The Centre for Spatial Economics

Assessing past, present and future economic and demographic change in Canada

The Ontario Tourism Regional Economic Impact Model (TREIM)

Prepared for:

Ministry of Tourism
Tourism Policy and Research Branch
700 Bay Street, 15th Floor,
Toronto, ON, M5G 1Z6

Prepared by:

The Centre for Spatial Economics
15 Martin Street, Suite 203
Milton, ON L9T 2R1

Updated: January 9, 2006

Abstract

The Tourism Regional Economic Impact Model is a versatile tool capable of providing detailed economic impact analysis for various user-selected geographies. The TREIM can be used to distribute total direct tourist spending across Ontario Census Divisions (CDs), Census Metropolitan Areas (CMAs) or Ontario's Tourism Regions. The TREIM can also be used to estimate the economic impact of specific tourism events or impacts on the supply side by tourism industry sector or type of capital project at the CD, CMA or Tourism Region level of geography. Finally, the application can be used to review the impact at the provincial level of supply or demand side tourism sector activity.

About this Report

This report was prepared by The Centre for Spatial Economics, a consulting organization created to improve the quality of spatial economic and demographic research in Canada. The report was commissioned by the Ontario Ministry of Tourism.

Questions or comments about this report can be sent to:

Ernie Stokes
Executive Director
905-878-8292
estokes@c4se.com

Robin Somerville
Director of Corporate Research Services
905-337-3855
rsomerville@c4se.com

The Centre for Spatial Economics
15 Martin Street, Suite 203
Milton, ON L9T 2R1
telephone: 905-878-8292
fax: 905-878-8502
web: www.c4se.com

Table of Contents

Introduction

This document is a guide to the design, specification and construction of the Ontario Tourism Regional Economic Impact Model (TREIM) and was prepared by The Centre for Spatial Economics (C_4SE). The TREIM was commissioned by the Tourism Branch of the Ontario Ministry of Tourism and Recreation. The purpose of this model is to forecast the economic impact of tourism events and infrastructure development at the sub-provincial level in Ontario.

Overview

The Tourism Regional Economic Impact Model will be a versatile tool capable of providing detailed economic impact analysis for various user-selected geographies. The TREIM could be used to distribute total direct tourist spending across Ontario Census Divisions (CDs), CMAs or Ontario's Tourism Regions. The TREIM can also be used to estimate the economic impact of specific tourism events or impacts on the supply side by tourism industry sector or type of capital project at the CD, CMA or Tourism Region level of geography. Finally, the application can be used to review the impact at the provincial level of supply or demand side tourism sector activity.

The economic impacts from each of these applications must go beyond those of a standard open input-output model. The TREIM must, therefore, have the capability of being closed with respect to households and investment. This will (i) allow the impact on economic activity of the additional income paid to households, as a result of the tourism sector activity, to be captured and (ii) reflect the impact of changes in economic activity on business investment. The TREIM will produce direct, indirect and induced impacts so the user can chose to "turn on or off" the induced impacts.

Households' willingness to spend additional income is dependent upon economic conditions so the propensity to consume will be a function not only of the change in income resulting from the shock but also of broader economic conditions. Factors such as the interest rate, inflation, the unemployment rate and the exchange rate will be considered in the equation. Similarly, business investment may have to rise to produce the additional goods and services from any shock. This response is, however, dependent upon not only the size of the shock but also the current state of the economy. Businesses' willingness to invest will be a function of factors such as the output gap, the interest rate, inflation. The TREIM must also be able to generate estimates of the impact upon federal government revenue generated in Ontario as well as provincial and local government revenue.

Finally, the economic impacts from the TREIM must be defensible. The methodology used to construct the model and the database must be clearly documented. While the model is intrinsically static and will only provide comparative statics analysis, it must provide the user with the ability to generate economic impact estimates for current, prior or future years. This means that nominal dollar amounts must be converted to the equivalent value for the model's input-output table base year and the resulting output reconverted back to current (or future) year's nominal values. Data will be generated to allow the model to operate up to five years beyond the current input-output table year.

The initial deliverable from this assignment will provide the Ministry with a report detailing a complete methodology and design for the model. The subsequent deliverable involves the construction and deployment of the TREIM in MS Access. A set of screens will be designed to allow users to input data for simulations and to update the model's parameters. Up to three screens will be developed with a set of built-in defaults regarding tourists' expenditures by type of event or costs by tourism sector or capital project.

Once the MS Access version of the model is completed, an IT vendor (to be supplied by the Ministry) will require advice and assistance in order to program the model for use on the internet. The final task is to address issues and costs associated with maintaining the model over the next few years.

TREIM Model Simulations

The TREIM model can be solved in one of two ways. The first approach (single-region) involves simulating the impact of tourism-related activity in a specific region and its impact on that region and other parts of the province. This type of simulation can be run directly from EViews or accessed via the internet through the Ministry of Tourism & Recreation's web site. The second approach (province-wide) involves simulating the impact of tourism spending in one or more regions throughout the province. This type of simulation can only be run directly from EViews. Access via the internet for this option is not available at this time.

The two approaches yield near identical impacts at the Census Division level of geography. The differences are due to some minor differences in the solution processes between these two approaches which are described in this document. The impacts at the other levels of geography – Census Metropolitan Areas and Census Agglogmerations, Travel Regions, and the whole province – are derived using different methodologies for each approach and, therefore, yield different results. The differences in approach are described in this document and were necessary in order to achieve the varying objectives of the Ministry.

This documentation will first review the process taken to generate the single-region impacts followed by the province-wide impact approach.

Single-Region Simulations

The TREIM model can simulate the impact of a variety of demand and supply side tourism-related activities at either the CD, CMA, TR or the provincial level of geography. These simulations can either be conducted directly using EViews or via internet using the Ministry of Tourism & Recreation's web site.

The user must supply a set of inputs in order to simulate the model. The user can supply these inputs directly in the web pages on the internet. Instructions and help screens are provided directly on line. Alternatively, the user can solve the model directly in EViews. This document will focus on the later option since documentation for the web-based version is available on the internet.

Single Region Shock Options

The user must enter a set of options for their shock in the EViews program **treim_region.prg** and in the Excel spreadsheet **SHOCK.xls**. In the web-based version, all the parameters and data described below are entered in the appropriate web pages by the user.

The user must provide information for the following arguments.

- A label for the shock, %event, can be one or more words enclosed in double quotes
- The type of shock, %shock. Three types of tourism-related shocks are available in this version of the TREIM. Tourism spending "spending", the operating expenses of a tourism-related business "operating", or investment by a tourism-related business "investment".
- The option %shock_category refers to either the activity for tourism spending shocks or the industry for the operating and investment shocks. The numeric code beside the appropriate activity or industry should be entered in the program.

Code	Activity or Event
1	Festivals/Fairs
2	Cultural Performances
3	Heritage Sites
4	Museums & Galleries
5	Any Cultural Activity (net 1-4)
6	National/Provincial Nature Parks
7	Fishing
8	Golfing
9	Hunting
10	Boating
11	Downhill Ski
12	Any Outdoors (net 6-11)
13	Zoos, Botanical Gardens, Aquariums
14	Sporting Events
15	Casinos
16	Theme/Amusement Parks
17	Any Entertainment (net 13-16)
18	I don't know

Code	Industry
1	Retail (4A)
2	Recreation & Entertainment (71)
3	Accommodation (721)
4	Restaurants (721)

- The option %spend_detail refers to the amount of information available to the user for the simulation. The table below matches the appropriate %spend_detail to the type of shock chosen. The next section provides a more complete description of each of the single region shock options available in the TREIM.

Shock Type	%shock	%spend_detail
Shock Option 1	spending	yes
Shock Option 2	spending	no
Shock Option 3	spending	partial
Shock Option 4	operating	yes
Shock Option 5	operating	no
Shock Option 6	investment	yes
Shock Option 7	investment	no

- The level of geography for the shock, %reg1, is “ON” for provincial, “TR” for Travel Region, “CMA” for Census Metropolitan Area / Census Agglomeration, and “CD” and Census Division
- The specific region for the analysis, %reg2, is the numeric code for the region
- The option %impact determines whether the economic impact table will display the impact on the whole of the province, “Ontario”, or by selecting “region2” on another region of the same geographic type as %reg1.
- The other region to be displayed in the economic impact tables, %reg3, is selected with the numeric code for that region. The region type for %reg3 must match %reg2.

- The option %year determines the year the shock occurs in. The range of years that the model will produce results for is limited to 1996 through 2008 inclusive.
- The option %induced_h determines whether household induced impacts are desired "yes" or not "no".
- The option %induced_b determines whether business induced impacts are desired "yes" or not "no".
- The option %local determines whether local government revenue impacts should reflect just the change in economic activity "no", or whether they should reflect the total contribution to local government revenue from the shock "yes".
- The option %custom_macro determines whether the user wants to specify their own macroeconomic environment "fcst" or accept the baseline scenario "no".

The user should note that not all options are relevant in all situations. If, for example, %reg1="ON" then the values selected for %reg2, %impact and %reg3 are redundant. In this instance any set of values can be provided for these arguments.

User Inputs

The TREIM model is simulated by entering values for a specific type of shock in the Excel spreadsheet: **shock.xls**. The arguments in the EViews program **treim_region.prg** must then be edited and this program saved and run in order to generate impacts.

In the web-based version, the numeric assumptions entered into **shock.xls** are provided by the user on specific web pages and the options chosen by the user will select a specific program that is used to generate the impacts.

The set of simulation types included in this documentation reflect the current options available to the user. It is, however, relatively easy to include additional types of tourism-related shocks with alternate information and assumptions and some modifications may be made in future work on the TREIM.

At present, seven general types of tourism-related shocks can be simulated.

1. Visitor Spending – spending detail is known
2. Visitor Spending – number of visitors by origin, duration of stay and activity type is known
3. Visitor Spending – total spending (allocated by visitor origin) and activity type is known
4. Operational Spending – spending detail and industry is known
5. Operational Spending – total spending and industry is known
6. Investment Spending – spending detail and industry is known
7. Investment Spending – total spending and industry is known

The first three options simulate the impact of visistor spending on a region. They differ to accommodate users with varying levels of information available to them. The next two options simulate the economic impact of operational spending by a tourism-related business. The user must specify the type of business. The industries currently available are: retail (NAICS/IO Sector 4A), recreation and entertainment (NAICS 71), accommodation (NAICS 721) and restaurants

(NAICS 722). The final two options simulate the impact of investment spending for one of the four tourism-related industries listed above.

Option 1

The first option is a shock when the user knows visitor spending for the eleven categories listed in the table below. Although total spending must be positive, zero values for one or more spending categories are acceptable. Spending should be entered in dollars in the nominal dollars of the shock year (all values shown in these tables are for illustrative purposes only).

Tourists' Spending

Tourists' Spending Breakdown	**$**
Travel Services	16788005
Public Transportation	45996478
Private Transportation - Rental	9895864
Private Transportation - Operation	24012303
Local Transportation	837333
Accommodation	42593802
Food & Beverages - At Stores	10991696
Food & Beverages - At Restaurants/Bars	30518260
Recreation & Entertainment	10827548
Retail - Clothing	21207736
Retail - Other	10977448
Total	224646472

The subroutine **shock_spending** in the program **SHOCK_SUBROUTINES.prg** converts the inputs for the next three options into a spending shock vector. The spending for each category in the table above is converted to millions of dollars and multiplied by a matrix, **sh_{%cat}**, that allocates the spending to a set of S-level input-output industries and commodities in the 57x25 matrix **sh_all**. This process yields a shock specific "make" matrix, **dmat_{%reg}**, and, by collapsing the industry columns, a commodity-based shock vector **shock_{%reg}**.

sh_all[com,ind] = 0.000001 * $\Sigma_{\%cat}$ sh_{%cat}[com,ind] * spending[%cat]

dmat_{%reg} = sh_all / Σ_{ind} sh_all

shock_{%reg} = Σ_{ind} sh_all

Option 2

The second option is a shock when the user knows the number of visitors of origin and duration of visit. The user must also select the type of activity or event that the tourists are engaged in from the table below.

Code	Activity or Event
1	Festivals/Fairs
2	Cultural Performances
3	Heritage Sites
4	Museums & Galleries
5	Any Cultural Activity (net 1-4)
6	National/Provincial Nature Parks
7	Fishing
8	Golfing
9	Hunting
10	Boating
11	Downhill Ski
12	Any Outdoors (net 6-11)
13	Zoos, Botanical Gardens, Aquariums
14	Sporting Events
15	Casinos
16	Theme/Amusement Parks
17	Any Entertainment (net 13-16)
18	I don't know

Next, the user must provide information on the number of visitors by origin. The user must then indicate the proportion of visitors that are same day and those that are overnight for each groupof visitors. For overnight visitors, the average length of stay (number of nights) must also be provided.

Tourists' Spending Using Number of Visitors

Activity (or Event) 1

Origin	Total Number of Visitors	Same Day	Overnight	
		Percent of Visitors' Origin	Percent of Visitors' Origin	Average Length of Stay (nights)
Ontario	200000	22	78	3
Rest of Canada	40000	6	94	5
USA	565000	5	95	4
Overseas	17600	0	100	7
Total	822600			

This information is combined with the CTS and ITS surveys of tourism spending in 2003 to generate a spending vector for the 11 spending categories listed in the table shown for Option 1. The surveys provide information on average spending for each of the 11 spending categories for each visitor based on their origin, destination and duration of visit. The data in survey_{%cat} is expressed in 2003 base year dollars. The following formula is used to generate spending for each of the four visitor origin categories for the specified destination region.

vs_base[%cat,%origin] = #visitors[%origin] * (.01 * same_day_share[%origin] *
survey_{%cat}[%destination,%duration,%origin] + .01 *
overnight_share[%origin] * average_stay[%origin] *
survey_{%cat}[%destination,%duration,%origin])

spending[%cat] = $\Sigma_{\%origin}$ vs_base * cpi[%year]/cpi[2003]

The spending figures are then converted from 2003 dollars to shock year dollars using the CPI. The spending vector is then converted a region-specific make matrix and shock vector following the same methodology discussed for Option 1.

Option 3

The third option is a shock when the user knows total visitor spending, the source of that spending by origin of visitor and the type of activity or event. The set of activities/events is the same as that listed under Option 2. Total spending must be entered in dollars for the year the shock takes place. Total spending must then be allocated between vistors originating from Ontario, the rest of Canada, the US or overseas.

Tourists' Spending Using Total S

Activity (or Event) 1

Visitors' Origin	Spending
Total Spending $	125000000
Ontario (%)	10
Rest of Canada (%)	5
USA (%)	83
Overseas (%)	2
Total % Spending	**100**

This information is combined with the CTS and ITS surveys of tourism spending in 2003 to generate a spending vector for the 11 spending categories listed in the table shown for Option 1. The surveys provide information on average spending for each of the 11 spending categories for each visitor based on their origin, destination and duration of visit. The following formula is used to generate spending for each of the 11 spending categories where the data in **survey_cat** is expressed as a percentage of total spending in that category by that class of tourist. The resulting vector is, therefore, still expressed in shock year dollars.

$$\text{spending[\%cat]} = \text{total\_spending} * (\Sigma_{\%origin} \text{ spending\_share[\%origin]} * \text{survey\_\{\%cat\}[\%destination,\%duration,\%origin]} / 100)$$

This spending vector is then converted a region-specific make matrix and shock vector following the same methodology discussed for Option 1.

Option 4

The fourth and fifth options simulate the impact of operational spending of a tourism-related business. The user must first select an industry from the list below.

Code	Industry
1	Retail (4A)
2	Recreation & Entertainment (71)
3	Accommodation (721)
4	Restaurants (721)

The fourth option is a shock where the user knows the operational spending for the categories listed in the second table in this section. Although total revenue must be positive, zero values for one or more spending categories are acceptable. Spending should be entered in dollars in the nominal dollars of the shock year.

Tourist Business Operating Expenses

Type of Tourism Facility/Operation	2

Operating Expenses	$
Total Revenue (incl. sales taxes & grants, subsidies)	78332000
Grants and subsidies	0
Food products	1370015
Alcoholic beverges	524720
All other mechandise	7327703
Office and all other supplies	1462878
Salaries, wages	29198423
Commission paid	0
Employee benefits	5605042
Sub-contract laundry, cleaning and maintenance	0
Legal, accounting and other professional fees	371185
Maketing, advertising and promotion	1454012
Travel(transportation, accommodation, food, entertainn	0
Rent or lease	0
Repair and maintenance	11267164
Insurance	492481
Heat, light, power and water	2249537
Telephone, fax and internet fees	422221
Depreciation	0
Royalities and franchise fees	949572
Property tax and business tax, licences and permits	0
All other operating expenses	3875427
Interest expenses	0
Sales Taxes	4927885

The subroutine **shock_operating** in the program **SHOCK_SUBROUTINES.prg** converts the inputs for the next two options into a shock vector.

The values for each categoriy in the table above are converted to millions of dollars, total revenue is converted to other operating surplus by subtracting the expense items from food products on, and grants and subsidies are multiplied by -1.

The values for all categories except the Cost of Goods Sold (Food Products, Alcoholic Beverages and All Other Merchandise) are multiplied by a matrix, **sh_{%cat}**, that allocates the spending to a set of S-level input-output industries and commodities in the 57x25 matrix **sh_all**. This spending is all allocated to the chosen tourism-related industry.

A similar process is followed for the Cost of Goods Sold categories except that the spending is allocated to the industry that produced the commodity. This is because the input-output accounts treat retailing as an intermediary with households paying the retail margins to the retailer and the remainder to the industry that produced the commodity. This process yields a shock specific "make" matrix, **dmat_{%reg}**, and, by collapsing the industry columns, a commodity-based shock vector **shock_{%reg}**.

sh_all[com,ind] = 0.000001 * $\Sigma_{\%cat}$ sh_{%cat}[com,ind] * spending[%cat]

dmat_{%reg} = sh_all / Σ_{ind} sh_all

shock_{%reg} = Σ_{ind} sh_all

Option 5

The fifth option is a shock when the user knows total revenue for the selected industry. Total revenue is then allocated to the spending categories shown in the previous table based on the purchasing patterns for that industry from the input-output use table.

Tourist Business Operating Expenses

Type of Tourism Facility/Operation	2

Operating Expenses	**$**
Total Amount	10000000

A spending vector is generated using the average operating expense shares for each tourism-related industry based on the following formula:

Spending[%cat] = total_spending * sh_operate_default[%cat,%ind]

This spending vector is then converted a region-specific make matrix and shock vector following the same methodology discussed for Option 4.

This option should be used with caution – particularly for the retail industry. The cost of goods sold is assumed to be $0 for all industries. This is because the input-output accounts do not provide any information about the cost of goods sold for retail operations. While Recration and Entertainment, Accommodation and Restaurant industries do engage in some retail activity, this is not their primary business. The model will produce poor results based on the extent to which the business being simulated engages in retail activities.

Option 6

The sixth and seven shocks simulate the impact of an investment project undtertaken by a tourism-related business. The sixth option is a shock where the user knows investment spending for the six categories listed in the table below. Although total spending must be positive, zero values for one or more spending categories are acceptable. Spending should be entered in dollars in the nominal dollars of the shock year.

Tourist Business Investment Expenditure

Type of Tourism Facility/Operation	3

Investment Category	**$**
Buildings and Renovations	3670000
Machinery and Equipment	2880000
Furniture and Fixtures	1310000
Transportation Equipment	665000
Other Supplies	1100000
Other Services	375000
Total	**10000000**

The subroutine **shock_investment** in the program **SHOCK_SUBROUTINES.prg** converts the inputs for the next two options into a shock vector. This spending is allocated to S-level industries and commodities and is used to construct the shock vector.

The values for all categories are multiplied by a matrix, **sh_{%cat}**, that allocates the spending to a set of S-level input-output industries and commodities in the 57x25 matrix **sh_all**. This process yields a shock specific "make" matrix, **dmat_{%reg}**, and, by collapsing the industry columns, a commodity-based shock vector **shock_{%reg}**.

sh_all[com,ind] = 0.000001 * $\Sigma_{\%cat}$ sh_{%cat}[com,ind] * spending[%cat]

dmat_{%reg} = sh_all / Σ_{ind} sh_all

shock_{%reg} = Σ_{ind} sh_all

Option 7

The seventh option is a shock where the user only knows the industry and total investment spending. Spending should be entered in dollars in the nominal dollars of the shock year.

Tourist Business Investment Expenditure

Type of Tourism Facility/Operation	3
Investment Expenditure	**$**
Total Amount	72000000

This spending is then allocated to the six spending categories in the table from the previous section before being allocated to S-level industries and commodities. These values are used to construct the shock vector.

Spending[%cat] = total_spending * sh_investment_default[%cat,%ind]

This spending vector is then converted a region-specific make matrix and shock vector following the same methodology discussed for Option 6.

Macroeconomic Environment

The induced impacts in the TREIM are generated using a dynamic macroeconometric model. The results are, therefore, dependent on the economic environment. The user can either elect to use the default values in the model or enter their own assumptions for the key macroeconomic variables in the model.

TREIM: Custom Macroeconomic Environment Assumptions

	2003	2004	2005	2006	2007
Ontario Real GDP (%change)					
Baseline	1.77	2.78	3.26	2.76	3.24
Custom	1.77	2.78	3.26	2.76	3.24
Ontario CPI (%change)					
Baseline	2.74	1.11	1.54	1.95	2.15
Custom	2.74	1.11	1.54	1.95	2.15
Ontario Population					
Baseline	1.16	1.02	0.92	0.94	0.96
Custom	1.16	1.02	0.92	0.94	0.96
Government of Canada 3 month T-Bill Rate					
Baseline	2.84	2.53	3.14	4.03	4.47
Custom	2.84	2.53	3.14	4.03	4.47
Canada-US Exchange Rate (C$/US$)					
Baseline	1.41	1.34	1.31	1.31	1.32
Custom	1.41	1.34	1.31	1.31	1.32

Program Execution

Once all options have been selected, the program TREIM_REGION.prg can be run. The program will first execute the setup subroutine from the SHOCK_SUBROUTINES program, it will then execute the macro_assumptions subroutine if %custom_macro is not "no" before chosing the appropriate subroutine based on the type of geography chosen by %reg1.

Setup

The subroutine **setup** in **SHOCK_SUBROUTINES** opens an EViews workfile and reads the data objects, equations and other objects required by the TREIM from the EViews database **db_treim**.

Macro Assumptions

The subroutines **macro_assumptions** in **SHOCK_SUBROUTINES** adjusts the values of five key macroeconomic variables to match those set by the user if the option %custom_macro = "fcst".

Single Region Impact Overview

The type of geography selected by %reg1 determines the subroutine used to generate the economic impacts. If %reg1 = "CD" then the program calls the subroutine **sr_region_cd** from the program SIM_REGION_CD. If %reg1 = "CMA" then the program calls the subroutine **sr_region_cma** from the program **SIM_REGION_CMA**. If %reg1 = "TR" then the program calls the subroutine **sr_region_tr** from the program **SIM_REGION_TR**. These three subroutines are essentially the same: the only difference is the type of geographic coverage modeled. Finally, if %reg1 = "ON" then the program calls the subroutine **sr_region_on** from **SIM_REGION_ON**. This subroutine differs in certain respects from the other subroutines because it does not have to deal with intraprovincial trade flows. This document will first discuss the simpler Ontario model before reviewing the more complex subprovincial model.

The model is solved by following a sequence of operations. These operations involve generating the intital shock vector; building the leakage vectors; determining the direct, indirect and induced impact on the selected region of the shock in that region; determining the direct, indirect and induced impact on the other regions of the province; and finally producing the economic impact tables.

Import Leakage Vectors

A set of import leakage vectors are created for the type of geography selected. If the selected geography is "CD" then the subroutine **import_leakage_cd** is called from the **SHOCK_SUBROUTINES** program. Similarly named subroutines exist for each of the "TR", "CMA" and "ON" geographies.

For the CD, CMA and TR geographies, the following sets of leakage vectors – actually diagonal matrices – are created for each region (%r) using data from the regional trade matrices:

mlx_{%r}	created from either mpx_cd, mpx_tr, mpx_cma
ml_{%r}	created from either mp_cd, mp_tr, mp_cma
mlro_{%r}	created from either mpro_cd, mpro_tr, mpro_cma
mlrs_{%r}	created from either mprs_cd, mprs_tr, mprs_cma
mlsr_{%r}	created from either mpsr_cd, mpsr_tr, mpsr_cma
ml_{%r}_{%s}	created from mpdom_{%r}

For the Ontario ("ON" geography) only the **ml_on** leakage vector is used.

The construction of the import leakage vectors is discussed in the Regional Trade Matrices sections of the Data Construction chapter.

If the option %shock = "spending" or "operating" then a set of adjustments are made to the leakage vectors for the direct and indirect impacts.

Shock Vector

The shock vector is generated based on the information supplied by the user. As discussed in the preceeding sections, one of three subroutines, **shock_spending**, **shock_operating**, **shock_investment** generates the shock vector **shock_{%r}.**

If the option %shock is not "operating" then indirect commodity taxes are removed from the shock vector for each S-level commodity:

```
ftxi$_{%r}[c] = shock_{%r}[c] * (ctax[c] / (1+ctax[c])
```

These taxes become part of the "exogenous direct" impact of the shock. If the option %shock = "operating" then this procedure is not followed because the industry use matrix has already a portion of industry gross output to indirect taxes.

Ontario Impacts

The impact of tourism related events occurring in Ontario can be generated using a standard provincial input-output model (without feedback from the other provinces). The "ON" level of geography uses the subroutine **sr_region_on**.

Direct Impacts

The shock impacts for Ontario are generated from provincial S-level final demand vectors for consumption (fdc_c), residential investment (fdc_ir), business investment in machinery and equipment (fdc_ime) and structures (fdc_ic), government investment (fdc_ig) and current spending (fdc_g) and exports (fdc_x). The appropriate leakage vector is applied to all non-export final demand categories and then converted to an industry basis using the S-level technical requirements matrix to produce the direct impact vector **y_on**. The following formula shows the general transformation (excluding the removal of indirect taxes) from the final demand commodity shock to the industry-based direct impact expressed in IO base year dollars.

y_on = transpose(dmat) * ((i57-mleak) * (fdc_c+fdc_ir+fdc_ic+fdc_ime+fdc_ig+fdc_g) + fdc_x) * p_i[1999] / p_i[shock year]

The direct and indirect impacts for a variety of different concepts are generated by the subroutine **direct_impacts_1**. The concepts generated include: value added by industry (**dva_on**), indirect taxes (**dti_on**), subsidies (**dsub_on**), wages and salaries (**dws_on**), supplementary labour income (**dsli_on**), and mixed income (**dyo_on**). These impacts are simply generated by multiplying the diagonal primary input share matrices by the gross output vector.

```
dva_on = vmat * y_on
dti_on = timat * y_on
dsub_on = submat * y_on
dws_on = wsmat * y_on
dsli_on = slimat * y_on
dyo_on = yomat * y_on
```

The indirect tax impact can be further split among the federal, provincial and local levels of government. The size of the local government revenue impact depends on whether the user has chosen to consider just the impact from the change in economic activity or the total revenue that could be attributed to the local government from the shock. The key issue for local government impacts is that residential and nonresidential property taxes are not – in many instances – affected by changes in economic activity[1].

```
dtif_on = tifsh * dti_on
dtip_on = tipsh * dti_on
dtil_on = if %local="yes" then        tilsh1*dti_on
          or                          tilsh2*dti_on
```

The direct impacts on employment are a little more complicated to estimate. The model generates impacts for total employment (**de_on**) and the split between paid (**depd_on**) and unpaid workers (**deupd_on**). The impact on employment is adjusted for changes in productivity from the IO base year to the shock year.

```
de_on[i] = 1000000 * y_on[i] / (ioemp99[i,productivity] * (pr{%i}on[shock year] / pr{%i}on[1999] ))
depd_on[i] = de_on[i] * ioemp99[i,paid workers] / ioemp99[i,total employment]
deupd_on[i] = de_on[i] - depd_on[i]
```

Indirect Impacts

The direct and indirect impacts at the provincial level can now be generated and stored in the industry gross output vector: **xgo_on**.

```
xgo_on = inverse(i25-transpose(dmat)*(i57-mleak)*bmat) * y_on
```

The indirect impacts for a variety of different concepts are generated by the subroutine **indirect_impacts_1**. The concepts generated include: value added by industry (**xva_on**), indirect taxes (**xti_on**), subsidies (**xsub_on**), wages and salaries (**xws_on**), supplementary labour income (**xsli_on**), and mixed income (**xyo_on**). These impacts are simply generated by multiplying the diagonal primary input share matrices by the gross output vector.

```
xva_on = vmat * xgo_on
xti_on = timat * xgo_on
xsub_on = submat * xgo_on
xws_on = wsmat * xgo_on
xsli_on = slimat * xgo_on
xyo_on = yomat * xgo_on
```

The indirect tax impact can be further split among the federal, provincial and local levels of government. The size of the local government revenue impact depends on whether the user has chosen to consider just the impact from the change in economic activity or the total revenue that could be attributed to the local government from the shock. The key issue for local government impacts is that residential and nonresidential property taxes are not – in many instances – affected by changes in economic activity[2].

---

[1] Induced impacts that affect residential and nonresidential activity will influence property tax revenue under either assumption. Property taxes can be directly affected by changes in the region's industrial structure; i.e. adding – or subtracting – a business or industry. In contrast, changing the value of sales of existing businesses will not have a material impact on local property tax revenues.

[2] Induced impacts that affect residential and nonresidential activity will influence property tax revenue under either assumption. Property taxes can be directly affected by changes in the region's industrial

```
xtif_on = tifsh * xti_on
xtip_on = tipsh * xti_on
xtil_on = if %local="yes" then        tilsh1*xti_on
          or                          tilsh2*xti_on
```

The direct and indirect impacts on employment are a little more complicated to estimate. The model generates impacts for total employment (**xe_on**) and the split between paid (**xepd_on**) and unpaid workers (**xeupd_on**). The impact on employment is adjusted for changes in productivity from the IO base year to the shock year.

```
xe_on[i] = 1000000 * xgo_on[i] / (ioemp99[i,productivity] * (pr{%i}on[shock year] / pr{%i}on[1999] ))
xepd_on[i] = xe_on[i] * ioemp99[i,paid workers] / ioemp99[i,total employment]
xeupd_on[i] = xe_on[i] - xepd_on[i]
```

Induced Impacts

If desired, the model can generate impacts induced from the household or business sectors. The subroutine **induced_macro_1** collects the income terms from the direct and indirect impacts and determines their impact on household and business spending. The key driver for the household sector is the change in personal income from the direct and indirect impacts while the key driver for business investment is the change in GDP (or value added) in the economy from the direct and indirect impacts. These income terms must be converted from the IO base year (1999) to the Provincial Economic Accounts reference year (1997). Personal income is converted to 1997 dollars using the CPI for Ontario while GDP is converted using the chain-weighted GDP deflator for Ontario.

$$xywssl\_on = (\Sigma_i\, xws\_on[i] + \Sigma_i\, xsli\_on[i]) * cpi\_on[1997]/cpi\_on[1999]$$

$$xyp\_on = (\Sigma_i\, xws\_on[i] + \Sigma_i\, xsli\_on[i] + \Sigma_i\, xyo\_on[i]) * cpi\_on[1997]/cpi\_on[1999]$$

$$xgdp\_on = \Sigma_i\, xva\_on[i] * pgdp\_on[1997]/pgdp\_on[1999]$$

The resulting shocks to income are applied to the induced model equations for the year in which the shock is assumed to occur. The value for **xyp_on** is used to shock (add factor) the equation for disposable income while the value for **xgdp_on** is used to shock (add factor) the equation for business investment.

The user can also make alternative assumptions regarding the exogenous variables in the induced model system (set the option **%custom_macro** to either "hist" or "fcst"). In which case, the model is first solved with these changes made and then re-solved with those changes plus the shocks to income from the direct and indirect effects.

Solving the induced model equations yields impacts to household spending and business investment. These impacts are expressed in 1997 dollars and must be converted back to IO reference year dollars (1999).

$$xhhe\_on = \Delta\, hhe\_on[shock\ year] * cpi\_on[1999]/cpi\_on[1997]$$

$$xib\_on = \Delta\, ib\_on[shock\ year] * pgdp\_on[1999]/pgdp\_on[1997]$$

If the user elected not to include household induced effects in the simulation then they can be simply excluded by setting **xhhe_on** equal to zero at this time. Similarly, if the user elected not

---

structure; i.e. adding – or subtracting – a business or industry. In contrast, changing the value of sales of existing businesses will not have a material impact on local property tax revenues.

to include induced business investment effects in the simulation then they can be excluded by setting **xib_on** equal to zero.

The impacts from the induced effects model are now distributed among S-level commodities. The household spending impact is split between consumption of goods and services and residential investment. The business investment impact is split between non-residential construction and machinery and equipment investment. These values are then allocated to S-level commodities according to the purchasing patterns in the final demand table.

```
induced_c_on[i] = xhhe_on * c_on[shock year]/(c_on[shock year]+ir_on[shock year]) *
                  cmat[i,consumption]

induced_ir_on[i] = xhhe_on * ir_on[shock year]/(c_on[shock year]+ir_on[shock year]) *
                  cmat[i,residential investment]

induced_ic_on[i] = xib_on * ic_on[shock year]/(ic_on,[shock year]+ime_on[shock year]) *
                  cmat[i,non-residential construction]

induced_ime_on[i] = xib_on * ime_on[shock year]/(ic_on[shock year]+ime_on[shock year]) *
                  cmat[i,machinery and equipment]
```

The vector, **yi_on**, combines the impacts to each final demand sector, subjects them to import leakages, and converts them to the 25 S-level sectors in the technical requirements matrix.

```
yi_on = transpose(dmat) * (i57-mleak) *
        (induced_c_on+induced_ir_on+induced_ic_on+induced_ime_on)
```

Indirect tax revenue is also generated from final demand activity – both direct and induced. Each column in the matrix tishmat2 has the share of indirect taxes for a final demand category accruing to either the federal, provincial or local government.

The indirect tax revenue from the direct shock's final demand activity is generated as follows:

```
matrix ftif_on =
        fdc_c(52,1)*tishmat2(1,1)+fdc_ir(52,1)*tishmat2(2,1)+fdc_ime(52,1)*tishmat2(3,1)+fdc_ic(5
        2,1)*tishmat2(4,1)+fdc_ig(52,1)*tishmat2(5,1)+fdc_x(52,1)*tishmat2(6,1)
matrix ftip_on =
        fdc_c(52,1)*tishmat2(1,2)+fdc_ir(52,1)*tishmat2(2,2)+fdc_ime(52,1)*tishmat2(3,2)+fdc_ic(5
        2,1)*tishmat2(4,2)+fdc_ig(52,1)*tishmat2(5,2)+fdc_x(52,1)*tishmat2(6,2)
if %local="yes" then
   matrix ftil_on =
        fdc_c(52,1)*tishmat2(1,3)+fdc_ir(52,1)*tishmat2(2,3)+fdc_ime(52,1)*tishmat2(3,3)+fdc_ic(5
        2,1)*tishmat2(4,3)+fdc_ig(52,1)*tishmat2(5,3)+fdc_x(52,1)*tishmat2(6,3)
else
   matrix ftil_on =
        fdc_c(52,1)*tishmat2(1,4)+fdc_ir(52,1)*tishmat2(2,4)+fdc_ime(52,1)*tishmat2(3,4)+fdc_ic(5
        2,1)*tishmat2(4,4)+fdc_ig(52,1)*tishmat2(5,4)+fdc_x(52,1)*tishmat2(6,4)
endif
```

The indirect tax revenue from induced final demand activity is generated as follows:

```
fxtif_on = induced_c_on(52,1)*tishmat2(1,1)+induced_ir_on(52,1)*tishmat2(2,1)+
        induced_ime_on(52,1)*tishmat2(3,1)+induced_ic_on(52,1)*tishmat2(4,1)

fxtip_on = induced_c_on(52,1)*tishmat2(1,2)+induced_ir_on(52,1)*tishmat2(2,2)+
        induced_ime_on(52,1)*tishmat2(3,2)+induced_ic_on(52,1)*tishmat2(4,2)

if %local="yes" then

   fxtil_on = induced_c_on(52,1)*tishmat2(1,3)+induced_ir_on(52,1)*tishmat2(2,3)+
        induced_ime_on(52,1)*tishmat2(3,3)+induced_ic_on(52,1)*tishmat2(4,3)
```

```
else

    fxtil_on = induced_c_on(52,1)*tishmat2(1,4)+induced_ir_on(52,1)*tishmat2(2,3)+
        induced_ime_on(52,1)*tishmat2(3,3)+induced_ic_on(52,1)*tishmat2(4,3)

endif
```

The induced impacts at the provincial level can now be generated and stored in the industry gross output vector: **ixgo_on**.

```
ixgo_on = inverse(i25-transpose(dmat)*(i57-mleak)*bmat) * yi_on
```

As before, the induced impacts for a variety of different concepts are generated by the subroutine **induced_impacts_1**. These include: value added by industry (**ixva_on**), indirect taxes (**ixti_on**), subsidies (**ixsub_on**), wages and salaries (**ixws_on**), supplementary labour income (**ixsli_on**), and mixed income (**ixyo_on**). These impacts are simply generated by multiplying the diagonal primary input share matrices by the gross output vector.

```
ixva_on = vmat * ixgo_on
ixti_on = timat * ixgo_on
ixsub_on = submat * ixgo_on
ixws_on = wsmat * ixgo_on
ixsli_on = slimat * ixgo_on
ixyo_on = yomat * ixgo_on
```

The indirect tax impact from induced industry activity can – as before – be split among the federal, provincial and local levels of government.

```
ixtif_on = tifsh * ixti_on
ixtip_on = tipsh * ixti_on
ixtil_on = if %local="yes" then        tilsh1*ixti_on
           or                          tilsh2*ixti_on
```

The induced impacts on employment are estimated in the same way as they were for the direct and indirect impacts. The model generates impacts for total employment (**ixe_on**) and the split between paid (**ixepd_on**) and unpaid workers (**ixeupd_on**). The impact on employment is adjusted for changes in productivity from the IO base year to the shock year.

```
ixe_on[i] = 1000000 * ixgo_on[i] / (ioemp99[i,productivity] * (pr{%i}on[shock year] / pr{%i}on[1999] ))

ixepd_on[i] = ixe_on[i] * ioemp99[i,paid workers] / ioemp99[i,total employment]

ixeupd_on[i] = ixe_on[i] - ixepd_on[i]
```

The induced impacts are then augmented to reflect the infinite re-spending of income (generated by the induced impact) in the economy.

```
scalar induced_mult_{%r} = 1 / (1-@sum(@columnextract(ixva_{%r},1)) /
(@sum(@columnextract(xva_{%r},1)) + @sum(@columnextract(dxva_{%r},1))))
```

This scalar is then applied to the induced impacts generated above to produce the final induced impact.

Convert Impacts to "Shock Year Dollars"

The impacts generated from the preceeding steps are expressed in IO base year dollars. These impacts are converted to the same dollar basis as the year the shock takes place and collected in a set of matrices by the subroutine **impact_t3**.

Government Revenue Impacts

The subroutine **impact_tax_1** generates and stores the direct, indirect and induced government revenue impacts for each level of government and type of tax.

The econometric model is solved again to determine the direct tax revenue resulting from the induced economic activity.

$$ixywssl\_on = (\Sigma_i\ ixws\_on[i] + \Sigma_i\ ixsli\_on[i]) * cpi\_on[1997]/cpi\_on[1999]$$

$$ixyp\_on = (\Sigma_i\ ixws\_on[i] + \Sigma_i\ ixsli\_on[i] + \Sigma_i\ ixyo\_on[i]) * cpi\_on[1997]/cpi\_on[1999]$$

$$ixgdp\_on = \Sigma_i\ ixva\_on[i] * pgdp\_on[1997]/pgdp\_on[1999]$$

The impacts above are used to increase the baseline values for wages and salaries, personal income and GDP to determine the impact on each government revenue source for the direct, indirect and induced impacts.

Imports and Other Memo Items

The subroutine **impact_memo_3** generates and stores the direct, indirect and induced impacts on imports and allocates NAICS sector 72 among NAICS sectors 721 and 722.

Multi-Region Input-Output Model

If the geography for the shock is not the province, then the model will solve for impacts at the chosen sub-provincial level of geography. The regional model used for the provincial impact is then replaced with a multi-region input-output model. In this type of model demand from the rest of Ontario for the region's goods and services is endogenized. In order to do this, a multi-region model incorporates a set of origin-only inter-regional trade matrices.

The two-by-two region version of this model is reviewed in the figure below. The TREIM includes ***N***x***N*** versions of this model for each of the CD, CMA and TR geographies. A spending shock in region ***r***, Y(r), is evaluated to determine its impact both in region ***r*** and also in the rest of the province (RoP). The model assumes that there is no spending shock in the rest of the province; i.e. Y(RoP)=0. The **A** matrices on the main diagonal are the regional input coefficients that reflect both regional production technology and the share of each input supplied from within the region. The other **A** matrices are the trade coefficients that determine the amount of input ***i***

Multi-Region Input-Output Model

$$\left\{\begin{bmatrix} I & 0 \\ 0 & I\end{bmatrix} - \begin{bmatrix} A(r) & A(r,RoP) \\ A(RoP,r) & A(RoP)\end{bmatrix}\right\} \begin{bmatrix} X(r) \\ X(RoP)\end{bmatrix} = \begin{bmatrix} Y(r)\\ Y(RoP)\end{bmatrix}$$

Multi-region input-output structure

Assume: $Y(RoP)=0$

$$X(r) = \left[\left(I-A(r)\right) - A(r,RoP)\cdot\left(I-A(RoP)\right)^{-1}\cdot A(RoP,r)\right]^{-1}\cdot Y(r)$$

Impact on region 'r'

$$X(RoP) = \left(I-A(RoP)\right)^{-1}\cdot A(RoP,r)\cdot X(r)$$

Impact on Rest of Province

produced by firms in region ***r*** that are used to produce a unit of output of sector ***j*** in region ***s***. Solving the system yields the impact on region ***r***, X(r), and also on the rest of the province: X(RoP).

The following equations show how the model is operationalized in the TREIM. The first equation shows how to generate the impact on region ***r*** of a shock to that region. The second equation shows the impact on region ***s*** of the shock to region ***r***.

```
xgo_r = inverse(i25-transpose(dmat)*(i57-mleak_r)*bmat
        - transpose(dmat)*(i57-mleak_rs)*bmat
        * inverse(i25-transpose(dmat)*(i57-mleak_s)*bmat)
        * transpose(dmat)*(i57-mleak_sr)*bmat) * y_r

xgo_s = inverse(i25-transpose(dmat)*(i57-mleak_s)*bmat)
        * transpose(dmat)*(i57-mleak_sr)*bmat * xgo_r
```

The matrix **mleak_s** is import leakage matrix for the rest of the province and is calculated in the same way as the regional import proportion matrix. For example, at the Census Division level of geography the rest of province import proportion for a particular region and commodity is generated as follows, where the summations across CDs exclude the shock region.

$$mpro\_\{\%c\}\_\{\%cd\} = \Sigma_{cd}\ m\_\{\%c\}\_\{\%cd\} / (\Sigma_{cd}\ cdi\_\{\%c\}\_\{\%cd\} + \Sigma_{cd}\ cdf\_\{\%c\}\_\{\%cd\})$$

The matrix **mleak_rs** describes the proportion of a commodity used in the rest of the province and supplied by the shock region. The variable **xdom_{%c}_{%cd}** is commodity exports from the shock region to the rest of the province.

$$mprs\_\{\%c\}\_\{\%cd\} = xdom\_\{\%c\}\_\{\%cd\} / (\Sigma_{cd}\ cdi\_\{\%c\}\_\{\%cd\} + \Sigma_{cd}\ cdf\_\{\%c\}\_\{\%cd\})$$

The matrix **mleak_sr** describes the proportion of a commodity used in the shock region and supplied by the rest of the province. The variable **mdom_{%c}_{%cd}** is commodity imports from the rest of the province to the shock region.

```
mpsr_{%c}_{%cd} = mdom_{%c}_{%cd} / (cdi_{%c}_{%cd} + cdf_{%c}_{%cd})
```

The construction of the data used in these leakage matrices is discussed in the Data Construction section of this document.

Activity in the rest of the province (i.e. all regions other than ***r***) is generated by summing the impacts accros all the other regions.

Impact on Region of Shock to Region

The single region impact framework initially determines the economic impact on the region in which the spending (shock) took place. It next generates the impact on all other regions in the province to determine the total provincial impact.

Direct Impact

The model generates direct impacts in millions of IO-base year dollars.

```
matrix y_{%r} = @transpose(dmat_{%r})*(i57-ml_{%r}_direct)*(shock_{%r}-ftxi$_{%r}) *
@elem(pgdp_on,"1999")/@elem(pgdp_on,%year)
```

The commodity-based spending vector is converted to an industry basis and expressed in 1999 base year dollars: **y_{%r}**. Imports are removed from the direct impact using a leakages vector. If there are no imports then the total value of industry-basis direct impact will be the same as the commodity shock entered by the user. If, however, the shock includes commodities that are produced outside the region (i.e. a T-shirt made in China) then the value of that commodity is subtracted from the direct impact to the region.

Two adjustments are made to the direct impact. The shock is first adjusted to remove indirect taxes which are added back later as part of the "exogenous direct" impact. The "spending" shocks use a modified leakages vector that adjusts the economy-wide average leakages vector to more acurately reflect imports of tourism-related goods and services.

The gross output impact is used to generate impacts on other concepts (value added, wages and salaries, supplementary labour income, other income, indirect taxes, subsidies, employment) using the subroutine **direct_impacts_1**.

Indirect Impact

The indirect impacts in millions of IO-base year dollars, **xgo_{%r}**, are generated using a multi-region input-output model.

```
matrix xgo_{%r} = @inverse(i25-@transpose(dmat)*(i57-ml_{%r}_indirect)*bmat-
@transpose(dmat)*(mlrs_{%r})*bmat*@inverse(i25-@transpose(dmat)*(i57-
mlro_{%r})*bmat)*@transpose(dmat)*(mlsr_{%r})*bmat) * y_{%r}
```

The gross output impact is used to generate impacts on other concepts using the subroutine **indirect_impacts_1**.

Induced Impact

If desired, the model can generate impacts induced from the household or business sectors. The induced impacts are generated by first calling the subroutine **induced_macro_1**. This program takes the income measures from the direct and indirect impacts and shocks the econometric induced impacts model **m_treim**.

The key driver for the household sector is the change in personal income from the direct and indirect impacts while the key driver for business investment is the change in GDP (or value added) in the economy from the direct and indirect impacts. These income terms must be converted from the IO base year (1999) to the Provincial Economic Accounts reference year (1997). Personal income is converted to 1997 dollars using the CPI for Ontario while GDP is converted using the chain-weighted GDP deflator for Ontario. The key difference between the impact at the regional versus the provincial level of geography is an adjustment made to personal income to reflect the fact that some of the additional workers employed as a result of the shock may reside outside of the region in which the shock occurs (and therefore spend most of their income outside that region).

$$xyp\_r = (\Sigma_i\ xws\_r[i] + \Sigma_i\ xsli\_r[i] + \Sigma_i\ xyo\_r[i]) * (cpi\_on[1997]/cpi\_on[1999]) * .01 * \min(100,100/epowadj[\%r])$$

$$xgdp\_r = \Sigma_i\ xva\_r[i] * pgdp\_on[1997]/pgdp\_on[1999]$$

The resulting shocks to income are applied to the induced model equations for the year in which the shock is assumed to occur. The value for **xyp_r** is used to shock (add factor) the equation for disposable income while the value for **xgdp_r** is used to shock (add factor) the equation for business investment.

Any alternative assumptions regarding the exogenous variables in the induced model system made at the provincial level should be applied for the regional simulations as well. Again, the model is first solved with these changes made and then re-solved with those changes plus the shocks to income from the direct and indirect effects.

Solving the induced model equations yields impacts to household spending and business investment. These impacts are expressed in 1997 dollars and must be converted back to IO reference year dollars (1999).

```
xhhe_r = Δ hhe_r[shock year] * cpi_on[1999]/cpi_on[1997]
xib_r = Δ ib_r[shock year] * pgdp_on[1999]/pgdp_on[1997]
```

If the user elected not to include household induced effects in the simulation then they can be simply excluded by setting **xhhe_r** equal to zero at this time. Similarly, if the user elected not to include induced business investment effects in the simulation then they can be excluded by setting **xib_r** equal to zero.

The impacts from the induced effects model are now distributed among S-level commodities. The household spending impact is split between consumption of goods and services and residential investment. The business investment impact is split between non-residential construction and machinery and equipment investment. Regional spending for each of these final demand categories is generated using the region's share of spending applied to total provincial spending.

```
c_r = c_on * cx_{%r}
ir_r = ir_on * irx_{%r}
ic_r = ic_on * icx_{%r}
ime_r = ime_on * imex_{%r}
```

These values are then allocated to S-level commodities according to the purchasing patterns in the final demand table.

```
induced_c_r[i] = xhhe_r * c_r[shock year]/(c_r[shock year]+ir_r[shock year]) * cmat[i,consumption]
induced_ir_r[i] = xhhe_r * ir_r[shock year]/(c_r[shock year]+ir_r[shock year]) * cmat[i,residential
                  investment]
induced_ic_r[i] = xib_r * ic_r[shock year]/(ic_r,[shock year]+ime_r[shock year]) * cmat[i,non-
                  residential construction]
induced_ime_r[i] = xib_r * ime_r[shock year]/(ic_r[shock year]+ime_r[shock year]) *
                  cmat[i,machinery and equipment]
```

This model creates a set of final demand impacts which are distributed among the S-level input-output commodities and combined to produce the final demand vector **induced_{%r}**. This spending is converted to an industry basis as the vector **iy_{%r}**.

```
matrix iy_{%r} = @transpose(dmat) * (i57-ml_{%r}) * induced_{%r}
```

The induced shock is then put through the multi-region input-output model to generate the impact from the induced spending: **ixgo_{%r}**.

```
matrix ixgo_{%r} = @inverse(i25-@transpose(dmat)*(i57-ml_{%r})*bmat-
@transpose(dmat)*(mlrs_{%r})*bmat*@inverse(i25-@transpose(dmat)*(i57-
mlro_{%r})*bmat)*@transpose(dmat)*(mlsr_{%r})*bmat) * iy_{%r}
```

The gross output impact is used to generate impacts on other concepts using the subroutine **induced_impacts_1**. The induced impacts are then augmented to reflect the infinite re-spending of income (generated by the induced impact) in the economy.

```
scalar induced_mult_{%r} = 1 / (1-@sum(@columnextract(ixva_{%r},1)) /
(@sum(@columnextract(xva_{%r},1)) + @sum(@columnextract(dxva_{%r},1))))
```

This scalar is then applied to the induced impacts generated above to produce the final induced impact.

Convert Impacts to "Shock Year Dollars"

The impacts generated from the preceeding steps are expressed in IO base year dollars. These impacts are converted to the same dollar basis as the year the shock takes place and collected in a set of matrices by the subroutine **impact_t3**.

Government Revenue Impacts

The subroutine **impact_tax_1** generates and stores the direct, indirect and induced government revenue impacts for each level of government and type of tax.

Imports and Other Memo Items

The subroutine **impact_memo_3** generates and stores the direct, indirect and induced impacts on imports and allocates NAICS sector 72 among NAICS sectors 721 and 722.

Impact of Shock Region on all other Regions

After generating the impact of the shock on the region in which the shock originated, the program generates the impact of that shock on all other regions in the province. The sum of these impacts provides the total provincial impact.

Direct Impact

The model generates direct impacts in millions of IO-base year dollars. This is done by allocating the import leakages from the direct and induced impacts from the previous step to each other region in the province.

The first step is to determine the value of intraprovincial versus out-of-province imports from the direct and induced impact spending. A further adjustment to the induced impact spending is made to account for the spending by non-residents.

```
'# Direct Impact Leakages
matrix md_{%r} = (ml_{%r}_direct-mlx_{%r}_direct) * (shock_{%r}-ftxi$_{%r})

'# Induced Impact Leakages
matrix mi_{%r} = (ml_{%r}-mlx_{%r}) * induced_{%r}

'# Induced Impact non-resident employment adjustment
matrix zi_{%r} = ((epowadj_cd(!r)<100)*0+(epowadj_cd(!r)>100)*(.01*epowadj_cd(!r)-1)) *
induced_{%r}
```

The direct impact of the shock region on each other region is determined by allocating the intraprovincial imports of the shock region to all other regions in the province.

```
yx$(!c) = md_{%r}(!c)*morig_{%r}(!s,!c)
```

This impact is then converted from a commodity to an industry basis and expressed in 1999 base year dollars.

```
matrix y_{%r}_{%s} = @transpose(dmat_{%r})*(yx$) *
@elem(pgdp_on,"1999")/@elem(pgdp_on,%year)
```

The gross output impact is used to generate impacts on other concepts using the subroutine **direct_impacts_2**.

Indirect Impact

The direct and indirect impact of spending in region **r** on region **s** in millions of IO-base year dollars is generated using a multi-region input-output model.

```
matrix xgo_{%r}_{%s} = @inverse(i25-@transpose(dmat)*(i57-mlx_{%s}_indirect)*bmat) *
(@transpose(dmat)*(ml{%r}_{%s})*bmat*xgo_{%r} + y_{%r}_{%s})
```

The gross output impact is used to generate impacts on other concepts using the subroutine **indirect_impacts_2**.

Induced Impact

The induced impacts for the other regions are augmented by:

1. The impact from exports to region **r**:

```
iy1_{%r}_{%s}(!c) = mi_{%r}(!c)*morig_{%r}(!s,!c)
```

2. The impact from non-resident worker spending in the region:

```
iy2_{%r}_{%s}(!c) = zi_{%r}(!c)*morig_{%r}(!s,!c)
```

These impacts are allocated to all the other regions in the province.

The induced impacts are generated by calling the subroutine **induced_macro_2**. This program takes the income measures from the direct and indirect impacts and shocks the econometric induced impacts model **m_treim** to produce the final demand vector **ind_{%r}_{%s}**. To this is added the two factors discussed above (iy1_{%r}_{%s} and iy2_{%r}_{%s}) and the feedback from the induced spending in the shock region.

```
matrix ixgo_{%r}_{%s} = @inverse(i25-@transpose(dmat)*(i57-mlx_{%s})*bmat) *
(@transpose(dmat)*ml{%r}_{%s}*bmat*ixgo_{%r} + @transpose(dmat)*(i57-
mlx_{%s})*ind_{%r}_{%s} + @transpose(dmat)*iy1_{%r}_{%s} + @transpose(dmat)*(i57-
mlx_{%s})*iy2_{%r}_{%s})
```

The gross output impact is used to generate impacts on other concepts using the subroutine **induced_impacts_2**. The induced impacts are then augmented to reflect the infinite re-spending of income in the economy. The re-spending multiplier for each region is set equal to the re-spending multiplier from the shock region.

```
scalar induced_mult_{%s} = induced_mult_{%r}
```

This scalar is then applied to the induced impacts generated above to produce the final induced impact.

Convert Impacts to "Shock Year Dollars"

The impacts generated from the preceeding steps are expressed in IO base year dollars. These impacts are converted to the same dollar basis as the year the shock takes place and collected in a set of matrices by the subroutine **impact_regs**.

Government Revenue Impacts

The subroutine **impact_tax_2** generates and stores the direct, indirect and induced government revenue impacts for each level of government and type of tax.

Imports and Other Memo Items

The subroutine **impact_memo_2** generates and stores the direct, indirect and induced impacts on imports and allocates NAICS sector 72 among NAICS sectors 721 and 722.

Data Construction

This chapter describes how the data for the TREIM is constructed. Data must be constructed at the provincial, Census Division, Census Metropolitan Area, and Tourism Region levels of geography. This document provides information on the sources of the data used, the assumptions and the equations. The source data is stored in a series of Microsoft Excel spreadsheets. The data for these models can be constructed by running a set of EViews subroutines.

Ontario Provincial Data

The TREIM can be used to provide information at the provincial level of geography so a full set of models data must be developed at this level of geography. The Ontario data is also used to constrain data and drive trends at lower levels of geography.

S-Level Provincial Input-Output Data

The TREIM is constructed so as to be consistent with the current set of S-level input-output tables for Ontario published by Statistics Canada. The current model is constructed based upon the 1999 tables and interprovincial trade data.

The spreadsheet **on_1999s.xls** contains the make, use and final demand tables in separate sheets. The make and use tables are as published by Statistics Canada. The final demand table has been modified. The final demand categories have been collapsed to include the following: consumption, residential investment, non-residential construction investment, machinery and equipment investment, government investment, government spending on goods and services, inventory change, international exports, international imports and two additional columns from the interprovincial trade data: interprovincial exports and interprovincial imports.

The EViews subroutine, **EST_IO_ON**, reads in this data and constructs the set of matrices required to construct the data for the TREIM.

The S-level input-output system of accounts includes 57 commodities and 25 industries. The 57x25 make matrix is called **mmat**, the 57x25 use matrix is called **umat**, and the 57x11 final demand matrix is called **fmat**. The data for these matrices is read from **on_1999s.xls**.

Two identity matrices are required. One is 25x25 and the other 57x57. These are called **i25** and **i57** respectively in the program.

These matrices are used to create the following matrices and vectors:

- The make matrix is normalized by its row totals. The row totals are generated and stored in a vector, **dsum**, and used to create the matrix **dmat**.
- The make matrix is also normalized by its column totals. The column totals are generated and stored in the vector, **psum**, and these are used to create the matrix **pmat**.
- The use matrix is normalized by its column totals. The column totals are generated and stored in the vector, **bsum**, and are used to create the matrix **umat**.
- The final demand matrix is also normalized by its column totals. The column totals are generated and stored in the vector, **csum**, and are used to create the matrix **fmat**.
- A vector of total commodity demand by industry, **isum**, is created as the sum of rows in the use matrix.

- A vector of total commodity demand for final demand, **fsum**, is created as the sum of rows in the final demand matrix.
- A government services leakage vector, **gv**, is created for each row (or commodity). It takes government sector output (column 25 from the make matrix) and divides this by the sum of total industry and final demand plus international imports and interprovincial imports (columns 9 and 11 from the final demand matrix)[3].

  gv[c] = mmat[c,25] / (isum[c]+fsum[c]-fmat[c,9]-fmat[c,11])
- An import leakage vector, **mv**, is created for each row (or commodity). It divides total international and interprovincial imports (columns 9 and 11 from the final demand matrix) by the sum of total industry and final demand (with imports added back in). This denominator is adjusted to only include inventory changes for each commodity if they are positive. This resulting import leakage vector is adjusted so that values higher than 1 are converted to 1.

  mv[c] = min((fmat[c,9] + fmat[c,11]) / (isum[c]+fsum[c]-fmat[c,9]-fmat[c,11] – fmat[c,7] + max(fmat[c,7],0)), 1)
- The import leakage vector is converted into the diagonal matrix, **mleak**.

Provincial technical requirements matrices are constructed in the standard way. The standard matrix, $(I-D'B)^{-1}$, without leakages is called **trmat** and is calculated as follows:

```
qmat = transpose(dmat) * bmat
trmat = inverse(i25 – qmat)
```

The provincial technical requirements matrix with import leakages, $(I-D'(I-M)B)^{-1}$, is called **trmat_m** and is calculated as follows:

```
qmat = transpose(dmat) * (i57 – mleak) * bmat
trmat_m = inverse(i25 – qmat)
```

A value added matrix can be constructed as follows. The vector **vsum** is generated as the sum of primary commodities (rows 52 through 57) from the use matrix, **umat**, divided by total output by industry (i.e. the vector **bsum**). The vector **vsum** is then converted into a diagonal matrix called **vmat**. The value added impact matrix is then calculated:

```
vamat = trmat * vmat
```

A set of matrices for the primary inputs – S-level commodities 52 through 56 – is constructed by taking each of primary commodity rows from the use matrix, **umat**, and dividing by total output by industry (the vector **bsum**). The resulting vectors are then converted into a diagonal matrices called respectively: **timat**, **submat**, **wsmat**, **slimat**, and **yomat**.

Indirect taxes are then divided into federal, provincial and local. Matrices **tishmat1** and **tishmat2** are read from the **TI** sheet in **on_1999s.xls**. The columns in these matrices are used to create diagonal matrices. The federal share of indirect taxes by sector, **TIFSH**, is created from the first column of **tishmat1**. The provincial share of indirect taxes by sector, **TIPSH**, is created from the second column of **tishmat1**. The municipal share of indirect taxes by sector, **TILSH1**, is created from the third column of **tishmat1**. The municipal share of indirect taxes by sector excluding business and residential property taxes, **TILSH2**, is created from the fourth column of **tishmat1**.

---

[3] Imports are recorded as negative numbers in the input-output final demand table.

These matrices and vectors are used throughout the data generating process for the Census Division, Census Metropolitan Area, and Tourism Region geographies.

Provincial Economic Accounts

Data from the current Provincial Economic Accounts published by Statistics Canada is stored in the spreadsheet **PEA.xls**. The EViews subroutine, **DATA_PEA**, reads in some of this data and converts the chain weighted constant dollar data from a 1997 reference year to a 1999 reference year.

The reference year for the chain weighted constant dollar data in the Provincial Economic Accounts is 1997. Constant dollar data for consumption, residential investment, non-residential construction investment, machinery and equipment investment, government investment and government spending is converted to an index with a value of 1.0 in 1999 (consistent with the Input-Output table year) and then rebased to equal the relevant column totals from the final demand table in 1999.

Census Division Data

The economy of each of the 49 Census Divisions (CD) in Ontario must be represented with a technical requirements matrix incorporating import leakages from international, interprovincial and intraprovincial sources. This involves the creation of an information set describing economic activity in each CD.

Census Division Geography

The distance from one Census Division to another is generated using the EViews subroutine: **GEOGRAPHY_CD**. This program reads in data from the spreadsheet **Geography.xls**.

Average distances from the trucking survey are stored in the 49 by 49 matrix, **distance_raw**, read from the sheet **CD Distance**. The trucking data is based on a survey and distances represent average distance travelled[4] delivering commodities from one CD to another. Because the data is survey based, the distance from one CD to another can differ from the distance from that CD back. The final distance matrix, **distance_cd**, is constructed as the average of the upper diagonal and the lower diagonal and is symmetric with zeros on the diagonal.

For some origin-destination pairs, there was no trade recorded in the trucking database. An arbitrary value of 5,000 km was entered in these instances. This is about twice as far as the longest within-province shipment recorded in the database and, as such, reduces the probability of trade between these regions.

Industry Employment

Employment by industry for each of Ontario's CDs is generated using the EViews subroutine: **DATA_CD_EMPLOYMENT**. This program reads in data from the spreadsheet **CD_Employment.xls**.

The 2001 Census data for the number of recipients of wages and salaries, by NAICS sector and CD is stored in the sheet **CD Raw**. This information is read into the sheet **Census** and organized as a matrix with the 25 S-level industries in the rows and the Ontario provincial total and 49

[4] Data is the average of all commodities for years 1999 through 2002.

Census Divisions in the columns. The data from the Census sheet is read into the EViews workfile as a 22x49 matrix called **census_cd_emp**.

Most employment data is recorded based upon where the employee resides. This may not, however, coincide with where the employee works. The input-output framework provides an accounting of economic activity in a specific region. The TREIM must, therefore, estimate both production and demand within each region. The sheet **POW Adjustment** is from the 1996 Census and provides a multiplicative adjustment factor for each Census Division to convert residence-based employment estimates to place-of-work employment estimates. The place-of-work adjustment vector is read into the EViews workfile as a 49 element vector called **epowadj_cd**.

The sheet **IO 1999** provides various data for 1999 from Statistics Canada's Input-Output Division. It includes Ontario output, total and paid employment, output per worker, and the ratio of total to paid workers for the 25 S-level industries. The data from this sheet is read into the EViews workfile as a 25x5 matrix called **ioemp99**.

The sheet **CD Employment** provides Labour Force Survey basis employment data – both history and forecast – by industry in Ontario. This data is from the C_4SE's Provincial Economic Service. The data from this sheet is read in as 17 time series from 1987 through the forecast period. The mnemonics are elfs{%i}_on where {%i} is an industry number from 1 to 17.

The first step is to convert the Census recipients of wages and salaries data to total employment on a place-of-work basis for each CD and S-level industry. This data is stored in the matrix **on_emp_cd**.

> on_emp_cd[i,cd] = Total Employment Factor[i] * census_cd_emp[i,cd] * Place of work adjustment[cd]

The data in this matrix is adjusted to be consistent with the total sector employment data for Ontario in **ioemp99**. This adjustment involves dividing the elements in each column by the column totals (sum of CDs) and multiplying by the total employment figures in **ioemp99**.

The Ontario labour force employment series are used to create time series data for employment by CD and S-level industry. The 16 sectors from the C_4SE's Provincial Economic Service are mapped to the 25 S-level industries. This imperfect mapping means that employment for some S-level sectors will grow at the same rate as others that use the same, broader employment driver.

> e_{%i}_{%cd} = on_emp_cd[i,cd] * elfs{%i}_on / elfs{%i}_on[1999]

An adjustment is made to the LFS and Census data for Education, Health and Government Services to match the input-output sector definitions. The input-output data excludes public sector employment in the Education and Health sectors – these workers, and their output, are classified as part of Government Services. To compensate, 90% of education sector workers and 60% of health sector workers are moved from their LFS and Census categories over to public administration.

Finally a set of aggregate data is created by summing across industries and CDs.

Industry Output

The employment data created in the previous step is used to create output by industry for each Ontario CD. The EViews subroutine **DATA_CD_OUTPUT** creates this data. This program reads in data from an additional sheet in **CD_Employment.xls** called **ON Productivity**. The data in this sheet is a set of time series estimates of labour productivity by sector in Ontario from the C_4SE's Ontario Economic Service. The data from this sheet is read in as 14 time series from 1987 through the forecast interval. The mnemonics are pr{%i}on where {%i} is a two or three letter identifier for the industry sector.

Gross output in constant reference year 1999 dollars is generated for the 22 non-fictive industries for each CD. The 14 sectors from the C_4SE's Ontario Economic Service are mapped to the 25 S-level industries. This imperfect mapping means that productivity trends for some S-level sectors will grow at the same rate as others that use the same, broader productivity driver. Gross output is, therefore, simply employment times output per worker where the productivity growth estimates are benchmarked to the data from the 1999 input-output tables.

go_{%i}_{%cd} = e_{%i}_{%cd} * ioemp99[i,productivity] * pr{%i}on / pr{%i}on[1999] / 1000000

Total gross output for the province for each non-fictive sector is generated by summing across the 49 CDs.

Generating gross output for the three fictive sectors is a little more complicated because these sectors, by construction, have no employment (or value added) to the economy. Data, however, needs to be constructed because the TREIM needs to account for commodity supply and demand and these sectors both produce and consume various commodities.

The make matrix was used to determine which other industries produced the commodities supplied by each fictive industry.

Sector F1: Operating, Office, Cafeteria and Laboratory Supplies are assumed to be produced by:
- 85% Sector 3A: Manufacturing
- 15% Sector 41: Wholesale Trade

Sector F2: Travel & Entertainment, Advertising & Promotion are assumed to be produced by:
- 25% Sector 3A: Manufacturing
- 25% Sector 4B: Transportation and Warehousing
- 10% Sector 51: Information and Cultural Industries
- 15% Sector 54: Professional, Scientific and Technical Services
- 25% Sector 72: Accommodation and Food Services

Sector F3: Transportation Margins are assumed to be produced by:
- 100% Sector 4B: Transportation and Warehousing

Time series data for each sector by CD is created as an index with an initial value of 1 in 1987. The index is created by cumulating the weighted gross output growth rates for the sectors that are assumed to produce the fictive industry's output. The data is then benchmarked to the sector totals from the 1999 input-output tables.

Step 1: go_{%f}_{%cd} = go_{%f}_{%cd}[-1] * (1 + Σ_i α_i * %ch(go_{%i}_{%cd}))

Step 2: go_{%f}_{%cd} = ioemp[f,gross output] * (Σ_i α_i * go_{%i}_{%cd}[1999]) / go_{%f}_{%cd}[1999]

Total gross output for the province for each fictive sectors is generated by summing across the 49 CDs and total gross output by CD is generated by summing across S-level industries.

Consumption

Personal consumer spending on goods and services is estimated for each of Ontario's CDs. The EViews subroutine **DATA_CD_CONSUMPTION** creates this data. This program reads in data from the spreadsheet **CD_Consumption.xls**.

The sheet **Population CD** provides population data – both history and forecast – for CDs in Ontario. This data is from the C_4SE's Municipal Economic Service. The data from this sheet is read in as 50 time series from 1996 to 2007. The mnemonics are n_{%cd} where {%cd} is a Census Division identifier.

The sheet **Personal Income CD** provides personal income data – both history and forecast – for CDs in Ontario. This data is from the C_4SE's Municipal Economic Service. The data from this sheet is read in as 50 time series from 1996 to 2007. The mnemonics are yp$_{%cd} where {%cd} is a Census Division identifier.

Household spending is influenced by many factors. In deriving estimates of household spending across Ontario CD's, the TREIM considers first, the number of people living there and second, their income.

The share of Ontario's population resident in the CD acts as the starting point. These shares are then adjusted by an exponent equal to average per capita personal income in the region relative to the province itself raised to an exponent of value less than 1. This second exponent is to help account for higher savings rates in high income regions than in low income regions. A value of 0.7 for this second exponent yielded an unconstrained expenditure share (Step 1) total of approximately 1 for the years 1996 through 2007. Generated consumption shares by CD therefore lie between the region's population share and its share of personal income.

Step 1: cx_{%cd} = ((1 + (n_{%cd}/n_on)) exp(((yp$_{%cd}/n_{%cd}) / (yp$_on/n_on))$^{0.7}$) – 1)

The Step 1 consumption shares are normalized to equal one by dividing the Step 1 values by their sum across CDs.

This approach implies that, for example, although Toronto's (Census Division) share of the provinces population was 21.8% in 2000 and its share of provincial personal income was 23.1%[5] its share of personal expenditure in 2000 is estimated to be 22.8%. Toronto's share of provincial personal expenditure on goods and services in 2000 generated using this approach lies between the region's population and income shares.

Residential Construction Investment

Residential construction investment is estimated for each of Ontario's CDs. The EViews subroutine **DATA_CD_RESIDENTIAL** creates this data. This program reads in data from the spreadsheet **Data_Investment.xls**.

The sheet **Permits CD** provides residential building permits data from 1995 to 2002 for CDs in Ontario. The data from this sheet is read in as 50 time series. The mnemonics are bp$_{%cd} where {%cd} is a Census Division identifier.

Residential construction investment estimates for each CD are obtained from the residential building permits data. The building permits data is transformed into weighted moving averages through time reflecting the fact that not all activity associated with a given permit occurs during the calendar year the permit is issued. The share of the region's weighted building permits is then generated and used as an estimate of the region's share of residential construction activity.

irx_{%cd} = (0.5*bp$_{%cd}+0.5*bp$_{%cd}[-1]) / (0.5*bp$_on+0.5*bp$_on[-1])

[5] Per capita personal income was $32,600 in 2000 in Toronto versus $30,800 for the province.

Non residential Business Investment

Non-residential investment is estimated for each of Ontario's CDs. The EViews subroutine **DATA_CD_NONRESIDENTIAL** creates this data. This program reads in data from the spreadsheet **Data_Investment.xls**.

The sheet **Capital-Output Ratio** provides estimates of the capital-output ratio by sector in Ontario. This data is from the C_4SE's Ontario Economic Service. The data from this sheet is read in as 14 time series from 1991 through the forecast period. The mnemonics are kg{%i}on where {%i} is a two or three letter industry sector identifier.

The sheet **Depreciation Rates** provides estimates of the trend depreciation rates by sector in Ontario. This data is from the C_4SE's Ontario Economic Service. The data from this sheet is read in as 14 time series from 1991 through the forecast period. The mnemonics are rdk{%i}ton where {%i} is a two or three letter industry sector identifier.

The sheet **Construction Shares** provides estimates of the share of non-residential construction of total non-residential business investment by sector in Ontario. This data is from the C_4SE's Ontario Economic Service. The data from this sheet is read in as 14 time series from 1991 through the forecast period. The mnemonics are i{%i}cson where {%i} is a two or three letter industry sector identifier.

An estimate of raw capital stock data by sector and CD is generated by multiplying the capital-output ratio by next year's gross output times the value added share for the sector (stored in the vector **vsum**). The 25 S-level industries are mapped into the 14 sectors for which capital-output ratios are available. This means that data for several S-level industries are aggregated to provide an appropriate output series for some capital-output ratios.

```
kraw_{%i}_{%cd} = kg{%i}on * go_{%i}_{%cd}[+1] * vsum[i]
```

This capital stock estimate cannot be used reliably. It, in principal, includes shifts in capacity utilization rates for the sector's capital stock which adjust more rapidly to shifting economic conditions than the actual capital stock. To help account for these shifts in utilization rates a new, smoothed, capital stock series is generated using the Hodrick-Prescott filter.

```
k_{%i}_{%cd} = HP(kraw_{%i}_{%cd})
```

Investment by industry sector and CD is generated using the familiar identity:

```
i_{%i}_{%cd} = d(k_{%i}_{%cd}) + rdk{%i}ton * k_{%i}_{%cd}[-1]
```

Non-residential construction and Machinery and equipment investment are generated using the construction share estimates:

```
ic_{%i}_{%cd} = i{%i}cson * i_{%i}_{%cd}
ime_{%i}_{%cd} = i_{%i}_{%cd} – ic_{%i}_{%cd}
```

The non-residential construction and machinery and equipment investment estimates are summed across the 13 sectors[6] to generate two non-residential business investment series for each CD. These series are further summed across CDs to generate an unconstrained provincial total which is used to generate investment shares for each CD.

```
icx_{%cd} = ic_{%cd} / ic_sum
```

[6] Public sector investment is dropped since this is generated independently.

imex_{%cd} = ime_{%cd} / ime_sum

Government Investment

Government investment is estimated for each of Ontario's CDs. The EViews subroutine **DATA_CD_GOVINV** creates this data. Government investment within each CD is generated by generating as a function of both the region's share of provincial population and LFS public sector employment.

The share of Ontario's population resident in the CD acts as the starting point. These shares are then adjusted by an exponent equal to the share of public sector employment in the region itself raised to an exponent of value less than 1. This second exponent ensures that public sector investment flows to regions to support (1) the local population and (2) the public sector workforce. A value for this exponent of 0.2 leads to an unconstrained expenditure share total of close to 1 for the years 1996 through 2007. Finally, the resulting "shares" are normalized to equal one.

Step 1: igx_{%cd} = ((1 + (n_{%cd}/n_on)) exp(((e_gs_{%cd}/e_{%cd}) / (e_gs_on/e_on))$^{0.2}$) – 1)

The Step 1 government investment shares are normalized to equal one by dividing the Step 1 values by their sum across CDs.

This approach implies that each region's share of provincial government investment lies between the region's population and public sector employment shares.

Government Spending

Government spending on current goods and services is estimated for each of Ontario's CDs. The EViews subroutine **DATA_CD_GOVT** creates this data. Government spending within each CD is simply generated using that region's share of LFS public sector employment.

gx_{%cd} = e_gs_{%cd} / e_gs_on

Commodity Flows

The EViews subroutine, **DATA_CD_COMMODITY**, generates estimates of S-level commodity flows at the Census Division level in Ontario. This program generates information for three flows: total commodity production, total commodity demand by industry, and total commodity demand from domestic sources[7].

Commodity Production

The CD level industry output estimates are combined with information from the Ontario make matrix to determine the amount of each S-level commodity produced in the region. The make matrix is normalized by the commodity row totals (**pmat**) and then multiplied by the industry output vector for each CD to yield a commodity output vector.

cs_{%c}_{%cd} = Σ_i pmat[c,i] * go_{%i}_{%cd}

Total provincial production of each commodity is generated by summing this data across CDs.

[7] This is the sum of consumption, total public and private investment, and government spending.

Commodity Intermediate Demand

The amount of each commodity demanded by industries in a region is called intermediate industry demand. Commodity intermediate demand within each CD is generated in a similar way to commodity production. The Ontario use matrix must be normalized by the industry column totals (**bmat**). This matrix is then multiplied by the industry output vector for each CD to yield the amount of each commodity demanded by industry in the region.

```
cdi_{%c}_{%cd} = Σi bmat[c,i] * go_{%i}_{%cd}
```

Commodity Final Domestic Demand

The amount of final domestic demand for each commodity within each CD is generated using total demand in the province from that sector, the CD's share of that demand, and the Ontario final demand matrix. The Ontario final demand matrix is normalized by the category column totals (**cmat**).

```
cdf_{%c}_{%cd} = c_on * cx_{%cd} * cmat[c,consumption] +
                 ir_on * irx_{%cd} * cmat[c,residential investment] +
                 icx_on * icx_{%cd} * cmat[c,non-residential construction] +
                 ime_on * imex_{%cd} * cmat[c,machinery & equipment investment] +
                 ig_on * igx_{%cd} * cmat[c,government investment] +
                 g_on * gx_{%cd} * cmat[c,government spending]
```

Commodity Net Exports

Commodity net exports for each CD are generated as the difference between production and industry plus final domestic demand.

```
nx_{%c}_{%cd} = cs_{%c}_{%cd} - cdi_{%c}_{%cd} - cdf_{%c}_{%cd}
```

Exports

Commodity exports are for each CD are defined as sales of goods or services to any buyer outside that CD. The EViews subroutine **DATA_CD_EXPORTS** creates this data. This program reads in data from the spreadsheet **Data_Exports.xls**.

The input-output system of accounts equates commodity supply and demand in a region. Exports are assumed to be a function of output. The proportion of a commodity supplied by producers from within region is called the regional supply proportion (RP). This concept, while not used by the modelling framework, provides useful information and is used to review the impact of alternative assumptions for export behaviour.

```
m_{%c}_{%cd} = cdi_{%c}_{%cd} + cdf_{%c}_{%cd} + x_{%c}_{%cd} – cs_{%c}_{%cd}

rp_{%c}_{%cd} = (cs_{%c}_{%cd} – x_{%c}_{%cd}) / (cs_{%c}_{%cd} – x_{%c}_{%cd} -
                m_{%c}_{%cd})
```

In order to operationalise the above equations we must produce estimates of commodity exports by region. Exports are assumed to be a function of production. In particular, they are a fixed proportion of production in the region. The proportion α will vary by commodity, by region and by level of geography. The determination of α is one of the most critical assumptions in the model. No single approach can be used to determine α for each commodity and geography, instead a series of estimates must be developed and the most desirable one selected for use by the model.

The EViews program begins by reading in a set of assumptions regarding exports for each commodity and adjustments to for each CD. The data from sheet **A1** is used to populate the matrix **xp_assumption_1**. This matrix is 2 rows by 51 columns. Each column represents two parameters for each S-level commodity. Data from sheet **CD** is used to populate the 49 element vector **xp_assumption_cd**. Each element in this matrix represents an export adjustment coefficient for each CD.

An Ontario exports vector, **xv**, is created for each row (or commodity) from the Ontario input-output tables. It is calculated as the minimum of international and interprovincial exports (columns 8 and 10 from the final demand matrix) divided by total production of each commodity from vector **dsum** or one.

```
xv[c] = min( ((fmat[c,8]+fmat[c,10]) / dsum[c]) , 1)
```

A set of location quotients (LQ) are created for each commodity and CD. The location quotient is a measure of the degree to which a particular region specializes in the production of a commodity.

```
lq_{%c}_{%cd} = (cs_{%c}_{%cd} / cs_{%cd}) / (cs_{%c}_on / cs_on)
```

A location quotient value of 1 indicates the region produces the commodity in the same proportion as the province. Values greater than 1 indicate the region specializes in production of the commodity while values less than 1 indicate that other regions produce the commodity and this region may need to import it.

The average value from 1991 to 2002 for each location quotient is generated and stored in a 49 by 51 matrix called **lq_mat_cd**. Values for commodities 49 (non-competing imports) and 50 (unallocated imports and exports) are set to 0 because they are not produced in Ontario.

Estimates of commodity exports by CD are generated using the location quotients and assumptions as a set of proportions which are calculated and stored in the matrix **xp_cd**. The coefficients in the first column of the matrix **xp_assumption_1** provide an asymptotic maximum value for the export share of production for each commodity[8]. The asymptotic maximums are raised or lowered for each CD based on the assumptions in the vector **xp_assumption_cd**. The coefficients in the second column of the matrix **xp_assumption_1** provide threshold values for commodity exports. If the location quotient is less than the threshold value then the region sells all its production locally. Raising the value of this coefficient ensures that a higher proportion of goods and services are sold locally[9]. The denominator in the exponent for this equation is adjusted by the positive scalar, **xfactor**, which ensures that the exponent takes on a value of less than 1. Setting **xfactor** to a small value raises the value of the exponent (towards an asymptotic maximum of 1) which is applied to the maximum export share for that commodity and CD.

```
if lq_mat_cd[cd,c]>xp_assumption_1[c,2]:
        xp_cd[cd,c] = (1 + max(xp_assumption_1[c,1] + xp_assumption_cd[cd],0)) *
        exp((lq_mat_cd[cd,c] - xp_assumption_1[c,2]) /
        (lq_mat_cd[cd,c]) - xp_assumption_1[c,2]+zz)) - 1
else:   xp_cd[cd,c] = 0
```

[8] These coefficients can take on values between, and including, 0 and 1. A region with a high location quotient will export nearly this proportion of its output.

[9] This coefficient must be positive.

Exports are calculated as a share of production.

```
x_{%c}_{%cd} = xp_cd[cd,c] * cs_{%c}_{%cd}
```

An exception to this formula is followed for commodity 34 (Other Utilities). In this case exports are set equal to net exports if they are positive.

```
If nx_{%c}_{%cd}>0:   x_{%c}_{%cd} = nx_{%c}_{%cd}
else:                 x_{%c}_{%cd} = 0
```

Finally, total exports (including intraprovincial shipments) are calculated for each commodity.

Imports

Commodity imports are for each CD are generated be the EViews subroutine **DATA_CD_IMPORTS**. The commodity flow identity discussed previously can now be generated along with a set of import proportions.

```
m_{%c}_{%cd} = cdi_{%c}_{%cd} + cdf_{%c}_{%cd} + x_{%c}_{%cd} – cs_{%c}_{%cd}
mp_{%c}_{%cd} = m_{%c}_{%cd} / (cdi_{%c}_{%cd} + cdf_{%c}_{%cd})
```

The average values from 1996 to 2002 for these import proportions are stored in the 49 by 51 matrix **mp_cd**. Values less than zero are converted to zeros. Values for commodties 29, 30, 31, 37, 45, 46, 47 and 48 are set to zero. These commodities are not traded.

Finally, total imports (including intraprovincial shipments) are calculated for each commodity.

Regional Trade Flows

The EViews subroutines, **DATA_CD_TRADE1** and **DATA_CD_TRADE2**, generate commodity trade flows among Census Divisions in Ontario. This program reads in data from the spreadsheet **CD_Truck.xls**.

Goods Flows

Three matrices are read from **CD_Truck.xls** describing commodity shipments from each Census Division in Ontario (exports). The matrix **truck_cd_xtot** describes total shipments by SCTG[10] commodity from Ontario CDs. The matrix **truck_cd_xusa** describes shipments by SCTG commodity from Ontario CDs to the United States. The matrix **truck_cd_xroc** describes shipments by SCTG commodity from Ontario CDs to other provinces in Canada. The matrix **truck_cd_xrop** can then be constructed:

```
truck_cd_xrop = truck_cd_xtot – truck_cd_xusa – truck_cd_xroc
```

This matrix describes shipments by SCTG commodity from an Ontario CD to the sum of all other Ontario CDs – i.e. intraprovincial trade.

Next, a set of 49 matrices are read from **CD_Truck.xls**. These summarize SCTG commodity shipments from a single CD to each of the other CDs in Ontario. These 43 by 49 matrices are called **truck_cd_{%cd}**.

[10] The commodities in the trucking database are reported according to the Standard Classification of Transported Goods (SCTG) at the 2-digit level of detail. This classification includes 43 categories and corresponds approximately to the S-level input-output commodity classification.

A new set of matrices are constructed by mapping the SCTG commodities to input-output S-level commodities. The 51 by 49 matrix **xdom_cd** represents the proportion of each S-level commodity shipped from an Ontario CD destined for another CD in Ontario.

```
xdom_cd[c,cd] = truck_cd_xrop[sctg,cd] / truck_cd_xtot[sctg,cd]
```

A set of 51 by 49 matrices are constructed as the proportion of each S-level commodity shipped from a specific CD to the other CDs in Ontario: **xdest_{%cd}**. Commodity shipments within a CD are set to zero. These matrices define the trading relationships between CDs in Ontario.

```
xdest_{%cd}[c,destination] = truck_cd_{%cd}[sctg,destination] /
                             Σ_destination truck_cd_{%cd}[sctg,destination]
```

Service Flows

The trucking database provided information on shipments of goods in Ontario. Trade in services must, however, be estimated using an alternate approach.

The share of service exports[11] from each CD to the rest of the province as a proportion of exports to all destinations is generated and placed in the matrix **xdom_cd**. The estimate is based on total commodity exports generated earlier and out-of-province exports from Statistics Canada's input-output and interprovincial trade data. At present, all regions are assumed to export the same share of a commodity to out-of-province destinations.

```
xdom[c,cd] = ( x_{%c}_on[1999] – fmat[c,international exports] – fmat[c,interprovincial exports] ) /
             x_{%c}_on[1999]
```

Service exports from one CD to another in Ontario are estimated using a gravity model approach. The distance from one CD to another is derived from the trucking database and is modified by a commodity specific friction factor. This is multiplied by shipments from the region and demand in the destination region. This calculation is then divided by the sum across destination regions of the distance and friction factors times demand in the other regions.

```
xdest_{%cd}[c,destination] = (1 / distance[cd,destination] * exp(friction[c]) ) *
                             cs_{%c}_{%cd}[1999] *
                             (cdi_{%c}_{%destination}[1999]+ cdf_{%c}_{%destination}[1999]) /
                             Σ_destination ( (1 / distance[cd,destination] * exp(friction[c]) ) *
                             (cdi_{%c}_{%destination}[1999]+ cdf_{%c}_{%destination}[1999]) )
```

The friction factor adjusts the importance of distance in determining trade flows. Setting the friction factor equal to zero means that distance plays no role in the trade flow. The greater the friction factor, the more that distance will determine the degree of trade between two regions.

Finally, the resulting measures are normalized so as to sum to one across destinations for each commodity. This calculation completes the trading relationship between CDs in Ontario.

Intraprovincial Exports

A time series of domestic exports, i.e. shipments destined for other CDs in Ontario, can now be generated for all S-level commodities. The provincial total is also generated by summing across CDs.

```
xdom_{%c}_{%cd} = x_{%c}_{%cd} * xdom_cd[c,cd]
```

---

[11] Services are defined as the following S-level commodities: 8, 32, 33, 34, 35, 36, 38, 39, 40, 41, 42, 43, 44, and 51.

Intraprovincial Imports

Imports from other CDs in Ontario are generated by summing domestic exports from each other CD in the province destined for that particular CD.

mdom_{%c}_{%cd} = Σ_{origin} (x_{%c}_{%origin} * xdest_{%origin}[c,cd])

Regional Trade Matrices

Three 49 by 51 regional trade matrices at the Census Division level for S-level commodities are constructed for the TREIM by the subroutine **DATA_CD_TRADE2**. These matrices augment the matrix **mp_cd** generated earlier. The elements in the matrices are constructed as the averages from 1996 to 2002 of the following time series.

The series **mpro_{%c}_{%cd}** is the rest of province import proportion for a particular region and commodity is generated as follows, where the summations across CDs exclude the region. This is analogous to the **mp_{%c}_{%cd}** series generated earlier where the rest of the province is now treated as the region. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mpro_cd**.

mpro_{%c}_{%cd} = Σ_r m_{%c}_{%cd} / (Σ_r cdi_{%c}_{%cd} + Σ_r cdf_{%c}_{%cd})

The series **mprs_{%c}_{%cd}** describes the proportion of a commodity used in the rest of the province and supplied by the region. Again, the summation across CDs excludes the region. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mprs_cd**.

mprs_{%c}_{%cd} = xdom_{%c}_{%cd} / (Σ_r cdi_{%c}_{%cd} + Σ_r cdf_{%c}_{%cd})

The series **mpsr_{%c}_{%cd}** describes the proportion of a commodity used in the region and supplied by the rest of the province. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mpsr_cd**.

mpsr_{%c}_{%cd} = mdom_{%c}_{%cd} / (cdi_{%c}_{%cd} + cdf_{%c}_{%cd})

The elements for S-level commodities 29, 30, 31, 37, 45, 46, 47, and 48 are zero since no trade in these commodities is allowed.

Census Metropolitan Area Data

The economy of each of the 14 Census Metropolitan Areas (CMA) in Ontario must be represented with a technical requirements matrix incorporating import leakages from international, interprovincial and intraprovincial sources. This involves the creation of an information set describing economic activity in each CMA. The approach taken to creating each part of this information set is similar to that adopted in creating the Census Division data. Differences between the approaches will be discussed in the following sections.

Census Metropolitan Area Geography

A matrix is used to map data from Census Divisions to Census Metropolitan Areas. The 49 by 14 matrix includes the proportion of the labour force for each CD that is located in each CMA from the 2001 Census. The EViews subroutine **GEOGRAPHY_CMA** creates the matrices **map_cma** and **map_cma2** from the sheet **CMA** in the spreadsheet **geography.xls**.

A 15 by 15 distance matrix from CMA to CMA and CMA to rest of province is created by reading raw data from the sheet **CMA Distance** in the spreadsheet **geography.xls**. This creates the matrix **distance_raw** which, following the same procedure as the CD distance matrix, is used to create the distance matrix **distance_cma**.

Industry Employment

Employment by industry for each of Ontario's CMAs is generated using the EViews subroutine: **DATA_CMA_EMPLOYMENT**. This program read in data from the spreadsheet **CMA_Employment.xls**.

The 2001 Census data for the number of recipients of wages and salaries, by NAICS sector and CMA is stored in the sheet **CMA Raw**. This information is read into the sheet **Census** and organized as a matrix with the 25 S-level industries in the rows and the Ontario provincial total and 14 Census Metropolitan Areas in the columns. The data from the Census sheet is read into the EViews workfile as a 14x49 matrix called **census_cma_emp**.

Most employment data is recorded based upon where the employee resides. This may not, however, coincide with where the employee works. The input-output framework provides an accounting of economic activity in a specific region. The TREIM must, therefore, estimate both production and demand within each region. The sheet **POW Adjustment** is from the 1996 Census and provides a multiplicative adjustment factor for each Census Division to convert residence-based employment estimates to place-of-work employment estimates. The place-of-work adjustment vector is read into the EViews workfile as a 14 element vector called **epowadj_cma**.

The sheet **CMA Employment** provides Labour Force Survey basis employment data – both history and forecast – by industry for selected CMAs in Ontario. This data is from the C_4SE's Provincial Economic Service. The data from this sheet is read in from 1987 to the end of the forecast period. The mnemonics are elfs{%i}_{%cma} where {%i} is an industry number from 1 to 17 and {%cma} is a CMA identifier[12].

Census employment data for Ottawa-Carleton, Brantford, Guelph and Barrie was not included in the original 2001 Census data. Data for these CMAs was constructed using the CD-level data and the CD-CMA concordance map.

census_cma_emp[i,cma] = Σ_{cd} census_cd_emp[i,cd] * map_cma[cd,cma]

The Census recipients of wages and salaries data must now be converted to a total employment on a place-of-work basis for each CMA and S-level industry. This data is stored in the matrix **on_emp_cma**.

on_emp_cma[i,cma] = Total Employment Factor[i] * census_cma_emp[i,cma] * Place of work adjustment[cma]

The data in this matrix is adjusted to be consistent with the total sector employment data for Ontario in **ioemp99**. This adjustment involves dividing the elements in each column by the total from the sum of CDs and multiplying by the total employment figures in **ioemp99**.

The Ontario labour force employment series are used to create time series data for employment by CMA and S-level industry. Again, the 16 sectors from the C_4SE's Provincial Economic Service are mapped to the 25 S-level industries. This imperfect mapping means that employment

[12] Employment by sector data was available for the following CMAs: Ottawa-Gatineau, Toronto, Hamilton, St.Catherines-Niagara, Kitchener, London, Windsor.

for some S-level sectors will grow at the same rate as others that use the same, broader employment driver. Where available from the C_4SE's Provincial Economic Service, the employment estimates for each CMA are used to generate the time series estimates:

```
e_{%i}_{%cma} = on_emp[i,cma] * elfs{%i}_{%cma} / elfs{%i}_{%cma}[1999]
```

When CMA estimates are not available, the provincial totals are used:

```
e_{%i}_{%cma} = on_emp[i,cma] * elfs{%i}_on / elfs{%i}_on[1999]
```

Finally a set of aggregate data for each CMA is created by summing across industries.

Industry Output

The employment data created in the previous step is used to create output by industry for each Ontario CMA. The EViews subroutine **DATA_CMA_OUTPUT** creates this data. The approach and calculations used to generate this data are similar to those used to create the CD level data.

Gross output in constant reference year 1999 dollars is generated for the 22 non-fictive industries for each CMA. The 14 sectors from the C_4SE's Ontario Economic Service are mapped to the 25 S-level industries. This imperfect mapping means that productivity trends for some S-level sectors will grow at the same rate as others that use the same, broader productivity driver. Gross output is, therefore, simply employment times output per worker where the productivity growth estimates are benchmarked to the data from the 1999 input-output tables.

```
go_{%i}_{%cma} = e_{%i}_{%cma} * ioemp99[i,productivity] * pr{%i}on / pr{%i}on[1999] / 1000000
```

Generating gross output for the three fictive sectors is a little more complicated because these sectors, by construction, have no employment (or value added) to the economy. Data, however, needs to be constructed because the TREIM needs to account for commodity supply and demand and these sectors both produce and consume various commodities.

The make matrix was used to determine which other industries produced the commodities supplied by each fictive industry.

Sector F1: Operating, Office, Cafeteria and Laboratory Supplies are assumed to be produced by:
- 85% Sector 3A: Manufacturing
- 15% Sector 41: Wholesale Trade

Sector F2: Travel & Entertainment, Advertising & Promotion are assumed to be produced by:
- 25% Sector 3A: Manufacturing
- 25% Sector 4B: Transportation and Warehousing
- 10% Sector 51: Information and Cultural Industries
- 15% Sector 54: Professional, Scientific and Technical Services
- 25% Sector 72: Accommodation and Food Services

Sector F3: Transportation Margins are assumed to be produced by:
- 100% Sector 4B: Transportation and Warehousing

Time series data for each sector by CMA is created as an index with an initial value of 1 in 1987. The index is created by cumulating the weighted gross output growth rates for the sectors that are assumed to produce the fictive industry's output. The data is then benchmarked to the sector totals from the 1999 input-output tables.

```
Step 1: go_{%f}_{%cma} = go_{%f}_{%cma}[-1] * (1 + Σi αi * %ch(go_{%i}_{%cma}))

Step 2: go_{%f}_{%cma} = ioemp[f,gross output] * (Σi αi * go_{%i}_{%cma}[1999]) /
go_{%f}_{%cma}[1999]
```

Total gross output by CMA is generated by summing across S-level industries.

Consumption

Personal consumer spending on goods and services is estimated for each of Ontario's CMAs. The EViews subroutine **DATA_CMA_CONSUMPTION** creates this data. This program reads in data from the spreadsheet **CMA_Consumption.xls**.

The sheet **Population CMA** provides population data – both history and forecast – for CMAs in Ontario. This data is from the C_4SE's Municipal Economic Service. The data from this sheet is read in as 14 time series from 1996 to the end of the forecast period. The mnemonics are n_{%cma} where {%cma} is a Census Metropolitan Area identifier.

Personal income data for each CMA is constructed using the CD-level data and the CD-CMA concordance map.

> yp$_{%cma} = Σ_{cd} yp$_{%cd} * map_cma[cd,cma]

The share of Ontario's population resident in the CMA again acts as the starting point. These shares are then adjusted by an exponent equal to average per capita personal income in the region relative to the province itself raised to an exponent of 0.7. This second exponent is to help account for higher savings rates in high income regions than in low income regions. Generated consumption shares by CMA therefore lie between the region's population share and its share of personal income.

> Step 1: cx_{%cma} = ((1 + (n_{%cma}/n_on)) exp(((yp$_{%cma}/n_{%cma}) / (yp$_on/n_on))$^{0.7}$) – 1)

The Step 1 consumption shares are normalized to equal one by dividing the Step 1 values by the unconstrained sum across CDs.

Residential Construction Investment

Residential construction investment is estimated for each of Ontario's CMAs. The EViews subroutine **DATA_CMA_RESIDENTIAL** creates this data.

Residential construction investment estimates for each CMA are obtained from the CD estimates and the CD-CMA concordance map.

> irx_{%cma} = Σ_{cd} irx_{%cd} * map_cma[cd,cma]

Non residential Business Investment

Non-residential investment is estimated for each of Ontario's CMAs. The EViews subroutine **DATA_CMA_NONRESIDENTIAL** creates this data. The process for generating the CMA level data is the same as that used at the CD level of geography.

An estimate of raw capital stock data by sector and CMA is generated by multiplying the capital-output ratio by next year's gross output times the value added share for the sector (stored in the vector **vsum**). The 25 S-level industries are mapped into the 14 sectors for which capital-output ratios are available. This means that data for several S-level industries are aggregated to provide an appropriate output series for some capital-output ratios.

> kraw_{%i}_{%cma} = kg{%i}on * go_{%i}_{%cma}[+1] * vsum[i]

This capital stock estimate cannot be used reliably. It, in principal, includes shifts in capacity utilization rates for the sector's capital stock which adjust more rapidly to shifting economic conditions than the actual capital stock. To help account for these shifts in utilization rates a new, smoothed, capital stock series is generated using the Hodrick-Prescott filter.

k_{%i}_{%cma} = HP(kraw_{%i}_{%cma})

Investment by industry sector and CMA is generated using the familiar identity:

i_{%i}_{%cma} = d(k_{%i}_{%cma}) + rdk{%i}ton * k_{%i}_{%cma}[-1]

Non-residential construction and Machinery and equipment investment are generated using the construction share estimates:

ic_{%i}_{%cma} = i{%i}cson * i_{%i}_{%cma}

ime_{%i}_{%cma} = i_{%i}_{%cma} – ic_{%i}_{%cma}

The non-residential construction and machinery and equipment investment estimates are summed across the 13 sectors[13] to generate two non-residential business investment series for each CMA. These series are divided by the unconstrained CD totals to generate investment shares for each CMA.

icx_{%cma} = ic_{%cma} / ic_sum

imex_{%cma} = ime_{%cma} / ime_sum

Government Investment

Government investment is estimated for each of Ontario's CMAs. The EViews subroutine **DATA_CMA_GOVINV** creates this data. Government investment within each CMA is generated as a function of both the region's share of provincial population and LFS public sector employment.

The share of Ontario's population resident in the CMA acts as the starting point. These shares are then adjusted by an exponent equal to the share of public sector employment in the region itself raised to an exponent of value less than 1. This second exponent ensures that public sector investment flows to regions to support (1) the local population and (2) the public sector workforce. A value for this exponent of 0.2 leads to an unconstrained expenditure share total of close to 1 for the years 1996 through 2007.

Step 1: igx_{%cma} = ((1 + (n_{%cma}/n_on)) exp(((e_gs_{%cma}/e_{%cma}) / (e_gs_on/e_on))$^{0.2}$) – 1)

The Step 1 government investment shares are dividing by the unconstrained CD total.

Government Spending

Government spending on current goods and services is estimated for each of Ontario's CMAs. The EViews subroutine **DATA_CMA_GOVT** creates this data. Government spending within each CMA is simply generated using that region's share of LFS public sector employment.

gx_{%cma} = e_gs_{%cma} / e_gs_on

Commodity Flows

The EViews subroutine, **DATA_CMA_COMMODITY**, generates estimates of S-level commodity flows at the Census Division level in Ontario. This program generates information

[13] Public sector investment is dropped since this is generated independently.

for three flows: total commodity production, total commodity demand by industry, and total commodity demand from domestic sources[14].

Commodity Production

The CMA level industry output estimates are combined with information from the Ontario make matrix to determine the amount of each S-level commodity produced in the region. The make matrix is normalized by the commodity row totals (**pmat**) and then multiplied by the industry output vector for each CMA to yield a commodity output vector.

$$cs\_\{\%c\}\_\{\%cma\} = \Sigma_i \; pmat[c,i] * go\_\{\%i\}\_\{\%cma\}$$

Commodity Intermediate Demand

The amount of each commodity demanded by industries in a region is called intermediate industry demand. Commodity intermediate demand within each CMA is generated in a similar way to commodity production. The Ontario use matrix must be normalized by the industry column totals (**bmat**). This matrix is then multiplied by the industry output vector for each CMA to yield the amount of each commodity demanded by industry in the region.

$$cdi\_\{\%c\}\_\{\%cma\} = \Sigma_i \; bmat[c,i] * go\_\{\%i\}\_\{\%cma\}$$

Commodity Final Domestic Demand

The amount of final domestic demand for each commodity within each CMA is generated using total demand in the province from that sector, the CMA's share of that demand, and the Ontario final demand matrix. The Ontario final demand matrix is normalized by the category column totals (**cmat**).

```
cdf_{%c}_{%cma} = c_on * cx_{%cma} * cmat[c,consumption] +
                  ir_on * irx_{%cma} * cmat[c,residential investment] +
                  icx_on * icx_{%cma} * cmat[c,non-residential construction] +
                  ime_on * imex_{%cma} * cmat[c,machinery & equipment investment] +
                  ig_on * igx_{%cma} * cmat[c,government investment] +
                  g_on * gx_{%cma} * cmat[c,government spending]
```

Commodity Net Exports

Commodity net exports for each CMA are generated as the difference between production and industry plus final domestic demand.

```
nx_{%c}_{%cma} = cs_{%c}_{%cma} - cdi_{%c}_{%cma} - cdf_{%c}_{%cma}
```

CMA Rest of Province Data

The CMA level of geography complicates the TREIM because the sum of activity across CMAs is less than total provincial activity. In order to construct a set of regional trade matrices at the CMA level of geography, it is necessary to construct data for the rest of Ontario (i.e. Ontario less the sum of all the CMAs).

$$cs\_\{\%c\}\_cmarop = cs\_\{\%c\}\_on - \Sigma_{cma} \; cs\_\{\%c\}\_\{\%cma\}$$

$$cdi\_\{\%c\}\_cmarop = cdi\_\{\%c\}\_on - \Sigma_{cma} \; cdi\_\{\%c\}\_\{\%cma\}$$

$$cdf\_\{\%c\}\_cmarop = cdf\_\{\%c\}\_on - \Sigma_{cma} \; cdf\_\{\%c\}\_\{\%cma\}$$

---

[14] This is the sum of consumption, total public and private investment, and government spending.

Exports

Commodity exports are for each CMA are defined as sales of goods or services to any buyer outside that CMA. The EViews subroutine **DATA_CMA_EXPORTS** creates this data. This program reads in data from the spreadsheet **Data_Exports.xls**.

Exports are again assumed to be a function of production. In particular, they are a fixed proportion of production in the region. The proportion α will vary by commodity, by region and by level of geography. The determination of α is one of the most critical assumptions in the model. No single approach can be used to determine α for each commodity and geography, instead a series of estimates must be developed and the most desirable one selected for use by the model.

The EViews program begins by reading in a set of assumptions regarding exports for each commodity and adjustments to for each CMA. The data from sheet **A1** is used to populate the matrix **xp_assumption_1**. This matrix is 2 rows by 51 columns. Each column represents two parameters for each S-level commodity. Data from sheet **CMA** is used to populate the 14 element vector **xp_assumption_cma**. Each element in this matrix represents an export adjustment coefficient for each CMA.

A set of location quotients (LQ) are created for each commodity and CMA. The location quotient is a measure of the degree to which a particular region specializes in the production of a commodity.

```
lq_{%c}_{%cma} = (cs_{%c}_{%cma} / cs_{%cma}) / (cs_{%c}_on / cs_on)
```

A location quotient value of 1 indicates the region produces the commodity in the same proportion as the province. Values greater than 1 indicate the region specializes in production of the commodity while values less than 1 indicate that other regions produce the commodity and this region may need to import it.

The average value from 1991 to 2002 for each location quotient is generated and stored in a 14 by 51 matrix called **lq_mat_cma**. Values for commodities 49 (non-competing imports) and 50 (unallocated imports and exports) are set to 0 because they are not produced in Ontario.

Estimates of commodity exports by CMA are generated using the location quotients and assumptions as a set of proportions which are calculated and stored in the matrix **xp_cma**. The coefficients in the first column of the matrix **xp_assumption_1** provide an asymptotic maximum value for the export share of production for each commodity[15]. The asymptotic maximums are raised or lowered for each CMA based on the assumptions in the vector **xp_assumption_cma**. The coefficients in the second column of the matrix **xp_assumption_1** provide threshold values for commodity exports. If the location quotient is less than the threshold value then the region sells all its production locally. Raising the value of this coefficient ensures that a higher proportion of goods and services are sold locally[16]. The denominator in the exponent for this equation is adjusted by the positive scalar, **xfactor**, which ensures that the exponent takes on a value of less than 1. Setting **xfactor** to a small value raises the value of the exponent (towards an

[15] These coefficients can take on values between, and including, 0 and 1. A region with a high location quotient will export nearly this proportion of its output.

[16] This coefficient must be positive.

asymptotic maximum of 1) which is applied to the maximum export share for that commodity and CMA.

```
if lq_mat_cma[cma,c]>xp_assumption_1[c,2]:
        xp_cma[cma,c] = (1 + max(xp_assumption_1[c,1] + xp_assumption_cma[cma],0)) *
        exp((lq_mat_cma[cma,c] - xp_assumption_1[c,2]) /
        (lq_mat_cma[cma,c]) - xp_assumption_1[c,2]+zz)) - 1
else:   xp_cma[cma,c] = 0
```

Exports are calculated as a share of production.

```
x_{%c}_{%cma} = xp_cma[cma,c] * cs_{%c}_{%cma}
```

An exception to this formula is followed for commodity 34 (Other Utilities). In this case exports are set equal to net exports if they are positive.

```
If nx_{%c}_{%cma}>0: x_{%c}_{%cma} = nx_{%c}_{%cma}
else:                x_{%c}_{%cma} = 0
```

Again, it is necessary to construct export data for the rest of Ontario (i.e. Ontario less the sum of all the CMAs).

x_{%c}_cmarop = x_{%c}_on – Σ_{cma} x_{%c}_{%cma}

Imports

Commodity imports are for each CMA are generated be the EViews subroutine **DATA_CMA_IMPORTS**. The commodity flow identity can now be generated along with a set of import proportions.

```
m_{%c}_{%cma} = cdi_{%c}_{%cma} + cdf_{%c}_{%cma} + x_{%c}_{%cma} – cs_{%c}_{%cma}
mp_{%c}_{%cma} = m_{%c}_{%cma} / (cdi_{%c}_{%cma} + cdf_{%c}_{%cma})
```

The average values from 1996 to 2002 for these import proportions are stored in the 49 by 51 matrix **mp_cma**. Values less than zero are converted to zeros. Values for commodties 29, 30, 31, 37, 45, 46, 47 and 48 are set to zero. These commodities are not traded.

Finally, it is necessary to construct import data for the rest of Ontario (i.e. Ontario less the sum of all the CMAs).

m_{%c}_cmarop = m_{%c}_on – Σ_{cma} m_{%c}_{%cma}

Regional Trade Flows

The EViews subroutines, **DATA_CMA_TRADE1** and **DATA_CMA_TRADE2**, generate commodity trade flows among Census Metropolitan Areas in Ontario. This program reads in data from the spreadsheet **CMA_Truck.xls**.

Goods Flows

Three matrices are read from **CMA_Truck.xls** describing commodity shipments from each Census Metropolitan Area in Ontario (exports). The matrix **truck_cma_xtot** describes total shipments by SCTG commodity from Ontario CMAs. The matrix **truck_cma_xusa** describes shipments by SCTG commodity from Ontario CMAs to the United States. The matrix **truck_cma_xroc** describes shipments by SCTG commodity from Ontario CMAs to other provinces in Canada. The matrix **truck_cma_xrop** can then be constructed:

```
truck_cma_xrop = truck_cma_xtot – truck_cma_xusa – truck_cma_xroc
```

This matrix describes shipments by SCTG commodity from an Ontario CMA to the rest of Ontario – i.e. intraprovincial trade.

Next, a set of 15 matrices are read from **CMA_Truck.xls**. These summarize SCTG commodity shipments from a single CMA to each of the other CMAs in Ontario and the rest of the province. These 43 by 15 matrices are called **truck_cma_{%cma}**.

The trucking database does not include data for four CMAs: Kingston, Brantford, Guelph and Barrie. A set of data is created for these regions using the second CD to CMA map, **map_cma2**, which includes an additional column for the rest-of-Ontario. Each of the matrices read from **CMA_Truck.xls** was used to generate a set of new, artificial, data. For example,

t_cma_xtot = truck_cd_xtot * map_cma2 and

t_cma_{%cd} = truck_cd_{%cd} * map_cma2

The resulting 49 matrices, t_cma_{%cd}, must be further adjusted to collapse them to just 15 matrices.

t_cma_{%cma}[c,destination] = Σ_{cd} (t_cma_{%cd}[c,destination] * map_cma2[cd,destination])

In matrices **truck_cma_xtot** and **truck_cma_xrop**, the columns for the missing CMAs were filled using the data created in **t_cma_xtot** and **t_cma_xrop** respectively.

The artificial export by destination matrices for the four missing CMAs were renamed. So, for example, the matrix for Kingston (cma35521) is:

truck_cma_cma35521 = t_cma_cma35521

Finally, the data for the other CMAs is adjusted to include columns for the four missing CMAs from the artificial data.

This data is now used to create a new set of matrices by mapping the SCTG commodities to input-output S-level commodities. The 51 by 15 matrix **xdom_cma** represents the proportion of each S-level commodity shipped from an Ontario CMA destined for another CMA (or rest of province) in Ontario.

xdom_cma[c,cma] = truck_cma_xrop[sctg,cma] / truck_cma_xtot[sctg,cma]

A set of 51 by 15 matrices are constructed as the proportion of each S-level commodity shipped from a specific CMA to the other CMAs or the rest of the province: **xdest_{%cma}**. Commodity shipments within a CMA (or the rest of the province) are set to zero.

xdest_{%cma}[c,destination] = truck_cma_{%cma}[sctg,destination] / $\Sigma_{destination}$ truck_cma_{%cma}[sctg,destination]

Service Flows

The trucking database provided information on shipments of goods in Ontario. Trade in services must, however, be estimated using an alternate approach.

The share of service exports from each CMA to the rest of the province as a proportion of exports to all destinations is generated and placed in the matrix **xdom_cma**. The estimate is based on total commodity exports generated earlier and out-of-province exports from Statistics Canada's input-output and interprovincial trade data. At present, all regions are assumed to export the same share of a commodity to out-of-province destinations.

xdom[c,cma] = (x_{%c}_on[1999] – fmat[c,international exports] – fmat[c,interprovincial exports]) / x_{%c}_on[1999]

Service exports from one CMA to another and to the rest of the province are estimated using a gravity model approach. The distance from one CMA to another is derived from the trucking database and is modified by a commodity specific friction factor. This is multiplied by shipments from the region and demand in the destination region. This calculation is then divided by the sum across destination regions of the distance and friction factors times demand in the other regions.

```
xdest_{%cma}[c,destination] = (1 / distance[cma,destination] * exp(friction[c]) ) *
                              cs_{%c}_{%cma}[1999] *
                              (cdi_{%c}_{%destination}[1999]+ cdf_{%c}_{%destination}[1999]) /
                              Σ_destination ( (1 / distance[cma,destination] * exp(friction[c]) ) *
                              (cdi_{%c}_{%destination}[1999]+ cdf_{%c}_{%destination}[1999]) )
```

Finally, the resulting measures are normalized so as to sum to one across destinations for each commodity. This calculation completes the trading relationship between CMAs in Ontario.

Intraprovincial Exports

A time series of domestic exports, i.e. shipments destined for other CMAs in Ontario, can now be generated for all S-level commodities.

```
xdom_{%c}_{%cma} = x_{%c}_{%cma} * xdom_cma[c,cma]
```

Intraprovincial Imports

Imports from other CMAs in Ontario are generated by summing domestic exports from each other CMA and the rest of the province destined for that particular CMA.

```
mdom_{%c}_{%cma} = Σ_origin (x_{%c}_{%origin} * xdest_{%origin}[c,cma])
```

Regional Trade Matrices

Three 15 by 51 regional trade matrices at the Census Metropolitan Area level for S-level commodities are constructed for the TREIM by the subroutine **DATA_CMA_TRADE2**. These matrices augment the matrix **mp_cma** generated earlier. The elements in the matrices are constructed as the averages from 1996 to 2002 of the following time series.

The series **mpro_{%c}_{%cma}** is the rest of province import proportion for a particular region and commodity is generated as follows, where the summations across CMAs exclude the region. This is analogous to the **mp_{%c}_{%cma}** series generated earlier where the rest of the province is now treated as the region. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mpro_cma**.

```
mpro_{%c}_{%cma} = Σ_r m_{%c}_{%cma} / (Σ_r cdi_{%c}_{%cma} + Σ_r cdf_{%c}_{%cma})
```

The series **mprs_{%c}_{%cma}** describes the proportion of a commodity used in the rest of the province and supplied by the region. Again, the summation across CMAs excludes the region. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mprs_cma**.

```
mprs_{%c}_{%cma} = xdom_{%c}_{%cma} / (Σ_r cdi_{%c}_{%cma} + Σ_r cdf_{%c}_{%cma})
```

The series **mpsr_{%c}_{%cma}** describes the proportion of a commodity used in the region and supplied by the rest of the province. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mpsr_cma**.

```
mpsr_{%c}_{%cma} = mdom_{%c}_{%cma} / (cdi_{%c}_{%cma} + cdf_{%c}_{%cma})
```

The elements for S-level commodities 29, 30, 31, 37, 45, 46, 47, and 48 are zero since no trade in these commodities is allowed.

Ontario Tourism Region Data

The economy of each of the 12 Tourism Regions (TR) in Ontario must be represented with a technical requirements matrix incorporating import leakages from international, interprovincial and intraprovincial sources. This involves the creation of an information set describing economic activity in each TR. The approach taken to creating each part of this information set is similar to that adopted in creating the Census Division data. Differences between the approaches will be discussed in the following sections.

Tourism Region Geography

A matrix is used to map data from Census Divisions to Tourism Regions. The 49 by 12 matrix includes the proportion of the labour force for each CD that is located in each TR from the 2001 Census. The matrix, **map_tr**, is read in from the sheet, **TR**, in the spreadsheet **geography.xls** and is created by the EViews subroutine **GEOGRAPHY_TR**.

A 12 by 12 distance matrix from Tourism Region to Tourism Region is created by reading raw data from the sheet **TR Distance** in the spreadsheet **geography.xls**. This creates the matrix **distance_raw** which, following the same procedure as the CD distance matrix, is used to create the distance matrix **distance_tr**.

Industry Employment

Employment by industry for each of Ontario's TRs is generated using the EViews subroutine: **DATA_TR_EMPLOYMENT**. Data is read from the spreadsheet **CMA_Employment.xls**.

Two employment vectors for each Census division are read from the sheet **POW Adjustment**. These are **epow_cd** and **epor_cd** for total Census Division employment by place of work and by place of residence respectively. These vectors are converted to Tourism Regions by multiplying by the CD-TR concordance map. The place-of-work adjustment vector, **epowadj_tr**, can then be generated as follows:

$$epow\_tr[tr] = \Sigma_{cd}\ epow\_cd[cd] * map\_tr[cd,tr]$$

$$epor\_tr[tr] = \Sigma_{cd}\ epor\_cd[cd] * map\_tr[cd,tr]$$

$$epowadj\_tr[tr] = 100 * epow\_tr[tr] / epor\_tr[tr]$$

Tourism Region employment data was constructed using the CD-level Census data and the CD-TR concordance map.

$$census\_tr\_emp[i,tr] = \Sigma_{cd}\ census\_cd\_emp[i,cd] * map\_tr[cd,tr]$$

The Census recipients of wages and salaries data must now be converted to a total employment on a place-of-work basis for each TR and S-level industry. This data is stored in the matrix **on_emp_tr**.

$$on\_emp\_tr[i,tr] = \text{Total Employment Factor}[i] * census\_tr\_emp[i,tr] * \text{Place of work adjustment}[tr]$$

The data in this matrix is adjusted to be consistent with the total sector employment data for Ontario in **ioemp99**. This adjustment involves dividing the elements in each column by the total from the sum of CDs and multiplying by the total employment figures in **ioemp99**.

The Ontario labour force employment series are used to create time series data for employment by TR and S-level industry. Again, the 16 sectors from the C_4SE's Provincial Economic Service are mapped to the 25 S-level industries. This imperfect mapping means that employment for some S-level sectors will grow at the same rate as others that use the same, broader employment driver.

```
e_{%i}_{%tr} = on_emp[i,tr] * elfs{%i}_on / elfs{%i}_on[1999]
```

Finally a set of aggregate data for each TR is created by summing across industries.

Industry Output

The employment data created in the previous step is used to create output by industry for each Ontario TR. The EViews subroutine **DATA_TR_OUTPUT** creates this data. The approach and calculations used to generate this data are similar to those used to create the CD level data.

Gross output in constant reference year 1999 dollars is generated for the 22 non-fictive industries for each TR. The 14 sectors from the C_4SE's Ontario Economic Service are mapped to the 25 S-level industries. This imperfect mapping means that productivity trends for some S-level sectors will grow at the same rate as others that use the same, broader productivity driver. Gross output is, therefore, simply employment times output per worker where the productivity growth estimates are benchmarked to the data from the 1999 input-output tables.

```
go_{%i}_{%tr} = e_{%i}_{%tr} * ioemp99[i,productivity] * pr{%i}on / pr{%i}on[1999] / 1000000
```

Generating gross output for the three fictive sectors is a little more complicated because these sectors, by construction, have no employment (or value added) to the economy. Data, however, needs to be constructed because the TREIM needs to account for commodity supply and demand and these sectors both produce and consume various commodities.

The make matrix was used to determine which other industries produced the commodities supplied by each fictive industry.

Sector F1: Operating, Office, Cafeteria and Laboratory Supplies are assumed to be produced by:
- 85% Sector 3A: Manufacturing
- 15% Sector 41: Wholesale Trade

Sector F2: Travel & Entertainment, Advertising & Promotion are assumed to be produced by:
- 25% Sector 3A: Manufacturing
- 25% Sector 4B: Transportation and Warehousing
- 10% Sector 51: Information and Cultural Industries
- 15% Sector 54: Professional, Scientific and Technical Services
- 25% Sector 72: Accommodation and Food Services

Sector F3: Transportation Margins are assumed to be produced by:
- 100% Sector 4B: Transportation and Warehousing

Time series data for each sector by TR is created as an index with an initial value of 1 in 1987. The index is created by cumulating the weighted gross output growth rates for the sectors that are assumed to produce the fictive industry's output. The data is then benchmarked to the sector totals from the 1999 input-output tables.

```
Step 1: go_{%f}_{%tr} = go_{%f}_{%tr}[-1] * (1 + Σi αi * %ch(go_{%i}_{%tr}))

Step 2: go_{%f}_{%tr} = ioemp[f,gross output] * (Σi αi * go_{%i}_{%tr}[1999]) / go_{%f}_{%tr}[1999]
```

Total gross output by TR is generated by summing across S-level industries.

Consumption

Personal consumer spending on goods and services is estimated for each of Ontario's TRs. The EViews subroutine **DATA_TR_CONSUMPTION** creates this data.

Population and personal income data for each TR are constructed using the CD-level data and the CD-TR concordance map.

n_{%tr} = Σ_{cd} n_{%cd} * map_tr[cd,tr]

yp$_{%tr} = Σ_{cd} yp$_{%cd} * map_tr[cd,tr]

The share of Ontario's population resident in the TR again acts as the starting point. These shares are then adjusted by an exponent equal to average per capita personal income in the region relative to the province itself raised to an exponent of 0.7. This second exponent is to help account for higher savings rates in high income regions than in low income regions. Generated consumption shares by TR therefore lie between the region's population share and its share of personal income.

Step 1: cx_{%tr} = ((1 + (n_{%tr}/n_on)) exp(((yp$_{%tr}/n_{%tr}) / (yp$_on/n_on))$^{0.7}$) – 1)

The Step 1 consumption shares are normalized to equal one by dividing the Step 1 values by the unconstrained sum across CDs.

Residential Construction Investment

Residential construction investment is estimated for each of Ontario's TRs. The EViews subroutine **DATA_TR_RESIDENTIAL** creates this data.

Residential construction investment estimates for each TR are obtained from the CD estimates and the CD-TR concordance map.

irx_{%tr} = Σ_{cd} irx_{%cd} * map_tr[cd,tr]

Non residential Business Investment

Non-residential investment is estimated for each of Ontario's TRs. The EViews subroutine **DATA_TR_NONRESIDENTIAL** creates this data. The process for generating the TR level data is the same as that used at the CD level of geography.

An estimate of raw capital stock data by sector and TR is generated by multiplying the capital-output ratio by next year's gross output times the value added share for the sector (stored in the vector **vsum**). The 25 S-level industries are mapped into the 14 sectors for which capital-output ratios are available. This means that data for several S-level industries are aggregated to provide an appropriate output series for some capital-output ratios.

kraw_{%i}_{%tr} = kg{%i}on * go_{%i}_{%tr}[+1] * vsum[i]

This capital stock estimate cannot be used reliably. It, in principal, includes shifts in capacity utilization rates for the sector's capital stock which adjust more rapidly to shifting economic conditions than the actual capital stock. To help account for these shifts in utilization rates a new, smoothed, capital stock series is generated using the Hodrick-Prescott filter.

k_{%i}_{%tr} = HP(kraw_{%i}_{%tr})

Investment by industry sector and TR is generated using the familiar identity:

i_{%i}_{%tr} = d(k_{%i}_{%tr}) + rdk{%i}ton * k_{%i}_{%tr}[-1]

Non-residential construction and Machinery and equipment investment are generated using the construction share estimates:

ic_{%i}_{%tr} = i{%i}cson * i_{%i}_{%tr}

ime_{%i}_{%tr} = i_{%i}_{%tr} – ic_{%i}_{%tr}

The non-residential construction and machinery and equipment investment estimates are summed across the 13 sectors[17] to generate two non-residential business investment series for each TR. These series are divided by the unconstrained CD totals to generate investment shares for each TR.

icx_{%tr} = ic_{%tr} / ic_sum

imex_{%tr} = ime_{%tr} / ime_sum

Government Investment

Government investment is estimated for each of Ontario's TRs. The EViews subroutine **DATA_TR_GOVINV** creates this data. Government investment within each TR is generated as a function of both the region's share of provincial population and LFS public sector employment.

The share of Ontario's population resident in the TR acts as the starting point. These shares are then adjusted by an exponent equal to the share of public sector employment in the region itself raised to an exponent of value less than 1. This second exponent ensures that public sector investment flows to regions to support (1) the local population and (2) the public sector workforce. A value for this exponent of 0.2 leads to an unconstrained expenditure share total of close to 1 for the years 1996 through 2007.

Step 1: igx_{%tr} = ((1 + (n_{%tr}/n_on)) exp(((e_gs_{%tr}/e_{%tr}) / (e_gs_on/e_on))$^{0.2}$) – 1)

The Step 1 government investment shares are dividing by the unconstrained CD total.

Government Spending

Government spending on current goods and services is estimated for each of Ontario's TRs. The EViews subroutine **DATA_TR_GOVT** creates this data. Government spending within each TR is simply generated using that region's share of LFS public sector employment.

gx_{%tr} = e_gs_{%tr} / e_gs_on

Commodity Flows

The EViews subroutine, **DATA_TR_COMMODITY**, generates estimates of S-level commodity flows at the Census Division level in Ontario. This program generates information for three flows: total commodity production, total commodity demand by industry, and total commodity demand from domestic sources[18].

Commodity Production

The TR level industry output estimates are combined with information from the Ontario make matrix to determine the amount of each S-level commodity produced in the region. The make matrix is normalized by the commodity row totals (**pmat**) and then multiplied by the industry output vector for each TR to yield a commodity output vector.

cs_{%c}_{%tr} = Σ_i pmat[c,i] * go_{%i}_{%tr}

[17] Public sector investment is dropped since this is generated independently.

[18] This is the sum of consumption, total public and private investment, and government spending.

Commodity Intermediate Demand

The amount of each commodity demanded by industries in a region is called intermediate industry demand. Commodity intermediate demand within each TR is generated in a similar way to commodity production. The Ontario use matrix must be normalized by the industry column totals (**bmat**). This matrix is then multiplied by the industry output vector for each TR to yield the amount of each commodity demanded by industry in the region.

```
cdi_{%c}_{%tr} = Σi bmat[c,i] * go_{%i}_{%tr}
```

Commodity Final Domestic Demand

The amount of final domestic demand for each commodity within each TR is generated using total demand in the province from that sector, the TR's share of that demand, and the Ontario final demand matrix. The Ontario final demand matrix is normalized by the category column totals (**cmat**).

```
cdf_{%c}_{%tr} = c_on * cx_{%tr} * cmat[c,consumption] +
                 ir_on * irx_{%tr} * cmat[c,residential investment] +
                 icx_on * icx_{%tr} * cmat[c,non-residential construction] +
                 ime_on * imex_{%tr} * cmat[c,machinery & equipment investment] +
                 ig_on * igx_{%tr} * cmat[c,government investment] +
                 g_on * gx_{%tr} * cmat[c,government spending]
```

Commodity Net Exports

Commodity net exports for each TR are generated as the difference between production and industry plus final domestic demand.

```
nx_{%c}_{%tr} = cs_{%c}_{%tr} - cdi_{%c}_{%tr} - cdf_{%c}_{%tr}
```

Exports

Commodity exports are for each TR are defined as sales of goods or services to any buyer outside that TR. The EViews subroutine **DATA_TR_EXPORTS** creates this data. This program reads in data from the spreadsheet **Data_Exports.xls**.

Exports are again assumed to be a function of production. In particular, they are a fixed proportion of production in the region. The proportion α will vary by commodity, by region and by level of geography. The determination of α is one of the most critical assumptions in the model. No single approach can be used to determine α for each commodity and geography, instead a series of estimates must be developed and the most desirable one selected for use by the model.

The EViews program begins by reading in a set of assumptions regarding exports for each commodity and adjustments to for each TR. The data from sheet **A1** is used to populate the matrix **xp_assumption_1**. This matrix is 2 rows by 51 columns. Each column represents two parameters for each S-level commodity. Data from sheet **TR** is used to populate the 12 element vector **xp_assumption_tr**. Each element in this matrix represents an export adjustment coefficient for each TR.

A set of location quotients (LQ) are created for each commodity and TR. The location quotient is a measure of the degree to which a particular region specializes in the production of a commodity.

```
lq_{%c}_{%tr} = (cs_{%c}_{%tr} / cs_{%tr}) / (cs_{%c}_on / cs_on)
```

A location quotient value of 1 indicates the region produces the commodity in the same proportion as the province. Values greater than 1 indicate the region specializes in production of the commodity while values less than 1 indicate that other regions produce the commodity and this region may need to import it.

The average value from 1991 to 2002 for each location quotient is generated and stored in a 12 by 51 matrix called **lq_mat_tr**. Values for commodities 49 (non-competing imports) and 50 (unallocated imports and exports) are set to 0 because they are not produced in Ontario.

Estimates of commodity exports by TR are generated using the location quotients and assumptions as a set of proportions which are calculated and stored in the matrix **xp_tr**. The coefficients in the first column of the matrix **xp_assumption_1** provide an asymptotic maximum value for the export share of production for each commodity[19]. The asymptotic maximums are raised or lowered for each TR based on the assumptions in the vector **xp_assumption_tr**. The coefficients in the second column of the matrix **xp_assumption_1** provide threshold values for commodity exports. If the location quotient is less than the threshold value then the region sells all its production locally. Raising the value of this coefficient ensures that a higher proportion of goods and services are sold locally[20]. The denominator in the exponent for this equation is adjusted by the positive scalar, **xfactor**, which ensures that the exponent takes on a value of less than 1. Setting **xfactor** to a small value raises the value of the exponent (towards an asymptotic maximum of 1) which is applied to the maximum export share for that commodity and TR.

```
if lq_mat_tr[tr,c]>xp_assumption_1[c,2]:
        xp_tr[tr,c] = (1 + max(xp_assumption_1[c,1] + xp_assumption_tr[tr],0)) *
        exp((lq_mat_tr[tr,c] - xp_assumption_1[c,2]) /
        (lq_mat_tr[tr,c]) - xp_assumption_1[c,2]+zz)) - 1
else:   xp_tr[tr,c] = 0
```

Exports are calculated as a share of production.

```
x_{%c}_{%tr} = xp_tr[tr,c] * cs_{%c}_{%tr}
```

An exception to this formula is followed for commodity 34 (Other Utilities). In this case exports are set equal to net exports if they are positive.

```
If nx_{%c}_{%tr}>0:    x_{%c}_{%tr} = nx_{%c}_{%tr}
else:                  x_{%c}_{%tr} = 0
```

Imports

Commodity imports are for each TR are generated be the EViews subroutine **DATA_TR_IMPORTS**. The commodity flow identity can now be generated along with a set of import proportions.

```
m_{%c}_{%tr} = cdi_{%c}_{%tr} + cdf_{%c}_{%tr} + x_{%c}_{%tr} – cs_{%c}_{%tr}
mp_{%c}_{%tr} = m_{%c}_{%tr} / (cdi_{%c}_{%tr} + cdf_{%c}_{%tr})
```

[19] These coefficients can take on values between, and including, 0 and 1. A region with a high location quotient will export nearly this proportion of its output.

[20] This coefficient must be positive.

The average values from 1996 to 2001 for these import proportions are stored in the 49 by 51 matrix **mp_tr**. Values less than zero are converted to zeros. Values for commodties 29, 30, 31, 37, 45, 46, 47 and 48 are set to zero. These commodities are not traded.

Regional Trade Flows

The EViews subroutines, **DATA_TR_TRADE1** and **DATA_TR_TRADE2**, generate commodity trade flows among Tourism Regions in Ontario.

Goods Flows

The three matrices describing commodity shipments from each Census Division in Ontario are converted to Ontario's Tourism Regions using the CD to TR map. For example, the matrix **truck_tr_xtot** which describes total shipments by SCTG commodity from Ontario TRs is constructed as follows:

truck_tr_xtot = truck_cd_xtot * map_tr

The matrix **truck_tr_xrop** is then constructed which describes shipments by SCTG commodity from an Ontario TR to the rest of Ontario.

truck_tr_xrop = truck_tr_xtot – truck_tr_xusa – truck_tr_xroc

Shipments to each tourism region must be created as follows:

t_tr_{%cd} = truck_cd_{%cd} * map_tr

The resulting 49 matrices, t_tr_{%cd}, must be further adjusted to collapse them to just 12 matrices.

truck_tr_{%tr}[c,destination] = Σ_{cd} (t_tr_{%cd}[c,destination] * map_tr[cd,destination])

A new set of matrices are constructed by mapping the SCTG commodities to input-output S-level commodities. The 51 by 12 matrix **xdom_tr** represents the proportion of each S-level commodity shipped from an Ontario TR destined for another TR in Ontario.

xdom_tr[c,tr] = truck_tr_xrop[sctg,tr] / truck_tr_xtot[sctg,tr]

A set of 51 by 12 matrices are constructed as the proportion of each S-level commodity shipped from a specific TR to the other TRs in Ontario: **xdest_{%tr}**. Commodity shipments within a TR are set to zero. These matrices define the trading relationships between TRs in Ontario.

xdest_{%tr}[c,destination] = truck_tr_{%tr}[sctg,destination] /
$\Sigma_{destination}$ truck_tr_{%cd}[sctg,destination]

Service Flows

The trucking database provided information on shipments of goods in Ontario. Trade in services must, however, be estimated using an alternate approach.

The share of service exports from each TR to the rest of the province as a proportion of exports to all destinations is generated and placed in the matrix **xdom_tr**. The estimate is based on total commodity exports generated earlier and out-of-province exports from Statistics Canada's input-output and interprovincial trade data. At present, all regions are assumed to export the same share of a commodity to out-of-province destinations.

xdom[c,tr] = (x_{%c}_on[1999] – fmat[c,international exports] – fmat[c,interprovincial exports]) /
x_{%c}_on[1999]

Service exports from one TR to another in Ontario are estimated using a gravity model approach. The distance from one TR to another is derived from the trucking database and is modified by a commodity specific friction factor. This is multiplied by shipments from the region and demand in the destination region. This calculation is then divided by the sum across destination regions of the distance and friction factors times demand in the other regions.

xdest_{%tr}[c,destination] = (1 / distance[tr,destination] * exp(friction[c])) *
cs_{%c}_{%tr}[1999] *
(cdi_{%c}_{%destination}[1999]+ cdf_{%c}_{%destination}[1999]) /
$\Sigma_{destination}$ ((1 / distance[tr,destination] * exp(friction[c])) *
(cdi_{%c}_{%destination}[1999]+ cdf_{%c}_{%destination}[1999]))

Finally, the resulting measures are normalized so as to sum to one across destinations for each commodity. This calculation completes the trading relationship between TRs in Ontario.

Intraprovincial Exports

A time series of domestic exports, i.e. shipments destined for other TRs in Ontario, can now be generated for all S-level commodities.

xdom_{%c}_{%tr} = x_{%c}_{%tr} * xdom_cd[c,tr]

Intraprovincial Imports

Imports from other TRs in Ontario are generated by summing domestic exports from each other TR in the province destined for that particular TR.

mdom_{%c}_{%tr} = Σ_{origin} (x_{%c}_{%origin} * xdest_{%origin}[c,tr])

Regional Trade Matrices

Three 12 by 51 regional trade matrices at the Tourism Region level for S-level commodities are constructed for the TREIM by the subroutine **DATA_TR_TRADE2**. These matrices augment the matrix **mp_tr** generated earlier. The elements in the matrices are constructed as the averages from 1996 to 2002 of the following time series.

The series **mpro_{%c}_{%tr}** is the rest of province import proportion for a particular region and commodity is generated as follows, where the summations across TRs exclude the region. This is analogous to the **mp_{%c}_{%tr}** series generated earlier where the rest of the province is now treated as the region. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mpro_tr**.

mpro_{%c}_{%tr} = Σ_r m_{%c}_{%tr} / (Σ_r cdi_{%c}_{%tr} + Σ_r cdf_{%c}_{%tr})

The series **mprs_{%c}_{%tr}** describes the proportion of a commodity used in the rest of the province and supplied by the region. Again, the summation across TRs excludes the region. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mprs_tr**.

mprs_{%c}_{%tr} = xdom_{%c}_{%tr} / (Σ_r cdi_{%c}_{%tr} + Σ_r cdf_{%c}_{%tr})

The series **mpsr_{%c}_{%tr}** describes the proportion of a commodity used in the region and supplied by the rest of the province. The average of these series from 1996 to 2002 is used to fill the elements in the matrix **mpsr_tr**.

mpsr_{%c}_{%tr} = mdom_{%c}_{%tr} / (cdi_{%c}_{%cd} + cdf_{%c}_{%tr})

The elements for S-level commodities 29, 30, 31, 37, 45, 46, 47, and 48 are zero since no trade in these commodities is allowed.

Induced and Government Revenue Impacts Model

The economic impacts from the TREIM can go beyond those of a standard open input-output model. The TREIM must has the capability of being closed with respect to households and investment. This (i) allows the impact on economic activity of the additional income paid to households, as a result of the tourism sector activity, to be captured and (ii) reflects the impact of changes in economic activity on business investment. The TREIM produces direct, indirect and induced impacts so the user can chose to "turn on or off" the induced impacts. The TREIM also differs from a standard input-output model in that it yields estimates of direct taxe revenue for the federal, provincial, and local governments.

Households' willingness to spend additional income is dependent upon economic conditions so the propensity to consume is a function not only of the change in income resulting from the shock but also of broader economic conditions. Factors such as the interest rate, inflation, and the unemployment rate are included in the model. Similarly, business investment may have to rise to produce the additional goods and services from any shock. This response is, however, dependent upon not only the size of the shock but also the current state of the economy. Businesses' willingness to invest will be a function of factors such as the interest rate, inflation, and the real exchange rate (i.e. Ontario's competitiveness relative to the United States).

There are ten tax revenue equations equations in the model. These supplement the indirect tax revenue impacts generated from the input-output tables. The tax revenue equations estimate the impact on: federal government direct taxes on persons, direct taxes on corporations, contributions to social insurance, other direct personal taxes; provincial government direct taxes on persons, direct taxes on corporations, contributions to social insurance, other direct personal taxes; local government other direct personal taxes; and CPP revenue.

In any model, estimation of plausible coefficients is critical. The C_4SE believes that well specified models in conjunction with appropriate estimation techniques yield usable coefficients. It is widely recognised that economic variables are cointegrated – that is, they share a common trend. Linear OLS specifications, however, result in "nonsense" regressions since their errors are serially correlated. This means that the resulting coefficients are biased and, in too many instances, can not even be found with the correct sign (plausible coefficients for relative price terms in export or import equations, for instance, can rarely be found). Specifying the model in error correction form and estimating it using instrumental variables techniques such as GMM corrects these shortcomings. It addresses the simultaneity bias in the model and allows for the use of contemporaneous exogenous variables.

This approach is critically important for the TREIM because it is a comparative statics model so we are more concerned with the impact multiplier rather than the total dynamic multiplier. Also, a standard linear model would yield the same consumption or investment response to a given change in income regardless of the state of the economy (the values of the other exogenous variables). In a dynamic model, the short-run multiplier depends on the values of all the other variables in the system.

Additional data are required to estimate a set of equations to create a model of induced household spending and business investment resulting from the direct and indirect impact income flows as well as the impact on government revenues.

Data

The EViews subroutine **DATA_CQM**, reads in history and forecast values for certain national and international variables used in the induced impacts model and the government revenue impacts model. The data is read from the sheet **CQMF033** in the spreadsheet **exovars.xls**. The quarterly data is converted to annual frequency data by averaging over the four calendar quarters of the year.

The EViews subroutine **DATA_EXO**, reads data for a set of variables from the C_4SE's forecast for Ontario's economy. The data is read from the sheet **ONF031** in the spreadsheet **exovars.xls**.

The EViews subroutine **DATA_INDUCED**, creates the additional series required by the induced and government revenue impacts model.

A time trend variable called **TIME**, equal to 1981 in the year 1981 is created.

Measures of real personal income and real disposable income expressed in millions of 1997 reference year dollars are generated by dividing nominal personal income and nominal disposable income by the Consumer Price Index for Ontario (adjusted to equal 1 in 1997). An average wage rate (expressed in thousands of dollars) for Ontario is created by dividing nominal wages, salaries and supplementary labour income by employment in Ontario.

Total household expenditure, **HHE_ON**, is generated by the chain-weighted addition of personal consumption and residential investment in Ontario. This measure is expressed in millions of 1997 reference year dollars. The chain-weighted deflator for this concept is also created: **PHHE_ON**.

Total non-residential business investment, **IB_ON**, is generated by the chain-weighted addition of non-residential construction investment and machinery and equipment investment in Ontario. This measure is expressed in millions of 1997 reference year dollars. The chain-weighted deflator for this concept is also created: **PIB_ON**.

Estimation Results

The EViews subroutine **EST_INDUCED**, estimates the household and business induced activity equations. The EViews subroutine **EST_GOVT**, estimates the government revenue equations. The EViews subroutine **MAKE_MOD**, makes the induced and government revenue model and adds a set of identities for total nominal direct taxes, nominal gross provincial product, nominal personal income, nominal disposable income, nominal wages, salaries and supplementary labour income, and real disposable income. The EViews subrourtine **SOLVE_MOD** generates baseline forecast data for the model.

Household Spending

The equation for total household spending in Ontario is estimated as a function of real disposable income, population, the real short-term interest rate, and the unemployment rate. An increase in real disposable income or population raises household spending while an increase in the real short-term interest rate or the unemployment rate lowers spending. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2002.

Household Spending Equation

```
DLOG(HHE_ON) = -0.06312095789*LOG(HHE_ON(-2)) + 0.06355996681*LOG(YD_ON(-2)) -
0.402311682*DLOG(HHE_ON(-1)) + 0.8956407114*DLOG(YD_ON) + 1.009249678*DLOG(N_ON) -
0.6333432146*DLOG((1+.01*RMS_CA)/(1+@PCH(CPI_ON))) - 0.08315501485*DLOG(RU_ON)
```

Household Spending Regression Statistics

Dependent Variable: DLOG(HHE_ON)
Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1983 2002
Included observations: 20 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 4 weight matrices, 5 total coef iterations
Instrument list: LOG(HHE_ON(-2)) LOG(YD_ON(-2)) DLOG(HHE_ON(-1)) DLOG(YD_ON) DLOG(N_ON) DLOG((1+.01*RMS_CA)/(1 +@PCH(CPI_ON))) DLOG(RU_ON)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(HHE_ON(-2))	-0.063121	0.034874	-1.809989	0.0935
LOG(YD_ON(-2))	0.063560	0.035039	1.813964	0.0928
DLOG(HHE_ON(-1))	-0.402312	0.110925	-3.626889	0.0031
DLOG(YD_ON)	0.895641	0.160799	5.569930	0.0001
DLOG(N_ON)	1.009250	0.340629	2.962901	0.0110
DLOG((1+.01*RMS_CA)/(1+@PCH(CPI_ON)))	-0.633343	0.088950	-7.120242	0.0000
DLOG(RU_ON)	-0.083155	0.020914	-3.975968	0.0016

R-squared	0.772191	Mean dependent var	0.033334
Adjusted R-squared	0.667048	S.D. dependent var	0.023445
S.E. of regression	0.013528	Sum squared resid	0.002379
Durbin-Watson stat	1.942973	J-statistic	0.006278

Business Investment

The equation for total non-residential business investment in Ontario is estimated as a function of real gross domestic product, the real Canada-US exchange rate, and the real long-term interest rate. An increase in real output raises investment while an appreciation of the real Canada-US exchange rate (a reduction in competitiveness) and an increase in the real long-term interest rate reduces investment. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1984-2002.

Business Investment Equation

DLOG(IB_ON) = -0.2574940686*LOG(IB_ON(-2)) + 0.1694027492*LOG(YGDP_ON(-2)) - 0.1056791929*LOG((1/RX_CA$US(-2))*PGDP_ON(-2)/PGDP_US(-2)) - 0.05686728306*DLOG(IB_ON(-1)) - 1.928465688*DLOG((1+.01*RML_CA(-1))/(1+@PCH(CPI_ON(-1)))) + 1.171221579*DLOG(YGDP_ON) - 1.899535268*DLOG((1+.01*RML_CA)/(1+@PCH(CPI_ON)))

Business Investment Regression Statistics

Dependent Variable: DLOG(IB_ON)
Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1984 2002
Included observations: 19 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 5 weight matrices, 6 total coef iterations
Instrument list: LOG(IB_ON(-2)) LOG(YGDP_ON(-2)) LOG((1 /RX_CA$US(-2))*PGDP_ON(-2)/PGDP_US(-2)) DLOG(IB_ON(-1)) DLOG((1+.01*RML_CA(-1))/(1+@PCH(CPI_ON(-1)))) DLOG(YGDP_ON) DLOG((1+.01*RML_CA)/(1+@PCH(CPI_ON)))

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(IB_ON(-2))	-0.257494	0.033098	-7.779658	0.0000
LOG(YGDP_ON(-2))	0.169403	0.064656	2.620055	0.0224
LOG((1/RX_CA$US(-2))*PGDP_ON(-	-0.105679	0.120143	-0.879613	0.3963

2)/PGDP_US(-2))				
DLOG(IB_ON(-1))	-0.056867	0.084346	-0.674218	0.5130
DLOG((1+.01*RML_CA(-1))/(1+@PCH(CPI_ON(-1))))	-1.928466	0.466541	-4.133537	0.0014
DLOG(YGDP_ON)	1.171222	0.346918	3.376074	0.0055
DLOG((1+.01*RML_CA)/(1+@PCH(CPI_ON)))	-1.899535	0.635222	-2.990350	0.0113

R-squared	0.832146	Mean dependent var	0.050913
Adjusted R-squared	0.748219	S.D. dependent var	0.084383
S.E. of regression	0.042342	Sum squared resid	0.021514
Durbin-Watson stat	2.438830	J-statistic	0.009012

Federal Revenue: Direct Taxes from Persons

The equation for federal direct personal tax revenue collected from Ontario residents is estimated as a function of personal income, the unemployment rate, and a set of dummy variables to account for changes in the tax system. An increase in personal income raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Federal Direct Personal Tax Equation

DLOG(TDPF$_ON) = -0.1480456033*LOG(TDPF$_ON(-2)) + 0.1270767752*LOG(YP$_ON(-2)) - 0.08267092045*DLOG(TDPF$_ON(-1)) + 0.6626632224*DLOG(YP$_ON) - 0.1681210414*DLOG(YP$_ON(-1)) + 0.008268332969*D(RU_ON(-1)) - 0.09710915342*(TIME<1985) - 0.09558515826*(TIME>1990 AND TIME<1995)

Federal Direct Personal Tax Regression Statistics

Dependent Variable: DLOG(TDPF$_ON)
Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1983 2000
Included observations: 18 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 22 weight matrices, 23 total coef iterations
Instrument list: LOG(TDPF$_ON(-2)) LOG(YP$_ON(-2)) DLOG(TDPF$_ON(-1)) DLOG(YP$_ON) DLOG(YP$_ON(-1)) D(RU_ON(-1)) (TIME<1985) (TIME>1990 AND TIME<1995)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TDPF$_ON(-2))	-0.148046	0.032168	-4.602294	0.0010
LOG(YP$_ON(-2))	0.127077	0.026706	4.758427	0.0008
DLOG(TDPF$_ON(-1))	-0.082671	0.061114	-1.352723	0.2059
DLOG(YP$_ON)	0.662663	0.094101	7.042058	0.0000
DLOG(YP$_ON(-1))	-0.168121	0.092968	-1.808367	0.1007
D(RU_ON(-1))	0.008268	0.001525	5.420597	0.0003
TIME<1985	-0.097109	0.009942	-9.767619	0.0000
(TIME>1990 AND TIME<1995)	-0.095585	0.005768	-16.57305	0.0000

R-squared	0.941692	Mean dependent var	0.076844
Adjusted R-squared	0.900877	S.D. dependent var	0.056413
S.E. of regression	0.017761	Sum squared resid	0.003155
Durbin-Watson stat	1.618781	J-statistic	0.085714

Provincial Revenue: Direct Taxes from Persons

The equation for provincial direct personal tax revenue collected in Ontario is estimated as a function of personal income, the unemployment rate, and a set of dummy variables to account for changes in the tax system. An increase in personal income raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Provincial Direct Personal Tax Equation
DLOG(TDPP$_ON) = -0.3179241021*LOG(TDPP$_ON(-2)) + 0.248441167*LOG(YP$_ON(-2)) - 0.3731260362*DLOG(TDPP$_ON(-1)) + 0.631286999*DLOG(YP$_ON) - 0.01101461262*D(RU_ON) - 0.1039822949*(TIME<=1985) - 0.04585827317*(TIME>=1997 AND TIME<=2000)

Provincial Direct Personal Tax Regression Statistics
Dependent Variable: DLOG(TDPP$_ON)
Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1983 2000
Included observations: 18 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 7 weight matrices, 8 total coef iterations
Instrument list: LOG(TDPP$_ON(-2)) LOG(YP$_ON(-2))
DLOG(TDPP$_ON(-1)) DLOG(YP$_ON) D(RU_ON) (TIME<=1985)
(TIME>=1997 AND TIME<=2000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TDPP$_ON(-2))	-0.317924	0.111349	-2.855202	0.0157
LOG(YP$_ON(-2))	0.248441	0.085077	2.920197	0.0139
DLOG(TDPP$_ON(-1))	-0.373126	0.180360	-2.068786	0.0629
DLOG(YP$_ON)	0.631287	0.457845	1.378823	0.1953
D(RU_ON)	-0.011015	0.007916	-1.391505	0.1916
TIME<=1985	-0.103982	0.023104	-4.500628	0.0009
(TIME>=1997 AND TIME<=2000)	-0.045858	0.035804	-1.280824	0.2266

R-squared	0.637456	Mean dependent var	0.065956
Adjusted R-squared	0.439705	S.D. dependent var	0.072760
S.E. of regression	0.054463	Sum squared resid	0.032629
Durbin-Watson stat	2.280438	J-statistic	0.051717

Federal Revenue: Direct Taxes from Corporations

The equation for federal direct corporate tax revenue collected from corporations and government business enterprises in Ontario is estimated as a function of gross provincial product, and a set of dummy variables to account for changes in the tax system. An increase in gross provincial product raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Federal Direct Corporate Tax Equation
DLOG(TDBF$_ON) = -0.08133990766*LOG(TDBF$_ON(-2)) + 0.06233196137*LOG(YGDP$_ON(-2)) - 0.1740163114*DLOG(TDBF$_ON(-1)) + 2.150638728*DLOG(YGDP$_ON) - 0.1906768151*(TIME<1994)

Federal Direct Corporate Tax Regression Statistics
Dependent Variable: DLOG(TDBF$_ON)
Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1983 2000
Included observations: 18 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 4 weight matrices, 5 total coef iterations
Instrument list: LOG(TDBF$_ON(-2)) LOG(YGDP$_ON(-2))
DLOG(TDBF$_ON(-1)) DLOG(YGDP$_ON) (TIME<1994)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TDBF$_ON(-2))	-0.081340	0.093761	-0.867523	0.4014
LOG(YGDP$_ON(-2))	0.062332	0.064757	0.962549	0.3533

DLOG(TDBF$_ON(-1))	-0.174016	0.126896	-1.371333	0.1935
DLOG(YGDP$_ON)	2.150639	0.405019	5.309966	0.0001
TIME<1994	-0.190677	0.038093	-5.005518	0.0002

R-squared	0.628934	Mean dependent var	0.095033
Adjusted R-squared	0.514760	S.D. dependent var	0.125069
S.E. of regression	0.087122	Sum squared resid	0.098674
Durbin-Watson stat	2.324816	J-statistic	0.002662

Provincial Revenue: Direct Taxes from Corporations

The equation for provincial direct corporate tax revenue collected from corporations and government business enterprises in Ontario is estimated as a function of gross provincial product, the unemployment rate, and a set of dummy variables to account for changes in the tax system. An increase in gross provincial product raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Provincial Direct Corporate Tax Equation

DLOG(TDBP$_ON) = -0.2609725776*LOG(TDBP$_ON(-2)) + 0.1704230186*LOG(YGDP$_ON(-2)) - 0.2031124416*DLOG(TDBP$_ON(-1)) + 1.779219175*DLOG(YGDP$_ON(-1)) + 1.323305264*DLOG(YGDP$_ON) - 0.02380193839*D(RU_ON) - 0.2666269681*(TIME<1993)

Provincial Direct Corporate Tax Regression Statistics

Dependent Variable: DLOG(TDBP$_ON)
Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1983 2000
Included observations: 18 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 4 weight matrices, 5 total coef iterations
Instrument list: LOG(TDBP$_ON(-2)) LOG(YGDP$_ON(-2))
DLOG(TDBP$_ON(-1)) DLOG(YGDP$_ON(-1)) DLOG(YGDP$_ON)
D(RU_ON) (TIME<1993)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TDBP$_ON(-2))	-0.260973	0.032346	-8.068093	0.0000
LOG(YGDP$_ON(-2))	0.170423	0.019761	8.624420	0.0000
DLOG(TDBP$_ON(-1))	-0.203112	0.106234	-1.911939	0.0823
DLOG(YGDP$_ON(-1))	1.779219	1.058326	1.681163	0.1209
DLOG(YGDP$_ON)	1.323305	0.913584	1.448477	0.1754
D(RU_ON)	-0.023802	0.013743	-1.731948	0.1112
TIME<1993	-0.266627	0.030795	-8.658151	0.0000

Federal Revenue: Contributions to Social Insurance

The equation for federal contributions to social insurance collected from Ontario residents and businesses is estimated as a function of wages, salaries and supplementary labour income, and a set of dummy variables to account for changes in the tax system. An increase in wages and salaries raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Federal Contributions to Social Insurance Equation

DLOG(TCSIPF$_ON) = -0.6004663228*LOG(TCSIPF$_ON(-2)) + 0.4386432805*LOG(YWSSL$_ON(-2)) - 0.9574943174*DLOG(TCSIPF$_ON(-1)) + 0.2727359483*DLOG(YWSSL$_ON) - 0.007997368021*D(RU_ON) - 0.1318736517*(TIME=1989) + 0.1837503885*(TIME>=1991 AND TIME<=1994) + 0.09068238267*(TIME>1994 AND TIME<1999)

Federal Contributions to Social Insurance Regression Statistics

Dependent Variable: DLOG(TCSIPF$_ON)

Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1983 2000
Included observations: 18 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 1 weight matrix, 2 total coef iterations
Instrument list: LOG(TCSIPF$_ON(-2)) LOG(YWSSL$_ON(-2))
DLOG(TCSIPF$_ON(-1)) DLOG(YWSSL$_ON) D(RU_ON)
(TIME>=1991 AND TIME<=1994) (TIME>1994 AND TIME<1999)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TCSIPF$_ON(-2))	-0.600466	0.053960	-11.12796	0.0000
LOG(YWSSL$_ON(-2))	0.438643	0.038156	11.49617	0.0000
DLOG(TCSIPF$_ON(-1))	-0.957494	0.120329	-7.957279	0.0000
DLOG(YWSSL$_ON)	0.272736	0.289330	0.942646	0.3681
D(RU_ON)	-0.007997	0.007231	-1.106057	0.2946
TIME=1989	-0.131874	0.075916	-1.737098	0.1130
(TIME>=1991 AND TIME<=1994)	0.183750	0.038816	4.733921	0.0008
(TIME>1994 AND TIME<1999)	0.090682	0.022193	4.086029	0.0022

R-squared	0.962880	Mean dependent var	0.078693
Adjusted R-squared	0.936897	S.D. dependent var	0.118023
S.E. of regression	0.029648	Sum squared resid	0.008790
Durbin-Watson stat	3.140227	J-statistic	2.31E-22

Provincial Revenue: Contributions to Social Insurance

The equation for provincial contributions to social insurance collected from Ontario residents and businesses is estimated as a function of wages, salaries and supplementary labour income, and a set of dummy variables to account for changes in the tax system. An increase in wages and salaries raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Provincial Contributions to Social Insurance Equation
DLOG(TCSIPP$_ON) = -0.05860436355*LOG(TCSIPP$_ON(-2)) + 0.03697035617*LOG(YWSSL$_ON(-2)) - 0.3075863619*DLOG(TCSIPP$_ON(-1)) + 0.9020731413*DLOG(YWSSL$_ON) - 0.05194014944*D(RU_ON) + 0.1170684*(TIME<1991) - 0.1505007824*(TIME>=1997 AND TIME<=1998)

Provincial Contributions to Social Insurance Regression Statistics
Dependent Variable: DLOG(TCSIPP$_ON)
Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1983 2000
Included observations: 18 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 3 weight matrices, 4 total coef iterations
Instrument list: LOG(TCSIPP$_ON(-2)) LOG(YWSSL$_ON(-2))
DLOG(TCSIPP$_ON(-1)) DLOG(YWSSL$_ON) D(RU_ON)
(TIME<1991) (TIME>=1997 AND TIME<=1998)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TCSIPP$_ON(-2))	-0.058604	0.019326	-3.032345	0.0114
LOG(YWSSL$_ON(-2))	0.036970	0.013351	2.769118	0.0183
DLOG(TCSIPP$_ON(-1))	-0.307586	0.163007	-1.886949	0.0858
DLOG(YWSSL$_ON)	0.902073	0.368896	2.445329	0.0325
D(RU_ON)	-0.051940	0.007872	-6.598228	0.0000

TIME<1991	0.117068	0.028300	4.136757	0.0017
(TIME>=1997 AND TIME<=1998)	-0.150501	0.023104	-6.514159	0.0000

R-squared	0.912371	Mean dependent var	0.072308
Adjusted R-squared	0.864573	S.D. dependent var	0.122585
S.E. of regression	0.045112	Sum squared resid	0.022386
Durbin-Watson stat	2.644896	J-statistic	0.000390

Federal Revenue: Other Direct Personal Taxes

The equation for federal other direct personal taxes collected from Ontario residents is estimated as a function of personal income, and a set of dummy variables to account for changes in the tax system. An increase in personal income raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Federal Other Direct Personal Tax Equation

LOG(TOF$_ON) = -7.381389132 + 0.7746345047*LOG(YP$_ON) + 0.9766335972*(TIME>=1992 AND TIME<=1993) + 0.7922246571*(TIME>=1996 AND TIME<=1997) + 0.5368474744*(TIME>=1989 AND TIME<=1991) + 0.2761391178*(TIME>=1985 AND TIME<=1987) - 0.3646413944*(TIME=1999)

Federal Other Direct Personal Tax Regression Statistics

Dependent Variable: LOG(TOF$_ON)
Method: Two-Stage Least Squares
Date: 12/09/03 Time: 14:20
Sample: 1981 2000
Included observations: 20
Instrument list: LOG(YP$_ON) (TIME>=1992 AND TIME<=1993) (TIME>=1996 AND TIME<=1997) (TIME>=1989 AND TIME<=1991) (TIME>=1985 AND TIME<=1987) (TIME=1999)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.381389	0.803694	-9.184332	0.0000
LOG(YP$_ON)	0.774635	0.065956	11.74467	0.0000
(TIME>=1992 AND TIME<=1993)	0.976634	0.066473	14.69223	0.0000
(TIME>=1996 AND TIME<=1997)	0.792225	0.068630	11.54337	0.0000
(TIME>=1989 AND TIME<=1991)	0.536847	0.056294	9.536411	0.0000
(TIME>=1985 AND TIME<=1987)	0.276139	0.055217	5.001012	0.0002
TIME=1999	-0.364641	0.092563	-3.939400	0.0017

R-squared	0.983022	Mean dependent var	2.412116
Adjusted R-squared	0.975186	S.D. dependent var	0.519986
S.E. of regression	0.081911	Sum squared resid	0.087223
F-statistic	125.4479	Durbin-Watson stat	2.037296
Prob(F-statistic)	0.000000		

Provincial Revenue: Other Direct Personal Taxes

The equation for provincial other direct personal taxes collected from Ontario residents is estimated as a function of personal income, and a set of dummy variables to account for changes in the tax system. An increase in personal income raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Provincial Other Direct Personal Tax Equation

DLOG(TOP$_ON) = -0.02336812237*LOG(TOP$_ON(-1)) + 0.01532750472*LOG(YP$_ON(-1)) + 0.6718264966*DLOG(YP$_ON) - 0.9549237852*(TIME=1990)

Provincial Other Direct Personal Tax Regression Statistics

Dependent Variable: DLOG(TOP$_ON)
Method: Two-Stage Least Squares
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1982 2000
Included observations: 19 after adjusting endpoints
Instrument list: LOG(TOP$_ON(-1)) LOG(YP$_ON(-1)) DLOG(YP$_ON) (TIME=1990)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TOP$_ON(-1))	-0.023368	0.093044	-0.251152	0.8051
LOG(YP$_ON(-1))	0.015328	0.051356	0.298457	0.7694
DLOG(YP$_ON)	0.671826	1.092048	0.615199	0.5476
TIME=1990	-0.954924	0.081784	-11.67612	0.0000

R-squared	0.940362	Mean dependent var	0.004854
Adjusted R-squared	0.928434	S.D. dependent var	0.230111
S.E. of regression	0.061559	Sum squared resid	0.056843
Durbin-Watson stat	1.067751		

Local Revenue: Other Direct Personal Taxes

The equation for local government other direct personal taxes collected from Ontario residents is estimated as a function of personal income, and a set of dummy variables to account for changes in the tax system. An increase in personal income raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Local Other Direct Personal Tax Equation

DLOG(TOL$_ON) = -0.131964272*LOG(TOL$_ON(-1)) + 0.05290504366*LOG(YP$_ON(-1)) + 0.8276989372*DLOG(YP$_ON) + 0.6534385029*(TIME=2000)

Local Other Direct Personal Tax Regression Statistics

Dependent Variable: DLOG(TOL$_ON)
Method: Two-Stage Least Squares
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1982 2000
Included observations: 19 after adjusting endpoints
Instrument list: LOG(TOL$_ON(-1)) LOG(YP$_ON(-1)) DLOG(YP$_ON) (TIME=2000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(TOL$_ON(-1))	-0.131964	0.110153	-1.198005	0.2495
LOG(YP$_ON(-1))	0.052905	0.045165	1.171367	0.2597
DLOG(YP$_ON)	0.827699	1.301809	0.635807	0.5345
TIME=2000	0.653439	0.147592	4.427328	0.0005

R-squared	0.662522	Mean dependent var	0.141576
Adjusted R-squared	0.595026	S.D. dependent var	0.187066
S.E. of regression	0.119045	Sum squared resid	0.212574
Durbin-Watson stat	1.976892		

Canada Pension Plan Contributions

The equation for Canada Pension Plan contributions collected from Ontario residents is estimated as a function of wages, salaries and supplementary labour income, and a set of dummy variables to account for changes in the tax system. An increase in wages and salaries raises tax revenue. This equation was estimated using annual data from the Provincial Economic Accounts over the period 1983-2000.

Canada Pension Plan Contributions Equation

DLOG(TCPP$_ON) = -4.840869478 - 0.4612140604*LOG(TCPP$_ON(-2)) + 0.7356460883*LOG(YWSSL$_ON(-2)) - 0.6379729692*DLOG(TCPP$_ON(-1)) + 1.083007286*DLOG(YWSSL$_ON) + 0.136262042*(TIME>1997)

Canada Pension Plan Contributions Regression Statistics

Dependent Variable: DLOG(TCPP$_ON)
Method: Generalized Method of Moments
Date: 12/09/03 Time: 14:20
Sample(adjusted): 1983 2000
Included observations: 18 after adjusting endpoints
Kernel: Bartlett, Bandwidth: Fixed (2), No prewhitening
Simultaneous weighting matrix & coefficient iteration
Convergence achieved after: 1 weight matrix, 2 total coef iterations
Instrument list: LOG(TCPP$_ON(-2)) LOG(YWSSL$_ON(-2)) DLOG(TCPP$_ON(-1)) DLOG(YWSSL$_ON) (TIME>1997)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4.840869	0.854961	-5.662091	0.0001
LOG(TCPP$_ON(-2))	-0.461214	0.080053	-5.761351	0.0001
LOG(YWSSL$_ON(-2))	0.735646	0.123714	5.946350	0.0001
DLOG(TCPP$_ON(-1))	-0.637973	0.119000	-5.361097	0.0002
DLOG(YWSSL$_ON)	1.083007	0.286807	3.776079	0.0026
TIME>1997	0.136262	0.019874	6.856399	0.0000

R-squared	0.777054	Mean dependent var	0.096755
Adjusted R-squared	0.684160	S.D. dependent var	0.060145
S.E. of regression	0.033801	Sum squared resid	0.013710
Durbin-Watson stat	1.955157	J-statistic	1.68E-21

Normalized Equations

The equations used in the model must be normalized so that the left hand side variable is expressed as a level. It is important to note that the exponent and logarithm expressions all use base '**e**' (not base 10). The equations listed below have been ordered so that they will solve recursively.

```
ygdp$_on  = ygdp_on  * pgdp_on

yp$_on  = yp_on  * (cpi_on  / @elem(cpi_on  , "1997"))

ywssl$_on  = ywssl_on  * (cpi_on  / @elem(cpi_on  , "1997"))

tdbf$_on = exp(log(tdbf$_on(-1))
         - 0.0813399076554224*log(tdbf$_on( - 2))
         + 0.0623319613695852*log(ygdp$_on( - 2))
         - 0.174016311439087*dlog(tdbf$_on( - 1))
         + 2.15063872844148*dlog(ygdp$_on)
         - 0.190676815085595*(time < 1994))

tdbp$_on = exp(log(tdbp$_on(-1))
         - 0.260972577576223*log(tdbp$_on( - 2))
         + 0.170423018643666*log(ygdp$_on( - 2))
         - 0.203112441554752*dlog(tdbp$_on( - 1))
         + 1.77921917487358*dlog(ygdp$_on( - 1))
         + 1.32330526416684*dlog(ygdp$_on)
         - 0.0238019383862193*d(ru_on)
         - 0.266626968123775*(time < 1993))

tdpf$_on = exp(log(tdpf$_on(-1))
         - 0.14804560334455*log(tdpf$_on( - 2))
         + 0.127076775175746*log(yp$_on( - 2))
         - 0.0826709204471841*dlog(tdpf$_on( - 1))
         + 0.662663222375221*dlog(yp$_on)
         - 0.168121041380998*dlog(yp$_on( - 1))
```

```
          + 0.00826833296909445*d(ru_on( - 1))
          - 0.0971091534229979*(time < 1985)
          - 0.0955851582625259*(time > 1990 and time < 1995))

tdpp$_on = exp(log(tdpp$_on(-1))
          - 0.317924102136299*log(tdpp$_on( - 2))
          + 0.248441166994963*log(yp$_on( - 2))
          - 0.373126036244063*dlog(tdpp$_on( - 1))
          + 0.63128699900321*dlog(yp$_on)
          - 0.0110146126181089*d(ru_on)
          - 0.10398229492303*(time <= 1985)
          - 0.0458582731699207*(time >= 1997 and time <= 2000))

tcsipf$_on = exp(log(tcsipf$_on(-1))
          - 0.60046632275045*log(tcsipf$_on( - 2))
          + 0.438643280526148*log(ywssl$_on( - 2))
          - 0.957494317435871*dlog(tcsipf$_on( - 1))
          + 0.272735948344412*dlog(ywssl$_on)
          - 0.00799736802123186*d(ru_on)
          - 0.131873651673284*(time = 1989)
          + 0.183750388538545*(time >= 1991 and time <= 1994)
          + 0.0906823826716824*(time > 1994 and time < 1999))

tcsipp$_on = exp(log(tcsipp$_on(-1))
          - 0.0586043635490175*log(tcsipp$_on( - 2))
          + 0.0369703561742828*log(ywssl$_on( - 2))
          - 0.307586361873964*dlog(tcsipp$_on( - 1))
          + 0.902073141299696*dlog(ywssl$_on)
          - 0.0519401494440164*d(ru_on)
          + 0.117068400022961*(time < 1991)
          - 0.150500782361195*(time >= 1997 and time <= 1998))

tof$_on = exp(log(tof$_on(-1))
          - 7.38138913243263
          + 0.774634504690094*log(yp$_on)
          + 0.976633597207542*(time >= 1992 and time <= 1993)
          + 0.792224657063288*(time >= 1996 and time <= 1997)
          + 0.536847474443372*(time >= 1989 and time <= 1991)
          + 0.276139117767916*(time >= 1985 and time <= 1987)
          - 0.364641394384175*(time = 1999))

top$_on = exp(log(top$_on(-1))
          - 0.0233681223657975*log(top$_on( - 1))
          + 0.0153275047214425*log(yp$_on( - 1))
          + 0.671826496645915*dlog(yp$_on)
          - 0.954923785160638*(time = 1990))

tol$_on = exp(log(tol$_on(-1))
          - 0.131964272017277*log(tol$_on( - 1))
          + 0.0529050436567772*log(yp$_on( - 1))
          + 0.827698937233893*dlog(yp$_on)
          + 0.65343850288895*(time = 2000))

tcpp$_on = exp(log(tcpp$_on(-1))
          - 4.84086947821893
          - 0.461214060433861*log(tcpp$_on( - 2))
          + 0.73564608826701*log(ywssl$_on( - 2))
          - 0.637972969173599*dlog(tcpp$_on( - 1))
```

```
         + 1.08300728634554*dlog(ywssl$_on)
         + 0.136262042007419*(time > 1997))

td$_on  = tdpf$_on  + tcsipf$_on  + tof$_on
         + tdpp$_on  + tcsipp$_on  + top$_on
         + tol$_on  + tcpp$_on

yd$_on  = yp$_on  - td$_on

yd_on  = yd$_on  / (cpi_on  / @elem(cpi_on  , "1997"))

hhe_on = exp(log(hhe_on(-1))
          - 0.0631209578919201*log(hhe_on( - 2))
         + 0.0635599668096959*log(yd_on( - 2))
         - 0.402311682016429*dlog(hhe_on( - 1))
         + 0.895640711435651*dlog(yd_on)
         + 1.00924967753127*dlog(n_on)
         - 0.633343214584622*dlog((1 + .01*rms_ca)/(1 + @pch(cpi_on)))
         - 0.0831550148523398*dlog(ru_on))

ib_on = exp(log(ib_on(-1))
         - 0.257494068625426*log(ib_on( - 2))
         + 0.169402749224423*log(ygdp_on( - 2))
         - 0.105679192943932*log((1/rx_ca$us( - 2))*pgdp_on( - 2)/pgdp_us( - 2))
         - 0.0568672830571183*dlog(ib_on( - 1))
         - 1.92846568843313*dlog((1 + .01*rml_ca( - 1))/(1 + @pch(cpi_on( - 1))))
         + 1.17122157901603*dlog(ygdp_on)
         - 1.89953526816419*dlog((1 + .01*rml_ca)/(1 + @pch(cpi_on))))
```

Simulation Properties

The tables in this section provide the results from a series of simulations designed to illustrate the properties of the induced impact and government revenue equations.

Real GDP was increased by $500 million in 1999. Real personal income and employment income were raised by an amount equal to their ratio relative to GDP[21]. The increase in personal income led to a rise in disposable income of $324 million and household spending of $298 million. The increase in GDP led to an increase in business investment of $64 million.

As discussed earlier, these impacts can be affected by the values of other exogenous variables in the model. The model was simulated with alternative values for each of the exogenous variables in the model and then shocked with the same increases in real personal income, employment income and GDP. The impacts from the original simulations were then subtracted from the simulations with the altered exogenous variables. The resulting difference indicates the effect upon the impacts of different exogenous variable values.

For example, raising the unemployment rate to 7.3 from 6.3 in 1999, raises the impact on disposable income to $324.2 million from $323.9 million ($0.3 million). Household spending, however, is reduced by $3.4 million to $294.3 million from $297.7 million. The experiment was then repeated with the unemployment rate being lowered to 5.3 from 6.3. This results in an

[21] Note that this analysis is intended to demonstrate the properties of the model. The results of any simulation from TREIM would yield slightly different impacts on personal income and employment income from a given change in GDP.

increase of $4.2 million in household spending. The impacts from this type of dynamic equation are sensitive to both the system's information set and to the direction of the shock.

An increase in the unemployment rate raises disposable income's share of personal income (by reducing direct taxes) but households reduce their spending in order to raise savings. Higher real short-term interest rates raise the intertemporal cost of current consumption (and, therefore, lower consumption) while higher real long-term interest rates raise the cost of capital thus reducing investment. An increase in population raises total household spending. A depreciation of the real exchange rate raises the competitiveness of Ontario's businesses and increases business investment.

Impact of Changes in Induced Income in 1999

	Real Impacts			Nominal Impacts				
	Disposable Income	Household Spending	Business Investment	GDP	Personal Income	Disposable Income	Wages & Salaries	Direct Tax Revenue
Impact on Baseline Simulation								
Real GDP + $500.0 million Real Personal Income + $386.8 million Real Wages & Salaries + $254.5 million	323.9	297.7	63.7	504.6	397.9	333.2	261.8	64.7
Impact on Custom Simulations								
Change in Unemployment Rate: t=0								
+1 percent	0.3	-3.4				0.4		-0.3
-1 percent	-0.4	4.2				-0.3		0.3
Change in Real Short-term Interest Rates: t=0								
+ 200 bp		-3.4						
- 200 bp		3.8						
Change in Real Long-term Interest Rates: t=0								
+ 200 bp			-2.2					
- 200 bp			2.4					
Change in Real Long-term Interest Rates: t=-1								
+ 200 bp			0.0					
- 200 bp			0.0					
Change in Population: t=0								
+ 100 thousand		2.7						
- 100 thousand		-2.5						
Change in Real Exchange Rate: t=-2								
Depreciate 5 cents			0.5					
Appreciate 5 cents			-0.4					

Impact on Government Revenue of Changes in Induced Income in 1999

	Federal Government				Provincial Government				Local	
	Personal	Corporate	Social Insurance	Other	Personal	Corporate	Social Insurance	Other	Other	Canada Pension Plan
Impact on Baseline Simulation										
Real GDP + $500.0 million										
Real Personal Income + $386.8 million	31.9	29.2	2.6	0.0	13.7	11.0	3.0	1.6	0.2	11.7
Real Wages & Salaries + $254.5 million										
Impact on Custom Simulations										
Change in Unemployment Rate: t=0										
+1 percent			0.0		-0.1	-0.3	-0.1			
-1 percent			0.0		0.2	0.3	0.2			
Change in Real Short-term Interest Rates: t=0										
+ 200 bp										
- 200 bp										
Change in Real Long-term Interest Rates: t=0										
+ 200 bp										
- 200 bp										
Change in Real Long-term Interest Rates: t=-1										
+ 200 bp										
- 200 bp										
Change in Population: t=0										
+ 100 thousand										
- 100 thousand										
Change in Real Exchange Rate: t=-2										
Depreciate 5 cents										
Appreciate 5 cents										