.0	0.0	0.0	0.0
Forestry	0.0	0.0	-0.1	0.0	-0.1
Mining	0.0	0.0	-0.4	-0.2	-0.7
Manufacturing	0.0	-4.5	-2.1	-0.3	-6.9
Construction	-5.8	0.0	-0.1	-0.3	-6.2
Transp., Comm., & Utilities	0.0	-0.4	-1.1	-0.7	-2.2
Wholesale & Retail Trade	0.0	-1.6	-0.7	-0.8	-3.0
Finance, Insurance & Real Estate	0.0	-0.1	-0.7	-0.9	-1.7
Com., Bus. & Pers. Services	0.0	-0.7	-0.9	-0.6	-2.2
Total	-5.8	-7.3	-6.1	-4.0	-23.3

Table 7

Value Added Impacts of Total Expenditures on Residential Alterations & Improvements by Industry Canada, 1992

Billions of 1986 $

Industry	Direct Output	Direct Supply	Indirect	Induced	Total
Agriculture	0.0	0.0	-0.1	-0.1	-0.2
Fishing & Trapping	0.0	0.0	0.0	0.0	0.0
Forestry	0.0	0.0	0.0	0.0	-0.1
Mining	0.0	0.0	-0.3	-0.2	-0.5
Manufacturing	0.0	-2.4	-1.2	-0.6	-4.2
Construction	-3.2	0.0	0.0	-0.3	-3.5
Transp., Comm., & Utilities	0.0	-0.2	-0.7	-0.6	-1.5
Wholesale & Retail Trade	0.0	-1.1	-0.4	-0.7	-2.1
Finance, Insurance & Real Estate	0.0	0.0	-0.4	-0.7	-1.2
Com., Bus. & Pers. Services	0.0	-0.5	-0.5	-0.5	-1.5
Total	-3.2	-4.2	-3.7	-3.8	-14.9

Table 8

Value Added Impacts of Total Expenditures on Residential Transfer Costs by Industry Canada, 1992

Billions of 1986 $

Industry	Direct Output	Direct Supply	Indirect	Induced	Total
Agriculture	0.0	0.0	0.0	-0.1	-0.1
Fishing & Trapping	0.0	0.0	0.0	0.0	0.0
Forestry	0.0	0.0	0.0	0.0	0.0
Mining	-0.1	0.0	-0.1	-0.2	-0.3
Manufacturing	0.0	-0.1	-0.3	-0.9	-1.3
Construction	0.0	-0.1	0.0	-0.2	-0.3
Transp., Comm., & Utilities	0.0	-0.5	-0.3	-0.5	-1.3
Wholesale & Retail Trade	0.0	-0.1	-0.1	-0.6	-0.8
Finance, Insurance & Real Estate	-4.9	-0.5	-0.2	-0.6	-6.2
Com., Bus. & Pers. Services	0.0	-0.5	-0.3	-0.4	-1.2
Total	-5.0	-1.6	-1.4	-3.6	-11.6

Appendix I

The DRI Macroeconomic Model of the Canadian Economy

Personal Consumption

Over the last decade, the share of household income devoted to paying the interest on outstanding consumer credit has ranged from about 7% to nearly 10%. To help reflect this important consideration in consumer spending decisions, the consumption equations are functions of real disposable income net of household interest expense, relative prices, real interest rates, and where appropriate, a number of other factors including the unemployment rate, motor vehicle sales and the housing stock. Interest expense on household consumer and mortgage credit are based upon the stocks of debt and the level of interest rates. As a result, increases in the interest burden, flowing from higher interest rates will have a significant dampening effect on consumption.

Residential Investment and Housing

Residential construction is typically the first sector to turn down in a recession and the first to rebound in a recovery. Moreover, the magnitude of the building cycle is often the key to that of the subsequent macroeconomic cycle. Total residential investment in the model is defined as the sum of new construction, alterations and improvements and transaction costs. New residential investment is modeled as a function of apartment and non-apartment housing starts and real household disposable income.

Household formation used in the housing start equation provides a link from DRI's detailed Canadian Demographic model through to the macroeconometric. After estimating the changes in the propensity for specific age-sex groups to form independent households, the resulting "headship rates" were multiplied by corresponding population statistics to estimate the trend expansion of households. In the model, housing starts reflect the rate of household formation, the stock of housing, mortgage costs as a share of household disposable income (a "mortgage burden" term) and the relative cost of housing.

Business Investment

Energy investment is treated exogenously by the macro model and is obtained directly from the Canadian energy model. Non-energy investment can be characterized as a cash flow augmented, neoclassical stock-adjustment model. Specifically, investment is modeled as the difference between the desired and actual capital stock of the previous period with the desired level of the capital stock a function of real final sales and the user cost of capital. The user cost of capital is derived from corporate income tax rates, appropriate depreciation rates and the average yield of long-term corporate bonds.

Foreign Sector

In general, the export equations are specified as functions of the level of foreign demand and domestic export prices relative to competing U.S. prices times the exchange rate. Wherever appropriate, the measure of foreign demand is a trade-weighted average of indices of industrial production in the United States, the major European economies and Japan.

Similarly, the import equations are specified as functions of import prices relative to domestic prices, as well as appropriate measures of Canadian demand by import category. In cases where the relevant Canadian activity variable was an intermediate demand, the actual industrial output variable was replaced by an equivalent weighted sum of final demands, with the weights being calculated from the input-output matrix of the economy. This synthetic construct allows the industry output block to remain entirely recursive to the model (i.e. changes in final demand affect industrial output but not vice versa), while still providing a realistic measure of Canadian demand.

By using balance of payments data, service receipts (exports) and disbursements (imports) are each disaggregated into five categories in the model.

The foreign sector gives the model its open economy properties. The role of interest rates in determining capital flows and the exchange rate provides a strong link from monetary policy to the real sector via the current account balance.

Government Expenditures and Revenue

Government expenditures and revenues are modeled for two levels of government: federal and provincial, local and hospital.

Current expenditures at both the federal and provincial and local levels of government are exogenously determined in the model, and can be set in either real

or nominal terms. This facilitates the modelling of a particular government policy that has been specified in nominal dollars. It also allows a particular level of real government expenditures (or growth in real government expenditures) to be maintained despite changes elsewhere in the economy.

The model also explicitly includes equations covering government capital expenditures, interest payments on the debt and transfer payments under the unemployment insurance program, old-age security fund payments, Canada Pension Plan payments and other transfers.

The model also contains a considerable amount of detail on government revenue, including four sources of direct taxes at the federal level, two sources of direct taxes at the provincial level and detailed indirect taxes (including the GST) at both levels of government.

The level of detail on both government expenditures and revenues facilitates the modelling of specific fiscal policies. Moreover, the government sector is also explicitly linked to prices and private sector expenditures allowing changes in government policy to have realistic and direct impacts to the rest of the economy.

Prices

The price sector of the model is based on a detailed stages-of-processing approach which relates final demand prices to industry prices and explicitly accounts for the level of indirect taxes. Specifically, at the core of the price sector of the model is an input-output based block of approximately 50 industry unit cost equations (based on the medium level of aggregation of Statistics Canada's input-output tables). This industry unit cost sub-model captures the inter-related and simultaneously nature of costs and prices in the economy.

The industry unit cost sub-model is essentially a variation on the standard translog cost function[4] with the unit cost of a particular industry modeled as a non-linear function of the prices of capital and labour services and a weighted function of the material inputs (including energy) based on input-output technical coefficients:

$$\text{Unit Cost of Industry X} = f[b_K * g(K,r), b_E * h(E,w), b_I * k(I,p), T, P]$$

[4] This general structure is based on a model developed by Hudson and Jorgenson. see Hudson, E.A. and Jorgenson D.W., "U.S. Energy Policy and Economic Growth". Bell Journal of Economics, Autumn 1974.

where,

K is the capital stock of industry X,
r is the user cost of capital for industy X,
E is the level of employment in industry X,
w is the wage rate in industry X,

I is a vector of material inputs,
p is a vector of industry selling prices corresponding to the material inputs, (when industry prices are unavailable, the industry unit costs are used as a proxy)
T are relevant indirect taxes,
P represents profit margins,
f,g and h
are non-linear functions and
b_K,b_E,and b_I
are the endogenously determined input-output based technical coefficients (and b_I is actually a vector of coefficients).

However, the major innovation of the industry unit cost sub-model is that the input-output coefficients are determined endogenously in a technology sub-model.

Based on the industry unit cost sub-model are an additional 22 industry prices which reflect both domestic unit costs, exchange rate adjusted foreign prices and capacity utilization rates. As well, the model includes a detailed disaggregation of consumer price indexes and expenditure deflators including import and export prices.

Demographics

As Canada population continues to age, immigration policy has become a key element in preserving our ability to produce enough goods and services to support our social programmes. To help model the effects of immigration policy and other demographic changes on the Canadian economy, total population is endogenous to the macro model. Specifically, total population is calculated from births, deaths and net immigration. The Canadian macro model demographic assumptions are fully integrated with DRI's demographic model for Canada, which projects population by single year age group and by sex. As well, total population is disaggregated into five age categories which are then linked explicitly to consumption and residential sector expenditures.

Labour Market

The labour market equations explain employment of the civilian labour force, the unemployment rate, average hourly earnings in manufacturing, and wages, salaries and supplementary labour income.

Aggregate employment is expressed as a function of real output and the GDP deflator relative to labour input prices. This formulation is consistent with an aggregate production function of the Cobb-Douglas structure. The unemployment rate is essentially an Okun's law derivative which state's that the rate of unemployment depends on the ratio of actual to potential output. As well, the dependent variable in the equation is actually "labour market slack", (that is the actual unemployment rate less the full-employment rate of unemployment).

In relating the labour force, employment and the unemployment rate to each other, the model includes a switch which results in either the unemployment rate or the labour force being estimated with the other concept being calculated residually by identity.

The key wage rate in the model, average hourly earnings in manufacturing is a function of the rate of inflation and labour market slack. As well, the ratio of wages, salaries and supplementary labour income to employment is determined by inflation, productivity and labour market slack.

Financial Sector and the Exchange Rate

The financial sector of the model covers the major interest-rate concepts, the money supply, the net international investment position and the outstanding debt positions of the household, corporate and government sectors.

Monetary policy functions through the key short-term interest rates in the model. A reduction of the money supply through the Bank of Canada's open-market sales of government securities would be traced through the DRI model from interest rates to the money supply.

The 90-day finance company paper rate and the bank rate are key rates that affect other short-term interest rates. The finance company rate determines treasury bill yields and the one-to-three-year government bond rate, which in turn feeds into the equations explaining long-term interest rates.

The exchange rate in the model is the noon-spot rate for the U.S. dollar ($Cdn/$U.S.). The equation for the exchange rate combines the influences of both short and long-term interest-rate differentials (Canadian vis a vis U.S. rates), the

purchasing power parity value of the currency and both the current account and government deficits as a share of GDP.

Incomes

Wages and salaries are determined by multiplying average wages by the level of employment. Total personal income is then equal to wages, salaries and supplementary income, military pay, farm income, interest and dividend income and transfers to persons from government and corporations. Total disposable income is then equal to total personal income less total direct personal taxes. As is customary, profits are derived as the residual income in the model. Net national income is equal to GDP plus subsidies, less indirect taxes, capital consumption allowances and the residual error of the estimate. ■