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DISCUSSION PAPER NO. 361

General Equilibrium Models in the Development of Social Policy

by

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and Bernard Fortin

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SUMMARY

Social policy is not a costless endeavour, since it often produces inefficiencies in the allocation of resources. For example, transfers to persons and taxes used to finance them can modify the private return to labour relative to its cost to employers. This in turn affects the quantity of labour supplied and demanded in the economy. This impacts on the demand for capital and the level of output, as well as on government revenues themselves.

The proposition that social policy often involves a trade-off between equity and efficiency is well known. However, most studies and critiques of social policies lack analytical tools to assess the empirical importance of this trade-off. The computable general equilibrium framework offers a promising avenue for assessing the effects of these policies both on welfare distribution and on economic behaviour.

General equilibrium models are challenging and sophisticated tools with relatively simple structures. They provide indications of how the various economic entities interact. Various models, such as those described in Pierre Cloutier's paper, represent the point of departure of a lengthy development process. Widely used partial equilibrium models designed to estimate the first-round impact of policy changes need to be complemented by models suited for the estimation of second-round effects.

Although there are disagreements among economists on particular issues, such as labour supply and demand elasticities, the basic strength of general equilibrium models lies in their well-accepted micro-economic foundations. Despite their limitations, these models can nevertheless challenge the results derived from more simple methods. In other words, these models produce results that cannot be achieved using partial equilibrium models. After the initial impact of a policy change, the subsequent economic impact resulting from behavioural changes can, to some extent, affect the intended outcome of the policy change. Although it is unrealistic to expect that the new equilibrium state derived by the model will actually be attained, the basic trends are significant. General equilibrium models are designed to get some insight into the likely result of policies following the adjustments of markets. As such they can be viewed as valuable simulation tools for policy development.

In his paper, Pierre Cloutier presents a general equilibrium model developed at the Council and a proposal to improve its capacity for social policy analysis.

This model is an adaptation of the model built by B. Fortin and H.-P. Rousseau at Laval University. It is based on a static general equilibrium model of the Ontario economy using segmented linear budget constraints faced by defined groups of taxpayers. The households sector is disaggregated in 37 representative individuals defined by their socio-economic characteristics. The "small open economy" assumption allows production to be aggregated into a single sector using capital and three labour categories as factors of production.

In the current version of the model, the level of Unemployment Insurance (UI) benefits received by each individual is assumed to be constant. As such, the model does not allow the study of interactions between UI and other social policy programs on individual behaviour and income distribution. The paper by Bernard Fortin is an attempt to deal with this limitation. It provides a theoretical framework that allows UI parameters to affect individual choices in the labour market, while retaining the general equilibrium framework approach.

Under this approach, each participant in the labour market is characterized by three parameters: a wage rate, an employment-unemployment cycle and the length of the work week. Each representative worker chooses his/her preferred participation based on the jobs available to him/her. It is shown how UI parameters may influence this choice. The author distinguishes two UI programs, where one plays the role of a payroll tax and the other, a wage subsidy.

The paper further provides a procedure for setting the basic parameters of the model, and includes a discussion of the empirical results relating to the values of these parameters.

The author considers various extensions of the basic model selected, in particular, a simple approach incorporating involuntary unemployment into the model. Finally, in the last section, he shows how the model could be modified to make it possible to simulate the impact of the Forget Report recommendations.

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FOREWORD

The development of analytical tools to assist decision-makers in choosing among competing policy options has always been a primary objective of the Economic Council of Canada. In the field of social policy there has been, over the last several years, an increasing interest in the development of general equilibrium models that would capture long run impacts, taking into account behaviourial adjustments, of any actual or proposed policy change.

We are pleased, therefore, to contribute to the growing literature in this area by releasing papers prepared for the Council by Bernard Fortin, Professor of Economics at Laval University and A. Pierre Cloutier, formerly from the Economic Council of Canada, and now at the Federal Department of Finance. The paper developed by Pierre Cloutier builds upon previous work of Bernard Fortin and H.-P. Rousseau at Laval University. The paper by Professor Fortin represents a further refinement of that model.

The appeal of such models is clear: they are firmly based upon economic theory, and allow for an iterative market clearing process based upon assumptions regarding behaviourial adjustment. While these models are conceptually simple, they require considerable skill in their structural development, particularly when incorporating the design of social programs such as unemployment insurance.

Such models do invite considerable debate over the magnitude of assumed behaviourial adjustment, particularly labour supply elasticities. However, even in this regard, the models are useful in that because of the manner in which these models disaggregate the household sector of the economy, sensitivity analysis can highlight which behaviourial assumptions are most critical and deserving of further empirical research.

The models developed by Pierre Cloutier and Professor Fortin represent major contributions in this field, and we at the Council wish to encourage, and indeed participate in, the further development of this potentially powerful policy relevant research tool.

Judith Maxwell
Chairman

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1 A COMPUTABLE GENERAL EQUILIBRIUM MODEL FOR THE STUDY OF THE TAX-TRANSFER SYSTEM

by A. Pierre Cloutier

1.1 Introduction

The general equilibrium (G.E.) model developed at the Economic Council of Canada (ECC) to study the tax-transfer system is an adaptation of the model built by B. Fortin and H.-P. Rousseau (FR) to assess the efficiency and redistribution effects of reforms proposed in the Quebec White Paper on the Personal Tax and Transfer System (FR, 1984). The model has been adapted for Ontario and plans are to replicate this exercise for other Canadian provinces.

In the development process, significant changes were made to the earlier Fortin-Rousseau model:

- the solution algorithm has been revised;

- the non-differentiability (or segmented linearity) of the budget curves has been retained;

- the husband and wife labour supply optimization process has been modified to account for the Canadian individual income tax filing system and to allow for the reverse sequencing of decisions affecting husband and wife labour supply;

- a peripheral accounting model has been constructed to easily and precisely derive the segmented linearity and non-convex budget constraints imposed on households and individuals by the tax-transfer system and potential reform measures;

- additional software was developed to convert the accounting model output to a format compatible with the G.E. model requirements.

The G.E. model, the accounting model and related software run at no computing cost, since they are fully adapted to a micro-computer environment.

The G.E. model is a one-period general equilibrium model with the following features: a provincial economy open to trade; a defined tax-transfer system; a work force disaggregated into 37 representative individuals (11 singles, 8 single-parent families and 9 two-parent families); and 3 categories or skill levels of labour. This allows the analyst to compile distributional information. Each individual is assigned to one of the three labour skill levels (income classes) so that individual labour supplies can be aggregated into three labour skill inputs.

The disaggregation of the household sector and the precise modelling of the individual budget curves (the net tax curves) currently determine the size of the model. With 37 individuals and about 30 segments per individual budget constraint, it may be inherently unsatisfactory for those who need timely policy advice. However, the current model and its peripheral software have been designed to minimize the time and cost required to run tax-transfer scenarios. Currently, a tax-transfer policy simulation can be run on a vintage IBM-PC or compatible by a trained person in as little as two days. (The more extensive the tax-transfer policy simulation, the longer it takes to obtain final results.) Sensitivity simulations for the labour supply parameters can be derived using a PC in a matter of minutes.

The G.E. model can be used to evaluate tax-transfer policy options on numerous fronts:

1 it can be used for welfare, efficiency and distributional analysis;

2 it provides an estimation of the resulting input mix to the aggregate production process;

3 it may be used to determine the direction that government outlays may take under a given scenario;

4 it provides policy makers with substantial details about the feedback effects of tax-transfer reforms;

5 it is probably the best tool at present to evaluate the work disincentive effects of tax and transfer systems.

In addition, it could prove useful to researchers concerned with the estimation of various elasticities; through sensitivity analysis, they can identify the elasticities for which robust estimates are required.

Many other tools have been developed to investigate the Canadian tax-transfer system. However, none of them can be used to analyze the interaction between the tax-transfer system, labour supply behaviour and the business sector. These other tools are micro-simulation models, social accounting matrices (SAM) and disposable income accounting models.

The tools used to assess policy changes on the tax-transfer system can be classified into three types:

a accounting models (DIAM);
b statistical models (micro-simulation models); and
c economic models, including:
   i) input-output models (SAM)
   ii) general equilibrium models.

Each model type serves a particular purpose:

- Micro-simulation models can be used to accurately generate the distributional analysis of a policy change, assuming no behaviourial adjustment to the new policy.

- Social accounting matrices permit the tracking of economic shocks through the impact of multiplier effects in appropriate sectors of the economy.

- Accounting models (DIAMs) are used to generate micro examples of the impact of policy changes on household disposable incomes (classed by level of income).

The following sections of this chapter contain an overview of the general equilibrium model and typical simulation results. In Section 1.2, we give a short technical description of the model. In Section 1.3, the construction of the benchmark data set is outlined, including the disposable income accounting model, the potential data problems and their solutions. Section 1.4 is devoted to the main difference between the earlier model and the ECC model. In Section 1.5, we highlight a further difference between the Fortin-Rousseau model and the ECCs, namely the solution program. Section 1.6 discusses the way welfare measures are computed. Finally, we present the more technical simulation results of the marginal welfare cost of taxing in Ontario.

1.2 The Specification of the General Equilibrium Model

The G.E. model comprises three broad sectors: household, business and government. These are modeled or represented respectively by:

1 Households, maximizing utility, which are subject to non-convex and piecewise-linear budget constraints reflecting all the inflection points of the specific net tax structure to which is submitted by each representative socio-economic characteristic.

2 A neoclassical cost function assuming constant returns to scale and using a (translog) flexible functional form.

3 A net revenue function aggregating the product of transfer payments and locally applied tax rates.

These sectors are illustrated by three boxes in Figure 1-1.

1.2.1 The Non-Parametric Assumptions

1 All disposable income is spent (FR, 1985, p. 10).

2 All stock variables of the personal sector are constant (FR, 1985, p. 10).

3 The provincial economy is price-taking on both the goods and capital markets (FR, 1985, p. 9).

4 The aggregate exogenous output price is the numéraire, while the rental price of capital is fixed in terms of the numéraire.

5 The structure of sales tax rates is constant (FR, 1985, p. 11).

6 The production technology shows constant returns to scale (i.e., it is homogeneous and homothetic).

7 The supply of capital to the provincial economy is perfectly elastic at the international fixed rental price of capital (net of the capital taxes) (FR, 1985, p. 14).

8 Capital stock can be owned by residents and non-residents (FR, 1985, p. 14).

9 Following from 2 and 7, the property income for each individual is constant (FR, 1985, p. 14).

10 There is no migration (FR, 1985, p. 15).

11 The labour supply of young people (15 to 17 years old) and the elderly (65 years old and over) is constant (FR, 1985, p. 15).

1.2.2 The Equations of the Model

Although the model may appear to be complex, it is fairly simple in terms of its main equations:

Translog cost function

$$c = q + c_0 + K'v + \tfrac{1}{2} v'Av$$

Factor price frontier

$$0 = K_0 + K'v + \tfrac{1}{2} v'Av$$

Input derived demand equations

$$s = K + Av$$

Budget constraints for individuals (37 equations)

$$X = \frac{1}{(1+t_s)} (wh + y - i)$$

Net income tax functions (over 1,000 equations)

$$i = i_0^t + i_1^t (wh + yt)$$

Virtual incomes (37 equations)

$$y^* = \frac{1}{(1+t_s)} (y + i_1^t wh - i)$$

Labour supply equations (37 equations)

$$h = S + Cw \frac{(1-i_1^t)}{(1+t_s)} + Dy^*$$

Direct utility functions (37 equations)

$$U = ((h - C/D) / D) \exp [-1-[D(X + \frac{S}{D} - \frac{C}{D^2})] / (\frac{C}{D} - h)]$$

Utility functions are taken from Hausman (1980), who derived them from the linear labour supply equations.

Government net tax collection

$$G = INTX + TW + TK + TS$$

1.2.3 Symbols

c	=	cost of production (log)
c_0	=	a constant
q	=	the level of production (log)
K	=	vector of calibrated coefficients (4 x 1)
v	=	vector of input prices (log) (4 x 1)
A	=	square matrix of the production technology (4 x 4)
K_0	=	a calibrated coefficient
s	=	vector of input shares (4 x 1)
X	=	individual's disposable income
t_s	=	the indirect tax rate
w	=	the individual's wage rate
h	=	the individual's labour supply (hours)
y	=	the individual non-labour income
i	=	the individual's net income tax
i_0^t	=	the intercept of the t-th budget segment faced by the individual
i_1^t	=	the effective marginal tax rate on the t-th budget segment faced by the individual
yt	=	the individual's taxable non-labour income

y*	=	the individual's virtual income
S	=	a calibrated coefficient specific to the individual
C, D	=	the individual's labour supply parameters
U	=	the individual's utility index
G	=	calibrated net tax collection by the public sector
INTX	=	net income taxes paid
TW	=	payroll taxes paid
TK	=	taxes paid on the returns to capital
TS	=	indirect taxes paid

1.2.4 The Parametric Assumptions

1 The elasticity of substitution between aggregate labour and capital is set at 1, as was estimated for Quebec (Corbo and Dufour, 1978).

2 It is more difficult to substitute capital for high-skilled workers than for low-skill workers (Hamermesh, 1976). Consequently, it is assumed that ($\sigma_{43} = \sigma_{42}$ - 0,5 and $\sigma_{41} = \sigma_{42}$ + 0,5 where σ_{ij} represents the elasticity of substitution between capital i = 4) and the labour skill category (j). (FR, 1985, p. 14).

3 The price elasticity of the total demand for all labour (with production constant) is set to -0.7, as was done in the FR model (1984, 1985).

4 The difference in the price elasticities of the demand for workers with various labour skills is set at 0,3 (Hamermesh, 1976, 1984). Consequently,

E_{11} = -1.0, E_{22} = -0.7 et E_{33} = -0.4 as assumed in the FR model (1985).

5 Uncompensated labour supply curves have positive slopes ($C \geq 0$) (FR, 1985, p. 20).

6 Individual labour supply elasticities are set as shown in Table 1-1.

7 Leisure is considered a normal good ($D < 0$).

8 For three-quarters of the representative individuals, uncompensated wage elasticities are taken from the benchmark weighted averages used in FR (1985). These elasticities are been modified somewhat for the remains of individuals (see Section 1.3).

1.3 The Benchmark Equilibrium Data Set

The model was developed using data for the 1981 Ontario economy. No subsequent changes have been taken into account.

Most parameters of the model are set according to estimates from the literature estimates. The remaining parameters are calibrated. These include the intercepts of labour supply functions, the factor share equations and the factor price. frontier. In addition, seven elements of the matrix of elasticities of substitution are calibrated.

The disaggregation of the labour supply side of the economy is similar to the FR model (1984). The three skill categories are defined by their income levels i.e., the income levels can be taken to represent skill categories. This classification may induce some biases especially with further disaggregation of the labour force. The G.E. model developed at the ECC can handle any classification criteria. This should prove useful with further refinements of the data set.

Table 1-2 shows the source and method used to obtain the basic data required by the G.E. model.

Some adjustments had to be made to the data in order to construct a benchmark equilibrium data set; data are rarely consistent with equilibrium conditions. The data were adjusted to conform to Provincial Economic Accounts (P.E.A.). For example, because the micro data were not consistent with P.E.A. data, some parameters were obtained as residuals:

1 The exogenous labour supply (age groups 15 to 17 and 65 and over) was calculated residually by subtracting the aggregation of micro data from the aggregate wages, salaries and supplementary labour income (including military pay and allowances).

2 Given the provincial net income at factor cost, the aggregate labour cost, the value of capital services and the tax rate on capital income, the net rental rate of capital is obtained residually to comply with the constant returns to scale assumption, which implies that $Q = wL + rK$.

Since all residual parameters are ultimately dependent upon the quality of the micro data, the source for these data is of crucial importance. Due to cost constraints, data from the Survey of Consumer Finances (SCF) was used here. In the next version of this model, we will use Census data, which is recognized as better data source, especially in terms of consistency between hours worked and earnings. The wage rates derived from the SCF are rough estimates based on reported earnings and hours of work.

1.3.1 The Disposable Income Accounting Model (DIAM)

The purpose of constructing the DIAM was to derive basic data for the G.E. model. It generates the effective marginal net tax rates used to estimate the budget curves for each representative individual in the G.E. model.

The solution of this accounting model is obtained by using INTRAN, an algorithm developed by Richard J. Morrison and H. Lewis. INTRAN solves the accounting model for all the turning points of the net tax curve faced by a user-defined individual. Among other things, INTRAN also provides the source of the marginal tax change, identifying the changes to social program (transfers), tax deduction, premium, exemption or tax credit that modify the slope and intercept of the net tax curve. The DIAM takes into account federal and provincial personal income tax laws and the majority of relevant welfare programs (family allowances, family benefits, child tax credits, supplementary aid, Ontario tax credits, child care exemptions). The unemployment insurance program, health insurance and related programs, and programs for the elderly are excluded in this version of the accounting model.

1.3.2 Basic Assumptions of the Disposable Income Accounting Model for Ontario (1981)

1 The dependent child age structure as reported in the Survey of Consumer Finances was modified to fit the parameter

constraints. Children under 17 years of age in SCF appear in the model as children aged 14 years or less. Children aged between 18 and 24 years appear as children 18 years and older.

2 It is assumed that the spouse with the highest income will claim the child tax exemption and report family allowances on his/her income tax return.

3 Social assistance benefits were calculated with data provided by Health and Welfare Canada. The result is an "approximation of annual social assistance benefits for a family in Ontario." A take-up rate of 100 per cent is assumed in the results presented in Sections 1.6 and 1.7. The methodology for determining the participation rate will be refined using SCF information.

4 Supplementary needs are established for the dependent child allowance and the life insurance allowance. The other 10 special allowances (such as homeowner repairs, special diets, etc.) are not considered because of either a lack of data or because the usual beneficiaries are permanently unable to work.

5 In-kind benefits received by social assistance beneficiaries are set at $500 per year regardless of the size of the household. This is a temporary assumption. The in-kind benefits structure will be refined when relevant data become available. An arbitrary portion of in-kind benefits is approximated by a declining function of income. However, this approximation function is not used for the results presented in Sections 1.6 and 1.7.

6 Canada Pension Plan contributions cannot yet be a function of total contributory earnings of self-employed workers. Since no representative individual is yet defined as a self-employed person, this constraint is not binding. On average, self-employment earnings represent a very small share of the total earnings for the representative individual retained in the G.E. model.

7 Deductions which are not established through formulas are estimated with data from "Taxation Statistics" by interpolation between income classes. A single interpolation for the $0-$50,000 income range was used for the benchmark simulation in order to minimize the number of non-significant inflection points of the net tax curve and to speed the convergence of INTRAN. These deductions include contributions made to private pension plans, RRSP, RHOSP and union dues.

8 Other deductions, such as tuition fees and business investment losses, are set at zero.

9 It is assumed that all allowable expenses related to the child care deduction are fully spent.

10 The federal tax reduction is not transferable to a spouse.

11 It is assumed that the child tax credit is claimed by the wife.

12 In a two-parents household, it is assumed that OHIP premiums are paid by the husband.

13 Fixed work-related costs are set to zero.

1.3.3 Data Requirements of the DIAM

The data on individuals and households required by the DIAM are listed in Table 1-3. All data concern the socio-economic characteristics of the representative households.

1.3.4 Data Problems

It was found that the microdata assembled from the SCF tape, the data generated by the DIAM, the labour supply elasticity assumptions and the derived utility functions were not mutually consistent. There were two main areas of inconsistency.

1 Three representative individuals had an income (SCF) which implied an effective marginal income tax rate higher than 100 per cent (according to the rates derived from the DIAM). Consequently, the coefficients of the respective labour supply equations had the wrong sign.

This difficulty can be explained by the following factors:

a The number of hours worked is an average, obtained from a number of individuals working different numbers of hours.

b The static optimization procedure may not be consistent with a lifetime optimization.

c The individuals did not adjust their labour supply behaviour as quickly as might have been expected. Two years earlier (in 1979) few effective tax rates exceeded 100 per cent, since the social assistance tax back rate was 75 per cent (25 per cent below the 1981 rate).

d Because of institutional factors, the effective take-up rate on social assistance is lower than the rate determined by eligibility criteria.

There were several ways this aspect of the consistency problem could be dealt with:

a The SCF tape information could be read again to split the representative individual into two individuals with different income levels.

b The slope of the budget curve could be locally modified in accordance with the theoretical constraints.

c The representative individual could be artificially split into two so as to preserve the average number of hours, the wage rate and the average non-labour income.

For pragmatic reasons, the results reported in Sections 1.6 and 1.7 were generated with solution c. Theoretically speaking, solution a is probably the best.

2 Another consistency problem was discrepancies between the result of the optimization process and the observed number of hours. Because the budget curves are shaped like saw teeth,

the observed number of hours worked corresponds to a lower utility index than that of the simulated optimum.

There are two solutions to this problem:

a Modify the budget curve by eliminating a segment and linearly interpolating between the remaining segments.

b Re-shape a portion of the indifference curve so that the simulated optimum corresponds to the observed number of hours.

The second solution was adopted for the purpose of this version. This is equivalent to modifying the labour supply elasticity assumptions.

1.4 The Shape of Budget Curves and the Treatment of Two-Earner Households

1.4.1 Background

FR (1984, 1985) used polynomial regression to plot the budget curves faced by individuals and households. The data used in the regressions came from Quebec's Ministry of Finance. The polynomial form smooths out the inflection points in the net tax curves. This smoothing was necessitated by the lack of an appropriate solution algorithm in their income tax and transfer model. While the non-convexity of the budget set is preserved by polynomial smoothing, its piecewise linearity is eliminated. This may lead to biases in the results and may slow the solution algorithm. For example, it is known that a polynomial regression produces a bias in the net tax curves faced by lower and higher income workers. Such biases may be undesirable, especially when studying income redistribution.

In addition, the non-convexity of the budget sets raises the possibility of multiple equilibria. This situation requires global utility comparisons. When one gets rid of the piecewise-linearity of the curve through regression over an arbitrary amount of weighted points, some local tangencies crucial in a global utility comparison may well be omitted.

The polynomial approximation of a non-convex and piecewise linear budget set implies that the net wage rate changes infinitesimally along the budget curve. This is not realistic, because individuals do make their labour supply decisions with the assumption of constant wage rates over portions (segments) of the budget curves.

Figure 1-2 gives an example of the biases induced by polynomial regression. Both a segmented budget curve and a continuous polynomial approximation of it are shown. The tangencies are not located at the same place, so labour supply decisions would inevitably be different under the two approaches ($H \neq H^1$).

While not claiming that FR results are biased, I feel there is potential for biases in the procedure. They have shown great care in estimating the approximate polynomial, and the degrees of the polynomials are high enough to capture most marginal tax rate changes.

The modelling of a household disposable income accounting model is generally done by fixing either the husband-wife earnings ratio or one spouse's earnings. No attempt was made here to construct the solution of the G.E. model with budget curves generated by such a household accounting model, with the exception of a simplified model (8 individuals) for Ontario (1979). Instead, both the husband-wife maximization problems were modeled with the sole use of individual net tax functions. (For additional information on the derivation of these functions, please consult Section 1.3.)

1.4.2 The FR Approach with Household Budget Curves

Unlike the system in the United States, the Canadian tax system imposes limitations on the construction of a household budget constraint. In fact, the Canadian system of disjoint income tax filing makes it impossible to model a household budget set without making restrictive assumptions.

FR used such household budget sets in the solution algorithm of their G.E. model. For instance, the labour supply decision of a wife is modeled as the maximization of her own utility function, subject to the household budget constraint. This assumes that her non-employment income is augmented by the husband's gross wage income (FR, 1985, p. 22).

Once equilibrium is reached, the household net tax function is used to compute the equilibrium value of the household tax burden. Consequently, for any alternative simulation that modifies the labour supply of any one spouse, the tax calculation with the household tax function is biased by either the fixity of husband-wife earning ratio, the fixity of the other spouse's income, or the result of a regression on a set of points gathered from a mix of husband-wife earning ratios.

1.4.3 The Approach with Individual Budget Curves

In this model, the approach adopted for solving the two-parent household labour supply decision problem was to use only individual net tax functions. These make the following assumptions:

1 The husband's net tax schedule (or budget constraint) assumes that the maximum level of transfer payments depends on the base-case earnings of his wife.

2 The wife's net tax schedule assumes that her husband is entitled to all family social assistance transfer payments.

The procedure for solving the two-parent household labour supply decision problem is as follows:

1 Since, according to empirical evidence, the "cross-substitution elasticity for the husband's labour supply is not significantly different from zero, whereas the comparable elasticity for the wife's labour supply is usually significantly positive" (Killingsworth, 1983, p. 109), the husband maximizes his utility function in accordance with his budget constraint, assuming his spouse does not work.

2 The wife then makes her labour supply decision. She maximizes her own utility function in accordance with her own budget constraint and her non-labour income (and her potential income), augmented by the husband's <u>total net income</u>.

Once private sector equilibrium is reached, the household tax burden is calculated as the sum of each spouse's net tax calculation.

1.5 The Solution Algorithm

1.5.1 How Equilibrium is Reached

The basic solution of the model proceeds as follows:

1 The wage rates of two skill categories are entered by the user.

2 The third wage rate is obtained by solving the factor price frontier.

3 A labour supply optimization process inspired by Hausman (1980) follows, with a global utility comparison for each individual.

4 The individual labour supply decisions are aggregated, following which the corresponding production level (assuming the supply of one skill category equals the demand) and the factor demands are sequentially solved.

5 The supply of capital is set equal to the demand.

6 The labour supply and demand of two labour skill categories are compared and the two corresponding wage rates are

category. The process then starts over with these revised wage rates.

7 Once all markets clear, the level of net taxes is compared to the budget requirement of the government. Any discrepancy is redistributed according to a government reaction function (usually as a lump sum tax or transfer). The process is repeated until all markets clear and the government budget is balanced.

1.5.2 The Factor-Price Revision Rule (FPRR)

Once the individual labour supply optimization problems are solved, the labour input supplies are aggregated and the factor demands are calculated.

By comparing factor demands and supplies, factor prices are revised according to the excess demand in each input market.

The factor-price revision rule (FPRR) used must be a smooth sign-preserving function of excess demand (Varian, 1978). The primary criterion in the choice is usually one of speed in the iterative process.

The retained adjustment function is

$$P_{i+1} = P_i \ [1 + \frac{D-S}{SE_s - DE_d}]$$

where E_s is the labour supply elasticity and E_d is the labour demand elasticity E_d is calculated according to the iteration process, and $E_d = \frac{dDp}{dpD}$, while E_s is assumed constant.[2]

This FPRR will not work for all precision levels if the aggregate labour supply is perfectly elastic at the equilibrium wage. Kinks in the budget constraints are likely to produce such occurrences. A revised FPRR could be constructed to deal with a potential local infinite elasticity of the aggregate labour supply.

FR (1984, 1985, 1986) used Kimbell and Harrison's (1984) FPRR.

1.6 Welfare Calculations

The waste inherent in a tax distorted general equilibrium can be evaluated by summing the Hicksian equivalent variations (EV). These EV presuppose the selection of a vector of reference prices. Like Diewert (1985), Fortin and Rousseau (1986) selected a price vector corresponding to an (arbitrary) Pareto optimal equilibrium defined as a lump-sum taxation scheme where each individual pays his benchmark contributions to all taxes (payroll, income, indirect and capital taxes net of the implicit guaranteed income).

The calculation of individual contributions to payroll, income and indirect taxes is straightforward. However, in order to obtain a Pareto optimal equilibrium, the effective capital taxes paid by Canadians are distributed to domestic capital owners according to their specific share in domestic capital ownership:

$$TKCONT_j = \frac{INVY_j * t_k}{(1-t_k)}$$

where

$TKCONT_j$ = the implicit contribution to capital taxation of the j-th consumer;

$INVY_j$ = the investment income of the j-th individual;

t_k = the average tax rate on capital.

The advantage of using a Pareto optimal set of prices as a reference appears to be the ability to measure the waste engendered by the benchmark tax-transfer system. However, in choosing this approach, the result can only be statements such as "the observed net tax structure implies a welfare cost of <u>at least</u> \$...." The money metric measure remains linked to the choice of the Pareto optimal equilibrium. The resulting measure can be interpreted as the sum of the amounts of money the households would need to be given at the benchmark set of prices to attain the level of utility reached in the specified Pareto optimal simulation.

Alternatively, the welfare loss due to the tax-transfer system could be measured as an output difference (evaluated at reference prices) between an undistorted tax-transfer equilibrium and the distorted equilibrium (Diewert, 1985).

The welfare cost of a distorted tax-transfer equilibrium is of no use to policy analysts or designers. The welfare cost needs to be compared to that of a possible reform or scenario.

In this sense, there may be no need to define a Pareto optimal equilibrium. The relative improvement in welfare due to a tax-transfer policy reform can be assessed without using a Pareto optimal reference price vector.

Similar to the approach taken by Fortin and Rousseau (1986) and Diewert (1985), I made calculations relating to welfare by comparing the distorted tax-transfer system to a non-distorted Pareto optimal system.

The Pareto optimum chosen is different from that used by Fortin and Rousseau (1986), however. The Pareto optimum selected by FR is based on a uniform per-capita lump-sum tax that finances the same level of aggregate public goods and guaranteed income as those in the benchmark equilibrium. The optimum used here is defined by individual lump-sum taxes that finances the same level of public goods and guaranteed income[3] per household as those observed in the benchmark equilibrium. The individual lump-sum tax thus corresponds to the amount of tax (transfers) paid (received) by each representative individual in 1981. The main difference from FRs lump-sum tax is the absence of redistribution.

The deadweight loss calculation is the sum of minus the individual equivalent variations defined in terms of the Pareto optimal (P.O.) equilibrium prices.

$$DL = \sum_i N_i \left[e_i \left(W_i^p, U_i^p \right) - e_i \left(w_i^p, U_i^{BM} \right) \right] = \sum_i N_i \left(-EV_i \right)$$

where

N_i = the number of individuals represented by individual i;

W_i^p = the wage rate of individual i at the Pareto optimal equilibrium;

U_i^P = the utility index of individual i at the Pareto optimal equilibrium;

U_i^{BM} = the utility index of individual i at the benchmark equilibrium;

$e_i(.)$ = the expenditure function for individual i.

The treatment of couples in the household deadweight loss calculation is similar to FR's. The husband and wife equivalent variations (EV_H and EV_W, respectively) are added, and the change in the husband's disposable income (DYM) is netted out from the result to avoid double counting:

$$DL = \sum_i N_i \; [-EV - EV_W - (DYH^P - DYH^{BM})]$$

1.6.1 Marginal Welfare Costs

By raising all effective taxes by 1 per cent (at constant behaviour) the marginal welfare cost of the tax-transfer system[4] is calculated by a $(DL_3 - DL_1)/\Delta TAX$, where DL_3 is the deadweight loss evaluated by comparing the equilibrium with all taxes raised 1 per cent to the Pareto optimal equilibrium, and ΔTAX is the amount of additional taxes collected in the economy.

By raising effective personal income taxes by 1 per cent, the marginal welfare cost of the personal tax-transfer system is calculated by a $(DL_2 - DL_1)/\Delta TAX$, where DL_2 is the deadweight loss evaluated by comparing the equilibrium with personal income taxes raised to the Pareto optimal equilibrium, DL_1 is the deadweight loss evaluated by comparing the benchmark equilibrium with the Pareto optimal equilibrium, and ΔTAX is the amount of additional taxes collected in the economy (FR, 1986).

1.7 Results

The results of the simulation used to calculate the marginal welfare costs of the tax-transfer system are presented in Table 1-5. A marginal increase in effective income taxes reduces the labour supply by 0.08 per cent because of both the larger disincentive effects of higher marginal income tax rates and the lower opportunity cost of leisure.

In addition, the aggregate labour supply contraction induces a 0.09 per cent outflow of capital because of a decreasing consumption or output per unit of capital. Meanwhile, the substitution of labour for capital puts upward pressure on low- and high-skill-wage rates.

Because of the way the additional tax proceeds are redistributed to individuals, low-income individuals experience a welfare gain

(Table 1-6) while all other individuals experience a welfare loss commensurate with the tax increase and the respective changes in leisure time.

As expected, smaller labour supply elasticities moderate the output and employment effect and increase tax revenues.

Because of the output effect of lower input productivity and declining consumption, raising all taxes by a given percentage at constant behaviour (Scenario 2) does not lead to an equivalent increase in total tax revenues.

When base-case labour supply elasticities are used, the marginal welfare cost (MWC) of taxes appears to be very high. For example, the marginal welfare cost of the personal income tax-transfer system is estimated at 156 per cent. That is, for each additional dollar of income taxes (or transfer reduction) there is a welfare cost of $1.56. On the other hand, the marginal welfare cost of all effective taxes is estimated at 85 per cent of the additional taxes.

When compensated and uncompensated labour supply elasticities are halved, the MWC of all taxes is reduced to 39 per cent, and the MWC of personal tax-transfer system (TTS) works out to 65 per cent.

When the abatement of the labour supply elasticities is very large, the MWC of all taxes is reduced to Ø.

By simplifying the personal effective income tax structure (by arbitrary linear interpolation[5] on the net tax curve for each socioeconomic characteristic), the aggregate labour supply is expanded by 0.33 per cent and the production level and the government revenues are increased by 2.44 per cent. This arbitrary simplification of the personal effective tax structure entails a welfare loss for most couples at the same time as it enhances the welfare of singles and heads of single-parent families.

For this general equilibrium model, unemployment is exogenous and the unemployment insurance program does not influence the behaviour of labour supply. B. Fortin has proposed a theoretical framework and parametric assumptions designed to correct for these working assumptions and so permit the simulation of the impact of unemployment insurance reform proposals. The next chapter will examine this framework.

2 INCORPORATING UNEMPLOYMENT INSURANCE INTO A COMPUTABLE GENERAL EQUILIBRIUM MODEL OF TAXES AND TRANSFERS

by Bernard Fortin

2.1 Introduction

Incorporating unemployment insurance (UI) into a general equilibrium model of taxes and transfers, such as that developed by Fortin-Rousseau (1986), poses some difficult technical problems. Because of its very nature, UI cannot be modeled in the same way as social assistance and demogrant programs. For one thing, eligibility requirements are quite different for UI than for these other programs. To qualify for UI benefits, a person must have worked a minimum number of weeks in a reference period during which UI contributions were paid. In addition, benefits can only be drawn for a maximum number of weeks while unemployed. The benefits provided by social assistance and demogrant programs, on the other hand, are generally determined on the basis of households' socio-demographic characteristics, income levels and assets.

UI eligibility requirements may thus have a direct impact on the movement of workers in and out of the labour market. Theoretical studies (e.g., Mortensen 1977, Burdett 1979, Ben-Horim and Zuckerman 1987) have generally opted for a dynamic job search framework when modelling these choices. Unfortunately, this approach is not well suited to static general equilibrium models defined on an annual basis.

The strategy proposed here consists of modelling the average annual behaviour of an individual as he follows his employment-unemployment cycle, although in the cycle itself may be longer than a year. I believe that this approach is particularly well suited to a computable general equilibrium model, since each representative individual used in the analysis stands in for the average behaviour of a specific socio-economic class.

Based on the neoclassical theory of labour supply, this approach ties in well with the theoretical framework adopted in the Fortin-Rousseau general equilibrium model (FR). In particular, it allows taxes and transfers other than UI to be integrated into the model in a very natural way.

Section 2.2 presents the basic theoretical framework used in the analysis. Section 2.3 describes how taxes and transfers other than UI are incorporated into the model. In Section 2.4, the choice of the functional form retained for the utility functions is presented. Section 2.5 discusses the choice of the values for the labour supply elasticities. In Section 2.6 analyzes a simplified version of the model that assumes the length of the workweek is exogenous. Section 2.7 presents various extensions to the basic model. Finally, in Section 2.8, it is shown how a slightly modified version of the model could be used to simulate the main recommendations of the Forget Report.

2.2 Unemployment Insurance and Labour Supply

The proposed framework is an extension of the P. Fortin model (1984). This model assumes that working weeks and nonworking weeks within the employment-unemployment cycle are the only endogenous labour supply variables. In this model, the length of the workweek is exogenous. Our proposed approach allows labour supply to adjust both at the intensive margin (hours per week) and at the extensive margin (weeks).

It is important to keep these two adjustment margins distinct in the model because UI parameters can affect the price of leisure during working weeks relative to its price during nonworking weeks.

Thus UI can exert two opposing influences on the choice of working weeks and weekly hours of work. In certain cases, as we shall see, UI makes it advantageous for the individual to lengthen his workweek in order to raise the weekly amount of his UI benefits (below the imposed maximum) and yet simultaneously to decrease his number of working weeks in order to increase his dependency rate on UI (bunching effect).

The basic idea behind the Fortin model is to show that, because of UI entitlement provisions, the efficient leisure-income constraint depends on the periods of employment and nonemployment chosen by the individual. As the author conclusively demonstrates, this approach makes it possible to account simply and consistently for the impact of UI on participation rates, frequency and duration of unemployment (or joblessness) and the various behaviours of persons with strong and weak attachments to the labour market.

2.2.1 Optimization Problem

The individual's optimization problem is to select K, v, n, d and x in order to maximize his utility function:

$$u = u\,(x, n, d) \qquad u_x > 0;\ u_n,\ u_d < 0 \qquad (1)$$

provided that

$$x = wd\,(n + rv) + y \qquad (2)$$

$$v = \begin{cases} \min\,(1 - n - A/K,\ D/K) & \text{if } (1-n)K \geq A \text{ and } nK \geq M \\ 0 & \text{otherwise} \end{cases} \qquad (3)$$

$$x \geq 0,\ 0 \leq v \leq 1 - n \leq 1,\ 0 \leq d \leq 168,\ 0 \leq K \leq \infty, \text{ and}$$

$$w > 0,\ 0 \leq r \leq 1,\ A > 0,\ D > 0,\ M > 0$$

Equation (2) describes the budget constraint. In a complete cycle of working and nonworking weeks of total length K, the average weekly disposable income x is the sum of employment earnings wdn, unemployment insurance benefits wdrv and non-employment income y, where w = hourly wage,[6] d = length of the workweek, n = employment rate (number of weeks of employment as a percentage of K) over the cycle, r = the UI replacement ratio, and v = the rate of UI-compensated unemployment ($v \leq 1 - n$).

Equation 3 reflects UI eligibility requirements. A person only qualifies for UI once he has worked a minimum number of weeks ($nK \geq M$) and has waited a specified period [$(1 - n) K \geq A$]. The length of the benefit period vK is thus equal to the remaining weeks of unemployment $(1 - n) K - A$ or the maximum number of benefit weeks D, whichever is shorter.

The utility function (1) is increasing with x, decreasing with n and d and strictly quasi-concave in x, n and d. Since arguments n and d of the utility function also enter into the budget constraint (2) in the form of product dn, the budget constraint is intrinsically non-linear, which makes the optimization problem more complicated. One way to get around this difficulty is to rewrite the utility function in the following form:

$$u = u^* (x, nd, d) \qquad u^*_x > 0,\ u^*_{nd} < 0,\ u^*_d = ? \qquad (1')$$

where u^* (.) is obtained by rewriting $u(x, n, d) = u(x, nd/d, d) = u^*(x, nd, d)$. It will be assumed that u^* is strictly quasi-concave[7] in x, nd and d. The sign of u^*_d is undetermined because it describes how u reacts to variation in d when n varies in the opposite direction in order to keep nd constant.

The optimization problem can be solved in two steps. The first involves determining the length of the employment-unemployment cycle which maximizes the rate of UI-compensated unemployment v for a given employment rate n. This step determines $K^* = K^*(n, A, D, M)$, and allows us to derive the individual's efficient budget constraint, i.e., that which maximizes disposable income x for a given n and d. In the second step, the utility function is maximized subject to this efficient budget constraint.

2.2.2 The Efficient Budget Constraint

This constraint can be easily derived from a figure similar to the one used by Fortin (1984). The solution for K* is given by:

$$K^* = \max\,[(A + D)/(1 - n),\; M/n] \qquad (4)$$

The corresponding maximum value of v is thus:

$$v^* = D/K^* = \min\,[(1 - n)D/(A + D),\; nD/M] \qquad (5)$$

Finally, substituting (5) into (2), the efficient budget constraint is expressed as:

$$x^* = w_a \, n_d + w_d + y \qquad (6)$$

where

$$w_a = \begin{cases} w\,(1 - rD/(A + D)) & \text{if } n_c \le n \le 1 \\ w\,(1 + rD/M) & \text{if } 0 \le n < n_c \end{cases}$$

and

$$w_d = \begin{cases} wrD/(A + D) & \text{if } n_c \le n \le 1 \\ 0 & \text{if } 0 \le n < n_c \end{cases}$$

w_a represents the opportunity cost of a marginal decrease in total hours worked n_d, <u>for a given d</u>, taking into account the impact of this decrease on the level of UI benefits received. w_d represents the opportunity cost of a shorter workweek d, <u>for a given total number of hours n_d</u>. $n_c = M/(M + A + D)$ is the critical employment rate where the functions defining K* and v* switch modes.

These results can be interpreted as follows. When $n \ge n_c$ (in which case we say that the individual has a <u>strong attachment to the labour market</u>), there is a range of values for the length of cycle K such that the eligibility requirement $nK \ge M$ is met and nonworking weeks $(1 - n)K$ do not exceed $A + D$. In this case, the individual is induced to choose the maximum length of unemployment $(1 - n)K^* = A + D$ in order to reduce the loss of benefits associated with the existence of the waiting period A. The benefit period vK is then equal to D. As long as the individual has a strong attachment to the labour market, any decrease in employment (and in K), since the length of nonworking weeks will always be equal to $A + D$.

For $n \geq n_c$, w_a is equal to $w(1 - rD/(A + D))$. This expression is <u>less</u> than the hourly wage w because the UI-compensated unemployment rate falls as n increases:

$$\frac{\partial v^*}{\partial n} = - D/(A + D).$$

UI thus affects workweeks in the same way as a <u>payroll tax</u> at the rate $rD/(A + D)$.

On the other hand, w_d is equal to $wrD/(A + D)$. This figure is positive because a higher weekly wage pushes up UI benefits by a proportion r over the compensated period of unemployment. Thus the effect of UI on the length of the workweek is the same as a wage <u>subsidy</u>.

When $n = n_c$, the length of employment coincides with the minimum period for program eligibility: $nK^* = M$. If the employment rate falls below n_c (in which case the individual is said to have a weak attachment to the labour market), it is the period of nonemployment (and so K^*) that increases, since working weeks remain at the minimum M. The benefit period remains equal to D.

For $n < n_c$, w_a is given by $w(1 + rD/M)$. This variable will remain the same regardless of whether working hours increase as a result of a greater number of working weeks or a longer workweek. This opportunity cost increases with n: $\partial v^*/\partial n = D/M$. Thus the effect of UI on working hours is the same as a wage subsidy at the rate rD/M.

2.2.3 Utility Maximization

The maximization of equation (1′) subject to the efficient budget constraint (6) generates two labour supply functions: the individual's average annual supply of working hours, $a^* = 52(nd)^*$ over his cycle, and his weekly supply of working hours (assuming an interior solution):

$$a^* = a^* (w_a, w_d, y) \qquad (7)$$

$$d^* = d^* (w_a, w_d, y) \qquad (8)$$

The values of w_a and w_d vary according to whether the individual has a weak or strong attachment to the labour market (see equation (6)).

The signs of the partial derivatives of (7) and (8) are determined from neoclassical consumer theory:

$a_1^* >< 0$ depending on whether the substitution effect is greater or less than the income effect on the total working hours supply.

$a_2^* < 0$ if total working hours are a gross substitute for weekly working hours, and $a_3^* < 0$ if total annual leisure is a normal good.

$d_2^* >< 0$ depending on whether the substitution effect is greater or less than the income effect on weekly working hours supply.

$d_1^* < 0$ if weekly working hours is a gross substitute for total working hours, and $d_3^* < 0$ if leisure during working weeks is a normal good.

In the model, the decision to have a strong or weak attachment to the labour market can be made endogenous. The consumer's optimum is calculated by first assuming that $n_c \leq n^* \leq 1$, then that $0 \leq n^* < n_c$; after comparing the corresponding utility levels, the highest of these optimum values is retained.

2.3 Incorporation of Taxes and Transfers other than UI

The model can easily be extended in order to take into account the existence of taxes and other transfers. The consumer's budget constraint (equation 6) may be rewritten on an annual basis as follows:

$$52x = 52\ (w_a nd + w_d d + y) - T\ (52(w_a nd + w_d d),\ c) \qquad (9)$$

The function T (.) represents income taxes net of transfers other than UI. For the purposes of simplicity, it is assumed that the accounting period used to calculate taxes and transfers other than UI corresponds to the individual's cycle K. T (.) is thus equal to the average annual amount of income taxes net of transfers other than UI paid by the individual in the course of his cycle.[8] It will also be noted that expression $52\ (w_a nd + w_d d)$ represents annual employment income plus annual UI benefits. This formula is valid as long as UI payments are treated as employment earnings by the tax system and the other transfer programs. c represents taxable income other than earned and transfer income.

Because of income-tested transfers and income tax progressivity, the variable T is a piecemeal linear function of the sum of employment income and UI benefits. Let us define the linear income tax net of transfers function for the i-th income bracket (assuming m brackets corresponding to m tax rates τ_i) as follows:

$$T_i = \overline{T}_i + \tau_i \ (52\ (w_a nd + w_d d) + c - R_i) \qquad (10)$$

where $\overline{T}_i$ represents the level of income tax net of transfers at the minimum taxable income R_i in bracket i.

By substituting (10) for T (.) in constraint (9), the linearized budget constraint associated with bracket i is obtained:

$$52x = 52\ (w_a\ (1 - \tau_i)nd + w_d\ (1 - \tau_i)\ d) \qquad (11)$$
$$+ (52y - \overline{T}_i + \tau_i\ R_i - \tau_i c)$$

The last term in parentheses on the right-hand side of equation (11) represents the virtual non-employment income corresponding to bracket i. The consumer's optimum is calculated by directly applying Hausman's (1981) algorithm. This is the method currently used to solve the FR general equilibrium model developed at the Economic Council of Canada.

2.4 <u>Procedure for Setting Utility Function Parameters</u>

We propose here the adoption of the indirect utility function used by Hausman and Ruud (1984) in their analysis of the labour supply of couples. It is basically an extension of Hausman's utility function, used in the FR model, and is capable of analyzing two labour supply functions simultaneously. While the

Hausman and Ruud paper concerns the labour supply of each member of a couple, we will use their function to derive both the supply of weeks and the supply of weekly working hours offered by an individual. A significant advantage of this utility function is that backward-bending supply curves are permitted.

The function is expressed as follows:

$$V = (\exp\ (b_a w_a + b_d w_d)) \bullet y^* \qquad (12)$$

where

$$y^* = y' + s + d_a w_a + d_d w_d + 0{,}5\ (g_a w_a{}^2 + g_d w_d{}^2 + 2k\ w_a w_a)$$

ignoring, for simplicity's sake, income taxes and transfers other than UI.

y' is annual non-employment income ($y' = 52y$) and k, b_a, b_d, s, d_a, d_d, g_a and g_d are the 8 parameters to be determined. (12) is a Gorman polar form, so that preferences are quasi-homothetic (see Deaton and Muellbauer, 1980).

The uncompensated labour supply functions derived from (12) are as follows:

$$a^* = d_a + g_a w_a + k\ w_d + b_a\ y^* \qquad (13)$$

$$d^* = 1/52\ (d_d + g_d w_d + K\ w_a + b_d\ y^*) \qquad (14)$$

These functions are linear in (virtual) non-employment income and quadratic in the marginal wage rates.

The expenditure function is easily derived by solving equation (12) for y'. The direct utility function is obtained by solving for w_a, w_d, and y' as functions of a, d and x, using (13), (14) and the budget constraint (6) and by substituting in the indirect utility function (see Hausman and Ruud, p. 244).

The 8 parameters of the indirect utility function must be selected for each representative individual. The method we propose involves imposing 8 linear constraints on the coefficients of the two labour supply functions. The value for each of the 8 parameters is determined by solving these 8 equations for each individual. The 8 constraints are chosen so that information from econometric studies on labour supply can easily be used.

The first two constraints are derived by assuming that equations (13) and (14) are respected for values of a*, d*, w_a, w_d and y' corresponding to the benchmark year. This calibration procedure is used in virtually all computable general equilibrium models.

The third constraint forces s = 0. Note that s appears as a constant in the expression y* and has no effect on labour supply responsiveness to wages and virtual income. This constraint might be considered as a standardization rule. In any event, it is always possible to carry out a sensitivity analysis of the results for different values of s.

The last five constraints determine the value, in the benchmark year, of the compensated and uncompensated elasticities of each labour supply (a* and d*) with respect to the wage rate w, as well as the compensated cross-elasticity of d* with respect to w_a. A survey of existing empirical literature on labour supply was of some assistance in assigning values to these elasticities. The algebraic calculation of the elasticities requires equations (13) and (14), the definitions of w_a and w_d given in (6), as well as Slutsky equations for the two labour supplies. Specifically, the symbols $E^c_{i,j}$ and $E_{i,j}$ are used to represent, respectively, the compensated and uncompensated elasticities of variable i with respect to variable j, from which we obtain:

$$E_{a*,w} = (w/a*)\ [g_a\ w_a' + k\ w_d' + b_a\ (d_a\ w_a' + d_d\ w_d' + g_a\ w_a\ w_a' + g_d\ w_d\ w_d' + kw_a\ w_d' + kw_d\ w_a')] \qquad (15)$$

$$E^c_{a*,w} = E_{a*,w} - w/a*\ [b_a\ (a*\ w_a' + \bar{d}*\ w_d')] \qquad (16)$$

$$E_{d*,w} = (w/\bar{d}*)\ [g_d\ w_d' + k\ w_a' + b_d\ (d_a\ w_a' + d_d\ w_d' + g_a\ w_a\ w_a' + g_d\ w_d\ w_d' + k\ w_a\ w_d' + k\ w_d\ w_a')] \quad (17)$$

$$E^c_{d*,w} = E_{d^*,w} - w/d*\ [b_d\ (a*\ w_a' + \bar{d}*\ w_d')] \quad (18)$$

$$E^c_{d*,w_a} = (w_a/\bar{d}*)\ [k + b_d\ (d_a + g_a\ w_a + kw_d - a*)] \quad (19)$$

where

$$w_a' = \partial w_a/\partial w = \begin{cases} 1 - rD/(A + D) & \text{if } n_c \leq n \leq 1 \\ 1 + rD/M & \text{if } 0 \leq n < n_c \end{cases}$$

$$w_d' = \partial w_d/\partial w = \begin{cases} rD/(A + D) & \text{if } n_c \leq n \leq 1 \\ 0 & \text{if } 0 \leq n < n_c \end{cases}$$

using equation (6) and defining $\bar{d}* = 52\ d*$.

2.5 Choice of Parameters

Despite the great number of econometric studies on labour supply in Canada and in the United States, there is little agreement on the precise values of the relevant elasticities. Moreover, few studies in Canada have distinguished between the elasticities of annual and weekly working hours with respect to wages (see, however, Fortin 1979, Ham and Hsiao 1984[9] and Smith and Stelcner

1985). There is only one study, to our knowledge, that offers results on the compensated cross-elasticity E_{d*,w_a} (Fortin 1979). A controversy has raged in Canadian literature in recent years on the differences between Canadian and U.S. labour supply elasticities. In fact, according to some empirical results (e.g., Nakamura and Nakamura 1981, Robinson and Tomes 1985), the wage-elasticity of women is negative in Canada. These results run counter to most American studies, which have found this elasticity to be positive (see Killingsworth 1983). Other Canadian studies (Stelcner and Breslaw 1985) have obtained results similar to those of U.S. studies (e.g., Fortin 1979, Stelcner and Breslaw 1985, Mazany 1985, Normand 1986, Prescott, Swidinsky and Wilton 1986).

Given such uncertainty about elasticity values, it will be important to analyze how simulation results may be affected by parameter choices.

Table 2-1 presents, for five representative groups, tentative values for the five elasticities needed to calibrate the model. In each case, upper and lower limits are suggested for the elasticity values. The following considerations entered into the selection of these figures:

1 The upper limits for $E^c_{a*,w}$ and $E_{a*,w}$ were derived from Table 2 of Fortin-Rousseau (1986).

2 The lower limits for the same variables were taken from Table 3.3 of a paper by Osberg (1986) surveying Canadian literature on labour supply. In this survey, Osberg appears to support elasticity figures that are more conservative than corresponding American figures. The compensated labour supply elasticity for married women is derived from Cloutier (1986).

3 Compensated and uncompensated elasticities for weekly working hours were obtained by dividing compensated and uncompensated annual working hours elasticities by five. The figures are consistent with the results of Hanoch (1980) for the United States and of Stelcner and Smith (1985) for Canada. These studies were concerned exclusively with the labour supply of married women, however.

4 Starting from the results of Fortin (1979), the compensated cross-elasticity of annual services supply with respect to the cost of leisure during nonworking weeks (corresponding to w_a) works out to -0.2 for married men. According to this result, annual and weekly hours act as net substitutes. Limits of 0.1 and 0.3 were selected for this elasticity, and the same elasticity values were used for the other demographic categories, since information on them was not available.

Note that the values selected for Table 2-1 elasticities satisfy some local restrictions imposed by consumer theory. Thus the compensated labour supply elasticities

$$E^c_{a*,w_a} = (E^c_{a*,w} - E^c_{a*,w_d} E_{w_d,w})(E_{w_a,w})^{-1}$$

and

$$E^c_{d*,w_d} = (E^c_{d*,w} - E^c_{d*,w_a} E_{w_a,w})(E_{w_d,w})^{-1}$$

are all positive.

2.6 Exogenous Weekly Working Hours

The model can be simplified if one is ready to assume that d is exogenous for the worker and fixed at a level $\bar{d}$ (e.g., Rea, 1977). In this case, it is assumed that annual working hours are only adjusted by making changes to working weeks, the length of the workweek remaining exogenous. In this case, the efficient budget constraint is still given by equation (6) but the restriction $d = \bar{d}$ is imposed. Figure 2-1 illustrates this constraint. 0yc represents the budget constraint with no UI (assuming again no taxes and no other income security programs). 0yBC illustrates the efficient budget constraint with UI. The segment yB corresponds to the situation where the individual has a weak attachment to the labour market ($0 \leq n \leq n_c$). In this case $w_a = w(1 + rD/M)$ and is represented by the slope of yB.

On the segment BC, the individual has a strong attachment to the labour market ($n_c \leq n \leq 1$) and the slope of this segment is given by $w_a = w(1 - rD/(A + D))$. The virtual weekly non-wage income associated with this situation is given by $y^v \equiv y + w\,\bar{d} = y + (wrD/(A + D))\,\bar{d}$ (see Figure 2-1).

Maximizing the utility function $u^*(x, n\bar{d}, \bar{d}) = u^*(x, n\bar{d})$ ascending to equation (6) yields the individual's constrained average annual labour supply over his cycle ($a^* = 52\, n^*\, \bar{d}$):

$$a^* = \bar{a}^*(w_a, y + w_d\,\bar{d}) \tag{20}$$

with w_a and w_d defined in equation (6), or equivalently.

$$a^* = \bar{a}^*(w_a, y^v) \tag{20'}$$

Assuming an interior solution, the individual's optimum corresponds to a tangency point between the efficient budget constraint and the indifference curve yielding the highest level of utility (not shown in Figure 2-1). The individual's attachment to the labour market can be endogenized using the approach described in Section 2.2.

The Hausman utility function (1981) as used by FR can be adopted to derive a functional form for equation (20). The linear uncompensated labour supply function corresponding to this utility function can be written as:

$$a^* = a_0 + a_1 w_a + a_2 52 (y + w_d \bar{d}) \qquad (21)$$

where a_0, a_1, a_2 are the three parameters to be determined. Taxes and transfers other than UI can be easily incorporated into the model using an approach similar to the one presented in Section 2.3.

2.7 Extensions to the Basic Model

The model may be extended in several directions to make it better reflect actual UI regulations or to relax some of the simplifying assumptions.

i) Up to now, it has been assumed that all nonemployment is the outcome of individual utility-maximizing choices, given the presence of UI and other transfer programs. However, it can be argued that this assumption is unrealistic, at least over short-term periods (Phipps, 1987). Demand-side constraints may interfere with individual labour supply decisions in many ways. Thus, given the existence of specific human capital associated by a particular job, an individual on temporary lay-off may prefer to wait for recall rather than to search for another job. Moreover, an unemployed worker who is looking for a job may find none available.

Recent theoretical work has provided various explanations for the existence of "rationed" unemployment consistent with both rational behaviour and the absence of any exploitable mutually advantageous exchange in the markets (for a survey of this literature, see Stiglitz, 1984). Until now, however, empirical studies have been unable to choose one proposed hypothesis to explain job rationing over the others. Given the state of our knowledge, a reasonable starting approach is to view part of unemployment as constituting a constraint on labour supply, without attempting to formally justify its existence. Indeed, recent empirical work (Ham, 1986) yields evidence supporting the hypothesis that constraints exist in the labour market.

Quantity constraints could be easily introduced in the model using a procedure proposed by Phipps. From econometric evidence, a probability of constraint is retained for each representative individual in the model. Then, each individual is replaced by 10 replicas of himself/herself. Finally, it is assumed that a fraction of these 10 individuals, corresponding to the probability of constraint, are effectively rationed in their labour choices. Sensitivity analysis with respect to the assumptions retained for the values of the probabilities of constraint could then be performed.

ii) The model might be extended to take into account other parameters of unemployment insurance: minimum and maximum limits on contributory employment income, the functional relationship between the number of contributory working weeks and the maximum number of weeks of unemployment with UI benefits, the presence of a work test, the repayment of a fraction of UI benefits above a certain annual income level. These extensions do not pose any particular theoretical difficulties and are left to the reader. Note, however, that they do increase the complexity of the budget constraint and have the effect of raising the programming costs and time involved in solving the model.

iii) The model predicts that all UI payments received by claimants will be completely utilized. This must be considered extreme behaviour, even though generally a significant proportion of beneficiaries (between 25 and 35 %) uses their benefits completely. This prediction of the model stems directly from the assumptions that $u_K = 0$, i.e., that cycle duration does not enter as an argument into the utility function, and that the gross wage rate w is exogenous. Let us discuss each assumption in turn. Assuming $u_K = 0$ means that, for a given consumption level and employment rate, the individual is indifferent to the choices of the frequency and the duration of his periods of employment. This assumption makes it possible to break the optimization problem into two steps, considerably simplifying the model. Indeed, our efforts to relax the assumption that $u_K \neq 0$ have so far been inconclusive. Moreover, to our knowledge, the sign and size of u_K has not been studied; this information is essential for setting the parameters of any utility function using K as an argument. A more promising approach to relax the full UI benefits utilization result would be to assume that there is a relationship between the individual's gross wage rate and the duration of his periods of employment and nonemployment. We are presently working in this direction.

iv) The model described in this paper is concerned only with the effects of UI on labour supply. One way to take the effects of UI on labour demand into account would be to introduce the number of workers N and the hours worked H as distinct inputs in the production function. In its present version, the FR model assumes that firms are indifferent to the choice of N and H in determining the number of person-hours of work NH needed to maximize profits. This assumption is valid only if the elasticity of production with respect to the number of workers N is equal to the elasticity of production with respect to working hours per worker H. To my knowledge, this prediction has never been empirically tested for Canada. Studies on data from the United States and Britain (e.g., Feldstein 1967, Leslie and Wise 1982) do not appear to support this result. Note, however, that virtually all computable general equilibrium models make this assumption, mainly for simplicity's sake.

As the FR model is developed in the future to take into account 1) the presence of fixed employment costs (hiring and training costs and non-hourly fringe benefits), 2) overtime, and 3) the distinct treatments of N and H by the tax system, it will become important to treat the demands for N and H separately in the model (see Fortin 1985 for a discussion of this topic). This would be necessary, for example, in order to simulate adequately the introduction of an experience-rating policy. Indeed, experience rating penalizes employers who resort to layoffs rather than reduced workweeks to lower their labour input in response to slackening demand for their products.

v) Finally, it would be interesting to extend the model in order to take into account the influence of UI on other individual choices: job search, worker mobility, work effort, etc. (see Cousineau 1985).

2.8 On Simulating Forget Report Recommendations

Important modifications to the basic model are needed in order to simulate the impact of reforms such as the annualization of UI benefits proposed in the Forget Report (1986, Recommendation 23). Under this reform, the level of weekly benefits would be proportional to the weekly average of insurable earnings over the 52 weeks preceeding the beginning of the unemployment spell. In terms of our model, this means that the UI replacement ratio r is now proportional (at a rate $\bar{r}$) to the individual's rate of employment n.

Indeed, the level of weekly UI benefits during UI-compensated weeks of unemployment is now given by $P=\bar{r}\ wa/52$. Therefore, the UI replacement ratio, which is defined as the ratio of P to the weekly labour earnings wd, is $r=\bar{r})\ wa/(52\ wd)$. Since $a = 52nd$, we thus have:

$$r = \bar{r}\ n \tag{22}$$

Note that r increases from 0 to $\bar{r}$ as n rises from 0 to 1. Equation (22) introduces a non-linearity in the individual's efficient budget constraint, as r becomes an endogenous variable in the model. Substituting equation (22) into equation (6) and assuming, to simplify the presentation, that the length of the workweek is $\bar{d}$, the efficient budget constraint is now:

$$x^* = w_a\, n\bar{d} + w_d\, \bar{d} + y \tag{23}$$

where

$$w_a = \begin{cases} w\,(1 - \bar{r}nD/(A + D)) & \text{if } n_c \le n \le 1 \\ w\,(1 + \bar{r}nD/M) & \text{if } 0 \le n < n_c \end{cases}$$

and

$$w_d = \begin{cases} w\,\bar{r}nD/(A + D)) & \text{if } n_c \le n \le 1 \\ 0 & \text{if } 0 \le n < n_c \end{cases}$$

The marginal opportunity cost of leisure $w_a^* = \partial x^*/\partial(n\bar{d})$ can be obtained by differentiating (23) with respect to $n\bar{d}$:

$$w_a^* = \begin{cases} w\,(1 - \bar{r}D(2n - 1)/(A + D)) & \text{if } n_c \le n \le 1 \\ w\,(1 + 2\bar{r}nD/M) & \text{if } 0 \le n < n_c \end{cases} \tag{24}$$

From equation (24), it is clear that the opportunity cost of leisure increases/decreases with annual hours of work 52 $n\bar{d}$ when the individual has a weak/strong attachment to the labour market.

The explanation for such a result is simple. When $0 \le n \le n_c$ (weak attachment) the UI system acts as a wage subsidy at a marginal rate given by $2\bar{r}nD/M$. Thus, the importance of the marginal wage subsidy rises with n, which explains why $\partial w_a^*/\partial(n\bar{d})$ is positive.

On the other hand, when $n_c \leq n \leq 1/2$, UI acts as a wage subsidy at a marginal rate of $\bar{r}D(1 - 2n)/(A + D)$. However, in this case, the importance of the marginal wage subsidy decreases with n. Moreover, for $n_c \leq 1/2 < n \leq 1$, the effect of UI at the margin is the same as a wage tax at a marginal rate of $\bar{r}\ D(2n - 1)/(A + D)$. Clearly, this tax rate increases with n. This explains why $\partial w_a^*/\partial(n\bar{d})$ is negative for $n_c \leq n \leq 1$ (strong attachment).

Figure 2-2 illustrates the efficient budget constraint with the annualization reform. It is assumed that $d = \bar{d}$ and that there are no taxes or other transfers. This constraint is given by 0yBC. The segment yB corresponds to a weak attachment situation. The slope of this segment at any given level of n is thus $w_a^* = w\ (1 + 2\bar{r}nD/M)$ from equation (24). Moreover, the segment yB is convex from the origin. On the other hand, the segment BC corresponds to a high-attachment situation. The slope of this segment (illustrated at point D) is given by $w_a^* = w\ (1 - \bar{r}D(2n - 1)/(A + D))$ and the segment is concave from the origin.

The individual's optimal hours of work can be obtained from a linearization procedure. Assuming an interior solution to the optimization problem, one must have at the individual's optimum $n^*\ \bar{d}$: $x^* = w_a^*\ n_a^*\ \bar{d} + y^v$ where y^v is the individual's virtual weekly non-wage income at the optimum. This linearized budget constraint is illustrated by the line y^V D in Figure 2-2, under the assumption that the optimum is at point D. y^V can be obtained by equating this linearized budget constraint to the actual budget constraint given by equation (23): $w_a{*}\, n{*}\, \bar{d} + y^V = w_a\, n{*}\bar{d} + w_d\, \bar{d} + y$. Isolating y^V in this equation yields:

$$y^V = y + w_d\, \bar{d} + (w_a - w_a{*})\, n{*}\, \bar{d} \qquad (25)$$

Substituting in equation (25) the definition of w_d, w_a and $w_a{*}$, as given in equations (23) and (24) with $n = n{*}$, y^V can also be expressed as:

$$y^V = \begin{cases} y + w\bar{r}n{*}^2\bar{d}D/(A + D) & \text{if } n_c \leq n \leq 1 \\ y - w\bar{r}n{*}^2\bar{d}D/M) & \text{if } 0 \leq n < n_c \end{cases} \qquad (25')$$

This linearization procedure allows us to use equation (20′) with w_a replaced by $w_a{*}$ to solve for the individual's average annual labour supply:

$$a{*} = \bar{a}{*}\, (w_a{*},\, y^V) \qquad (26)$$

with $w_a{*}$ and y^V derived respectively from equations (24) and (25′). Note that equation (26) is now a structural form and not a reduced form as in equation (20′), since both $w_a{*}$ and y^V depends on a* (or equivalently on n*).

Assuming, as in Section 2.6, that equation (26) has a linear functional form, it can be rewritten as:

$$a^* = a_0 + a_1 w_a^* + a_2 52 y^V \qquad (26')$$

Substituting the definition of w_a^* and y^V in (26′) and using $n = a/(52d)$, it is easily shown that (26′) can be expressed as a second-degree polynomial in a*:

$$A\, a^{*2} + B\, a^* + C = 0 \qquad (27)$$

with

$$A = \begin{cases} -a_2 w\bar{r}D/(52(A + D)\bar{d}) & \text{if } n_c \le n \le 1 \\ -a_2 w\bar{r}D/(52\, M\bar{d}) & \text{if } 0 \le n < n_c \end{cases}$$

$$B = \begin{cases} 1 + 2a_1 w\bar{r}D/(52(A + D)\bar{d}) & \text{if } n_c \le n \le 1 \\ 1 - 2a_1 w\bar{r}D/(52\, M\bar{d}) & \text{if } 0 \le n < n_c \end{cases}$$

$$C = \begin{cases} -(a_0 + a_1 w(1 - \bar{r}D/(A + D)) + a_2\, y') & \text{if } n_c \le n \le 1 \\ -(a_0 + a_1 w + a_2\, y') & \text{if } 0 \le n < n_c \end{cases}$$

The roots of equation (27) for a* can be solved for both the high and the low attachment cases. The root which is admissible and with the highest level of utility (checking also for the corner solutions at $a = 0$, $a = 52\, n_c\, \bar{d}$ and $a = 52\, \bar{d}$) corresponds to the individual's optimum. (The probability that two roots for a* yield the same level of utility is of measure zero.)

Introducing income taxes and other transfers into the model is straightforward (see Section 2.3). Moreover, it is possible to endogenize the length of the workweek d, using a similar approach. However, this makes the model much more complex to program.

Note finally that the annualization proposal can be simulated together with other recommendations of the Forget Commission such as:

- The introduction of particular eligibility conditions (such as a minimum number of hours of work, $\bar{H}$, (= 350 in Recommendation 23 of the report), during the reference period. In this case, the last inequality in equation (3) becomes $n\, \bar{d}K \geq \bar{H}$ or, equivalently, $nK \geq \bar{H}/\bar{d} = M'$. Thus M' may vary with $\bar{d}$ across representative individuals.

- Equalization of employers' and employees' payroll tax rates (Recommendation 46.1).

- Funding of UI benefits limited to UI contributions (Recommendation 45). This could be modeled by introducing a

UI budget constraint into the model, and by endogenizing the payroll tax rate.

- Introducing income supplementation, education or training programs funded by the reduction in UI benefits made possible by the annualization proposal (e.g., Recommendations 7, 8, 13, 14). Here, there are many degrees of freedom concerning the choice of the parameters of these programs as the Forget Report remains quite evasive in this respect. For example, the implicit-cum-explicit marginal tax rate for a given class of low-income households could be made endogenous (reflecting a particular reaction function for the government).

- Suppression of the age limit (65 years in the current system) for eligibility to UI (Recommendation 22).

2.9 Conclusion

The traditional labour/leisure choice framework used to analyze the impact of UI on labour supply is based on many simplifying assumptions. In particular, it is usually assumed that:

- all unemployment is the outcome of individual labour/leisure choices;

- the gross wage rate received by the individual is unaffected by experiences of employment and nonemployment;

- the individual's horizon is one year; and

- hours of work per week worked are fixed.

In this chapter, I present a labour supply model that takes into account tax and transfer programs (including UI) and that allows these two last assumptions to be relaxed in tractable and computable way. Moreover, it is shown how the model might be extended in order to take demand-side rationing into account. I also illustrate how the model could be used to simulate reforms such as those proposed in the Forget report.

Further work is needed to endogenize the skill level of each individual, in line with the human-capital literature. This would allow the individual's gross wage rate to be dependent on his/her work experience. It would also make it possible to relax one extreme prediction of the model -- the full utilization of UI benefits by the individual.

NOTES

1 It can be used to modify the whole tax-transfer system, as well as to change a small part of the system (i.e., to design a policy change, to eliminate one troublesome segment of the budget curves or to modify its slope).

2 Thanks to Denis Gauthier for suggesting the denominator of this FPRR.

3 The guaranteed income is the amount of transfers each individual would have received if he or she did not work. Any income other than earnings and transfers reduces the guaranteed income. This is consistent with the assumption that income other than earnings and transfers is exogenous. FR assumed guaranteed income to be the amount of transfers when no income other than transfers is received.

4 Marginal taxes raised are redistributed as per-capita lump-sum transfers.

5 This interpolation is done between 0 and $28,000 of labour income (1981 dollars).

6 For this section, explicit-cum-implicit transfers other than UI are ignored. This is discussed further in Section 4.3.

7 The strict quasi-concavity of u* (.) implies that this property holds for U (.); the reverse is not true, however.

8 One alternative would be to assume that the accounting period for social assistance is the same length as for UI (i.e., one week). However, this complicate the budget constraint (see Goulet 1986 and Lévesque 1986).

9 The Ham and Hsiao study is not very useful for our purposes, however, because the sign of their estimated compensated labour supply elasticity for weekly hours is negative. This violates an important restriction of consumer theory.

Table 1-1

Benchmark Average Net Wage Elasticities

	Compensated net wage elasticity	Uncompensated net wage elasticity
Singles under 30	0.26	0.17
Singles 30-64	0.19	0.05
Single-parent family heads	0.51	0.34
Married men	0.24	0.01
Married women	0.63	0.52

Note These are unweighted averages.

Table 1-2

Basic Data Requirements for the G. E. Model

	Description	Source/method
	Aggregate Data	
1	Total population in the labour force (16-64 years old)	Census
2	Net domestic product at factor cost (NDP at FC)	Provincial Economic Accounts (PEA)
3	Implicit indirect tax rate	(NDP/NDP at FC) - 1 (PEA)
4	Mid-year net stock of capital (MYNSK)	Fixed Capital Flows and Stocks, Ontario (Stat. Can.)
5	Payroll taxes	Statistics Canada, GNP Division National Accounts Section
6	Payroll tax rate	(Payroll taxes/wages, salaries and supplementary labour income) (PEA)
7	Tax rate on the return to capital	Calculation from direct taxes, corporate and government business enterprises (PEA) and the rate of return on fixed capital
8	Implicit aggregate wage rate for each 3 skill categories	Aggregation from the Survey of Consumer Finances (SCF) data
9	Rate of return on fixed capital	(NDP at FC - payroll) / MYNSK
	Micro Data	
1	Compensated and uncompensated net wage elasticities of labour supply	FR (1984)
2	Annual hours worked	Calculation from SCF data
3	Income tax net of transfers	Calculation using the DIAM
4	Income subject to tax other than earnings	SCF
5	Wage rate	Calculations from SCF * data
6	Number of individuals represented by each individual in the model	SCF
7	Marginal net income tax rate	Calculation with the DIAM

* Wage rate calculations are not supported by the SCF methodology.

Table 1-3

Basic Micro Data Requirements for the DIAM**

	Description	Source/method
1	Income subject to tax (other than earnings and U.I. benefits)	SCF
2	Investment income	SCF
3	Number of dependent children aged 4 to 12	SCF*
4	Number of dependent children aged 13 and older	SCF*
5	Number of dependent children aged 14 and younger	SCF*
6	Number of dependent children aged 15 and younger	SCF*
7	Number of dependent children aged 16 and 17	SCF*
8	Number of dependent children aged 18 and older	SCF*
9	Unemployment benefits received	SCF
10	Housing rent	-
11	Municipal taxes	-
12	Spouse's net income	Calculation with the DIAM
13	Spouse's gross income	Calculation from SCF data

* See Section 1.3.

** These are the data requirements for running the DIAM. The data requirements for its construction are outlined in Section 1.3.

Table 1-4

Alternative Net Wage Elasticities

	Compensated	Uncompensated
1 Compensated and uncompensated elasticities lowered by ½ (refers to column η/2 in Table 1-5).		
- Singles under 30	0.13	0.08
- Singles over 30	0.10	0.03
- Single-parent family heads	0.25	0.17
- Married men	0.12	0.005
- Married women	0.32	0.26

These elasticities are unweighted averages.
Please see Table 1-1 for the benchmark elasticities.

Table 1-5

Simulation Results

	Scenario 1			Scenario 2				Scenario 3	
Elasticities	η	$\eta/2$	η/∞	η	$\eta/2$	$\eta/4$	η/∞	η	$\eta/2$
Change in net domestic product (NDP) (%)	-0.08	-0.05	-	-0.19	-0.14	-0.10	-	+0.21	+0.13
Change in labour supply (5)	-0.08	-0.05	-	-0.13	-0.08	-0.04	-	+0.33	+0.21
Low-skill workers	-0.10	-0.06	-	-0.16	-0.11	-0.06	-	+0.52	+0.34
Medium-skill workers	-0.06	-0.04	-	-0.10	-0.06	-0.03	-	+0.41	+0.22
High-skill workers	-0.10	-0.06	-	-0.12	-0.07	-0.04	-	-0.21	-0.10
Change in the stock of capital (%)	-0.09	-0.05	-	-0.38	-0.33	-0.29	-	+0.08	+0.05
Change in average hour by wage (%)									
Low-skill workers	+0.003	+0.004	-	-0.08	-0.09	-0.10	-	-0.35	-0.22
Medium-skill workers	-0.01	-0.005	-	-0.13	-0.13	-0.13	-	-0.34	-0.16
High-skill workers	+0.02	+0.003	-	-0.22	-0.22	-0.21	-	+0.80	+0.43
Excess tax collection (%)	+0.45[1]	+0.55[1]	0.72	+0.52	+0.58	+0.63	0.68	+2.44	+2.30
Lump sum redistribution ($ per capita)	14.88	18.38	23.73	40.12	44.62	48.52	52.61	187.38	176.51
Marginal welfare cost	1.56	0.65	∅	0.85	0.39	0.21	∅		
Welfare gain (% of NDP)								0.21	0.08

1 Percentage of effective personal income taxes.

Scenario 1 A marginal increase in the personal tax-transfer system.
Scenario 2 A marginal increase in all taxes.
Scenario 3 Simplification of the tax-transfer structure (averaging the marginal tax rates).

Table 1–6

Distribution of Economic Gains and Losses from Marginal Increases in the Effective Tax Rates (Scenarios 1 and 2)

Description of household	Husband (Hd)/ Wife (W)	Percentage of working population	Age	Income class[2]	Number of children	Welfare analysis[1] Scenario 1 Gain ($)	Scenario 1 Loss ($)	Scenario 2 Gain ($)	Scenario 2 Loss ($)
Singles									
1*		2.8	18 - 20	VL	–	11		25	
2*		2.8	18 - 20	L	–	7		16	
3		0.6	18 - 20	M	–		14		20
4		4.4	21 - 24	L	–	7		18	
5		1.9	21 - 24	M	–		17		25
6		1.7	25 - 29	L	–	7		18	
7		2.0	25 - 29	M	–		20		29
8		0.3	25 - 29	H	–		67		112
9		2.7	30 - 64	L	–	4		14	
10		3.2	30 - 64	M	–		25		36
11		1.5	30 - 64	H	–		80		128
Single-parents									
12*		0.1	21 - 24	VL	1.2	16		28	
13*		0.1	21 - 24	L	1.2	16		24	
14*		0.1	25 - 29	VL	1.2	11		23	
15*		0.1	25 - 29	L	1.2	16		22	
16		0.2	25 - 29	M	1.3	4	4		14
17		1.2	30 - 64	L	1.6	16		20	
18		1.1	30 - 64	M	1.7		12		26
19		0.2	30 - 64	H	1.7	52		106	

Table 1-6 (cont'd)

Description of household	Husband (Hd)/ Wife (W)	Percentage of working population	Age	Income class[2]	Number of children	Welfare analysis[1] Scenario 1 Gain ($)	Scenario 1 Loss ($)	Scenario 2 Gain ($)	Scenario 2 Loss ($)
Married couples									
20	Hd	0.2	18 - 20	VL	0.6	28		49	
	W	0.2							
21	Hd	0.6	21 - 24	L	0.5	8		29	
	W	0.6							
22	Hd	1.1	21 - 24	M	0.5		26		35
	W	1.1							
23	Hd	0.9	25 - 29	L	0.9	15		32	
	W	0.9							
24	Hd	2.9	25 - 29	M	1.0		30		42
	W	2.9							
25	Hd	0.8	25 - 29	H	1.3		73		130
	W	0.8							
26	Hd	5.2	30 - 64	L	1.5	16		33	
	W	5.2							
27	Hd	15.3	30 - 64	M	1.5		38		53
	W	15.3							
28	Hd	9.6	30 - 64	H	1.6		110		174
	W	9.6							

* These individuals are the result of a mean-preserving artificial split up (See text, p. 19).

1 This analysis reports the value of the equivalent variation for individuals and couples. The numbers can be interpreted as the amount of money the individuals/couples would need to be given under the status quo to be indifferent to the reform as defined by Scenarios 1 and 2. (Benchmark elasticities are assumed.)

2 VL very low income
L low income (<$13,000)
M medium income ($13,000 to $27,000)
H high income (>$27,000)

Table 2-1

Tentative labour supply elasticities for setting model parameters

	$E^c_{a^*,w}$		$E_{a^*,w}$		$E^c_{d^*,w}$		$E_{d^*,w}$		$E^c_{d^*,w_a}$	
	l.l.	u.l.	l.l.	u.l.	l.l.	u.l.	l.l.	u.l.	l.l.	u.l.
Married women	0.18	0.7	-0.2	0.6	0.04	0.14	-0.04	0.12	-0.1	-0.3
Heads of single-parent families	0.15	0.45	0.05	0.2	0.03	0.09	0.01	0.04	-0.1	-0.3
Single persons under 30	0.13	0.4	0.03	0.1	0.25	0.08	0.006	0.02	-0.1	-0.3
Single persons over 30	0.1	0.3	-0.1	0.03	0.02	0.06	-0.002	0.006	-0.1	-0.3
Married men	0.1	0.15	-0.1	0.005	0.02	0.03	-0.002	0.001	-0.1	-0.3

l.l. = lower limit
u.l. = upper limit

Figure 1-1

A General Equilibrium Model for the Study of the Tax-Transfer System

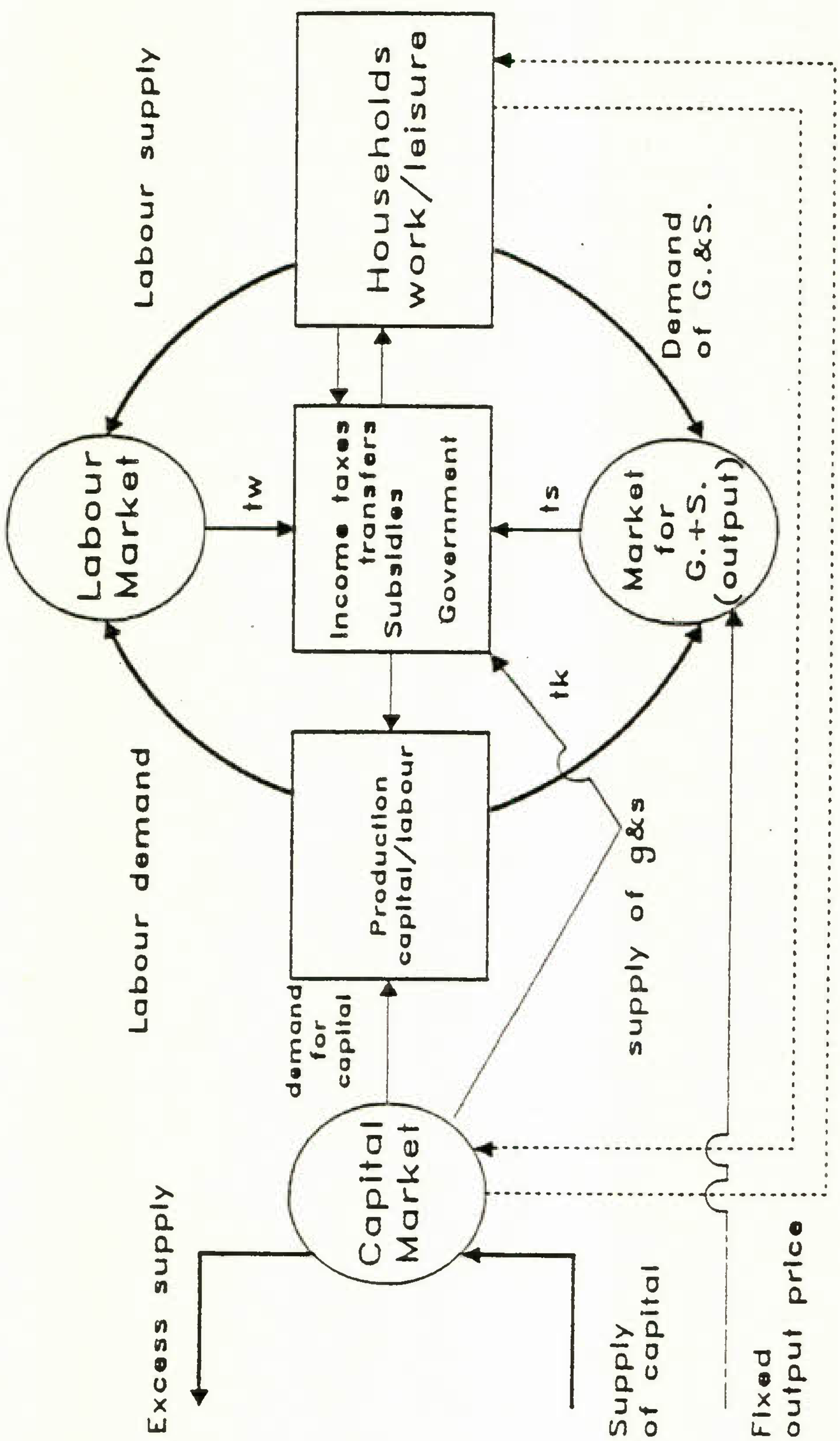


Figure 1-2

Illustration of a Polynomial Approximation to a Piece-Wise Linear Budget Curve

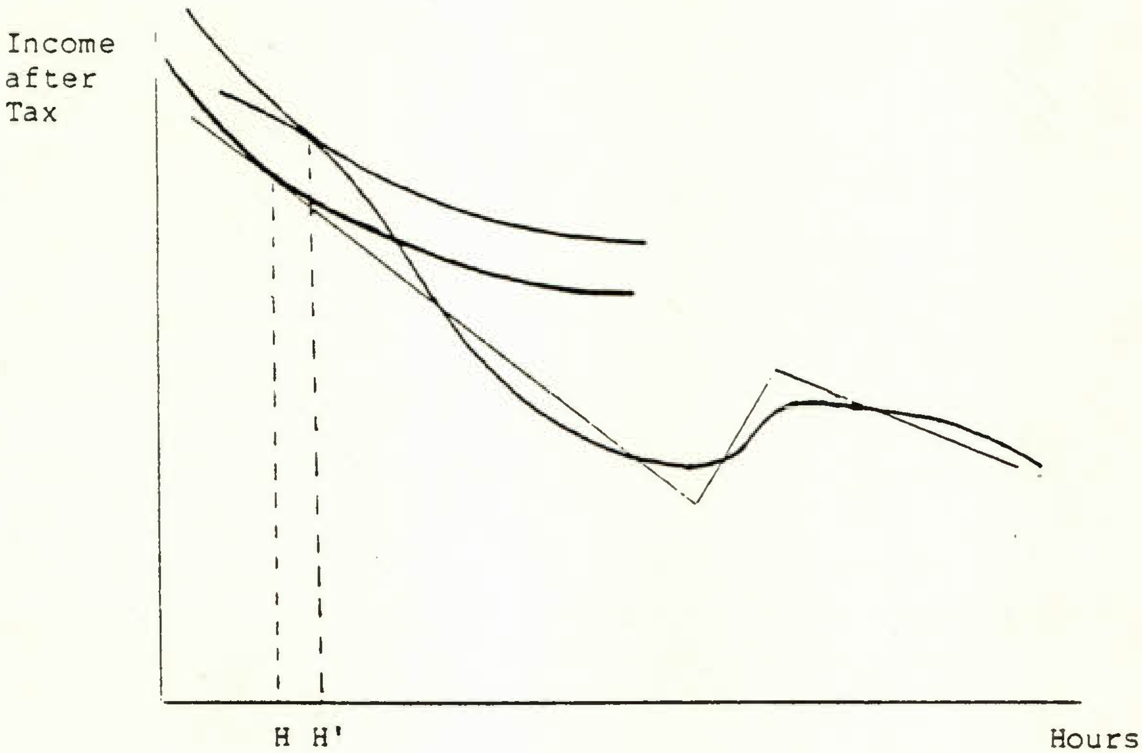
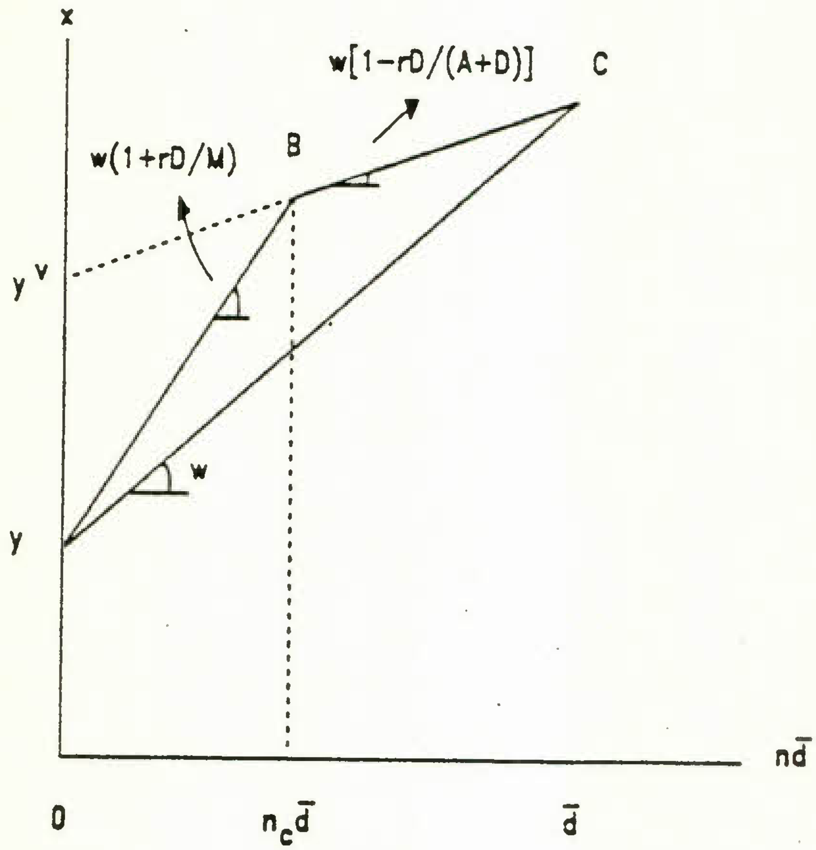


Figure 2-1

The Efficient Budget Constraint with Length of the Workweek Exogenous

(Average Weekly Disposable Income Over the Cycle)

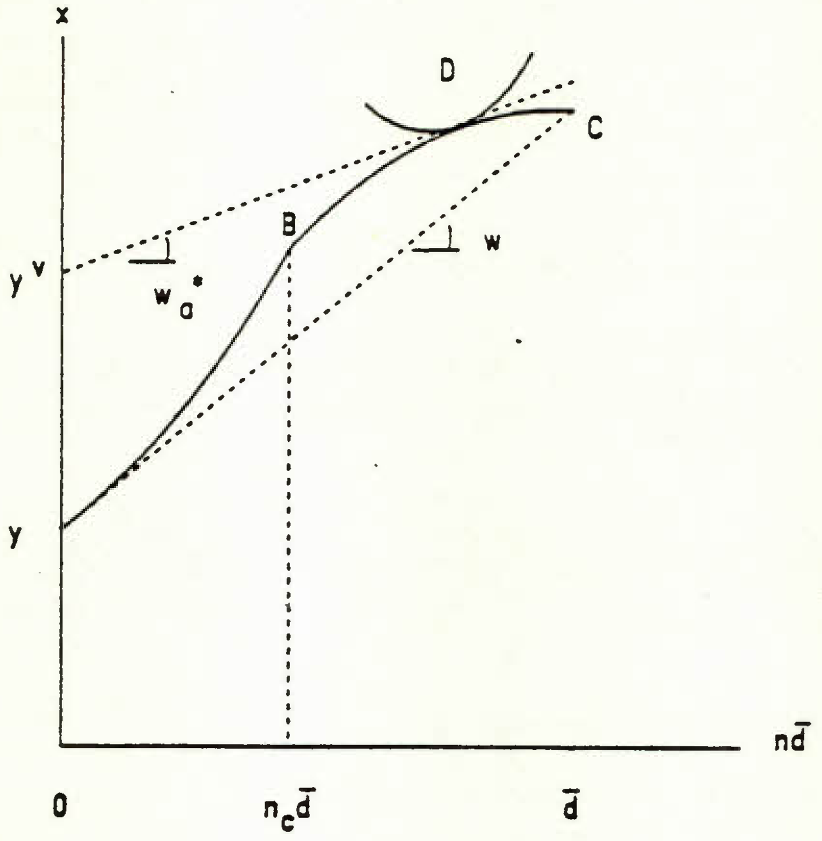


(Average Weekly Working Hours Over the Cycle)

Figure 2-2

The Efficient Budget Constraint with Annualization of UI Benefits and the Length of the Workweek Exogenous

(Average Weekly Disposable Income Over the Cycle)



(Average Weekly Working Hours Over the Cycle)

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