Some Experiments in Sales Tax Reform:
A General Equilibrium Simulation Approach

by

ROBERT BURTON NEWCOMB

B.Sc., ACADIA UNIVERSITY, 1985.

Thesis

submitted in partial fulfillment of the requirements for

the Degree of Master of Arts in Economics.

Acadia University

Spring Convocation 1990.

TO THE MEMORY OF MY

BELOVED GRANDFATHER

This thesis by Robert Burton Newcomb was defended successfully before the following committee on April 9, 1990.

Dr. S. Damus
(External Reader)

Dr. P. Townley
(Internal Reader)

Dr. P Hobson
(Supervisor)

Dr. R Ffrench
(Head of Department)

Dr. M. Peach
(Chair)

This thesis is accepted in its present form by the Office of Graduate Studies and Research as satisfying the thesis requirements for the degree of Master of Arts in Economics.

I Robert Burton Newcomb, hereby grant permission to the Head Librarian at Acadia University to provide copies of this thesis, on request, on a non-profit basis.

Robert Newcomb

(Author)

Paul Hobson

(Supervisor)

April 30, 1990

(Date)

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abstract

This thesis examines the choice of a tax base for federal sales taxation in Canada. The analysis is conducted using an open economy numerical general equilibrium model. Such a model permits consideration of the potential to export some of the burden of taxation to foreigners through terms of trade effects and changes in the net return paid to foreign owners of capital employed in Canada.

The thesis begins with a discussion of the issues involved in federal sales tax reform. Next, the analytical framework is described. Then alternative federal sales tax scenarios are simulated and the results discussed. Included here is the presentation of some of the results that are pertinent to the recently proposed federal goods and services tax. The results are compared with those from other studies of federal sales tax reform.

Overall, the results support the view that broad-based sales taxation promotes economic efficiency and improves welfare relative to the existing federal sales tax which is narrowly-based and highly discriminatory. The regressivity associated with moving to a broad-based federal sales tax, such as the proposed goods and services tax, appears to be offset when the impact of the proposed sales tax credit is

ACKNOWLEDGEMENTS

I would like to express my thanks and utmost appreciation to the Economics Department at Acadia University for standing behind me during the completion of this thesis. In particular I would like to thank Dr. Rudolph Ffrench for having the foresight and confidence in me to encourage me to enter the M.A. program. Also I would like to thank my supervisor, Dr. Paul Hobson, for his patience and support, without which the completion of this thesis would not have been possible.

I would also like to thank my mother and father for all their love and support and for putting up with me while I was completing this thesis. I must thank my Grandmother for her love and financial and moral support as well as her unshakeable confidence in me.

Chapter 1

Introduction

This thesis examines federal sales tax reform using a general equilibrium model. In particular, the thesis examines the issues of choice of base and rate structures.

An open-economy general equilibrium model allows for exporting some of the burden of the tax through terms of trade effects and changes in the net return to foreign owned capital. The goods and services tax as outlined in the Technical Paper issued August 1989 by the Minister of Finance is used as an actual example of a tax reform.

Two recent studies of sales tax reform in Canada (Thirsk (1987) and Hamilton and Whalley (1989)), using similar data and methodologies came up with rather different results. This discrepancy was felt to be significant enough to warrant further examination and the devotion of chapter three to the discussion of these two studies and the methodology they employ. A Thirsk-type general equilibrium model was used for the simulations conducted in this study.

One of the most contentious issues of the current

appropriate choice of tax base.

Chapter two outlines the theory of sales tax construction and reform. Section 2.1 looks at the types of indirect taxes, with section 2.2 describing the existing sales taxes in Canada. Section 2.3 discusses the judgment criteria for tax design and reform, while section 2.4 outlines the reasons for federal sales tax reforms. Section 2.5 rounds out the chapter outlining the recent tax reforms introduced by the federal government.

Chapter three compares the Thirsk (1985) and the Hamilton and Whalley (1989) study and critiques the methodologies they employed. Section 3.1 motivates the inclusion of this comparison in this study, while sections 3.2 and 3.3 detail the Thirsk (1987) and Hamilton and Whalley (1989) studies respectively. Section 3.4 compares the two studies and section 3.5 critiques their methodologies.

Chapter four outlines the general equilibrium model used to simulate the proposed tax changes examined in this exercise. Section 4.1 introduces the model and outlines the chapter, while section 4.2 gives a general description of the model. Section 4.3 specifies the production side of the

Chapter five describes the simulations conducted and their results. Section 5.1 describes the simulations conducted and their motivation. Section 5.2 outlines the welfare results with section 5.3 outlining the incidence results. Section 5.4 compares the result obtained from the simulations conducted in this study with the Hamilton and Whalley and Thirsk studies. Section 5.5 shows the sensitivity of the results to the foreign elasticity parameters, while section 5.6 gives the results of simulating the forthcoming goods and services tax. Section 5.7 finishes off the chapter with the conclusions drawn from the simulation results.

Chapter six summarizes the thesis and gives the conclusions drawn from conducting the entire exercise. Section 6.1 summarizes the thesis while the conclusions are given in section 6.2

Appendix A describes the derivation of the factor and final product demands in the model.

Appendix B describes the procedure used to remove the federal sales tax revenue from the model and calculate the new tax rates ran in the simulations conducted by this thesis.

Chapter 2 Federal Sales Tax Reform

Section 2.1 Types of Sales Taxation

There are two primary types of taxes in any tax system: direct and indirect. Indirect taxes have been traditionally distinguished from direct taxes because of their impersonal nature. Direct taxes are imposed on individuals and are typically tailored to fit an individual's tax-paying circumstances, while indirect taxes are levied against particular kinds of transactions and make no allowance for different taxpayers.[1]

Indirect taxes may apply to a large number of transactions (known as general sales taxes) or to just a few specific transactions (known as excise taxes). The base for an indirect tax is either the transaction value (ad-valorem taxation) or the quantity transacted (specific tax). Excise taxes are usually specific while sales taxes are ad valorem.

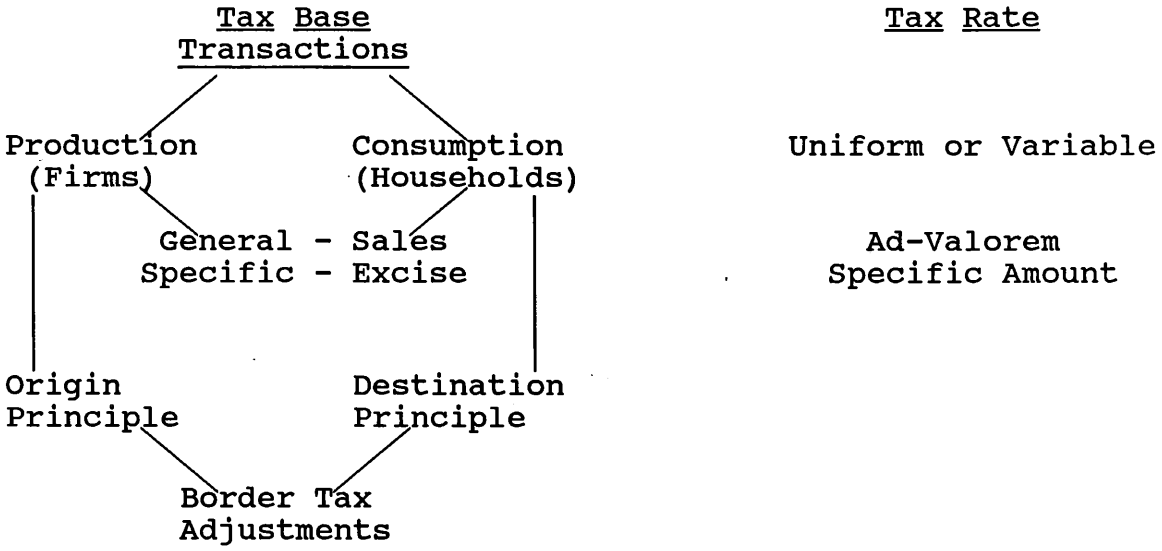
Figure 2.1 shows a variety of ways that indirect taxes can be fashioned by tax policy. The taxed transaction may be an act of production by firms in the economy or an act of consumption by households. A tax on production is based on what is known as the origin principle,[2] while a tax on

rebates of indirect taxes on exports and imposes equivalent rates of taxes on imports.

Whether a tax is origin-based or destination-based is an important consideration for how to fit it into a general equilibrium model. An origin-based tax alters the production process and thus must be entered into the production equations of the model[4], while destination-based taxes affect consumption patterns and thus must be entered into the consumer demand equations[5].

Figure 2.1

Schematic Structure of Indirect Taxes



Source: Economic Council of Canada Discussion Paper No. 294 Indirect Federal Taxes, The Cost of Capital and the Issue of Tax Incidence

it leaves the factory. Because the MST is imposed before the point of final consumption, it can be broken into three different types of taxes. 51% of the 1980 MST base was final consumption with 13.4% business acquisition of capital goods and the final 35.6% business purchases of intermediate inputs[6]. The portion of the MST base consisting of final consumption is modeled as a consumption tax. The capital goods portion of the base is modeled as a factor tax on capital. The tax on intermediate goods is modeled as a tax on value-added.

The 1989 federal budget raised the general MST rate by 1.5% to 13.5% effective June 1, 1989, the rate on construction materials increased by 1% to 9% effective January 1, 1990, and the rate on tobacco and alcohol rose from 18% to 19% effective April 28, 1989.

The manufacturer's sales tax is generally viewed as being badly flawed and harmful to the Canadian economy. The Finance Department's information package lists the following eight problems with it:

1. It discriminates in favour of imports and against domestic products;
2. It results in double taxation on many products;
3. It enables manufacturers to structure their operations to avoid the tax;

Section 2.2.2 Provincial Sales Taxes

Provincial sales taxes are imposed at the retail level with each province imposing a different rate on a different base, with the exception of Alberta which does not have a sales tax. To illustrate this, in 1983 Newfoundland had a tax rate of 12%, Nova Scotia 10%, New Brunswick 10%, Prince Edward Island 10%, Quebec 9%, Ontario 7%, Manitoba 6%, Saskatchewan 5%, and British Columbia 7%[8].

Provincial retail sales taxes are applied on the sale price of the goods to the consumer and are paid by the consumer and collected and remitted by the vendor. While food, prescription drugs, medical appliances, and farm machinery and equipment are exempt in all provinces, the treatment of other goods varies from province to province. A few examples include: Children's clothing which is exempt in every province, except Quebec and Saskatchewan; soaps and cleaning supplies which are only exempt in Prince Edward Island, Ontario, and Quebec; and production machinery which is exempt in Prince Edward Island, Nova Scotia, New Brunswick, Quebec, and Ontario[9].

Section 2.3 Criteria for Tax Reform

The criteria most commonly used to evaluate any tax

efficiency of the market. Assuming a static model with no labour/liesure choice, efficiency in the market place occurs when the three Pareto efficiency conditions[11] are satisfied. The introduction of a non-uniform sales tax into the market place creates a distortion in the market leading to a violation of one or more of these conditions. A uniform rate value-added or final demand sales tax will not violate any of the three efficiency conditions. Tax reformers are concerned about minimizing the market distortions caused by the tax system[12].

Two measures of the equity of taxes commonly used are, horizontal equity, the extent to which equals are treated equally, and vertical equity, the extent to which the burden of taxation is shared among people in different economic circumstances.

Horizontal equity means that two individuals with equal before-tax utility have equal after-tax utility. This condition is very difficult to achieve due to difficulty in measuring the income of an individual[13] and differential consumption patterns among different consumers. One individual may spend most of his income on highly taxed goods , while another may spend mostly on more lightly taxed

what is fair. The following sample of arguments shows how subjective any such analysis will be. For a progressive system, some argue that taxes should be based on ability to pay, while others use utility theory to argue that due to the diminishing marginal utility of money, higher income individuals must give up more income to give up the same degree of utility. Some argue that fair treatment is having a proportional tax system with everyone paying the same percentage of their income on the tax. Others argue that the higher income individuals use their money to create jobs and stimulate the economy and because of this they should not be taxed very heavily. A more literal interpretation of fair is to impose a lump-sum tax where all consumers make identical lump-sum payments regardless of income.

A tax must be simple to understand, easy to comply with and cheap to administer. Complex taxes are difficult to administer and incur high administration costs which eat up some of the revenue of the tax. The more complex and difficult a tax is for the vendors to comply with the greater will be the government's job to collect outstanding tax revenues.

Due to a relatively stable demand for social services,

noted that the demand for governemnt services will increase during downturns in the business cycle and decline during the boom periods while revenues will increase during boom periods and decline in recessions as national income falls. The government should look at stability of revenue to the extent that the revenue decline during a recession can be minimized.

In a democratic society, government accountability is seen as being of great importance. Knowledge of the existence of a tax and who levies it is required for accountability, which leads to the need for visible taxes. When taxes are visible, the people of the region know about them and can hold the government levying the tax accountable for it and thus replace them if they don't like the tax. This can have an affect on government policy due to the reaction of the public to the perceived incidence of a tax which may diverge from its actual and/or legal incidence.

Visibility of taxes can create a problem to the extent that they can be exported by changes in our terms of trade. In this case having the taxes visible could cause the foreign buyers to be reluctant to buy our exports since they would be paying taxes to a country in which they did not

invoices while the Exise Act, the piece of legislation imposing the tax, calls the tax a consumption tax. It is applied to a manufacturer's sales price of goods produced in Canada and to duty paid value of imported goods. Being applied at the manufacturer's level, it is incorporated into the cost structure as a tax on capital and intermediate inputs as well as entering the demand functions as a tax on final demand.

The manufacturer's sales tax discriminates against domestic goods and favours imports by adding a hidden cost of production to our locally produced goods. Imports are taxed at the duty paid rate, which is exclusive of transportation costs to the border, with our production taxed at the manufacturer's level which allows the tax to behave as three different taxes simultaneously. Some manufactured products (13.4%) are used as capital inputs in other industries. Other manufactured products (35.6%) are used as intermediate inputs for other industries, and a large portion (51%) of the manufactured output is final consumption. These capital and intermediate input portions of the MST become imbedded in the price of the manufactured goods upon which the MST is levied. Imports have very little

on imports and Canadian exports carry a degree of the tax buried in their price.

The manufacturer's sales tax causes double taxation of many industries with the corporate income tax also being levied on the output of the manufacturers. Since capital is being partially taxed by the MST, and the corporate income tax taxes corporate profits which are the return to capital, a double taxation of capital occurs due to the taxing of both the stock of capital during its accumulation and its yield upon usage. Hence the manufacturer has to pay for his capital twice.

With the tax being paid on the sale price at the manufacturer's level, firms can structure their production processes so most of the valued-added is created after the manufacturing stages. This is called vertical dis-integration. By taxing the price of the manufactured portion of the final output, companies are encouraged to break up the production process into distinct components so that the value-added in the manufacturing component of final production is as small as possible so they can aviod as much tax as possible.

The federal sales tax, being imposed at the

increased demand for imports along with a decrease in foreign demand for our exports, will cause the Canadian dollar to depreciate. Due to non-uniform tax rates across sectors the change in the exchange rate may be more than enough to offset the price increase in some sectors while not enough in others. Therefore, some exporters will benefit from the tax while others suffer. The MST burden represents more than ten percent of the profit margins of Canadian exporters.

The MST has very different effects on different commodities due to differing structures of the industries. The greater the percentage of value-added generated in the manufacturing stage of the commodity, the higher the relative effective tax rate.

The tax is unfair to low income Canadians because they pay a higher proportion of their income in sales tax.

The MST is one of the most complex sales taxes in the world which causes compliance headaches, expense for taxpayers, and costly administrative problems for the government. The problem is to determine where the manufacturing process ends and the tax-free distribution process starts in the overall production process.

value-added to after the manufacturing stage, it is an uncertain form of revenue for the government.

The need for tax reform in Canada has been heightened by the tax reforms that have and are taking place around the world. In 1986, the United States introduced sweeping reforms to its tax system lowering personal income and corporate income tax rates and broadening the base by closing loopholes. EEC countries have made value-added taxes mandatory. New Zealand also adopted a value-added tax in 1986 with Japan introducing one in 1987. The latter two countries have used the added revenue generated by the value-added tax to finance a reduction in income taxes, both personal and corporate. With our major trading partners streamlining their tax systems, Canada must keep pace to maintain its world market share for our exports.

Section 2.5 Proposed Tax Reforms

On June 18, 1987, the Honourable Michael H. Wilson, Minister of Finance, delivered a speech on proposed tax reforms for Canada. His reform package included sweeping changes to the existing system, especially to the federal sales tax system.

The Manufacturer's Sales Tax was to be replaced with

On April 26-27 1989, the next step on the road to sales tax reform was announced in the 1989 Federal Budget. In the budget papers released, the multi-stage tax to be implemented was revealed to be a goods and services tax[15] and its implementation date was set for January 1, 1991.

In August 1989, the Minister of Finance released a technical report on the implementation of the GST. The GST is to be a multi-stage tax hitting every link in the productive chain. To prevent double taxation and compounding, input tax credits will be applied to the tax remitted upon sale to the next stage of production.

Table 2.1

GST on a Washing Machine

Mine	buys ------ sells $100 ore	charges $9 tax	remits $9
Steel Makers	buys $100 ore sells $300 steel	pays $9 tax charges $27 tax	remits $18
Appliance Makers	buys $300 steel sells $600 washer	pays $27 tax charges $54 tax	remits $27
Appliance Dealer	buys $600 washer sells $700 washer	pays $54 tax charges $63 tax	remits $9 total $63

Source: The Goods and Services Tax Technical Paper Department of Finance August 1989

The mine creates $100 of value-added from mining the ore and selling it to the steel maker for $100 plus $9 tax

government. The appliance maker then uses the steel to make the washer and sells it to the appliance dealer for $600 plus $54 tax of which they deduct the $27 tax they paid on the steel and remit the remaining $27 to the government. The appliance dealer marks up the price of the washer and sells it for $700 plus $63 tax of which the $54 tax paid on the washer by the dealer is deducted and the remaining $9 is remitted to the government.

The proposed rate was to be nine percent on a base of all transactions with the following exceptions: tax-free items and tax-exempt items. Tax-free items are goods and services that have been deemed to be non-taxable at all stages of supply[16]. That is, a zero rate of tax will be imposed on the supply of these products and vendors will be eligible to claim tax credits for tax paid on items, or services, required in order to obtain these tax-free items. Tax-exempt items are not taxed at the time of sale, but vendors will not be able to claim a tax credit for tax paid on items needed in order to obtain these tax-exempt items.

Tax-free items fall into four main categories groceries, agricultural and fish products, prescription drugs, and required medical devices. Tax-exempt items also

multi-stage collection of the tax removes the added cost of paying tax on inputs bought at retail prices[17]. This allows our industries to lower their costs and be more competitive in the marketplace. The imposition of a multi-stage tax will have taxed most of the value-added before it gets to the retail level, not to mention that vendors will now have a vested interest in collecting the retail portion of the tax collected so they can get their tax credits back.

With the introduction of the tax on goods and services, the government also proposed the inclusion of enhanced sales tax credits of $3.6 billion for low income people and families, as well as an income tax rate reduction for middle income Canadians of about $700 million and a $900 million housing rebate[18].

December 19, 1989 a white paper on the Goods and Services Tax was tabled in the House of Commons amending the GST rate to 7% from 9%. Along with the rate reduction, sales tax credits were reduced from $3.6 billion to $2.4 billion. The middle income tax rate reduction was removed and the housing rebate was reduced from $900 million to $500 million. The functioning of the tax was left essentially unchanged

Endnotes

[1]Thirsk Wayne R. Discussion Paper No. 294 *Indirect Taxes, the Cost of Capital and the Issue of Tax Incidence* 1985 p.2

[2]The origin principle is taxing a commodity according to where it originated from. This allows a government to affect the production patterns within the economy by imposing differential tax rates.

[3]The destination principle says to tax commodities based on the location of their use thus allowing a government to affect the consumption patterns of the economy.

[4]When a commodity is taxed on the basis of where it was produced the market decision of where to produce it may be affected. Thus the tax must be incorporated into the production decision. However, it should be noted that an origin-based consumption tax that also exempts imports but affects consumer choice is also possible and would have be be entered in the consumer demand functions as well.

[5]When a tax is imposed based on the final consumption of a commodity the price level changes and, in the case of differential rates, will alter the consumption patterns of

[7]Tax Reform Papers 1987, Department of Finance

[8]Canadian Tax Paper No.76: Canadian Tax Policy 2nd ed, Robin Boadway and Harry Kitchen, Canadian Tax Foundation 1984

[9]Ibid

[10]Visibility of taxes in a democratic society is seen as promoting the accountability of government.

[11]The three Pareto efficiency conditions are:

1. Exchange efficiency condition:

$$MRS^{A}_{xy} = \frac{mu^{A}_{y}}{mu^{A}_{x}} = \frac{p_x}{p_y} = \frac{mu^{B}_{y}}{mu^{B}_{x}} = MRS^{B}_{xy}.$$

The marginal rate of substitution of good x for good y is equal for all consumers A,B.

2. Production efficiency condition:

$$MRTS^{x}_{lk} = \frac{MPP^{x}_{k}}{MPP^{x}_{l}} = \frac{w}{r} = \frac{MPP^{y}_{k}}{MPP^{y}_{l}} = MRTS^{y}_{lk}.$$

The marginal rate of technical substitution of the factors of production is equal to the wage/rent ratio in all production sectors.

3. Overall efficiency condition:

$$MRT_{xy} = \left[\frac{\Delta Y}{\Delta X}\right]_{production} = \left[\frac{\Delta Y}{\Delta X}\right]_{consumption} = MRS_{y}$$

The marginal rate of transformation of good x for good y

conditions, see pages 7-24 Public Sector Economics by Robin Boadway.

[12]In the sixties, due mainly to the pioneering work of Harberger, efficiency losses to society were thought to be small, in the neighbourhood of one percent of the GNP of the United States for its corporate, personal and property taxes combined. In more recent general equilibrium studies, these efficiency costs have been estimated to be as high as eight to ten percent of GNP.

[13]The income of an individual is difficult for a government to precisely determine due to non-money income sources such as the imputed income of owner-occupied housing and home production of food and other household goods. The nonrealization of capital gains also causes problems in the calculation of incomes.

[14]A multi-stage tax system is one which taxes every stage of production from raw material production to retail sales while allowing each stage of production to deduct the tax paid for its inputs from its tax liabilities for its sale of output.

[15]For a full description of the goods and services tax see the Goods and Services Tax Technical Paper issued by The

for a more detailed description of the tax base.

[17]The base of provincial sales taxes consists of 64.4% final consumption, 8.1% business acquisition of capital goods, and 27.5% business purchases of intermediate inputs. Kuo et al. (1985)

[18]See the Goods and Services Tax Technical Paper issued by the Honourable Michael H. Wilson, Minister of Finance, for a the complete details of the income supplements and credits introduced with the GST.

Chapter 3

Some General Equilibrium Simulation Studies

Section 3.1 Introduction

Since 1979, there have been several general equilibrium studies of the Canadian tax system conducted. A few of them are Ballentine and Thirsk (1979), Damus (1986), Damus, Hobson, and Thirsk (1986), Jenkins and Kuo (1985), Hamilton and Whalley (1988). Two of the more recent studies of the effects of sales tax reform (Thirsk (1985) and Hamilton and Whalley (1989)) yielded rather different incidence and welfare results using data from the same base year. Why should two studies using the same base year data, and the same analytical technique, yield such different results? The following chapter examines this question.

Section 3.2 The Thirsk Study

Section 3.2.1 The Objective

In 1985, Wayne Thirsk published a discussion paper for the Economic Council of Canada entitled: Indirect Federal Taxes, the Cost of Capital and the Issue of Tax Incidence. In his paper, Thirsk examined the appropriate role of indirect taxes in the Canadian tax system as well as their

equilibrium model developed in Ballentine and Thirsk (1979). It is an extended and disaggregated version of the basic Harberger model of tax incidence that captures Canada's important trade and capital market connections with the rest of the world and permits some portion of Canadian tax changes to be borne by foreign consumers or foreign taxpayers. The model contains a public sector financed from a variety of revenue sources including personal income taxes, corporate income taxes, property taxes and commodity taxes.

Production takes place in six sectors: two export sectors comprised of fixed priced and flexibly priced exports and four sectors producing non-traded output. One of these is a corporate sector producing both consumer and capital goods while the other three consist of essentially non-corporate output such as housing, domestic agriculture and a heterogeneous mixture of services. The flexibly priced export sector is also a predominantly corporate sector of the economy. Households consume five different kinds of output: the four non-traded outputs plus imports from the rest of the world which are considered imperfect substitutes in consumption for all kinds of domestically produced

households supply capital, labour and land resources to the economy. In addition, the rest of the world supplies some capital to the economy. Domestically supplied land, labour and capital are fixed in his model. Households are assumed to be utility maximizers and their demand functions exhibit the property of weak separability. This means that their utility gained from the consumption of one type of output is unaffected by the consumption of other types of output, not an unreasonable assumption given the large consumer aggregates used in the model. Firms are assumed to behave as perfectly competitive profit maximizers and to face production functions that display constant returns to scale.

The housing, domestic agriculture and fixed priced export sectors employ three-factor bundles of labour, capital and land services. All other sectors employ only capital and labour in production. Domestic capital and labour are assumed to be perfectly mobile between alternative employments while land is assumed to be perfectly mobile between domestic agriculture and fixed price exports and imperfectly mobile between these two sectors and the housing sector. In most cases, foreign capital is assumed to be imperfectly mobile between Canada

models capital as responsive to net or after-tax returns to capital.

Sufficient price flexibility is assumed in the economy to ensure full employment of all resources. Savings undertaken by both the private and public sectors are viewed as expenditures on the purchases of capital goods in the economy. The model is still considered a static one because the evolution of the economy over time with growing factor supplies is not considered. A balance of payments equilibrium is satisfied in the sense that the value for exports is matched by payments for imports and services supplied by owners of foreign capital. Alternatively, capital incomes received by foreign capital owners represent the difference between gross domestic and gross national product in the model.

Section 3.2.3 Data

Thirsk constructed a micro consistent data set for the 1980 Canadian economy using the methodology employed by Ballentine and Thirsk (1979). The input-output model was solved for direct and indirect inputs of primary factors to the production of the six goods in final demand. This transformation of final demands into primary factor demands

the tax structure of the economy, while government income and expenditure tables provided the relevant data on the public sector.

Section 3.2.4 Results

In his study, Thirsk performed three experiments testing changes in the tax mix between direct and indirect taxes. For his first experiment, he simulated the substitution of an increased income tax for the MST. He found that by replacing the MST with a higher personal income tax the bottom four income deciles of the economy would benefit while the top decile would suffer a welfare loss. The net gain to the ten groups as a whole was positive. He found that these results were relatively insensitive to variations in the parameters of the model and the model variant used.

His second experiment consisted of replacing the MST with higher personal and corporate income taxes. (The results were similar to his first experiment, however this time the bottom seven deciles showed an improvement in welfare while the top decile showed a decline with an overall welfare improvement for the entire economy.) This time he found that the size of the improvements depended on

tax with a broadly based uniform rate sales tax. This change showed a regressive incidence with the bottom five deciles suffering a welfare loss with the upper deciles enjoying a welfare gain. (The economy as a whole experienced a slight welfare loss however Thirsk opined that the increase in intertemporal efficiency would offset this decrease.)

Thirsk combined the results of experiments one and three to derive the effects of substituting a broad-based sales tax for the current MST. He found that such a substitution would yield welfare gains of $335-$370 million and would have a highly regressive incidence pattern with an income transfer from low income groups to high income groups.

Section 3.3 The Hamilton and Whalley Study

Section 3.3.1 Objective

Hamilton and Whalley (1989) conducted a study to evaluate some of the impacts of possible changes in indirect taxes in Canada using a general equilibrium model. They examined the efficiency and distributional impacts for a variety of changes including the replacement of existing federal and provincial sales taxes with a broad-based equal-yield alternative sales tax.

produce traded goods while nine produce non-traded goods. Production is represented by CES value-added functions and nested CES intermediate requirement functions. Capital and labour services are the primary inputs in each industry while the output of other industries enter as intermediate inputs in each industry.

The model defines twenty-three consumer expenditure categories which are compatible with both the Family Expenditure Survey Classification and the input-output data[1]. These are modeled as a CES function transformation of producer goods into consumer goods via the margin industries[2].

The household income sector of the economy is modeled as having forty-two income groups which allow for the distributional effects of sales tax changes to be observed. The data for household incomes is based on spousally-linked household data supplied by Revenue Canada. The proportion of labour income from the various sectors is assumed to be constant across all income groups. A major implication of this assumption is that differential changes in relative wage rates across sectors will affect all income groups relatively the same. This assumption is very *ad hoc* because

skilled occupations in othern sectors.

The demand side of the model is based on household utility-maximizing behavior and includes a labour/leisure choice by households. Nested CES demand functions are utilized along with an implicit assumption of separability to nest items according to their treatment under sales taxes.

Their model also includes a consolidated government sector which raises revenue through taxes and spends it on transfers to persons and the purchase of goods and services according to preferences represented by a CES utility function. Transfers to persons are assumed to be fully indexed to the general price level.

All major components of the Canadian tax system are included in the model. The federal sales tax, provincial sales taxes and other excise taxes and duties are modeled as ad valorem taxes on both intermediate and final purchases of goods, with margin industries excluded from the federal sales tax base. Property and corporate taxes appear as taxes on capital inputs by industry while CPP and UIC contributions appear as payroll taxes with personal income tax appearing as a tax on household incomes.

capital is exogenous so long as capital is assumed to be internationally mobile. Traded commodities are assumed to be homogeneous across countries, so that only net flows are of concern. This assumption of homogeneous traded goods leads to complete international specialization unless there is a commodity-specific immobile factor of production for each traded good. To get around this problem, Hamilton and Whalley make the ad hoc assumption that half of the labour used in each traded good is immobile. They test the sensitivity of this analysis by running their experiments with twenty percent, fifty percent, and eighty percent of the labour used in each traded good being immobile. They found their welfare results to be rather insensitive to the variation in mobility while their output results were highly sensitive to it.

Another implication of the small open economy assumption is its exclusion of any alteration of the terms of trade. Since all traded prices are fixed, any tax reforms can only alter the volume of trade relative to domestic production, which will have welfare effects on the economy but no terms of trade changes.

They use two model variants in their study. The first

Section 3.3.3 Data

Hamilton and Whalley also constructed a micro-consistent data set for the 1980 Canadian economy from input-output data, national accounts data and the family expenditure survey. They used the procedures outlined in St. Hilaire and Whalley (1983) to make the necessary adjustments to ensure micro-consistency.

They utilized the procedures from Mansur and Whalley (1984) to calibrate the model to reproduce the micro-consistent data set in the absence of any policy changes. These procedures use the data set along with exogenous elasticity values to determine parameter values for the CES functions used in the model. Specification of elasticities of substitution are required whenever CES functions are used, so they were obtained from estimates in the literature.

Section 3.3.4 Results

Hamilton and Whalley obtained the following results from their simulations.

Table 3.1
National Welfare Results

They used one model variant to examine the efficiency of the three taxes (the MST, Provincial sales tax, and a broad based sales tax) by comparing the marginal excess burden (MEB)[3] of the various taxes. A broad based sales tax was shown to have the lowest MEB at 7.3 cents per dollar of revenue raised while the provincial sales tax had a MEB of 16 cents per dollar with the MST having a MEB of 34.8 cents per dollar.

Hamilton and Whalley also attained the following incidence pattern for replacing the MST with a comprehensive sales tax. The figures in table 3.2 represent the welfare gains as a percentage of income. The incidence patterns achieved are bell shaped with the bottom income groups getting increasingly better off while the top deciles get progressively less better off.

Table 3.2

Welfare Gains by Income Group
(welfare gains as % of income

Income Range ($'000)	No Exclusions	Excluding Food	Excluding Clothing	Excluding both
0-10	.07	.14	.04	.10
10-20	.30	.32	.29	.31
20-30	.35	.36	.35	.36
30-40	.37	.37	.38	.37
40-50	.40	.37	.38	.37
50-60	.41	.38	.42	.38
60-70	.36	.30	.37	.31

Section 3.4 Comparison of the Studies

The two studies described above use similar data but produce very different incidence results for the replacement of the MST with a broad based sales tax. Hamilton and Whalley found this reform proposal to improve national welfare by $672.6 million, while Thirsk found it to be in the neighbourhood of $335-$370 million. Thirsk found the reform to be highly regressive with the bottom decile experiencing a welfare loss of .49 percent of real income while the top decile experiences a welfare gain of .46 percent while Hamilton and Whalley found the change to yield a bell shaped incidence with every decile experiencing a welfare improvement when nothing is excluded from the base and only the highest income decile experiencing a loss of welfare when food and/or clothing is exempted from the base.

Hamilton and Whalley explain the discrepancy in the magnitude of the welfare change as a matter of aggregation. They propose that the Thirsk model is too highly aggregated to capture the full effect of the intersectoral shifts that occur as a result of the proposed reform. Thirsk eliminated intermediate goods and thus their distortion caused by the

The two models diverge in their modeling of the foreign sector of the Canadian economy with Hamilton and Whalley assuming a price-taking economy while Thirsk models a degree of price flexibility in some foreign trade. This allows Thirsk to assume perfect mobility of capital and labour domestically while Hamilton and Whalley must assume a degree of factor immobility to avoid the problem of complete specialization. To avoid the problem of two way trade flows, Hamilton and Whalley only model net trade flows. They neglect to state how they model import duties in their model. These differences in the foreign sector, along with the fact that Thirsk also explicitly models land as a factor of production in three of his production sectors, would have repercussions on the change in the returns paid to households for supplying factors of production. Thus it is understandable that they found different incidence patterns and different welfare costs.

Thirsk in his study uses large consumer aggregates which allow him to assume separability of demands. Hamilton and Whalley also assume separability of demands however at such a disaggregated level this assumption must be questioned. Hamilton and Whalley appear to have used this

simultaneously.

Section 3.5 Critique

The Hamilton and Whalley model used a simplex solution algorithm as described in Mansur and Whalley (1982), while, Thirsk's model uses a local linearization technique[5] to attain a solution for equilibrium. Both procedures involve calibrating the model by using the benchmark data set to solve for the parameters that generate it and then using these parameters to solve for the counterfactual data set upon introduction of reforms into the model. As a result, the solutions are based on an approximation that is accurate in a small area around the point of initial equilibrium, thus any significant variation from the initial point would greatly reduce the accuracy of the results.

These models are static ones that use 1980 data sets. The fact that these are a static analysis means that any intertemporal considerations must be ignored. Thus the significance of these effects will reduce the certainty of the results obtained.

General equilibrium studies are plagued with a lag in the data. The sheer volume of data needed to document an entire economy takes years to compile. This lag in the data

deciles could have significant effects on the incidence pattern observed as compared to those projected.

Despite its shortcomings, general equilibrium analysis is the most comprehensive form of incidence analysis available to the policy maker at present and, even with its short comings, its results can be used as a ball park estimate to work with.

Endnotes

[1]They felt that forty-four industries and twenty-three expenditure categories represent enough commodity detail to capture the effects of differing sales tax treatment across commodities.

[2]Margin industries are industries that purchase or transport producer goods for the purpose of resale or sale as consumer goods without significantly altering their physical condition. Examples are the transportation, wholesale trade and retail trade industries. These are what the layman calls the "middleman" industries.

[3]The MEB is calculated as the change in national welfare divided by the increase in real government revenue. Real government revenue is defined as total revenue collected less transfer payments divided by a price index applicable to the government's purchases of goods and services.

[4]Hamilton and Whalley use nested CES utility functions. The product mix in each nest is the nesting pattern.

[5]Local linearization is a mathematical technique that uses the linear approximations of functions about a particular point. The difference of the first derivatives of

region and the function defining the constraint. The first derivative describes the slope of a function at a particular point in the domain and range of the function. In a small neighbourhood around that point, the derivative of the function very closely approximates the original function. Therefore, in the small neighbourhood around the point of tangency, a linear function derived from the derivative and the point of tangency is used to approximate the locus of optimum points for the constrained region as small parameter changes are made.

CHAPTER 4

The Model

Section 4.1 Introduction

This chapter describes the model used to run experiments testing the welfare change and incidence of substituting a broad-based sales tax for the MST. The model used is the same as that used by Damus, Hobson, and Thirsk (1987, 1988).

Section 4.2 gives a general description of the model while section 4.3 outlines the production technology and its resulting factor demands. Section 4.4 examines the utility functions, their assumptions, functional forms and the implied commodity demand functions. Section 4.5 looks at how foreign demand for Canadian exports is modeled with section 4.6 examining the issue of the supply of foreign capital.

Section 4.2 General Description

This study uses the general equilibrium model which was used by Damus, Hobson and Thirsk (1988). Consumers are split into ten distinct groups corresponding to the deciles of the income distribution in the Canadian economy. Each consumer

three factors of production are all employed in the housing, agricultural, and fixed-priced export sectors. The other sectors only use labour and capital. The factors of production are assumed to be perfectly mobile between sectors with the exception of land used in housing. The supply of labour and land in the economy is assumed to be fixed. Capital is assumed to be perfectly mobile between sectors and imperfectly mobile internationally.

The seven Canadian production sectors in the model are:

1. Food, (sector A). This sector consists of all domestically produced agricultural production consumed domestically. It also includes all domestic food processing production that is consumed domestically.

2. Housing, (sector H). This sector consists of all the industries involved in the production and maintenance of residential property. This includes all building supply industries, as well as construction firms that specialize in residential construction.

3. Corporate, (sector C). This sector includes all domestically consumed domestic manufacturing industries whether they are incorporated or not.

contains the exporting industries that face an externally predetermined price over which they have no influence to change. The main industries in this category are the agricultural exporters.

6. Flexible-priced exports, (sector E). This sector contains all the industries that do have some influence over the price of the goods exported. These industries tend to be mostly manufactured products, although some mineral exporters and service industries have some influence over their market price. Two prime examples are potash and tourism. Canada holds a large share of the world supply of potash and thus has some influence over its price. In tourism, the transactions take place domestically and usually in a monopoly position (i.e. tourist traps) local tourist operators do have a degree of market power.

7. Government services / public goods, (sector G). This sector consists of all the goods and services produced by all levels of government in Canada.

In the model, Canada is treated as an "almost" small open economy. The prices of fixed-priced exports and imports are exogenously given. Canada is assumed to have some monopoly power over the price of its flexibly priced

internationally mobile, it is not assumed to be perfectly mobile. This makes the elasticity of supply of foreign capital a very important piece of information. Also, the elasticity of foreign demand for Canadian exports is a very important piece of information as well.

The production functions are of the nested CES type. A literature search was relied on to furnish plausible estimates of the relevant parameters. A study by Burgess (1985) gives the elasticity of foreign demand for flexibly priced exports as -2.5. Hood et al (1982) gave 2.5 as the elasticity of supply of foreign capital. Murray (1982) has estimated that the elasticity of supply of foreign capital is between one and three.

Each commodity sector is an aggregate of consumers' demands with each differing essentially in its treatment under the corporate income tax. Both sectors C and E produce corporate output with sector E's output being traded, while sector C's output isn't. Sectors A and F both produce agricultural output with sector A's output being consumed domestically and sector F's output being traded. By the use of input-output tables, a dollar of expenditure on each category of output can be translated into value-added

(1985) is the source of the information on the tax rates used to determine the corporate and property tax payments in each industry. In all there are seven industries in the model and five consumer choice categories.

The five consumer choice categories are housing, domestic agriculture, domestically consumed corporate output, services, and imports.

The government sector is assumed to produce output according to a standard production function with capital and labour as its inputs. It is assumed that government sector production yields a separable "government utility".

Since the model is one of an open economy, it gives rise to an implicit exchange rate. This implicit exchange rate gives the price in Canadian dollars paid for fixed-priced imports. Given world prices of imports and all other prices, the exchange rate merely adjusts to ensure a balance of payments equilibrium. Except for this, the exchange rate is redundant.

Section 4.3 Specification of Technology

In this model production functions are assumed to be of the CES type[2]. Three factors of production, land, labour, and capital, are assumed. Land is only assumed to be used as

$$Q_i = \alpha_i[\delta_i L_i^{-\rho} + (1-\delta_i)\{[\gamma N_i^{-\pi} + (1-\gamma)K_i^{-\pi}]^{-1/\pi}\}^{-\rho}]^{-1/\rho}$$

for the three sectors that use land as a factor; Q_i is the quantity of commodity i produced; L_i is the amount of land required to produce Q_i; N_i is the amount of labour required to produce Q_i; K_i is the amount of capital that is required to produce Q_i; and

$$Q_i = \alpha_i[\delta_i N^{-\rho} + (1-\delta_i)K^{-\rho}]^{-1/\rho}$$

for the sectors that do not use land as a factor. It should be noted here that the values for ρ and π will be different for each sector. It should also be noted that constant returns to scale are assumed for all production processes. Another assumption that is implicit in use of CES functions is linear homogeneous technology[3].

Assuming perfect competition implies that the factors are paid the value of their marginal product. Based on this, it is possible to derive demand functions for the factors from the production functions using the optimization techniques outlined in Henderson and Quandt (1980).

The demand functions[4] for the factors in the three-factor sectors are:

$$L_i = \frac{(1-\delta)^{1/1+\rho} C_i}{\left[p_z^{\rho} p_1 \delta\right]^{1/1+\rho} + (1-\delta)^{1/1+\rho} p_{1_i}}$$

$$N_i = \frac{\gamma^{1/1+\pi}\left[C_i - p_l\left[\frac{(1-\delta)^{1/1+\rho}C_i}{\left[p_z^{\rho}p_l\delta\right]^{1/1+\rho} + (1-\delta)^{1/1+\rho}p_l}\right]\right]}{\left[p_n p_k^{\pi}(1-\gamma)\right]^{\frac{1}{1+\pi}} + \gamma^{1/1+\pi}p_k}$$

for land, capital and labour.

p_z is the input cost of the optimal combination of capital and labour needed to maximize profit in the ith three factor sector. C_i is the total input cost of the ith sector.

The demand functions[5] for the factors in the two-factor sectors are:

$$K_i = \frac{(1-\delta)^{1/1+\rho}C_i}{\left[p_n^{\rho}p_k\delta\right]^{1/1+\rho} + (1-\delta)^{1/1+\rho}p_k} \quad \text{for capital;}$$

$$N_i = \frac{\delta^{1/1+\rho}C_i}{\left[p_k^{\rho}p_n(1-\delta)\right]^{1/1+\rho} + \delta^{1/1+\rho}p_n} \quad \text{for labour.}$$

Section 4.4 Specification of Utility

The utility functions are CES type. The utility functions for each of the ten consumer groups have five final demand commodities plus a public goods commodity as well. There is no labour/leisure choice considerations in the model[6]. The utility derived from each of the consumption goods is assumed to be separable due to the large consumer

consumption goods, along with the utility derived from the consumption of capital and labour, is assumed to be separable due to the consumer aggregates they represent.

The utility function for the ith consumer group is:

$$U_i = u_i[\sum_{j=1}^{4} \upsilon_j X_j^{-\tau}]^{-1/\tau}$$

where U_i = total utility of ith consumer.

X_j = the amount of commodity j consumed (public goods and imports included)

υ_j = commodity j's budget share

u and τ are the standard CES function parameters.

The utility function for the government sector is:

$$U_g = Q_g$$

where U_g = total utility of the government sector.

Since this is a static model savings are modeled as the purchase of capital goods not yet in production. This means that it is assumed that each consumer will spend their entire budget. This assumption allows us to derive demand functions for the five final demand categories.

The demand function[7] for commodity X by consumer i is:

$$X_i = \frac{\nu_x I_i}{p_x^{\tau} \sum_{k=1}^{4} \nu_k p_k^{1-\tau}}$$

Section 4.5 Foreign Demand

In this model, two export sectors are explicitly modeled. In the case of fixed-priced exports, Canada is viewed as a small open economy accepting an exogenous world price of the export. In the other case, the flexibly-priced exports, Canada is viewed as producing imperfect substitutes for Canadian imports and thus has a degree of price-setting control.

The elasticity of foreign demand for all Canadian priced exports has been estimated to be -2.5 by Burgess (1985). This is the most recent estimate found at the time of this study.

Section 4.6 Foreign Capital Flows

In this model, domestic and foreign capital is imperfectly mobile internationally. Capital flows and all international capital service payments are net.

It has been traditionally thought that foreign capital was highly integrated and thus capital flows will respond to differentials in the net rate of return to capital. This means that if the after tax return to capital falls the rate of inflow will fall or even reverse.

With the introduction of foreign tax credits, some

profit abroad, when it repatriates its earnings it must pay corporate income tax on it. A foreign tax credit allows the firm to deduct the amount of tax it paid in the foreign country from its home tax bill. Thus as long as the tax rate in the host country is less than the home country tax rate, the effective corporate tax rate will be that of the home country[8]. Given this, an increase in the gross rate of return to capital in Canada will result in an inflow of foreign capital. Hence, for example, an increase in the corporate tax rate in Canada that raises the gross returns to capital will result in a inflow of foreign capital even though the net return to capital in Canada may have fallen.

The capital service flow function is

$$K = c[1 - (-r/\pi e)^{n}]$$

where c = a calibrated parameter of the model

r = Canadian rental rate on capital

π = U.S. rental rate on capital

e = exchange rate ($ Canadian per $ U.S.)

and $n < 0$.

Section 4.7 Model Variants

There are two basic variants of this model used in this study. The first variant assumes a fixed supply of labour

constant in all the simulations conducted with this model variant.

The second variant of the model assumes that domestic corporate tax rates are either higher than abroad or an insignificant portion of foreign profits are repatriated which leads to capital flows responding to the net return it receives. Once again, government revenue is held constant to examine the effect of revenue-neutral tax reforms.

Endnotes

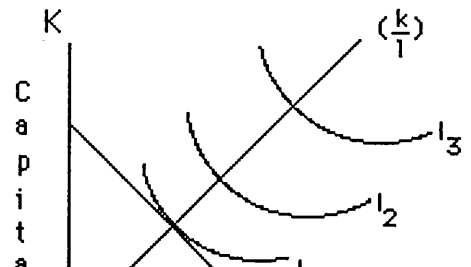
[1]Cross-hauling is a situation where a trading unit (country, province, state, territory, *etc*) will export identical goods in one region and import them in another.

[2]Damus (1986) gives a detailed description of a similar model.

[3]Implicit in the assumption of linear technology are the following: 1. The amount paid to the factors of production would exhaust the amount received for the product; 2. The input ratios are independent of the quantity of output, which gives a straight line expansion path emanating from the origin. On the graph, I_1, I_2, and I_3 represent isoquants for progressively larger quantities of output.

Figure 4.1

Isoquant Graph



[4]See appendix B for derivation

[5]ibid

[6]Since the proposed tax reforms examined in this study had only a negligible affect on the relative wage rate, and therefore, would have a minimal affect on labour\leisure choice it was decided not to use a model variant that incorporated a labour/leisure choice.

[7]See appendix B for derivation.

[8]For a more complete explanation of this see Ballentine and Thirsk (1979).

Chapter 5

Simulations

Section 5.1 Tax Reform Experiments

This chapter details the experiments conducted in this thesis. The first four experiments were designed to determine the most appropriate base for an equal rate federal sales tax, while the fifth and final experiment examined the implications of the new goods and services tax.

Section 5.1.1 Procedures used to Derive Equal-Yield VAT Rates

The first step toward deriving the new tax rates to be entered into the model was to collect the indirect tax revenue data from Statistics Canada publications, 68-202 Consolidated Government Finance (annual 1980 and 1981) and 68-211 Federal Government Finance (annual 1980). Total indirect tax revenue was found to be $20.154 billion, federal sales tax revenue was found to be $4.698 billion and Consolidated government sales tax revenue was found to be $11.640 billion. The benchmark data set contained total indirect tax revenues of $19.122 billion which made scaling of the FST revenue necessary. The published FST revenue was adjusted by multiplying it by the ratio of the model's total

the amount of FST revenue ($579 million) entered as a capital tax. This amount was then deducted from the adjusted amount and the result used in the recalculation of the sales tax rates for the experiments conducted in this thesis.

In order to find the amount of FST revenue paid by the import sector, import duties had to be modified and removed from the sales tax revenue collected by the import sector. This was done as outlined previously with the FST revenue to yield adjusted import duties of $3.025 billion. These import duties were then deducted from the total import sector indirect tax revenue ($4.729 billion) to yield $1.704 billion. The amount of FST collected in the import sector ($688 million) was found by multiplying $1.704 billion by .4036 (FST share of total sales tax revenue).

The model exempts the food, housing and commerce sectors from the FST base. The sales tax revenue from the export sectors was assumed to be 90% FST and 10% provincial and local sales taxes. It was believed that the provincial retail sales taxes, being imposed at the retail level and exempted from external sales, would have much lower cascading[1] effects on the price of exports. The amount of FST revenue collected in the fixed-price export sector was

This amounts to $2.732 billion.

The remaining sales tax revenue in each sector was then divided by the value-added in each sector to obtain the base value-added tax rate. The experimental VAT rates used for the simulations in this thesis were these base rates plus the equal-rate VAT.

Table 5.1

VAT Base and Rates*

Experiment	$ billions	Rate
1 (no excl.)	252.060	1.77%
2 (food excl)	232.900	1.91%
3 (exports excl)	191.104	2.33%
4 (food & exports excl)	171.944	2.59%

*see appendix B for derivations

Table 5.2

Model Sales Tax Rates*

Sector	Pre-reform	Post-reform			
		Exp. 1	Exp. 2	Exp. 3	Exp. 4
Import	0.099627	0.102815	0.104270	0.108455	0.111054
Housing	0.000000	0.017682	0.019137	0.023322	0.025921
Food	0.000000	0.017682	0.000000	0.023322	0.000000
Commerce	0.049510	0.067192	0.068642	0.072832	0.075431
Corporate	0.167028	0.148982	0.140437	0.154622	0.157221
Fix-price	0.008367	0.018502	0.019957	0.000820	0.000820
Flex-price	0.008346	0.018523	0.019978	0.000841	0.000841

* see appendix B for calculations

Therefore, the corporate income tax rates must be adjusted when the FST is removed.

The capital tax portion of FST revenue was $579 million. This revenue was multiplied by the sector shares of the corporate income tax base to distribute it across sectors. The amount of corporate income tax revenue for each sector was then adjusted by deducting the FST revenue from each sector and the new corporate income tax rates were calculated. Table 5.3 shows the old model rates along with the new ones. See appendix B for the detailed calculations.

Table 5.3

Corporate Income Tax Rates*

Sector	Model	Post-reform
Housing	0.060880	0.049628
Food	0.185792	0.174426
Commerce	0.169563	0.158246
Corporate	0.273410	0.262081
Fix-priced	0.370179	0.358815
Flex-priced	0.354738	0.343466

* see appendix C for calculations

Section 5.1.3 Experiments

The first four experiments examined the replacement of the federal sales tax with an equal yield sales tax. Each experiment examined a different base for an equal rate

The first experiment tested a base that included all non-government sources of value-added. This consisted of all non-traded sectors, as well as the import and export sectors. The motivation of this choice comes from the fact that in the absence of intertemporal and labour/leisure choice considerations the introduction of a uniform rate sales tax on all output will not distort the allocation of the output within a tax-free economy and hence be the most efficient tax. The equal yield rate was calculated to be 1.77%

It has been argued that food should be exempted from any consumption tax base on the grounds that its inclusion would have a regressive impact across income levels due to the lower income groups spending a larger proportion of their incomes on food than the higher income groups do. This led to the second simulation which allowed food to be the only exemption from the tax base used in the first simulation to see if this incidence argument has any validity and to examine the efficiency effects of the exemption of food from the tax base as well. The equal yield rate was calculated to be 1.91%

It is accepted economic practice to try to expand any

to be 2.33%

The fourth simulation exempted the food sector along with the export sectors from the tax base. This choice was in response to Department of Finance criticisms of the FST. The equal yield rate was calculated to be 2.59%.

The final simulation examined the effects of the implementation of the proposed goods and services tax at the originally proposed nine percent rate. The results of these simulations are shown in section 5.6. In this experiment, the sales tax credit is modeled as a reduction in the effective income tax rate of the low income groups. The sales tax changes and income tax rate changes are modeled as described in the technical report on the goods and services tax. A non-revenue neutral simulation was run to examine the effects of implementation of the GST.

In the absence of other taxes, the broader the base the more efficient a uniform rate tax should be. Due to the distortions caused by the rest of the current tax structure, the differential treatment under the FST may have behaved in a second best manner to offset some of these distortions and cause the substitution of a uniform rate sales tax for the FST to be less efficient than the existing FST.

narrowing of the base. For example, does the incidence result justify the efficiency loss?

A real world example of this policy dilemma is the GST being introduced by the federal government. It is introducing a uniform rate sales tax with the food and export sectors exempted from the tax base. It is also introducing sales tax credits and income tax reductions in an attempt to alter the incidence of the tax reform.

Section 5.2 Welfare Results

As expected, the substitution of a broad based uniform rate value-added tax for the FST showed an efficiency gain over the current FST of approximately $157.0 million using the first model variant, which assumed that foreign capital flows responded to gross returns to capital, and $172.8 million for the second model variant, which assumed that foreign capital flows responded to net returns to capital. Both variants also showed a marked improvement in the terms of trade[3] with an increase in national welfare of $195.5 million for the first variant and $193.3 million for the second with a combined national welfare improvement of $352.4 million from the first one and $366.1 million from the second. These welfare results along with the welfare

gain and $246.2 million from improvements in the terms of trade. The net returns variant yielded an overall welfare improvement of $363.0 million with $117.6 million due to gains in efficiency and $245.3 million resulting from the terms of trade change.

Exempting the export sectors yielded a national welfare gain of $58.9 million under variant one due to a reduction in the terms of trade to the tune of $140.7 million and an efficiency gain of $199.6 million. Variant two yielded a welfare improvement of $121.8 million which was composed of an efficiency gain of $276.7 million and a reduction in the terms of trade by $154.9 million.

Exempting the food sector along with the export sectors led to a national welfare loss of $37.3 million in the gross returns case with efficiency gains of $128.1 million while terms of trade movements lead to a welfare loss of $165.4 million. The net returns variant showed an overall welfare improvement of $23.9 million which can be broken down into an efficiency gain of $203.0 million and a terms of trade decline of $179.2 million.

Table 5.4

Welfare, Efficiency and Terms of Trade Changes!

Experiment		Efficiency Gains	Gains From Terms of Trade	Welfare Gains EV
1	Gross	157.0	195.5	352.4
	Net	172.8	193.3	366.1
2	Gross	110.3	246.2	356.5
	Net	117.6	245.3	363.0
3	Gross	199.6	-140.7*	58.9
	Net	276.7	-154.9*	121.8
4	Gross	128.1	-165.4*	-37.3
	Net	203.0	-179.2	23.9

! quantities in $ millions

* negative denotes a loss

Section 5.3 Incidence Results

In the first simulation, the replacement of the FST with a uniform rate broad-based federal sales tax had both model variants showing a regressive incidence with the net returns variant yielding slightly larger welfare improvements for the third to seventh income groups. Both cases showed that the bottom two deciles experience a welfare loss while the amount of welfare improvement increased steadily as one went from the bottom decile to the top decile. These incidence results are shown in table 5.5.

Table 5.5

Experiment 1 Incidence Results by Income Group

(EV in $ million)

Income Decile	Gross Returns to Capital	Net returns to Capital
1	-12.1	-11.5
2	- 8.1	- 8.1
3	2.2	3.3
4	6.9	8.3
5	12.9	16.1
6	22.0	24.0
7	40.8	43.1
8	61.6	61.6
9	80.2	80.2
10	159.0	159.0

With the exemption of the food sector from the tax base, the incidence pattern remained basicly the same as in the first simulation. However, this time only the bottom income group experienced a welfare loss and welfare gains increased with income. The net returns variant of the model had a slightly higher welfare gain for the fifth and sixth deciles . The magnitude of the welfare changes were smaller than the first simulation. These incidence results are shown in table 5.6.

Table 5.6

Experiment 2 Incidence Results by Income Group

(EV in $ million)

Income Decile	Gross Returns to Capital	Net returns to Capital
1	- 4.9	- 4.9
2	4.8	4.8
3	12.2	12.2
4	16.7	16.7
5	24.1	25.7
6	26.1	28.1
7	45.5	45.5
8	58.8	58.8
9	70.2	70.2
10	124.2	124.2

The exemption of the export sectors also yielded a strictly regressive incidence with the bottom five income deciles experiencing a welfare loss for the net returns model variant while the gross return variant showed welfare losses for the bottom six income groups. Steady declines in welfare loss among the income groups experiencing welfare losses, with the exception of the second decile, and steady increases in the welfare gains among the deciles that felt better off were obtained. These results are shown in table 5.7.

Table 5.7

Experiment 3 Incidence Results by Income Group

(EV in $ million)

Income Decile	Gross Returns to Capital	Net returns to Capital
1	-24.2	-24.2
2	-30.6	-28.2
3	-22.1	-18.8
4	-20.8	-13.9
5	-19.3	- 9.6
6	- 8.0	4.0
7	7.2	19.2
8	25.2	36.4
9	43.5	56.8
10	124.2	134.2

With the exemption of the food and export sectors in the fourth simulation, the incidence pattern remained strictly regressive with the bottom seven income groups experiencing a welfare loss while the top three gained in the gross returns model variant. The transition from gainers to losers occurred at the seventh income group for the net returns case with the top four deciles believing they were better off. These incidence results are shown in table 5.8.

Table 5.8

Experiment 4 Incidence Results by Income Group

(EV in $ million)

Income Decile	Gross Returns to Capital	Net returns to Capital
1	-15.4	-14.8
2	-18.5	-16.1

Section 5.4 Comparison with Other Studies

When the results of experiment one are compared to the corresponding experiments conducted in the Hamilton and Whalley (1989) and Thirsk (1985), see section 3.4, the following observations can be made. Hamilton and Whalley found the replacement of the FST with a broad-based sales tax to be welfare-improving by $672.6 million with Thirsk finding it to improve overall welfare by $335 to $370 million. This study found overall welfare to improve by $352.4 to $366.1 million.

Table 5.9
Comparason of
National Welfare Results

Study	National Welfare Gain* $ million	% of GDP
Hamilton and Whalley	672.6	.24
Thirsk	335.0	.12
This Study	366.1	.14

* using the model variant that allows capital flows to respond to net returns to capital.

Hamilton and Whalley found the change to yield a bell shaped incidence with all income groups experiencing a welfare improvement, while Thirsk found the change to yield a strictly regressive incidence with the bottom four or five

loss. It should be noted that Thirsk's incidence results correspond closely to the results from experiment three in this study.

This is not unexpected since the model used to conduct this study used a similar version of the model used by Thirsk. Thirsk arrives at the substitution of the FST by first eliminating it and increasing personal income taxes to maintain revenue neutrality. He then substitutes a broad based value-added tax for this increased income tax revenue. He arrives with his welfare and incidence results by adding the results of each change. This study removes the FST from the corporate income tax and sales tax and implements a VAT in one step. It allowed only the sales tax rate to adjust to ensure revenue neutrality. The results were then compared with the initial equilibrium to calculate the welfare effects.

As expected, the results obtained in this study are not inconsistent with the results of Thirsk. The strictly regressive incidence pattern of the substitution of a broad-based sales tax for the FST makes its implementation politically controversial. Any attempt to do so must be accompanied by some form of low income supplementation to

The results were tested for their sensitivity to changes in the values of the elasticity of foreign demand for Canadian exports and the elasticity of supply of foreign capital to Canada. It was found that the welfare gains decreased with the elasticities. The greater the elasticity of foreign demand the smaller the welfare improvements. The same was found for the elasticity of the foreign supply of capital. It was also noted that the terms of trade improved with the elasticity of foreign capital supply. These results are recorded in table 5.10.

Table 5.10

Sensitivity to Foreign Elasticities

Elasticities		Efficiency Gain *	Gains From Terms of Trade *	Welfare Gains EV *
Foreign Supply of Capital	0.0000	206.8	190.7	397.5
	0.8483	157.0	195.5	352.4
	1.9838	124.5	202.2	326.7
Foreign Demand	0.0	183.9	269.4	458.7
	-2.5	157.0	195.5	352.4
	-10.0	144.2	138.1	282.3

* numbers in $ millions

Section 5.6 Effects of the Goods and Services Tax

This section contains the results of simulating the proposed replacement of the FST with the goods and services tax. These results show what the effects would have been if

exception of the omission of the surtax on the high income groups. The GST was modeled by adding 7% to the base rates[4]. The low income tax credit was modeled as described in the white paper. In order to do this the credit had to be distributed over the current income deciles and then scaled to the model year. The most recent income distribution data was 1988. The procedures employed to do this are described in appendix C

Table 5.11

Tax Rates Used to Simulate the GST

Decile	Income Tax Rate	Sector	CIT Rate	Sales Tax Rate
1	-0.107212			
2	0.052617	Imports	———	0.155133
3	0.087373	Housing	0.049628	0.050431
4	0.115218	Food	0.174426	0.000000
5	0.169574	Commerce	0.158246	0.119510
6	0.176280	Corporate	0.262081	0.201300
7	0.170086	Fixed-price	0.358815	0.070820
8	0.173592	Flex-priced	0.343466	0.070841
9	0.173207			
10	0.205689			

The introduction of sales tax credits for the low income deciles yielded a strictly progressive incidence for both model variants with the bottom four deciles considering themselves better-off while the top six deciles considered themselves relatively worse-off. The gross returns model yielded a slight overall welfare improvement ($196 million)

Table 5.12 shows the incidence pattern of the implementation of the GST, while table 5.13 shows the welfare changes arising from the tax. Table 5.14 shows the increased revenue generated from the tax reform.

Table 5.12

GST Incidence Results by Income Group

(EV in $ million)

Income Decile	Gross Returns	Net Returns
1	431.9	428.6
2	459.8	449.3
3	225.8	212.5
4	25.0	2.8
5	- 25.5	- 36.5
6	- 87.0	-104.1
7	-121.4	-143.2
8	-154.5	-181.0
9	-202.2	-235.0
10	-353.6	-402.5

Table 5.13

Welfare, Efficiency and Terms of Trade Changes*

Experiment		Efficiency Gains	Gain From Terms of Trade	Welfare Gains EV
GST	var 1	-958.2	1154.5	196.3
	var 2	-1176.6	1167.4	-9.2

* numbers in $ millions

Table 5.14

Changes in Tax Revenue*

	Variant 1	Variant 2
GST	5144.0	5105.0

* numbers in $ millions

becomes, as is shown in table 5.4.

When food was exempted from the tax base, it yielded the same incidence pattern as including it in the tax base, but the magnitudes of the welfare changes for the extremes were smaller. The overall welfare improvement was less than that for the first experiment, so the welfare results were just scaled down accordingly it appears. The implication of this is that all income groups seem to have the same dependence on the food sector. This questions the rationale for the exclusion of food from the tax base.

Another factor that must also be taken into account is the effect of the tax reform on our terms of trade. According to the results shown in table 5.5 the exclusion of the export sectors from the tax base causes a significant decline in our terms of trade. This is due mainly to the relative decrease in the price of exports as compared to our imports caused by the removal of input taxes. Also, the exclusion of the export sectors leads to an increase in foreign investment in Canada which also leads to a deterioration of our terms of trade in that we have to pay more in total for this investment, even though the net rate of return falls. Including both of these considerations in

of the tax rates across sectors and the removal of taxes on intermediate goods. Hamilton and Whalley deliberately omitted terms of trade considerations by modeling Canada as a small open economy.

The exclusion of the export sectors from the tax base led to the bottom five income groups experiencing a welfare decline, while the top five income groups experienced a welfare improvement. This is due to the fact that the higher income groups get a higher percentage of their incomes from capital, which shifts into the expanding and capital intensive export sectors and thus yields a better return, while the lower income groups experience a decline in the relative wage rate along with a deterioration in the terms of trade, the latter of which causes them to relatively spend more on imports and thus experience a loss of welfare.

The replacement of the FST with an equal rate VAT has a highly regressive incidence. This fact has prompted the federal government to announce the introduction of sales tax credits for low income groups as well as further income tax breaks. The overall welfare gain resulting from the tax reform should allow adequate compensation to low income Canadians so that no income group needs to suffer a loss of

seven income groups do experience a welfare loss. The results are qualitatively independent of the model variant used, however they are quantitatively sensitive to the model variant used, as seen in table 5.13. Although, this study is applying the proposed reforms to ten-year-old data, it can still give a qualitative idea of the effects of the proposed reform.

Endnotes

[1]Cascading is the incorporation of a tax, imposed at a pre-final demand level of production, into the cost structure of a good that purchases the taxed good as an input.

[2]Changing the federal sales tax will cause changes in prices which have spill-over effects on provincial sales taxes as well as the size of the tax base.

[3]Terms of Trade welfare change is defined as the equivalent variation (EV) of the change in the balance of international trade.

EV = new exports * old price of exports
- old exports * old price of exports
- import price * change in imports
- old foreign capital cost * old capital stock
+ old foreign capital cost * new capital stock.

[4]See Appendix B

Chapter 6

Summary and Conclusions

Section 6.1 Summary

Chapter two began by examining the types of commodity taxes and the criteria used to evaluate any tax system. This was followed by outlining the existing sales taxes in Canada. A discussion of the criteria for evaluating tax reform followed by a discussion of the need for federal tax reform next followed. The chapter concluded with a summary of the recently proposed Canadian tax reforms.

Chapter three provided a detailed look at two recent Canadian studies that both used general equilibrium simulation models and the same base year for their data to arrive at quite different results.

Chapter four gave a description of the model used for the tax reform simulations conducted in chapter five. The production sectors, along with the final demand sectors, are described with the production and utility functions being explicitly defined as CES types. A description of the foreign demand and capital supply sectors is given along with the two model variants used in this study.

the base would have. The results of these experiments were compared with the results of Thirsk and Hamilton and Whalley. The final experiment was the simulation of the implementation of the proposed goods and services tax onto the 1980 Canadian economy.

Section 6.2 Conclusions

When considering the imposition or reform of a tax, one must consider many factors: efficiency, equity, stability, and costs of administration. In the case of indirect taxes, there is the question of whether to levy an origin-based tax or a destination-based tax. These considerations are not mutually independent. This, along with the fact that the equity and efficiency goals are often in direct conflict with one another, can make the choice of a tax or a reform very difficult indeed. The current uproar in Canada over the government's proposed goods and services tax is a timely example of this.

Once a decision is made on the type of tax to be implemented, the choice of the appropriate base for it must then be considered. Once again, the criteria of equity, efficiency, stability, and ease of administration are weighed to determine the most desirable base. When the first

equitable base is one that has food as its only exemption. A base with no exemptions is the easiest to administer because of its simplicity, as well as being the most stable source of income, due to the pooling of the risk of a change in the value of the base in the various sectors.

The proposed goods and services tax as described in the technical paper released by the Minister of Finance in August, 1989, when implemented into the model used in this study and using a 1980 data set, yielded overall a welfare gain of $196 million for the gross returns model and a welfare loss of $9.2 million using the net returns model. Both model variants showed a marked internal efficiency loss being offset by sizable a terms of trade improvement. Supplements to low income groups changed the incidence pattern from strictly regressive to mostly progressive, with the bottom four income groups experiencing improvements in welfare while the top six income groups experienced welfare reductions. As a result, the new tax package can be seen as being relatively progressive in nature which is consistent with the Canadian ideal of vertical equity.

It is important to keep in mind the criticisms noted in chapter three. All that can be drawn from a simulation

Despite the shortcomings of the model, the purpose of these models should be kept in mind. They are designed to help us understand how changes in one sector will affect the entire economy. To this end, the consistency of qualitative results justifies their use despite their pitfalls.

Bibliography

Ballard, C., D. Fullerton, J. B. Shoven, and J.Whalley (1985) *General Equilibrium Analysis of U.S. Tax Policies.* (Chicago: University of Chicago Press for NBER)

Ballentine, G. and W. Thirsk (1979) *The Fiscal Incidence of Some Community Experiments in Fiscal Federalism: Technical Report.* (Community Services Analysis Division, Canada Mortage and Housing Corp. Ottawa: Supply and Services.)

Boadway, R, W. (1979) *Public Sector Economics.* (Cambridge: Winthrop)

— and H. M. Kitchen (1984) *Canadian Tax Policy: 2nd ed.* Canadian Tax Paper No. 76, Canadian Tax Foundation

Chiang, A. C.(1984) *Fundamental Methods of Mathematics: 3rd ed.* (New York: McGraw-Hill)

Damus, S. (1986) "Micro-Computer Simulation with a General Equilibrium Model of Canada." Discussion Paper No. 311, Economic Council of Canada

— P. Hobson, and W. Thirsk (1987) "The Welfare Effects of Property Taxation in an Open Economy." Discussion paper

Department of Finance Canada (1989) "Budget 89: The Goods and Services Tax."

Department of Finance Canada (1989) "Goods and Services Tax Technical Paper."

Department of Finance Canada (1989) "Goods and Services Tax."

Economic Council of Canada (1987) "The Taxation of Savings and Investment." (Ottawa: Economic Council of Canada)

Fullerton, D. and R. H. Gordon (1983) "A Reexamination of Tax Distortions in General Equilibrium Models," in *Behavioral Simulation Models in Tax Policy Analysis.* Ed.: Martin Feldstein. (Chicago: University of Chicago Press)

Hamilton, B. and J. Whalley (1989) "Reforming Indirect taxes in Canada: Some General Equilibrium Estimates." *Canadian Journal of Economics* 22 561-75

Harberger, A C. (1962) "The Incidence of the Corporation Income Tax." *Journal of Political Economy* 70 215-40.

Henderson, J M. and R.E. Quandt (1980) *Microeconomic Theory: A Mathematical Approach 3rd ed.* (McGraw-Hill).

Jenkins, G. P. and C.-Y. Kuo (1985) "On Measuring the

Canadian Tax Journal 36, 655-70

Piggott, J. (1980) "A General Equilibrium Evaluation of Australian Tax Policy." Ph.D. dissertation, University of London

— and J. Whalley (1977)" General Equilibrium Investigation of U.K. Tax-Subsidy Policy: A Progress Report," in M. J. Artisand A. R. Nobay, eds, *Studies in Modern Economic Analysis*. (Oxford: Blackwell)

— (1985) "Economic Effects of U. K. Tax-Subsidy Policies: A General Equilibrium Appraisal," in *New Developments in Applied General Equilibrium Analysis*. (New York: Cambridge University Press)

Shoven, J. B. (1976) " The Incidence and Efficiency Effects of Taxes on Income from Capital." *Journal of Political Economy* 84 1261-83.

— and J. Whalley (1984) "Applied General Equilibrium Models of Taxation and International Trade: An introduction and Survey.", *Journal of Economic Literature* 22, 1007-051

— (1972)" A General Equilibrium Calculation of the Effects of Differential Taxation of Income from Capital in the U.S.." *Journal of Political Economy* 80, 281-321.

— (1973) " General Equilibrium with Taxes: A

Statistics Canada (1988) "Income Distribution by Size in Canada 1988." pub. no. 13-207 annual

Statistics Canada (1983) " Canadian Statistical Review." pub. no. 11-003E monthly March 1983.

Statistics Canada (1981) "Consolidated Government Finance 1980 and 1981." pub. no. 68-202 annual

Statistics Canada (1980) "Federal Government Finance 1980." pub. no. 68-211 annual

St.-Hilaire, F. and J. Whalley (1983) "A Microconsistent Data Set for Canada for use in Tax Policy Analysis." *Review of Income and Wealth* 29

Stiglitz, J. E. (1973) " Taxation, Corporate Financial Policy, and the Cost of Capital." *Journal of Political Economy* 2, 1-34.

Thirsk, W. R. (1987) "Indirect Federal Taxes, the cost of Capital and the Issue of Tax Incidence." Discussion Paper No. 294, Economic Council of Canada

Whalley, J. (1975) "A General Equilibrium Assessment of the 1973 United Kingdom Tax Reform." *Economica* 42, 139-61

Appendix A

Derivations of Factor and Product Demands

Section 1 Factor Demands for the Two Input Industries

The two input industries have CES production functions:

$$Q_i = A_i[\delta N_i^{-\rho} + (1-\delta)K_i^{-\rho}]^{-1/\rho}$$

Where:

Q_i is the quantity of output in the ith sector;

A_i is the scale parameter;

δ is the distribution parameter denoting the share of total cost spent on, in this case, labour;

N_i amount of labour used in the ith sector;

ρ is the elasticity of substitution parameter;

K_i is the amount of capital used in the ith sector.

It should be noted that δ and ρ may have different values for different sectors.

Producers are assumed to be profit maximizers so input demands can be derived by maximizing the profit function subject to cost and production constraints and solving for the optimum quantities of the inputs. This is done by using Lagrange multipliers.

function is:

$$\Pi = p_i\{A_i[\delta_i N_i^{-\rho} + (1-\delta)K_i^{-\rho}]^{-1/\rho}\} - \lambda(C_i - p_n N_i - p_k K_i)$$

The first order conditions are:

$$(1) \qquad \frac{\partial \Pi}{\partial N} = p_i\{A^{-\rho} Q_i^{1+\rho} \delta N_i^{-(1+\rho)}\} - \lambda p_n = 0$$

$$(2) \qquad \frac{\partial \Pi}{\partial N} = p_i\{A^{-\rho} Q_i^{1+\rho} (1-\delta) K_i^{-(1+\rho)}\} - \lambda p_k = 0$$

$$(3) \qquad \frac{\partial \Pi}{\partial \lambda} = C_i - p_n N_i - p_k K = 0$$

Solve (1) for λ, substitute the result into (2) and solve for L and K to get:

$$(4) \qquad N_i = \left[\frac{\delta p_k}{(1-\delta)p_n}\right]^{\frac{1}{1+\rho}} K_i$$

$$(5) \qquad K_i = \left[\frac{(1-\delta)p_n}{\delta p_k}\right]^{\frac{1}{1+\rho}} N_i$$

Substitute (5) into (3) and solve for N_i to get the demand for labour.

$$(7) \qquad N_i = \frac{\delta^{1/(1+\rho)} C_i}{\left[p_k^{\rho} p_n (1-\delta)\right]^{1/(1+\rho)} + \delta^{1/(1+\rho)} p_n}$$

Section 2 Factor Demands for the Three Input Industries

The three factor production function is a nested CES function with capital and labour nested in in a two input CES function explicitly defined as follows:

$$Q_i = A_i\{\delta L_i^{-\rho} + (1-\delta)B[\gamma N_i^{-\pi} + (1-\gamma)K_i^{-\pi}]^{-\rho}\}^{-1/\rho}$$

The profit function for the three factor sectors is:

$$\Pi = p_i A_i\{\delta L_i^{-\rho} + (1-\delta)B[\gamma N_i^{-\pi} + (1-\gamma)K_i^{-\pi}]^{-\rho}\}^{-1/\rho} + \lambda(C_i - p_l L_i - p_n N_i - p_k K_i)$$

The derivation of the factor demands is a two-step procedure, with the demands for land and the nest being

$p_k K_i + p_n N_i$.

The first order conditions for land and the nest are:

$$(1) \qquad \frac{\partial \Pi}{\partial Z} = p_i\{A^{-\rho} Q_i^{1+\rho} \delta L_i^{-(1+\rho)}\} - \lambda p_l = 0$$

$$(2) \qquad \frac{\partial \Pi}{\partial Z} = p_i\{A^{-\rho} Q_i^{1+\rho} (1-\delta) Z_i^{-(1+\rho)}\} - \lambda p_Z = 0$$

$$(3) \qquad \frac{\partial \Pi}{\partial \lambda} = C_i - p_l L_i - p_Z Z_i = 0$$

Solve (1) for λ and substitute the result into (2). Next solve for L_i and Z_i to obtain:

$$(4) \qquad L_i = \left[\frac{\delta p_Z}{(1-\delta) p_l}\right]^{\frac{1}{1+\rho}} Z_i$$

$$(5) \qquad Z_i = \left[\frac{(1-\delta) p_l}{\delta p_z}\right]^{\frac{1}{1+\rho}} N_i$$

Substitute (4) into (3) and solve for L_i to yield the

$$Z_i = B[\gamma K_i^{-\pi} + (1-\gamma)N_i^{-\pi}]^{-1/\pi}$$

first order conditions for the nest are as follows.

$$(7) \qquad \frac{\partial \Pi}{\partial N} = p_i\{B^{-\pi}Z_i^{1+\pi}\gamma N_i^{-(1+\pi)}\} - \lambda p_n = 0$$

$$(8) \qquad \frac{\partial \Pi}{\partial K} = p_i\{B^{-\pi}Z_i^{1+\pi}(1-\gamma)K_i^{-(1+\pi)}\} - \lambda p_k = 0$$

$$(10) \qquad \frac{\partial \Pi}{\partial \lambda} = C_i - p_l L_i - p_n N - p_k K = 0$$

Solve (1) for λ, substitute the result into (2) and solve for N and K:

$$(11) \qquad N_i = \left[\frac{\gamma p_k}{(1-\gamma)p_n}\right]^{\frac{1}{1+\pi}} K_i$$

$$(12) \qquad K_i = \left[\frac{(1-\gamma)p_n}{\gamma p_k}\right]^{\frac{1}{1+\pi}} N_i$$

Substitute (6) and (11) into (10) and solve for K to get the demand for capital:

Substitute (7) and (11) into (10) and solve for K to get the demand for capital.

$$N_i = \frac{\gamma^{1/(1+\pi)}\left[C_i - p_1\left[\frac{(1-\delta)^{1/(1+\rho)}C_i}{\left[p_z^{\rho}p_1\delta\right]^{\frac{1}{1+\rho}} + (1-\delta)^{1/(1+\rho)}p_1}\right]\right]}{\left[p_n p_k^{\pi}(1-\gamma)\right]^{\frac{1}{1+\pi}} + \gamma^{1/(1+\pi)}p_k}$$

Section 3 Derivation of consumer demand for a particular good.

As described in the text, standard indifference curve analysis along with the property of utility maximization is used to derive the demand an individual consumer has for a particular good. Indifference curve analysis states that a consumer will maximize their utility at the point of tangency between their indifference curve and their budget constraint. The assumption of separable utility for each good allows the calculation of each product demand curve independently, with the other goods in the utility function lumped together as a composite good. The budget constraint is denoted as:

$$I_i = p_X X_i + p_Y Y_i.$$

optimization technique used to determine the factor demands is employed. The Lagrangian is set up as:

$$U_i = u_i[\upsilon X^{-\tau} + (1-\upsilon)Y^{-\tau}]^{-1/\tau} + \lambda(I_j - p_x X_i - p_y Y_i)$$

The first order conditions are:

$$(1) \qquad \frac{\partial U}{\partial X} = u_i^{-\tau} U_i^{1+\tau} \upsilon X^{-(1+\tau)} - \lambda p_x = 0$$

$$(2) \qquad \frac{\partial U}{\partial Y} = u_i^{-\tau} U_i^{1+\tau} (1+\upsilon) Y^{-(1+\tau)} - \lambda p_y = 0$$

$$(3) \qquad \frac{\partial U}{\partial \lambda} = I_i - p_x X - p_y Y = 0$$

Solve the first two for X_i and Y_i and substitute them into (3) to get the following product demands.

$$(4) \qquad X_i = \frac{\upsilon^{1/(1+\tau)} I_i}{\left[p_x p_y^{\tau}(1-\upsilon)\right] + \upsilon^{1/(1+\tau)} p_x}$$

$$(5) \qquad Y_i = \frac{(1-\upsilon)^{1/(1+\tau)} I_i}{\left[p_x^{\tau} p_y \upsilon\right] + (1-\upsilon)^{1/(1+\tau)} p_x}$$

Appendix B

Derivation of Simulation Tax Rates and Bases

Section B1 Calculating Non-Federal Sales Tax Rates

The first step was to collect the data required to make the necessary calculations. The data needed for these calculations included the published total consumption tax revenue, total sales tax revenue, total import and customs duties paid in 1980 (source: Statistics Canada pub. 68-202) and the amount of federal sales tax revenue (source: Statistics Canada pub. 68-211) along with data from the benchmark data set. The published total consumption tax (TCT) revenue was $20.154 billion, total sales tax revenue was $11.640 billion, and total import and customs duties were $3.188 billion. The amount of FST revenue collected was $4.698 billion. The benchmark data set value for TCT was $19.122 billion. This discrepancy between the published TCT and the data TCT made scaling of the published duty revenue and FST revenue necessary. This was done using the formula the formula:

$$\text{pub. amount} * \frac{(\text{model TCT})}{(\text{pub TCT})}.$$

The adjusted duty revenues and FST revenues were $3.025 billion and $4.457 billion respectively.

Following Thirsk, it was assumed that the share of FST revenue that resulted from the factor tax portion was 13%. This rate was multiplied by the FST revenue to calculate the amount of FST revenue entered as a capital tax.

$4.457 billion
* 0.13
$579 million (CIT share)

$4.457 billion
- $0.579 billion
$3.878 billion (sales tax)

The amount of FST revenue modeled as a sales tax was calculated to be $3.878 billion.

The next step was to divide this sales tax portion of FST revenue and partition it across the various sectors of the model. The model exempted the food, commerce, and housing sectors from the FST base which only left the import, corporate, fix-priced exports and flexibly-priced exports to distribute the FST revenue over.

The import sector sales tax revenue from the data set was $4.729 billion. The FST amount of this was calculated

$4.729 billion (total tax rev)
- $3.025 billion (duty rev)
$1.704 billion (sales tax rev)

The import sector's FST share of total sales tax revenue was

The export sectors were assumed to collect 90% of their sales tax revenue from the FST which gave:

Fixed-priced exports

$102 million
* 0.9
$92 million (FST revenue)

Flex-priced exports

$407 million
* 0.9
$366 million (FST revenue)

The corporate sector portion of FST revenue was calculated as the residual amount after all the other sectors had been allotted.

$3.878 billion (total)
-$0.688 billion (imports)
-$0.092 billion (fixed-price)
-$0.366 billion (flex-price)
$2.732 billion (corporate)

The corporate sector FST revenue was $2.732 billion.

The non-federal sales tax rates for the model were then calculated by dividing what sales tax revenue that was left after removing the FST revenue from each sector by the value-added of each sector. These results are shown in table B1

TABLE B1

Computing Non-federal Sales Tax Rates

Sector	Residual* Revenue	Value-added *	Non-federal Tax rate
Import	4.041	47.467	0.085133
Housing	0.000	25.551	0.000000
Food	0.000	19.160	0.000000
Commerce	1.112	22.460	0.049510
Corporate	10.040	76.466	0.131300
Fixed-priced	0.010	12.191	0.000820
Flex-priced	0.041	48.765	0.000841

* values are in $ billions

Section B2 Simulation Tax Bases and VAT Rates

The tax base for the first simulation conducted for the thesis included all sectors the the base for an equal-yield equal-rate VAT to replace the FST. The base for the first simulation is the sum of the value-added column in table B1 which is $252.060 billion. The equal-yield VAT rate is

$$\frac{4.457}{252.060} = 0.017682 \text{ or approximately } 1.77\%.$$

The tax base for the second simulation conducted exempted the food sector and was calculated by deducting the value-added of the food sector from $252.060 billion for a base of $232.900.

$252.060 billion (base 1)

sectors only. It was calculated by deducting the export sector value-added from the first base to get a base of $191.104 billion.

252.060 billion (base 1)
-12.191 billion (fixed-priced)
-48.765 billion (flex-priced)
191.104.billion

The equal-yield rate was calculated to be

$$\frac{4.457}{191.104} = 0.023322 \text{ or approximately } 2.33\%.$$

The base for the fourth simulation exempted the food sector along with the two export sectors It was calculated to be $171.944 billion.

$191.104 billion (base 3)
-$19.160 billion (food sector)
$171.944 billion

The equal-yield VAT rate was calculated to be

$$\frac{4.457}{171.944} = 0.025921 \text{ or approximately } 2.59\%.$$

Section B3 Calculating the New Corporate Income Tax (CIT) Rates

Step 1 Determine the sector CIT bases.

$$\frac{\text{model CIT revenue}}{\text{model CIT rate}} = \text{Base}$$

Step 2 Calculate sector share of CIT base.

$$\frac{\text{sector base}}{\text{total base}} = \text{sector share}$$

CIT revenue - FST revenue = new CIT revenue

Step 5 Calculate the CIT simulation rates

$$\frac{\text{new CIT revenue}}{\text{base}} = \text{simulation rate} \left[\begin{matrix}\text{used for all}\\ \text{simulations}\end{matrix}\right]$$

Step 6 Enter the new rates into the model

Table B2

Model CIT Rates

	Housing	Food	Commerce	Corporate	Fixed-price	Flex-price
rate	0.060880	0.185792	0.169563	0.273410	0.370179	0.354738

Table B3

Calculating the Simulation CIT Rates

FST incl. in CIT 0.579 billion

sector	Model* CIT Revenue	Step 1 CIT* base	Step 2 sector share	Step 3 MST* CIT	Step 4 New* CIT	Step 5 New Rate
Housing	0.606	9.954	19.43%	0.112	0.494	0.049628
Food	0.850	4.575	8.93%	0.052	0.798	0.174426
Commerce	0.839	4.948	9.66%	0.056	0.783	0.158246
Corporate	4.368	15.976	31.19%	0.181	4.187	0.262081
Fixed-priced	1.075	2.904	5.67%	0.033	1.042	0.358815
Flex-priced	4.563	12.863	25.11%	0.145	4.418	0.343466

* values given in $ billions

Appendix C
Modeling the GST Credit

In order to model the GST credit one must determine, how to distribute the revenue among the income groups in the model and how the scale the amount of the tax credit to the dimensions of the model.

This study adjusted the tax credit by multiplying the amount of the tax credit by the ratio of the 1980 GNP divided by the 1988 GNP as published in The Canadian Statistical Review (March 1983) and The Canadian Economic Observer (January 1990)

$$\$2.4 \text{ billion} * \frac{\$291.869 \text{ billion}}{\$601.501 \text{ billion}} = \$1.165 \text{ billion}$$

The 1988 income deciles were calculated using income distribution data in Statistics Canada publication 13-207 Income Distribution by Size in Canada (1988). In calculating the income deciles, it was assumed that each income group listed in the publication had a uniform distribution of people across it. This allowed the eighteen income groups listed to be redistributed into ten. Table C1 shows the listed income groups and how they were allocated to the income deciles.

Table C1

Calculating the Income Deciles

Income Group ($)	% of Pop	% of Pop	Decile	% of Pop	Decile
0-4,999	2.6	2.6	1st		
5,000-9,999	9.1	7.4	1st	1.7	2nd
10,000-12,499	5.6	5.6	2nd		
12,500-14,999	4.0	2.7	2nd	1.3	3rd
15,000-17,499	4.7	4.7	3rd		
17,500-19,999	4.6	4.0	3rd	0.6	4th
20,000-24,999	8.4	8.4	4th		
25,000-29.999	7.6	1.0	4th	6.6	5th
30,000-34,999	7.5	3.4	5th	4.1	6th
35,000-39,999	7.2	5.9	6th	1.3	7th
40,000-44,999	6.3	6.3	7th		
45,000-49,999	5.5	2.4	7th	3.1	8th
50,000-54,999	5.2	5.2	8th		
55,000-59,999	4.0	1.7	8th	2.3	9th
60,000-64,999	3.3	3.3	9th		
65,000-69,999	2.9	2.9	9th		
70,000-74,999	2.1	1.4	9th	0.7	10th
75,000+	9.3	9.3	10th		

source: Statistics Canada pub. 13-207 Income Distribution by Size 1988

The technique of linear interpolation was used to get the boundaries of the income deciles. The income group that contained the boundary of a decile group was identified and the portion of that group in the lower decile was divided by the entire income group. This ratio was then multiplied by the width of the income group and the result was added to the lower limit of the group to yield the upper bound of the decile. The upper bound of the first decile was calculated:

Table C2

Income Deciles

Decile	Range
1	0-9,066
2	9,067-14,188
3	14,189-19,674
4	19,675-25,658
5	25,659-32,267
6	32,368-39,097
7	39,098-47,182
8	47,183-57,125
9	57,126-73,333
10	73,334+

The White Paper on the GST released December 19,1989 declared that a GST tax credit of $2.4 billion would accompany the introduction of the 7% GST. A family of four would receive a credit of $580 as long as their combined net income was below $24,800 with a reduction of the credit by 5% of their net income exceeding this amount. Thus, the cut off for the credit would be $36,400.

The bottom three deciles will receive the full credit while the upper end of the forth decile will see a slight reduction in the credit. The fifth decile will experience a declining credit with only the bottom end of the sixth decile seeing any credit.

The credit revenue was distributed over the decile groups by weighting each percentile by how much of the

weighted total of the credit is 47.4% distributed: 10% for each of the bottom three deciles; 9.9% for the forth decile; 6.4% for the fifth decile; and 1.1% for the sixth decile. The formulas for the area of a trapezoid and triangle were use to calculate the weights.

Decile four's weight-

$$8.57 + 1.43 * \frac{(1.0 + 0.926)}{2} = 9.9$$

8.57 is the portion of the decile that receives the full credit.

1.43 is the portion that the credit starts being reduced.

1.0 denotes a full credit

0.926 is the proportion of the credit received by the boundary individuals.

Fifth decile's weight-

$$10 * \frac{(0.926 + 0.356)}{2} = 6.4$$

10 is the number of percent in a decile.

0.926 is the proportion of the credit received by the lower boundary individuals.

0.356 is the proportion of the credit received by the lower boundary individuals.

Decile six' weight-

any credit.

The proportion of GST credit revenue allotted to each decile was determined by dividing the decile weights by the total weight. The first three deciles were allotted 20.8% each. The fourth decile received 20.6% with the fifth getting 13.3% and the sixth receiving 1.1%.

These rates were multiplied by the credit revenue to distribute the revenue among the deciles. The credit revenue was then deducted from the model income tax revenue and the result was divided by income to get the new income tax rates to be entered.

Table C3

Calculating GST Income Tax Rates

Decile	Model Rates	Model Income	Model Tax	GST Credit	New Tax	New Rates
1	0.05068	1.539	0.078	0.243	-0.165	-0.10721
2	0.12105	3.554	0.429	0.242	0.187	0.05262
3	0.11784	7.943	0.936	0.242	0.694	0.08737
4	0.13446	12.472	1.677	0.240	1.437	0.11522
5	0.17903	16.394	2.935	0.155	2.780	0.16957
6	0.17824	21.880	3.900	0.043	3.857	0.17628
7	0.17009	26.369	4.485	0.000	4.485	0.17009
8	0.17359	31.453	5.460	0.000	5.460	0.17359
9	0.17321	38.278	6.630	0.000	6.630	0.17321
10	0.20569	60.674	12.480	0.000	12.480	0.20569