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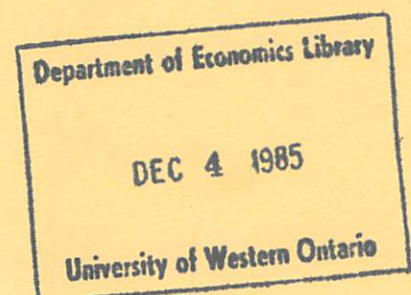
OPERATIONALIZING WALRAS:

EXPERIENCE WITH RECENT APPLIED GENERAL EQUILIBRIUM TAX MODELS

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This paper contains preliminary findings from research work still in progress and should not be quoted without prior approval of the author.

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Operationalizing Walras:
Experience with Recent Applied General Equilibrium Tax Models¹

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I Introduction

In a frequently quoted remark Joseph Schumpeter characterized the Walrasian system of general equilibrium as the "Magna Carta" of economics. What is less well remembered is that Schumpeter also believed that the Walrasian system could never be more than a broad organizational framework for thinking through the implications of interdependence between markets and economic actors. In Schumpeter's view, operationalizing Walras in the sense of providing a useable tool for policy makers and planners to evaluate the implications of different courses of action was a utopian pipedream.

Despite Schumpeter's cautions, operationalizing Walras has nonetheless been a preoccupation of economists for several decades. The debates in the 1930's on the feasibility of centralized calculation of a Pareto optimal allocation of resources in a Socialist economy involving von Mises, Hayek, Robbins, and Lange (and begun earlier by Barone) were implicitly debates on the operational content of the Walrasian system. The subsequent development by Leontief and others of input-output analysis was a conscious attempt to take Walras onto an empirical and ultimately policy relevant plane. The linear and non-linear programming planning models in the 1950's and 60's were viewed at the time very much as an improvement on input-output techniques through the introduction of optimization into Leontief's work. And today, with the use of applied general equilibrium models for policy evaluation, the same idea of operationalizing Walras is

driving a new generation of economists forward.

This paper discusses some of the recent attempts to operationalize the Walrasian general equilibrium system and apply it in the field of tax policy evaluation. In recent years, developments in this area have moved forward from the early two sector models of Harberger (1962) and Shoven and Whalley (1972), to much larger scale modelling efforts such as Piggott and Whalley (1976, 1985) on the UK, and Ballard, Fullerton, Shoven, and Whalley (1985) on the US, and others elsewhere. Simultaneously, other issue specific modelling such as by Summers (1981), Auerbach, Kotlikoff, Skinner (1983) and others has begun to grow in importance.

As someone who has been involved both with the development of applied general equilibrium techniques and in seeing their use through into the policy arena, I have come to realize that the issue of whether the Walrasian system can or cannot be operationalized is somewhat specious. In an exact sense it can never be done. The detail and complexity involved in actually making policy decisions rapidly overwhelms the abilities of any modeller to capture them all, even if all the required data and parameter estimates were available (which they never are). Also, the choice of which particular equilibrium model to use (static, dynamic, open to foreign trade or closed, with or without market imperfections, public goods, etc.) can dramatically affect results from the analysis, and unfortunately there is usually all too little evidence on which to base a decision as to

which model variant is the most appropriate. Subjective judgement on the part of the modeller is very much the name of the present game.

Having said this, the experience thus far with the tax models indicates, to me at least, that despite these problems they have a lot to contribute to policy debate. When used to generate insights rather than precise numbers, their use makes explicit the implicit models lying behind various policy positions, and forces policy making to be approached both from an economy wide point of view and in terms of a logically consistent framework.

As long as a significant body of economic thought views the Walrasian system as the basic organizational framework for our discipline, nothing could be more natural than to want to use numbers in such analyses. Theoretical analysis usually takes one only part way in policy debate; perhaps identifying the sign of an effect if various conditions hold, or suggesting that several effects enter whose net effect is ambiguous. The need for policy decision making demands more from such analysis, and in the presence of no obviously superior alternative, using numbers in such models (even if in a somewhat rough and ready manner) does not strike me as a bad way to proceed.

II Applied General Equilibrium Techniques Used in Recent Tax Models¹

Prior to summarizing the efforts of recent applied general equilibrium tax modellers, it is perhaps worthwhile clarifying the type of models they use. In a traditional general equilibrium model a number of consumers are identified, each with an initial endowment of commodities and a set of preferences. The latter yield household demand functions for each commodity, with market demands given by the sum of individual consumer's demands. Commodity market demands depend on all prices, are continuous, non-negative, homogeneous of degree zero (i.e., no money illusion) and satisfy Walras' Law (i.e., at any set of prices the total value of consumer expenditures equals consumer incomes). On the production side, technology is described by either constant returns to scale activities or non-increasing returns to scale production functions, and producers maximize profits.

The zero homogeneity of demand functions and the linear homogeneity of profits in prices (i.e., doubling all prices doubles money profits) implies that only relative prices are of any significance in this model; the absolute price level has no impact on the equilibrium outcome. Thus, equilibrium is characterized by a set of relative prices and levels of production by each industry such that market demand equals supply for all

¹The discussion in this and the next section draws heavily on Shoven and Whalley (1984).

commodities (including disposals if any commodity is a free good). Since producers are assumed to maximize profits, this implies that in the constant-returns-to-scale case no activity (or cost-minimizing techniques if production functions are used) does any better than break even at the equilibrium prices.

Taxes are typically introduced into this model in advalorem form (see Shoven and Whalley (1973) and Shoven (1974), either as producer taxes on inputs or consumer taxes on incomes or expenditures. Revenues are either redistributed to consumers, or used to finance publicly provided goods and services. The taxes which characterize modern tax systems (personal, corporate, sales, excise, property, social security, resource, and other taxes) are usually represented in model equivalent form. Once introduced, the equilibrium behaviour of the model can be investigated as taxes change, and on that basis policy evaluations made.

A Simple Numerical Example

A numerical example is a good way to illustrate how this approach is currently used. Although, in representing actual economies, much more specificity is required than in the general form of the Arrow Debreu model. Particular functional forms for production and demand functions need to be chosen, and parameter values selected. The policy instruments to be analyzed need to be incorporated, and the treatment (or model closure) of the various items such as foreign trade, savings, and public goods needs to be settled.

Here I outline a simple numerical example of a tax policy oriented general equilibrium model presented by Shoven and Whalley (1984). In this example, there are two final goods (manufacturing and non-manufacturing), two factors of production (capital and labor), and two classes of consumers; a "rich" consumer group which owns all the capital and a "poor" group which owns all the labor. There are no consumer demands for factors (i.e., no labor-leisure choice). Each consumer group generates demands by maximizing a CES utility function subject to its budget constraint. CES production functions are assumed.

The CES utility functions are:

$$(1) \quad U^c = \left[\sum_{i=1}^2 a_i^c \frac{1}{\sigma_c} X_i^c \right]^{\frac{\sigma_c}{\sigma_c - 1}}$$

where X_i^c is the quantity of good i demanded by the c th consumer, a_i^c are share parameters, and σ_c is the substitution elasticity in consumer c 's CES utility function. The consumer's budget constraint is $P_1 X_1^c + P_2 X_2^c \leq P_L W_L^c + P_K W_K^c = I^c$,

P_1 and P_2 are the consumer prices for the two goods, W_L^c and W_K^c are consumer c 's endowment of labor and capital, and I^c is the income of consumer c . Maximizing this utility function subject to the budget constraint yields the demands:

$$(2) \quad X_i^c = \frac{a_i^c I^c}{P_i^{\frac{\sigma_c}{\sigma_c - 1}} (a_1^c P_1^{\frac{\sigma_c}{\sigma_c - 1}} + a_2^c P_2^{\frac{\sigma_c}{\sigma_c - 1}})} \quad i=1,2; c=1,2.$$

The production functions are:

$$(3) \quad Q_i = \phi_i \left[\delta_i L_i^{\frac{\sigma_i - 1}{\sigma_i}} + (1 - \delta_i) K_i^{\frac{\sigma_i - 1}{\sigma_i}} \right]^{\frac{\sigma_i}{\sigma_i - 1}}, \quad i=1,2$$

where Q_i denotes output of the i th industry, ϕ_i is a scale or units parameter, δ_i is a distribution parameter, K_i and L_i are capital and labor factor inputs, and σ_i is the elasticity of factor substitution.

In this example there are six production function parameters (i.e., ϕ_i , δ_i and σ_i for $i=1,2$), six utility function parameters (i.e., $a_1^1, a_1^2, a_2^1, a_2^2, \sigma_1$, and σ_2), and four exogenous variables (the endowment of labour (W_L) and capital (W_K) for each of the two consumers).

An equilibrium solution to the model is given by the four prices P_1, P_2, P_L, P_K , and eight quantities $X_1^1, X_1^2, X_2^1, X_2^2$ and K_1, K_2, L_1, L_2 which meet the equilibrium conditions that market demand equals market supply for all inputs and outputs, and that zero profits are applied in each industry. Once the parameters are specified and the factor endowments are known, a complete general equilibrium model is available. Tax and other policy variables can then be added as desired.

Table 1 presents the values for all the parameters and the exogenous variables used by Shoven and Whalley. The equilibrium solution is reported in Table 2 for a case where a 50% input tax applies to the use of capital in manufacturing. Only relative prices are relevant in this model and, somewhat arbitrarily, labor has been chosen as the numeraire. At the equilibrium prices total demand for each output equals production, and producer revenues equal costs. Labor and capital endowments are fully employed, and consumer factor incomes plus transfers equal

TABLE 1
 Production and
 Demand Parameters, and Endowments used by
 Shoven and Whalley for their Two Sector
 General-Equilibrium Numerical Example

Production Parameters

<u>Sector</u>	ϕ_i	δ_i	σ_i
Manufacturing	1.5	0.6	2.0
Nonmanufacturing	2.0	0.7	0.5

Demand Parameters

<u>Rich Consumers</u>			<u>Poor Consumers</u>		
1	1	1	2	2	2
a_1	a_2	σ	a_1	a_2	σ
0.5	0.5	1.5	0.3	0.7	0.75

Endowments

	<u>K</u>	<u>L</u>
Rich Households	25	0
Poor Households	0	60

TABLE 2

Equilibrium Solution for Shoven and Whalley's Example
with a 50% Input
Tax on Capital in Manufacturing

Equilibrium Prices

Manufacturing Output	1.47
Nonmanufacturing Output	1.01
Capital	1.13
Labor	1.00

Production Side

Outputs

	<u>Quantity</u>	<u>Revenue</u>
Manufacturing	22.39	32.83
Nonmanufacturing	57.31	57.64

Inputs

	<u>Capital</u>	<u>Capital Cost (including tax)</u>	<u>Labor</u>	<u>Labor Cost</u>	<u>Total Cost</u>	<u>Cost Per Unit Output</u>
Manufacturing	4.04	6.83	1.00	26.00	32.83	1.47
Nonmanufacturing	20.96	23.64	34.00	34.00	57.60	1.00

Demand Side

Expenditures

	<u>Manufacturing</u>	<u>Nonmanufacturing</u>	<u>Expenditure</u>
Rich Households	8.94	15.83	29.10
Poor Households	13.40	41.48	61.37

Income

	<u>Labor Income</u>	<u>Capital Income</u>	<u>Transfers</u>	<u>Total Income</u>
Rich Households	0	28.19	.91	29.10
Poor Households	60.00	0	1.37	61.37

consumer expenditures. Because of the assumption of constant returns to scale, the per-unit costs in each industry equal the selling price, meaning that economic profits are zero. Expenditures by each household exhaust its income. Shoven and Whalley illustrate how this general equilibrium model can be adapted for policy evaluation work, by comparing the with tax equilibrium solution reported in Table 2 to a no tax equilibrium solution to obtain measures of the welfare costs of such a tax.

III Designing Larger Scale Realistic Models

The main differences between the models actually used to analyze tax policy proposals and the numerical example above lie in their dimensionality (i.e., the number of sectors and consumer types modeled), their parameter specification procedures and use of data, and their inclusion of more complex policy regimes than a simple tax on one factor in one sector.

A wide range of issues are encountered in designing larger scale models to be used in actual policy environments many of which are discussed by Shoven and Whalley. Should the model be of the traditional fixed-factor static form, or should it be dynamic? How are substitution in production and demand to be incorporated? How are parameter values to be chosen? Are literature estimates to be used, or is some other approach to be followed? Are some of the parameters to be estimated, for instance? How are trade, investment, government expenditures, or other features to be treated? How much difference do various alternative treatments make? How is the model to be solved:

using a fixed point solution method guaranteed to work, or a potentially quicker linearization or other procedure? How are computed equilibria to be compared; which summary statistics are to be used in evaluating policy changes?

(i) Model Structure

Although the appropriate general-equilibrium model for any particular policy analysis varies with the issue, most current tax models are variants of static, two-factor models that have long been employed in public finance and international trade. Most involve more than two goods, even though factors of production are classified in the two broad categories of capital and labor services. In some models these are further disaggregated into sub-groups (e.g., labor, for instance, may be identified as skilled or unskilled). Intermediate transactions are usually incorporated either through fixed or flexible input-output coefficients.

The rationale for proceeding this way is that tax and other policy issues are frequently analyzed using a similar theoretical framework, and it is natural to retain the same basic theoretical structure for applied work. This is especially the case if the major contribution of numerical work is to advance from qualitative to quantitative analysis. Also, most data on which the numerical specifications in tax models are based come in a form consistent with the two-sector approach. For instance, national accounts data identify wages and salaries and operating surplus as major cost components. Input-output data provide

intermediate transaction data, with value added broken down in a similar way. This all suggests a model in which capital and labor are identified as factor inputs.

The partition between goods and factors in two sector type models can also be used in tax (and other) models to simplify computation and thus sharply reduce execution costs. By using factor prices to generate cost-covering goods prices consumer demands can be calculated, and the derived demands for factors evaluated which meet consumer demands. Thus, even a model with a large number of goods can be solved by working only with the implicit system of excess factor demands.

There are also a range of more specific model design issues, which are usually encountered, including the treatment of investment, foreign trade and government expenditures. Where there are no international capital flows, the level of investment in the model reflects household-saving decisions (broadly defined to include corporate retentions). These are based on constant savings propensities in static models, but on explicit inter-temporal utility maximization in dynamic models. Government expenditures usually reflect transfers and real expenditures, with the latter frequently determined from assumed utility-maximizing behavior for the government. In this approach the government is treated as a separate consumption side agent that buys public goods and services. In a few cases, (such as Piggott and Whalley (1984)), tax models have been used with public goods explicitly appearing in household utility functions,

although this complicates the basic approach.

As regards the treatment of time, some of static equilibrium models have been sequenced through time to reflect changes in the economy's capital stock due to net saving. Models such as those due to Summers (1981), Auerbach, Kotlikoff and Skinner (1983), and Fullerton, Shoven and Whalley (1983) have been used to analyze intertemporal issues in tax policy, such as whether a move from an income tax to a consumption tax (under which saving is less heavily taxed) is desirable. This approach links a series of single-period equilibria through saving decisions that change the capital stock of the economy through time. Saving, in turn, is based on maximization of a utility function defined over current and expected future consumption. Myopic expectations (i.e., expected future rates of return on assets equal current rates of return) are often assumed to simplify computations. Saving in the period augments the capital stock in all future periods. The general equilibrium computed for each period is such that all markets clear, including that for newly-produced capital goods. The economy thus passes through a sequence of single-period equilibria, in which the capital stock grows. Tax changes that encourage higher saving typically cause lowered consumption in initial years, and eventually higher consumption due to the larger capital stock.

In treating external sector transactions a common approach in the tax models is to specify a set of export demand and imports supply functions which the economy being analyzed is

assumed to face (see the discussion in Whalley and Yeung (1984)).

These functions reflect the assumed behaviour of foreigners to changes in domestic prices induced by tax policy changes. These excess demand functions must also satisfy external sector balance for any set of prices (Walras Law for the foreign country). The external sector specification can be important in these models. The effects of tax policies on an economy which is a taker of prices on world markets, for instance, will be significantly different from those for a closed economy. Similarly, international capital mobility considerations can also be important. Although these are usually ignored, Goulder, Shoven and Whalley (1983) have shown how their incorporation can change the analysis of tax policy options compared to a model with immobile capital.

(ii) Choosing Functional Forms

In addition to selecting the general model structure when building a tax model to represent an actual economy, one also has to choose particular functional forms. The major constraints on the choice of demand and production functions are typically that they be consistent with the theoretical approach and are analytically tractable. The first consideration involves choosing functions that satisfy the usual demand and production side restrictions assumed in general equilibrium models, such as Walras' Law. The second consideration requires that excess demand responses be easy to evaluate for any price vector considered as a candidate equilibrium solution for the model.

The choice of a specific functional form by the modeller usually depends on how elasticities are to be used in the model.

The general approach is one of selecting the functional form that best allows key parameter values (e.g., income and price elasticities) to be incorporated, while retaining tractability. This largely explains why the functional forms used are so often drawn from the family of "convenient" forms (Cobb-Douglas, Constant Elasticity of Substitution (CES), Linear Expenditure System (LES), and Translog, Generalized Leontief, or other flexible functional forms.)

Demands from Cobb-Douglas utility functions are easy to work with, but have unitary income and uncompensated own-price elasticities, and zero cross-price elasticities. These restrictions are typically implausible. For CES functions, if all expenditure shares are small, compensated own-price elasticities equal the elasticity of substitution in preferences. It may thus be unacceptable to model all commodities as having essentially the same compensated own-price elasticities. One alternative is to use hierarchical or nested CES functions, adding further complexity in structure. Another is to use translog expenditure functions, although here the issues which arise are the global properties of these more flexible functional forms, such as concavity. Unitary income elasticities implied by Cobb-Douglas or CES functions can also be relaxed by using LES functions with a displaced origin, but the origin displacements need to be specified.

On the production side, where only two primary factors enter the model CES value-added functions are usually assumed. If more than two factors are used, hierarchical CES functions or translog cost functions are again used. Intermediate requirements functions may be modeled as fixed coefficients, or intermediate substitutability may be introduced.

(iii) Choice of Parameter Values

Parameter values for the functions in the models are also crucial in determining the results of simulations for various tax policies. The procedure most commonly used in these models has come to be labeled "calibration" (Mansur and Whalley 1984). Under this approach, the economy under consideration is assumed to be in equilibrium in the presence of existing tax policies, i.e. at a so-called "benchmark" equilibrium. Parameters for the model are then calculated such that the model can reproduce the equilibrium data as a model solution.

The main feature of this calibration procedure that has both attracted interest and raised concerns is that there is no statistical test of the resulting model specification implied by calibration. The procedure for calculating parameter values from a constructed equilibrium observation is deterministic. This typically involves the key assumption that the benchmark data represent an equilibrium for the economy under investigation, and required parameter values are then calculated using the model equilibrium conditions. If the equilibrium conditions are not sufficient to identify the model, additional parameter values

(typically elasticities) are exogenously specified until the model is identified. These are usually based on a literature search, or, less frequently, on separate estimation. In contrast to econometric work that often simplifies the structure of economic models to allow for substantial richness in statistical specification, in these models the procedure is quite the opposite. The richness of the economic structure only allows for a crude statistical model which, in the case of calibration to a single year's data, becomes deterministic.

Because the widespread use of deterministic calibration in these models is clearly troubling, it is perhaps worthwhile outlining some of the reasons why this calibration approach is so widely used. First, in some of the tax models several thousand parameters may be involved, and to simultaneously estimate all of the model parameters using time series methods requires either unrealistically large numbers of observations or overly severe identifying restrictions. Partitioning models into submodels (such as a demand and production system) may reduce or overcome this problem, but partitioning does not fully incorporate the equilibrium restrictions that are emphasized in calibration. Also, benchmark data sets are usually constructed in value terms, and their separation into price and quantity observations makes it difficult to sequence equilibrium observations with consistent units through time as would be required for time series estimation. Finally, the dimensions used in these models make the construction of benchmark equilibrium data sets a non trivial

exercise. Some of the large scale data sets have required upwards of eighteen months work, so that if time series are to be constructed the required workload may not be sustainable.

Calibration usually involves one year's data, or a single observation represented by an average over a number of years, and it is only in the Cobb-Douglas case that the benchmark data uniquely identify a set of parameter values. In other cases, the required values for the relevant elasticities needed to identify the other parameters in the model are usually based on other sources. Typically, a lot of reliance is placed on literature surveys of elasticities and, as many of the modellers have observed, it is surprising how sparse (and sometimes contradictory) the literature is on some elasticity values. Also, although this procedure might sound straightforward, it is often difficult because of differences among studies.

Elasticity values in these models are most conveniently thought of as prespecifying the curvature of isoquants and indifference surfaces, with their position given by the benchmark equilibrium data. Because the curvature of CES indifference curves and isoquants cannot be inferred from the benchmark data, extraneous values of substitution elasticities are required. Similarly, for LES demand functions, income elasticities are needed upon which to base the origin coordinates for utility measurement.

In practice, data representing benchmark equilibria for use in calibration are constructed from national accounts

and other government data sources. In these data the available information does not satisfy microconsistency conditions (e.g., payments to labor from firms will not equal labor income received by households) and a number of adjustments are needed to ensure that the equilibrium conditions of the models hold. In these adjustments some data are taken as correct and others adjusted to reflect consistency. Tax related data sets of this type are described in St.Hilaire and Whalley (1983), Piggott and Whalley (1985), and Ballard, Fullerton, Shoven, and Whalley (1985).

Because these benchmark data are usually produced in value terms, in using the data in a general equilibrium model units must be chosen for goods and factors so that separate price and quantity observations are obtained. A commonly used convention, originally adopted by Harberger (1962), is to assume units for both goods and factors such that they have a price of unity in the benchmark equilibrium.

(iv) Solving General Equilibrium Models

The early general equilibrium tax models typically used Scarf's algorithm (1967, 1973) for solution. Some of the more recent models continue to rely on Scarf-type methods, but use faster variants of his original algorithm due to Merrill (1972), Kuhn and MacKinnon (1975), Eaves (1974), and vanderLaan and Talman (1979). Merrill's refinement seems the most widely used. Newton-type methods or other local linearization techniques can also be used. These often work as quickly if not more quickly than the methods listed above, although convergence

is not guaranteed.

Another approach, implicit in Harberger's original work, is to use a linearized equilibrium system to solve for an approximation to an equilibrium, in some cases refining an initial estimate using a multi-step procedure so that approximation errors are eliminated. This approach has been used, for instance, by Bovenberg and Keller (1983). Its weakness is that it does not allow for multiple consuming agents and in its application the income-expenditure link central to Walras' Law is usually violated.

Execution costs for existing models seem manageable. However, no standard off-the-shelf computer routines have yet emerged for the complete sequence of data adjustment, calibration, and equilibrium computation. In part, this is due to the complexities involved in each application of these models. What currently seems to be the case is that it is no longer the solution methods that constrain model applications, but the availability of data and the ability of modellers to specify key parameters and capture the essence of the issues under debate.

(v) Evaluating Impacts of Policy Changes

Theoretical literature on welfare economics is usually followed in making comparisons between equilibria in order to arrive at policy evaluations based on the tax models. For welfare impacts, Hicksian compensating (CV) and equivalent variations (EV) are commonly used as summary measures of welfare impact by agent. Economy wide welfare measures are often computed

by aggregating CVs or EVs over consumer groups. While this is consistent with practice in cost-benefit literature, the theoretical shortcomings in using the sum of CVs or EVs as an aggregate welfare criterion are well known.

Models also provide a detailed evaluation of who gains, who loses, and by how much, as a result of a policy change. No single summary measure need be chosen if the policy analyst is interested only in the detailed impacts of any policy change. In some tax models, new (policy change) equilibria are computed under the restriction that government revenues remain constant. In these models this usually implies replacing one set of taxes with another, but with new tax rates endogenously determined to preserve revenues. In other models, government revenues change, but where this occurs the welfare impact from changes in the amount of public services needs to be factored into any economy-wide welfare measure.

In addition to welfare impacts, other impacts of tax changes can be investigated, such as income distribution effects using Lorenz curves or Gini coefficients. Alternative income concepts (e.g., gross of tax, or net of tax) can also be used in such calculations. Changes in relative prices can be evaluated, as can changes in the use of factors of production across industries, or changes in the product composition of consumer demands.

(v) Uniqueness of Equilibrium

One final point to keep in mind is that the applied general

equilibrium approach to tax policy may not be particularly instructive if the equilibrium solution in any of these models is not unique for any particular tax policy. Uniqueness, or the lack of it, has been a long-standing interest of general equilibrium theorists (see Kehoe 1980). There is, however, no theoretical argument that guarantees uniqueness in the tax models currently in use. With some of the models, researchers have conducted adhoc numerical experimentation (approaching equilibria from different directions and at different speeds), but have yet to find a case of nonuniqueness. In the case of the US tax model due to Ballard, Fullerton, Shoven and Whalley (1985), uniqueness has been numerically demonstrated by Kehoe and Whalley (1982). The current working hypothesis adopted by most tax modellers seems to be that uniqueness can be presumed in the models discussed here until a clear case of nonuniqueness is found.

IV Themes From Results Generated by the Applied Tax Models

In recent years the use of applied general equilibrium models in tax policy work has grown substantially. Much of this activity has its origins in a paper by Shoven and Whalley (1972) which extended the earlier Harberger (1962) analysis of the distorting effects of the U.S. corporate tax by using Harberger's data in full general equilibrium computations. Since then, a series of models have been constructed.

Shoven and Whalley have taken their work further in a larger dimensional model constructed to analyze US tax policies (Ballard, Fullerton, Shoven and Whalley (BFSW) (1985)). This has been used to analyze such issues as personal and corporate tax integration; (Fullerton, King, Shoven, and Whalley (1981)), possible moves from an income tax to a consumption tax (Fullerton, Shoven, and Whalley (1982)), and the marginal welfare costs of various US taxes (Ballard, Shoven, and Whalley (1985)).

A related model by Piggott and Whalley (PW) (1976, 1985) has been used to evaluate the impacts of possible tax changes in the U.K. This, in turn, was an outgrowth of earlier work by Whalley (1973) evaluating the impact of changes in UK tax policies at the time of British entry into the European economic community. In a series of related modelling efforts, other tax policy questions have been analyzed in smaller dimensional issue specific models such as Hamilton and Whalley (1985).

Shoven-Whalley type tax models have also been constructed by Serra Puche (1979) for Mexico, and Piggott (1982) for Australia.

There have also been a series of other tax policy modelling efforts which, while not of the Shoven-Whalley type, are in similar vein. Slemrod (1982), for instance, has attempted to incorporate endogenous financial policies of firms into a real side general equilibrium model so as to improve the modelling of corporate tax issues. Summers (1981), Auerbach, Kotlikoff, and Skinner (1983) and others have used one sector growth models with an overlapping generations demand side structure to evaluate the effects of changes in the tax treatment of capital income. Also, the original local linearization/approximation approach due to Harberger for analyzing counterfactual equilibria when tax policies change has been taken further by Keller (1982), Bovenberg and Keller (1984), Ballentine and Thirsk (1982), and others.

The Shoven-Whalley type models typically incorporate a number of household groups identified by ranges of household income or by other characteristics. There are 12 such groups in the BFSW model, and 100 groups in the PW model. A number of industry groups are also identified with value added functions defined over substitutable primary factors, and intermediate production requirements. 19 appear in the BFSW model and 33 in PW.

These models attempt to incorporate the main distorting features of modern tax subsidy systems, covering such policy elements as the corporate, personal income, property, social security, sales and excise taxes, along with redistributive

policies which operate through the tax transfer system. The models are calibrated to a microconsistent base year data observation, allowing various kinds of tax proposals to be evaluated.

These more recent efforts clearly suggest a rapid development in the field from the small dimensional numerical examples of earlier years towards a regime in which models are being used in a more serious manner to actually evaluate impacts of possible changes in tax policies. It is therefore reasonable to ask how appropriate this use of models is, what has been learned from these modelling exercises conducted thus far, what the future holds, and what the problems are.

My own view has always been that the empirical basis for applied general equilibrium tax models is unfortunately relatively weak. The basic assumptions such as full employment, constant returns to scale, complete information, perfect competition, taxes operating in ad valorem form, balanced government budgets, and so on, are either parently false, or largely untested. The rationale for using them hinges more on analytical tractability, their widespread use in theoretical work, and the relative absence of alternative workable assumptions than on any firm empirical basis. In addition, surprisingly little is known about the appropriate values to use for key elasticities in these models, and the little that we think we know is frequently shown to be contradicted by subsequent work. When combined with the absence of any statistical testing of the model specifica-

tions used, one might well query whether anything useful to policy makers can be generated by these models.

However, it must also be recognized that the policy process is such that tax policy decisions will be made with or without the input from such models. At present, using the input from these models in policy making seems to make sense, especially if the issues at hand are concerned with resource misallocation and income distribution effects of taxes, since reservations over data, elasticity values, testing, and other matters will not delay policy decisions. But sensible use of these models does seem to require that appropriate qualifications be attached to all model results, and only broad orders of magnitude be given major attention.

Because of these considerations, in my opinion the most interesting model results obtained thus far with the tax models tend to be qualitative, or at best only quantitative in a very approximate sense. The most important qualitative results are those which suggest lines of reasoning opposite to conventional thinking, and which upon reflection are plausible. This is because challenges to received wisdom based on a logically complete framework, specified with no prior position in mind, are always important to the policy debate. Among the important quantitative results are those which indicate whether effects are big or small, or whether effects roughly offset each other. In this section I briefly review some of the more important of these results which have emerged thus far from the models.

Costs of Distortions from Taxes

One of the strongest themes to emerge from existing models is the size of the social costs of distortions generated by modern tax subsidy systems. For many years these costs were thought to be relatively small, perhaps in the region of half to one and a half percent of GNP (although as a fraction of tax revenues raised these costs estimates are higher). These estimates were largely based on Harberger's calculations (1964, 1966) where he analyzed the welfare costs of corporate and other taxes. He placed the former in the region of three-quarters of 1% of GNP. The main distorting effects elsewhere in the tax system were thought to be concentrated in a few additional areas which Harberger also analyzed and concluded imposed only modest costs.

The applied general equilibrium tax models of the late 1970's, however, suggest that the costs of these distortions are considerably higher. The Piggott-Whalley (1976, 1985) model estimates that in the UK in the early 1970's the combined distortionary costs of the tax subsidy system were in the region of 6-9% of GNP, a figure which is similar to more recent estimates for the US by Ballard, Shoven and Whalley (1985).

In addition, these models have also produced results which emphasize the important difference between the total cost of distortions in the tax system, and the marginal cost associated with raising an additional dollar of tax revenue. Thus, in a recent paper, Ballard, Shoven and Whalley (1985)

have estimated that the marginal welfare costs of raising an additional dollar of revenue from already distorted US taxes may be as high as 30 to 40 cents per dollar of additional revenues raised. This work builds on earlier partial equilibrium calculations of marginal welfare costs due to Browning (1976) and others.

Results from these models have also provided indications as to how the total costs of tax distortions breakdown by tax, and how these tax distortions are interconnected since their effects are not independent of one another. The relative importance of various types of distortions in the tax system comes through strongly in models results. Distortions generated by the corporate tax system appear to be important in most model results, while, generally speaking, the welfare costs of tax distortions of labor supply appear to be smaller (although this counter to some of the recent work of Hausman (1982)). The compounding effects of taxes also appear in results. In early work, for instance, Whalley (1973) noted that an elimination of the property tax in the UK turned out to be welfare worsening because it offsets distortions of the wage rentals ratio associated with the corporate tax.

The Tax Treatment of Capital Income

The area where the general equilibrium tax models have been most extensively developed is in the analysis of tax treatment of capital income. In some respects this reflects the early orientation of Harberger tax models on inter sectoral

distortions of capital allocation.

A number of different distorting effects of tax treatment of capital income have been analyzed by the models, including inter-industry, inter-temporal, and interasset effects. In turn, a number of different approaches have been used, including the infinitely lived consumer approach of Fullerton, Shoven and Whalley (1982) and life cycle modelling efforts based to a large extent on the work of Summers (1981) and Auerbach, Kotlikoff, and Skinner (AKS)(1983). More recently Davies, Hamilton and Whalley (1985b) have extended the Shoven-Whalley type framework to a life cycle setting, noting some important differences relative to a Summers - AKS approach.

In terms of inter industry effects, most of the models build on Harberger's original work, even though his estimates were not based on a complete general equilibrium calculation. One of the best known general equilibrium recalculations of Harberger's estimates of the welfare costs of interindustry tax distortions of capital is by Shoven (1976). His estimates are approximately consistent with Harberger's original estimates, although he notes two offsetting arithmetic errors in Harberger's work. These welfare costs are thus still widely believed to be in the Harberger region of three-quarters of 1% of GNP, around 20% to 25% of revenues collected.

With regards to inter-temporal tax distortions, currently available estimates show more variation. In work using one sector growth models with a life cycle structure on the demand

side, Summers (1981) has estimated large welfare costs from inter-temporal tax distortions. In comparisons between steady states, he suggested that a move to a consumption tax in the US could yield gains as large as 10 to 11% of GNP on an annualized equivalent basis. These estimates of gains are larger than the revenues collected from the income tax system. These estimates have, however, been substantially downward revised in more recent work by Auerbach, Kotlikoff and Skinner (1983) who both incorporate a labour supply response into their model, and use different parameter values to those adopted by Summers.

In the fuller general equilibrium treatment of these issues, the approach taken thus far has been to work with infinitely lived consumer rather than lifecycle models. In Fullerton, Shoven and Whalley (1982) saving today is based on the expected rate of return on assets in the future, and saving augments the economy's capital. A series of single period equilibria are computed, connected through savings behavior and the augmentation of the economy's capital endowment. Under a move from an income to a consumption tax, savings increases and the short run impact is to cut both consumption and current welfare. Because the higher saving produces a larger capital stock and hence more output, welfare eventually increases beyond that which would be attained in the presence of an income tax. Their comparison across equilibrium sequences suggests that the gain to the US from a move to consumption tax might be in the region of 1 to 1 1/2% of GNP on an annualized equipment basis.

In more recent work using Canadian data, Hamilton and Whalley (1985) have taken this approach further and employed the same technique in a two asset framework, analyzing tax biases in favor of housing over non-housing assets under the income tax. They emphasize that the current tax treatment of housing is what one might adopt under a consumption tax, since the income return to the asset is not taxed. On the other hand, an inter-asset distortion exists between housing and non-housing assets under current tax treatment since non-housing assets by and large, are, treated on an income tax basis. Interestingly, they show that a move to either a pure income or pure consumption tax for all assets will be welfare improving, although a move to a consumption tax yields larger gains than a move to an income tax. Their results therefore suggest that interasset tax distortions are important in evaluating the tax treatment of capital income, a theme also emphasized by Fullerton and King (1984).

In subsequent work, Davies, Hamilton and Whalley (1985) have extended the Shoven-Whalley approach to models with overlapping generations in which capital assets are identified. In contrast to Summers and AKS they use a two commodity rather than one commodity approach based on Uzawa's (1962) extension of the original Solow (1956) one sector growth model to separately incorporate consumption and investment goods. They stress how asset capitalization effects can be important both in the analysis of capital income tax alternatives and in affecting aggregate savings elasticities.

Distribution Impacts of Taxes

Another area where the general equilibrium tax models have had an impact is in the analysis of distributional effects of taxes. For many years it was widely believed that the total effect of taxes on the distribution of income was roughly proportional i.e., that effective combined personal and other tax rates by income range are approximately constant across income ranges. The argument is that the income tax, while progressive, is not as progressive in practice as it appears on paper, and its progression is offset by regression elsewhere, such as through sales and excise taxes. This view is reflected, for instance, in the incidence calculations by Pechman and Okner (1974), but has a much longer history, appearing in a large number of earlier incidence studies.

However, these conclusions have been recently challenged, not only by other work in the incidence tradition such as Browning (1978) and Browning and Johnson (1979), but by calculations from general equilibrium tax models. Piggott and Whalley, for instance, estimate that in their model replacing all existing taxes and subsidies in the UK (including the income tax) by a yield preserving sales tax produces a gain for the top 10 per cent households of as much as 20% of income, with a comparable proportional loss for the lowest income ranges.

In subsequent work, Piggott and Whalley (1984) have also suggested that calculations of net fiscal incidence, associated with the work of Gillespie (1976) and Aaron and McGuire (1970)

can be equally misleading when considered in a general equilibrium framework. Their results clearly emphasize the importance of the distinction between marginal changes in levels of provision of public goods and taxes, and total changes where both taxes and public goods are reduced by large orders of magnitude.

A further theme from the general equilibrium work suggesting a reevaluation of incidence analysis of taxes and expenditures is the importance of redistribution between different ages cohorts of the population, rather than only between income groups. This theme appears strongly in the Summers-AKS life cycle work (see Auerbach and Kotlikoff (1983)), and also in some of the multi commodity general equilibrium work (see Davies, Hamilton and Whalley (1985)).

International Aspects of Taxes

Another area where the applied tax models have made contributions to policy debate is in the analysis of international aspects of tax policy.

International tax issues usually span two separate branches, covering the impacts of tax treatment of flows of goods between countries and international factor flows. In analyzing international goods flows the main contribution of previous academic literature had been to emphasize that the issue discussed by policy makers of whether or not indirect taxes should be administered on an origin or destination bases is an irrelevant issue in the balanced trade, no capital flow, uniform rate case. That

is because in long run equilibrium a change from one tax basis to another can be offset by either a change in exchange rates or price levels so that real trade flows between countries remain unchanged. This neutrality proposition has been widely cited to argue that the choice of tax basis has no effect on real behaviour. Put another way, under balanced trade it is irrelevant whether any individual country taxes all consumption or all production.

Prior to the use of numerical general equilibrium models to analyze these issues, little thought had been given to what happens when the tax base is non-neutral, even though the taxes at issue are non uniform and do not involve a comprehensive tax base. Hamilton and Whalley (1984) have examined this tax basis issue taking account of the non uniform treatment most countries use in their indirect tax systems. Their results are based on a global trade model in which taxes in major countries are identified. Their specification reflects the fact that the US is in a position of trading mainly with other developed countries in Europe, Japan, and Canada, all of whom have destination based sales taxes with rates which are higher on manufacturing than non-manufacturing goods, while the US has no such national tax. Their results suggest that any move by a major US trading partner away from their current destination basis towards an origin basis can have either a desirable or undesirable effect on the US, depending upon the bilateral trade balance in more highly taxed commodities. In the case where the US is a net importer of

manufactures from the country in question, such as with the EC and Japan, a move towards an origin basis abroad operates akin to a tax on exports and results in a term of trade deterioration for the US. On the other hand, where the US is a net exporter of manufactures to the country in question, such as with Canada, then from a US point of view the tax basis issue reverses.

The theme suggested by model stimulations is that the US should not have a uniform policy towards all its trading partners on the border tax question. Given that taxes abroad are heavier on manufacturing than non-manufacturing commodities, the US position on border tax adjustments should reflect their bilateral trade imbalance in more heavily taxed goods on a country by country basis.

The tax models have also contributed to debate on the impact of international capital mobility on the analysis of capital income tax alternatives. Goulder, Shoven and Whalley (1983) have shown that the effects of moving to a consumption tax from an income tax depends significantly on the specification of the international factor flow regime, reporting cases where a move to a consumption tax by the US is a welfare worsening proposition. The reason is that investors in the US equate the net of tax return which they receive on US investments to the net of tax return which they receive from abroad, discounting the tax benefits which would accrue to the rest of the economy from domestic investment. Where investments are made domestically these tax benefits are captured by domestic residents; if

investments are made abroad these tax benefits are captured by foreigners. A move to a consumption tax which increases savings by US households is a welfare worsening change in this case, a strong reversal of analysis of the same question in closed economy situation.

Thus, in these and other areas there seems little doubt than current numerical general equilibrium tax models are providing important inputs to ongoing policy debates on a range of issues.

While data is sparse and elasticity values remain highly uncertain, the main themes from results from these models seem to be both important and a contribution relative to what other approaches have generated for the policy process to digest. In this sense of providing useful policy input, Walras may be claimed to have been operationalized in these tax models. On the other hand, Walras has clearly not been operationalized in the sense of producing an exact, believable, all encompassing numerical model describing all economic activity within an integrated and detailed framework.

V Problems With the General Equilibrium Tax Models

Despite the contributions which the general equilibrium tax models are making to current policy debate, there are nonetheless many difficulties which their use raises. These largely reflect problems endemic to all attempts to operationalize general equilibrium theory in an empirically based setting. What they suggest is that empirically based general equilibrium modelling is inevitably a highly subjective

process, involving simultaneous and complex judgements across many different issues. It does not mean that such modelling efforts should not be undertaken, only that their weaknesses as well as their strengths should be clearly understood by all those involved, both at a production and a client level.

Which Model?

Perhaps the most fundamental issue in using any of the applied general equilibrium tax models concerns the choice of model form. All of those who have studied the theoretical literature in the last 15 to 20 years are only too well aware how easy it is to construct competing theoretical models, each of which produces sharply different conclusions. Simply by constructing a numerical model to represent a particular economy, this problem of choice between conflicting theoretical models is not avoided. Equally, there is all too often insufficient guidance from applied econometric literature on which to base the choice of model form.

It may help if I give a few examples of this problem as it rises in the tax policy area. One concerns the issue of whether capital (or some other factor) is assumed to be in inelastic or elastic supply. In Harberger models, the standard conclusion for many years was that capital bears the burden of the corporate tax. This result was shown to be robust to different degrees of disaggregation, and to different model specifications (such as factors assumed to be sector specific). However, some 10 to 15 years after the Harberger model was first

formulated, the observation that if the economy in question may be either a small open price taking economy, or international capital markets or specified in dynamic form so that there is a high elasticity of savings, changed this result. This is because if the supply function of the taxed factor capital is perfectly elastic, the factor no longer bears the burden of taxes. The choice of model form therefore crucially affects the results, independently of whether one is building a theoretical or numerical model.

Another example of the problem of model choice is the treatment of taxes themselves, and whether they should be modelled as benefit related. In the tax models it is common to treat social security taxes as advalorem payroll taxes on labor inputs by industry, even though they finance benefits for retirees and are dissimilar to other taxes. Again the choice of model form will fundamentally affect the conclusions from model results. Other examples can be given. The model analyses of property taxes, for instance, focus on inter sectoral distortions associated with the tax, even though the inter jurisdictional migration effects stressed by Tiebout (1956) can be the main effects at issue.

How Detailed?

A further problem is that all the tax models are inevitably highly aggregated. In practice, most policy decisions involve large amounts of detail which are crucial to the policy makers but are not captured (or even capturable) in current models.

This is especially the case with changes in depreciation provisions, investment tax credits and the like where industry detail at a fine level is often crucial to policy formation. Yet in the tax models 20 to 30 commodities or industries is regarded as large. Models in use are therefore simultaneously disaggregated relative to theoretical work and contain many model specific features, but are highly aggregated for analyzing real world policy issues, and typically not sufficiently disaggregated for policy makers wishing to know the precise details of what may happen if they make this or that change. This issue of detail can undermine the credibility of model results in the policy area, and will likely remain a serious issue given current constraints on data and computational solution of models.

Data and Parameter Values

A further problem with current tax models is that even after the model form has been specified, the constraints imposed by the availability of data and parameter estimates can be severe. Results from most of the models depend crucially on a small number of key elasticity values, for which there are often relatively few or even no estimates. In recent year, the literature on elasticity estimation has focused predominantly on problems with estimation procedures, especially for systems of demand functions. It has not focused so heavily on generating reliable estimates of parameter values for use in models of the type represented by current applied general equilibrium tax models. No doubt many of those involved in

estimation of demand and other systems feel that it is premature for any of these elasticity estimates to be used in this way. However, the current use of these models is driven in part by the prerogative of the policy process, and these models clearly represent a demand for elasticity estimates.

On the data front, the absence of usable microconsistent data sets has been the major problem. As they have evolved since the 1940's, National Accounting conventions have largely concentrated on the construction of macro economic aggregates. Yet in models of the type discussed here it is the sub-aggregate micro consistent detail which is crucial, i.e. data in which all the general equilibrium conditions of the model chosen are satisfied. The work on constructing micro consistent data sets referred to earlier has involved significant research efforts, using non-trivial amounts of resources. In turn, these efforts are difficult to continue and maintain after the initial development phase, although as further model developments occur efforts in these directions will no doubt be made.

Testing Model Specifications

A further issue with the tax models is the absence of any statistical tests of the specifications used. They are largely based on calibration of a chosen model structure with particular functional forms to base year data, with only limited sensitivity analysis of the many parameter values involved. To econometricians this has always seemed to be an especially inadequate procedure, especially given developments in

econometric techniques.

However, one has to also recognize that economic theory has become richer and more complex over the same period of time in which econometric techniques have tended to concentrate on improved statistical richness in models, while down playing their economic structure. If anything, the tendency has been to make the economic content of econometric models progressively simpler. Thus when general equilibrium tax models are constructed which have as many as 20,000 parameter values, estimating these models on any form of system wide econometric basis is hard to imagine. Equally, partitioning models and estimating model subsystems does not capture the general equilibrium restrictions at the heart of the analysis. For similar reasons, testing one model specification against another is equally difficult.

The calibration approach implies selecting a particular model specification such that it can be fitted to a single data observation in a purely deterministic manner. In part this is made possible by allowing the complexity of the economic model to expand so as to allow this to happen. Once this degree of flexibility is allowed in model specification there is little room for testing of models, since any data observation can be made consistent with a deterministic model. Put another way, given any micro consistent data observation a deterministic model can be selected to fit this exactly. This same point also applies to a series of data observations, as Kydland and Prescott (1981) have implicitly demonstrated. Thus, given the wide choice

of models available to modellers, increasingly complex deterministic models can be fitted to any given data observations. This, in turn, introduces a large element of subjectivity into the modelling exercise, something which is not easily escapable given the focus of current modelling efforts.

Communicating with Non-Modellers (Models as Black Boxes)

Finally, while the general equilibrium tax models discussed here are both richer and more complex than their underlying theoretical analogs, the richness of structure is simultaneously difficult to communicate to non-modellers and can undermine both their credibility and their usefulness. Consumers of results inevitably have only limited understanding of the model, and where results are difficult to interpret they frequently also have limited credibility. In trying to both model and accommodate real world phenomena, various institutional arrangements are brought into these models which inevitably substantially complicate their structure compounding the communication problems. This is especially the case if "ad hoceries" which depart from a pure Arrow-Debreu approach creep into the model.

It is often difficult for modellers to communicate to readers what the precise details of their modelling efforts entail since many different features need to be described, and to document and communicate all of those features often involves lengthy papers. Current applied tax (and other) models therefore face the problem of being dismissed as black boxes. This problem, of course, also arises with large scale econometric and

other models. The way to proceed seems to be for modellers themselves to be more sympathetic to model users and readers, to seek to improve communications with their audience, and to focus on comprehensible model syntheses which convey the main features of their modelling effort in a digestible and informative manner.

VI Tax Models and the Policy Process

The preceding discussion of recent general equilibrium tax models indicates that while these can be seen as part of a well established tradition of attempts to operationalize the Walrasian economic model they are not without their problems. Most of these appear to be endemic to all attempts to empirically implement a Walrasian approach to policy making, and will likely remain no matter what form future efforts take. Despite these problems, my opinion is that models of this type will be increasingly used in the policy process in the years ahead, and in this concluding section I briefly comment further on their potential role in policy making.

The main advantage of the general equilibrium tax models that I see relative to alternative approaches to policy making is the clear bridge between theory and policy analysis which they represent. Current economic theory often seems to produce work which is increasingly remote from what policy makers see as the practicalities of daily life. The theoretical questions of the 1950's and 1960's are dismissed by modern theoreticians as the issues of yesterday, and the new frontiers await. On the other hand, even the theoretical developments of those years are yet to

be digested by the policy process.

Having been tangentially involved in the policy process, what I find particularly striking is the limited analytical basis underlying actual policy decisions. Time horizons for decision making are unbelievably short. The research input is small, hastily assembled, and to an academic's eye of poor quality. Data on which policy decisions are based is poor and concrete analysis of the policy options available usually does not take place within a logically consistent analytic framework; as anyone else who has been involved with policy making will, I am sure, testify. Standards of academic purity, rigour, and precision are almost instantaneously compromised on entering the policy process, in the interest of raising the level of debate and analysis. Seen from this vantage point, even somewhat dated modelling has a lot to offer.

And having seen how both sides of the street operate, I see strong parallels between the modelling process and the process of policy decision making itself. Any typical policy issue will involve a myriad of different considerations which have to be factored into an eventual decision. Decisions will still be made taking into account a range of factors whether or not analytic frameworks are available for their consideration. To be told by an analytical economist that there is only one of, say, 15 or 16 factors which is amenable to analytic formulation and has been worked on in the literature is typically of little value to the policy decision maker. Policy decisions will still

be made independently of whether or not tractable analytic frameworks exist to analyze those considerations which policy makers feel compelled to deal with.

In trying to deal with the issues of the day, modellers also encounter similar decisions. How is this or that feature of reality to be treated, is it to be ignored, given scanty treatment, or to be carefully considered? Ignoring particular factors will undermine the credibility of models in the policy process for the same reasons that a policy decision maker cannot proceed to a policy decision without some discussion of all factors involved. These parallels are strong and emphasize the difficulties in operationalizing Walras from a numerical modelling point of view.

From the viewpoint of the policy process, perhaps the major virtue of current applied general equilibrium tax modelling efforts is that they bring to the fore the analytic framework which seems to be widely agreed on by many applied economists working in their respective applied fields, and introduces it into policy debate. By tracing through the implications of model results, both policy makers and modellers are forced to analyze the inter-connections between various components of the tax system, and evaluate how these interactions may or may not work their way through the economy. These models also force both modellers and policy makers to focus their thoughts on what the policy options actually are that they wish to consider. Whether or not the model calculations are in fact realistic is another

issue, but the bridge which is built between these two branches of activity seems to me to clearly be beneficial.

These models can also have the effect of changing the nature of policy debate to more fully focus on areas of analytical or empirical disagreement. If results of a model are to be discounted, the onus is typically shifted on to those who disagree with the conclusions. They have to show why particular model conclusions are inappropriate; which model assumptions are invalid, or which parameter values are mispecified. Debates focusing on issues such as this are, in my experience, more constructive than debates over whether or not a particular policy proposal is a desirable way to proceed considered in isolation of any outputs from modelling efforts.

The complete Walrasian general equilibrium framework in useable concrete form does not yet exist in the tax policy area, or indeed in any other area of economists. It may never exist, and how current efforts in the policy area will be viewed in 20 years remains to be seen. Clearly, my view is that significant contributions to policy formation have already occurred as a result of present modelling efforts, and further contributions can be made. For this to occur modellers must keep their feet on the ground and focus on the policy issues of the day, as well as worry about their analytical framework and model specification.

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