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GENERAL EQUILIBRIUM MODELS FOR
TAX POLICY EVALUATION"

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SURVEY OF DYNAMIC COMPUTATIONAL GENERAL EQUILIBRIUM MODELS
FOR TAX POLICY EVALUATION(*)

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Survey of Dynamic Computational General Equilibrium Models for Tax Policy Evaluation

1. Introduction

There is a well established and fast growing body of literature focusing on tax policy evaluation using disaggregated computational general equilibrium (CGE) models. That such models have become so popular is hardly surprizing. In fact, the CGE approach has several advantages over more macro oriented aggregated models or analytical partial equilibrium analysis. First, the CGE methodology allows the study of differential impacts across sectors of production and across consumer groups. Second, it allows one to consider the interactions among different sectors and agents so that the policy evaluation is not biased by ceteris paribus assumptions. Third, and in a more technical vein, it makes use of flexible computational numerical techniques. Analytical tools often become intractable for disaggregated models. Furthermore, the CGE modeller does not have to be confined to small changes in parameters. This is an important feature, because large changes in policy parameters are often contemplated in most tax reform proposals.

Historically, the field was fostered by the early pioneering work of Harberger (1959, 1962, 1966). Harberger uses a highly aggregated analytical model to focus on the taxation of capital income. The first fully disaggregated computational general equilibrium model was introduced by Shoven-Whalley (1972) to evaluate the effects of differential taxation of income from capital in the U.S.

Until the early eighties most empirical general equilibrium work for tax policy evaluation

followed in the tradition of such contributions, and shared the same generic characteristics. These models exclusively emphasize the real side of the economy. The economic environment is basically static. Investment passively adjusts to saving. The typical instruments in the U.S. tax system are modelled and the government budget is balanced. This state of affairs is discussed and surveyed in Shoven (1983), Fullerton-Henderson-Shoven (1984), and Shoven-Whalley (1984).

More recently, the thrust towards better descriptive power together with the nature of the tax policy issues under analysis - effects of a consumption tax, capital taxation, corporate tax integration, etc - has induced important developments. There have been attempts to incorporate life-cycle behavior, intergenerational issues, allocation of savings, investment decisions and adjustment costs, corporate financial decisions, and government deficits, in to the CGE models. Underlying all of these features is the need to endow the models with a dynamic structure, without which most of the above issues cannot be adequately addressed.

The first efforts to incorporate dynamics into the CGE tax models are associated with Fullerton-Shoven-Whalley (1978, 1981, 1983). Consumption decisions incorporate some intertemporal aspects and an intertemporal equilibrium path for the economy is obtained by the sequencing of static short-run equilibria. The equilibria are connected through the evolution of the capital endowments which in turn depend on saving behavior. A complete discussion of a recent version of this model is provided in Ballard-Fullerton-Shoven-Whalley (1985).

More recently, a whole new generation of models has been developed by Andersson (1987), Auerbach-Kotlikoff (1983, 1984, 1987), Ballard (1983), Ballard-Goulder (1985), Bovenberg (1984, 1985, 1986), Erlich-Ginsburgh-Heyden (1987), Feltenstein (1984, 1986), Goulder (1985), Jorgenson-Yun (1984), Pereira (1986b, 1987c, 1987d), and Goulder-Summers (1987).

This article focuses on such efforts. Our scope is narrow. By concentrating on decentralized

numerical general equilibrium modelling designed to address tax policy issues, we abstract from several other related areas and approaches. First, we abstract from analytic models along the lines of Abel-Blanchard (1983), and Judd (1985). Second, we abstract from centralized growth-type models of taxation like Chamley (1981, 1982). Third, we abstract from centralized models associated with World Bank researchers. See, for example, Adelman-Robinson (1978) and Dervis-de Melo-Robinson (1981). Finally, we abstract from other CGE fields. See, for example, Shoven-Whalley (1984) for a survey of international trade applications, Decaluwé-Martens (1985), and Robinson (1986) for applications in the area of development, James (1985) for a survey of economic history applications, and A. Manne (1986), and Borges (1986) for all encompassing surveys.

The models included in our comparison are:

1. Ballard-Fullerton-Shoven-Whalley (1985)
2. Andersson (1987)
3. Auerbach-Kotlikoff (1983, 1987)
4. Ballard (1983), and Ballard-Goulder (1985)
5. Bovenberg (1985, 1986)
6. Erlich-Ginsburgh-Heyden (1987)
7. Feltenstein (1984, 1986)
8. Goulder (1985)
9. Goulder-Summers (1987)
10. Jorgenson-Yun (1984)
11. Pereira (1986b, 1987d)

The key features of these models are summarized in Table 1, which provides a structure for the discussion. Most of the models that we examine could be said to be in the 'Yale tradition'. That is, they were developed by students of Herbert Scarf or students of the students of Herbert Scarf. This includes Ballard-Fullerton-Shoven-Whalley, Andersson, Ballard-Goulder, Bovenberg, Feltenstein, Goulder, Goulder-Summers, and Pereira. The exceptions from this heritage are Auerbach-Kotlikoff, Erlich-Ginsburgh-Heyden, and Jorgenson-Yun.

This survey is organized as follows. The second section provides a brief overview of 'non-dynamic' CGE models. The third section offers a discussion of modelling economic behavior and equilibrium. The fourth section focuses on model implementation and policy evaluation. The fifth section summarizes empirical evidence on selected policy issues. The sixth section illustrates the power and weaknesses of dynamic modelling with the issue of corporate tax integration. Finally, the last section summarizes the state-of-the-art in terms of dynamic modelling for tax policy evaluation, and suggests areas of future research.

	Country	year of data	dynamic setting	disagg.	objective	tastes	Consumers' Behavior				
							constraint	endog. labor	endog. sav.	Overlap. generat.	Bequest motives
Ballard-Fullerton-Shoven-Whalley 1985	US	1973	yes	12 income groups	Intertemporal utility max	CES	Intertemporal	yes	yes	no	no
Andersson 1987	Sweden	1984	yes	one aggregate consumer	Intertemporal utility max	CES	recursive eq. of motion for wealth	no	yes	no	no
Auerbach-Kotlikoff 1983, 1987	US	plausible/hypothetical	yes	55 age cohorts	Intertemporal utility max	isoelastic-1983/ CES-1987	no-1983 Intertemporal	yes-1987	yes	yes	no
Ballard-Goulder 1983, 1985	US	1973 BFSW expanded	yes	55 age cohorts	Intertemporal utility max	isoelastic	Intertemporal	yes	yes	yes	yes
Bovenberg 1985, 1986	US	plausible/hypothetical	yes	one aggregate consumer	Intertemporal utility max	isoelastic	recursive eq. of motion for wealth	no	yes	no	no
Erilch-Ginsburgh-Heyden 1987	Belgium	1980, 1983	yes	one aggregate consumer	Intertemporal utility max	Stone-Geary	Intertemporal	no	yes	no	no
Fallenstein 1984, 1986	Australia	1981-1982	yes	2 income groups (2-period)	Intertemporal utility max	two period CD	two yearly constraint	yes	yes in the first period	no	no
Goulder 1985	US	1973 BFSW expanded	yes	55 age cohorts	Intertemporal utility max	CES	Intertemporal	yes	yes	yes	yes
Goulder-Summers 1987	US	1973 BFSW expanded	yes	one aggregate consumer	Intertemporal utility max	isoelastic (log)	Intertemporal	no	yes	no	no
Jorgenson-Yun 1984	US	1955-80	yes	one aggregate consumer	Intertemporal utility max	translog	Intertemporal	yes	yes	no	no
Perreira 1986, 1987	US	1973 BFSW expanded	yes	3 income groups	Intertemporal utility max	C-D	recursive eq. of motion for wealth	yes	yes	no	no

TABLE 1 - Dynamic CGE Models for Tax Policy Evaluation

			Producers' behavior					optimal capital stock
	dynamic setting	disagg.	objective	technology	inputs	I-O matrix	adj. costs	
Ballard-Fullerton-Shoven-Whalley 1985	no	19 sectors	static cost min	CES in value added; I/O	capital labor	yes	no	no Invest. adjusts to savings
Andersson 1987	yes	2 sectors	max of intertemporal net cash flow	CD	capital labor	no	yes quadratic in I	yes
Auerbach-Kotlikoff 1983, 1987	no-1983 yes-1987	1 sector	cost min-1983 /max of value of the firm-1987	CD-1983 CES-1987	capital labor	no	no-1983/ quadratic in I/k-1987	yes
Ballard-Goulder 1983, 1985	no	19 sectors	static cost min	CES in value added; I/O	capital labor	yes	no	no invest. adjusts to savings
Bovenberg 1985, 1986	yes	2 sectors	max of value of the firm	CD	capital labor	no	yes quadratic in I/k	yes
Erlich-Ginsburgh-Heyden 1987	no	24 sectors	static cost min	CD in value added; I/O	several capital, labor	yes	no	no, global invest. adjusts to savings
Feltenstein 1984, 1986	no	30 sectors	static cost min	CD in value added; I/O	capital labor	yes	no	no; invest. adjusts to savings net of exog. govt. deficits
Goulder 1985	no	3 sectors	static cost min	CES in value added; I/O	capital labor	yes	no	no invest. adjusts to savings
Goulder-Summers 1987	yes	5 sectors	max of value of the firm	CES in value added; I/O	capital labor	yes	yes quadratic in I/k	yes
Jorgenson-Yun 1984	no	one sector produces two goods	equivalent to two-stage cost min	dual translog price function	capital labor	no	no	yes
Perels 1986, 1987	yes	4 sectors	max of intertemporal net cash flow	Cobb-Douglas in V. Added I/O	capital labor	yes	yes quadratic in I	yes

	government		behavior		deficits allowed	endogenous debt	taxes	foreign sector
	dynamic objective setting	constraints	expenditure					
Ballard-Fullerton-Shoven-Whalley 1985	no	yearly public utility max	yearly balanced budget	endogenous composition; EXP=REV	no	no debt	all major US taxes	balanced trade with constant elasticity funct.
Andersson 1987	no	-	yearly balance; initial debt maintained	exogenous; EXP=REV	no	no	all major Swedish taxes	small open econ., intern. rate of return induces capital flows
Auerbach-Kolm 1983, 1987	yes	-	Intertemporal	exogenous	yes bond-financed	yes (non-optimal)	all major US taxes	closed economy
Ballard-Goulder 1983, 1985	no	yearly public utility max	yearly balanced budget	endogenous composition; EXP=REV	no	no debt	all major US taxes	balanced trade with constant elasticity funct.
Bovenberg 1985, 1986	no	-	yearly balanced budget	exogenous	no	no debt	simplified US taxes	1985-closed econ. 1986-two country model
Erllich-Ginsburgh-Heyden 1987	no	-	yearly balanced budget	exogenous; EXP=REV	no	no	simplified Belgium taxes	Intert. well. funct. /short-run trade disequilibrium
Feltenstein 1984, 1986	no	min costs of producing a public good	yearly, Exp ≥ Tax Rev	exogenous	yes financed with money and bonds	yes (non-optimal)	simplified Australian taxes	rest of the world as a third consumer group
Goulder 1985	yes	yearly public utility max	annual and Intertemporal versions	endogenous composition; DEF+EXP=REV	yes bond-financed	yes (non-optimal)	all major US taxes	closed economy
Goulder-Summers 1987	no	yearly public utility max	yearly balanced budget	endogenous composition; EXP=REV	no	no	all major US taxes	balanced trade with constant elasticity funct.
Jorgenson-Yun 1984	no	-	yearly balanced budget	exogenous	no	no	all major US taxes	closed economy
Perreira 1986, 1987	yes	Intertemporal public utility max	recursive eq. of motion for debt	endogenous level and composition	yes bond-financed	yes (optimal)	all major US taxes	closed economy

TABLE 1 - Dynamic CGE Models for Tax Policy Evaluation

	financial assets and markets						equilibrium		
	private assets	debt/equity	dividend/retention	public debt	allocation of savings	risk premiums	time path	type	expect.
Ballard-Fullerton-Shoven-Whalley 1985	phys. cap./ no financial assets	exogenous	exogenous	no	used to buy physical capital	no	sequence of static equil.	TE	myopic
Andersson 1987	phys. cap./ no financial assets	no	no	yes	used to buy physical capital	no	dynamic	PF	perfect
Auerbach-Kotlikoff 1983, 1987	phys. cap./ no financial assets	no	no	yes	used to buy physical cap. and govt debt	no	dynamic	PF	perfect
Ballard-Goulder 1983, 1985	phys. cap./ no financial assets	exogenous	exogenous	no	used to buy physical capital	no	dynamic	PF	perfect
Bovenberg 1985, 1986	phys. cap./ no financial assets	no	no	no	used to buy physical capital	no	dynamic (continuous time)	PF	perfect
Erllich-Ginsburgh-Heyden 1987	phys. cap./ no financial assets	no	no	no	used to buy physical capital	no	dynamic (two periods)	PF	perfect
Foltenstein 1984, 1986	phys. cap./ investment is bond-financed	no	no	yes	used to buy physical cap. and govt debt	no	dynamic (two periods)	PF	perfect
Goulder 1985	phys. cap./ no financial assets	exogenous	exogenous	yes	used to buy physical cap. and govt debt	no	dynamic	PF/TE	perfect/ static
Goulder-Summers 1987	phys. cap./ bonds and equity	no	exogenous	no	used to buy bonds, equity	yes (exogenous)	dynamic	PF	perfect
Jorgenson-Yun 1984	phys. cap./ no financial assets	no	no	no	used to buy two types of physical capital	no	dynamic	PF	perfect
Perelra 1986, 1987	phys. cap./ bonds and equity	exogenous	exogenous	yes	used to buy govt debt, bonds, equity	no	dynamic	TE	flexible (non-perfect)

	Implementation			policy evaluation			
	calibration derivation	parameter solution	computation algorithm	equilibria compared	equal tax yield	policy evaluation indicators	efficiency effects
Ballard-Fullerton- -Sheven-Whalley 1985	base year replication	back. solution with exog. parameters	Merrill's algorithm	steady-state vs. transition steady-state	yes lump-sum, pers. inc.	intergroup with CV or EV	intersectoral Intertemporal
Andersson 1987	base year replication	back. solution with exog. parameters	SIMNON package, variant of multiple shooting	steady-state vs. transition steady-state	no	no aggregated indicator	intersectoral Intertemporal
Auerbach-Kotlikoff 1983, 1987	qualitative replication	by assumption/ sensitivity	Gauss-Seidel	steady-state vs. transition steady-state	yes any rate adjusts	intergenerations with util. measure	intertemporal intergenerat.
Ballard-Goulder 1983, 1985	base year replication+ steady state	back. solution with exog. parameters	Ballard- Goulder algorithm	steady-state vs. transition +steady-state	yes lump-sum, pers. inc.	dynamic CV	intersectoral intertemporal intergenerat.
Bovenberg 1985, 1986	qualitative replication	by assumption/ sensitivity	dynamic version of Johanson's linearization method	steady-state vs. transition +steady-state	yes same govt. expend. path	CV	Intertemporal
Erllich-Ginsburgh- -Heyden 1987	2 base years replication	back. solution with exog. parameters	variant of Negishi's optimization approach	actual versus counterfactual	no	no aggregated indicator	intersectoral Intertemporal
Feltenstein 1984, 1986	base year replication	back. solution with exog. parameters	Merrill's algorithm	actual versus counterfactual 1981-1982	no	no aggregated indicator	intersectoral Intertemporal
Goulder 1985	base year replication+ steady state	back. solution with exog. parameters	variant of Fair-Taylor/ Newton	steady-state vs. transition +steady-state	no	dynamic CV	intersectoral Intertemporal intergenerat.
Goulder-Summers 1987	base year replication+ steady state	back. solution with exog. parameters	variant of Fair-Taylor/ Newton	steady-state vs. transition +steady-state	fixed government spending	no aggregated indicator	intersectoral Intertemporal financial
Jorgenson-Yun 1984	-	-	econometric estimation	steady-state vs. transition +steady-state	no	Money metric social welfare function	intersectoral Intertemporal
Pereira 1986, 1987	qualitative replication	by assumption/ sensitivity	NPSOL optimization algorithm	optimal path vs. optimal path	yes lump-sum, pers. inc.	generalized dynamic CV or EV	intersectoral Intertemporal financial

policy issues	
Ballard-Fullerton- -Shoven-Whalley 1985	intergration; consumption tax; VAT; capital or labor tax changes
Andersson 1987	consumption tax, neutral corporate tax system
Auerbach-Kotlikoff 1983, 1987	consumption tax; capital vs labor taxation effects of taxation on capital formation dynamic fiscal policy; effects of government deficits
Bellard-Goulder 1983, 1985	effects of the adoption of a pure consumption tax; importance of cons. foresight
Bovenberg 1985, 1986	analytically oriented approach; effects of pure consumption tax; capital income taxation in open economies
Erllich-Ginsburgh- -Heyden 1987	real wage policies in Belgium
Feltenstein 1984, 1986	1984 - theoretical 1985 - financial crowding out
Goulder 1985	effects of tax- vs bond-financed changes in public expenditure
Goulder-Summers 1987	corporate tax cuts; reduced ITC; increase in gasoline taxes
Jorgenson-Yun 1984	effects of several programs of tax reform on the allocation of capital
Pereira 1986, 1987	corporate tax integration; effects of re-introducing investment tax credits

2. Brief overview of 'non-dynamic' CGE models

The origin of most of the models we survey goes back to the work of Scarf (1967, 1973), who first developed a reliable algorithm to compute equilibrium prices for a Arrow-Debreu economy. His algorithm used simplicial subdivision techniques and can be shown to be the computational analog of the fixed point theorems previously used to prove the existence of equilibrium. His technique could solve a model with an arbitrary number of consumers and commodities, as long as all agents were price takers, consumers were subject to budget constraints, demands were continuous, and production did not display increasing returns to scale. The algorithm, while guaranteed to converge, was relatively slow for problems involving more than say, 20 dimensions. A major improvement in computational speed was offered by Merrill's algorithm (1972), which used the same fundamental ideas as Scarf's procedure.

Scarf's model (as is true for the standard Arrow-Debreu model) does not include a government sector - neither taxes nor public goods. As one of the most promising applications of the new computational technique was in the area of tax policy evaluation, Shoven and Whalley (1973) extended the general equilibrium model and computational approach to include a wide array of taxes and a government spending plan. The original Shoven-Whalley model was static (although the different commodities could be considered similar goods available at different dates, as in Arrow-Debreu), and government was assumed to run a balanced budget. The data are arranged as a social accounting matrix. The model's specification and calibration is checked by solving it in the presence of the base set of taxes. The result should be exactly the initial social accounting matrix. After having passed this replication check, the model is solved for a counterfactual equilibrium in the presence of a new tax design. The result is once again a social accounting matrix. The two equilibria are compared in order to assess the impact of the new tax plan. The first uses of this

model for tax policy evaluation were Shoven-Whalley (1972), Whalley (1975), and Shoven (1976).

Completely static models as Shoven-Whalley's are unsatisfactory for many tax reform issues. These include corporate tax integration, effects of investment tax credits, effects of accelerated depreciations, consumer or expenditure taxes, importance of saving subsidies like IRA's, etc. These are essentially dynamic issues. They involve not only the allocation of capital across sectors, but perhaps more important the capital intensity of the economy. But, the capital accumulation and capital reallocation take time and may involve adjustment costs. Because of these issues, Ballard-Fullerton-Shoven-Whalley took the first steps towards developing a dynamic model.

In this context, the Shoven-Whalley model has been extended and implemented for the U.S. economy in Ballard-Fullerton-Shoven-Whalley (1985). While this book completely documents the model, it was used in several publications beginning in 1978. Their model consists of nineteen production sectors, twelve households, and fifteen consumer goods. It includes a very detailed set of taxes including the federal and state personal income taxes, federal and state corporate income taxes, Social Security taxes, property taxes, unemployment insurance, excise taxes, sales taxes, etc. It has been calibrated to reproduce the 1973 U.S. economy. Recently, a version corresponding to the 1983 U.S. economy has been developed.

The Ballard-Fullerton-Shoven-Whalley model is dynamic in the sense that consumers face a choice between current consumption and leisure versus future consumption (which can be purchased via savings). The consumer classes act as if they were maximizing a nested CES utility function over the domain of a CES aggregate of contemporaneous consumer goods and leisure, and future consumption, subject to their income constraint. The parameters of those functions determine the shares of income devoted to each commodity, to saving, and to the 'purchase' of leisure. They also determine the two key elasticities in the models - the elasticity of labor supply with

respect to the real after tax wage rate, and the elasticity of saving with respect to the real after tax rate of return to capital.

In the model, consumers have myopic expectations regarding future prices and, in particular, regarding the future rate of return to capital. Ballard (1983), and Ballard-Goulder (1985) incorporate both perfect foresight and limited foresight into this model. Future consumption is 'acquired' by buying a fixed composition portfolio of real investments that offer an infinite annuity of returns.

The production side of the model is completely static. The model incorporates a constant elasticity of substitution between primary inputs in production (capital and labor) and fixed coefficients for intermediate inputs. The model distinguishes between industrial outputs and consumer goods for the simple reason that the data are classified differently. Industrial sectors involve such categories as forestry and fisheries, metal mining, and publishing and printing, while consumers purchase furniture, automobiles, and books. This fact is recognized in the model by incorporating a second stage of production, which converts industrial outputs into consumer goods. This technology is usually modelled as a fixed-coefficient conversion matrix.

The Ballard-Fullerton-Shoven-Whalley model assumes that the private sector finances marginal investment with the same composition of debt and equity as currently exists in each sector. This is the same assumption that Harberger originally used. Investors all hold debt and equity in the same proportion. Therefore, this ownership can be aggregated into simply capital ownership. For tax purposes, however, the separate treatment of debt and equity is taken into account at both the corporate and personal level. Similarly, the dividend policies on corporate equity are established exogenously. There are no government bonds in the model, since there are no government deficits.

The model is solved for a sequence (as many as 100) of temporary equilibria, with consumers allocating income between present and future consumption at each point in time. The path for the

economy is a set of connected equilibria. The connection is provided by capital accumulation. Capital accumulation is endogenous and determined by saving. The model starts with a social accounting matrix. In the base case the economy is assumed to be in a steady state growth path (along which all relative prices are constant). The model solves for both the new steady state growth path and the transition to it after a policy intervention. The authors have frequently addressed the question of how long it takes to effectively settle onto a new steady state growth path.

The dynamics of the model are limited, however, in that future consumption is collapsed into a composite commodity. Also, the absence of government deficits and the lack of production dynamics limits the realism of the Ballard-Fullerton-Shoven-Whalley model for the analysis of dynamic policy issues (such as the adoption of a consumption tax or the elimination of the investment tax credit). The models we survey try to improve upon the Ballard-Fullerton-Shoven-Whalley dynamic modelling. The models incorporate more forward looking behavior. They improve the dynamics on the consumption side of the economy, and some of them introduce true dynamic behavior on the part of the producers. We turn now to the issues involved in developing such dynamic models.

3. Issues in the modelling of dynamic behavior

We will look first at the specification of economic behavior of consumers, producers, government, and the rest of the world. The modelling of corporate and household financial decisions is then addressed. Finally, the concept of equilibrium is discussed.

3.1 Consumers' behavior

Early efforts to build dynamic features into the economic behavior of consumers are due to Ballard (1983), and Auerbach-Kotlikoff (1983, 1984). Their work has been closely followed by several subsequent authors. In fact, dynamic household behavior is the single most pervasive aspect among the models surveyed.

All the models incorporate some form of life-cycle behavior. Household behavior is determined by the maximization of an additively separable, time invariant intertemporal utility function. The utility function is defined over the domain of the consumption goods in the economy. In most of the models, leisure is also an argument in utility, so that labor supply is optimally determined.

Utility maximization is subject to a lifetime intertemporal budget constraint which equalizes the present value of consumers' income and expenditure. More recently, in Andersson (1987), Bovenberg (1985), and Pereira (1986b, 1987d), the constraint is defined as a sequence of recursive equations of motion on wealth. This has the potential advantage of accommodating liquidity constraints. However, it should be recognized that in the absence of liquidity constraints (i.e. when consumers are free to completely borrow against future income), the two specifications of the household constraint are essentially equivalent. Furthermore, in both versions saving is optimally determined as a way of transferring wealth intertemporally.

Some models now have a sophisticated dynamic specification of household. In Ballard (1983), Ballard-Goulder (1985), and Auerbach-Kotlikoff (1983, 1984, 1987), consumer's behavior is embedded in an intergenerational setting. Each of them has 55 age cohorts simultaneously alive. Some measure of intergenerational altruism is considered in the form of bequest motives. In Ballard (1983) and Ballard-Goulder (1985), consumers derive utility directly from bequeathing part of their wealth. Therefore, bequests assume the form of a scrap value of terminal wealth of a generation. In Auerbach-Kotlikoff (1983, 1984, 1987), each generation empathizes with the utility of future generations over bequeathed wealth. In addition, Ballard (1983) includes detailed demographic projections with the intent of incorporating in the policy analysis the effects of the Post World War II baby-boom.

In the real world, household decisions also include the optimal allocation of saving among alternative physical or financial assets. Theories of household portfolio behavior are relatively well-established. However, they involve uncertainty as a crucial element. Accordingly, they have not been incorporated in the context of the deterministic dynamic models we survey here. We will come back to this issue below.

3.2 Producers' behavior

The efforts to build dynamic features into the economic behavior of producers are more recent and less widely adopted. The first attempts are due to Bovenberg (1984, 1985) and Summers (1985). Dynamic behavior has been more fully incorporated in the recent models of Andersson (1987), Auerbach-Kotlikoff (1987), Goulder-Summers (1987), and Pereira (1986b, 1987d).

Part of the reason why production side dynamics has been more slowly adopted is the weak supply of accepted theories referring to the dynamic behavior of the firms. In the models referred

to above, dynamic production and investment behavior are induced by the existence of capital adjustment costs and linked to Tobin's q theory. Adjustment costs are designed to capture both the incomplete mobility of capital across industries and installation costs (i.e. the costs of adjusting capital towards its optimal level).

Adjustment costs can be conceived as internal to the firm and measured in terms of foregone output along the lines of Lucas (1967). Alternatively, adjustment costs can be viewed as actual external costs incurred together with the purchase costs, along the lines of Gould (1969). With the exception of Pereira (1986b, 1987d), all of the CGE authors follow the former approach.

The firms in the economy maximize their market value, as the present discounted value of the future stream of dividends. In Andersson (1987), and Pereira (1986b, 1987d), firms are seen as maximizing the present discounted value of net cash flow. Maximization is constrained by the adjustment cost technology and an equation of motion describing the evolution of the capital stock. It should be noted that under exogenous dividend/retention rules the two problems are equivalent. It should also be noted that a satisfactory economic rationale for the existence of dividends with the present tax code is missing in the profession (Shoven (1986)).

The models with static formulation of producers' behavior are characterized by passive investment behavior. Investment merely accomodates to saving in the economy. With a dynamic formulation induced by adjustment costs, real investment decisions are forward looking. Investment is endogenously and optimally determined by the firms. A fundamental difference between the short-run in which capital stock is given, and long-run in which the level of capital is allowed to be optimally determined is emphasized.

This extra richness of production dynamics is not without costs. A careful look at the summary tables will clearly show an inverse relation between the adoption of dynamic features in production and the level of disaggregation of the production side of the economy. In fact, with production

dynamics, the dimension of the problems is immensely increased. Let us be more specific.

In a static framework with constant returns to scale production technology, the output level is indeterminate. The optimal allocation of inputs can be obtained by cost minimization, with any feasible output level generating zero profits. Such zero profit conditions are used to solve for the output prices in terms of the factor prices and hence to reduce the dimensionality of the problem from the number of commodities and factors to the number of factors. Thus, even if the model deals with 30 production sectors, the computation of an economic equilibrium can take place using only the dimensionality of the primary inputs in the economy.

Now, under certain regularity conditions on the production and adjustment costs technologies, leading to enough concavity of the optimality objective, the intertemporal output path for the firm is endogenously, optimally, and uniquely determined even with constant returns to scale technologies (see Pereira (1985, 1987a)). Accordingly, with adjustment costs in the model optimal profits will in general be non-zero. This result has crucial implications for the computation of equilibrium in the models with production dynamics. With adjustment costs, no reduction of dimensionality is possible. The curse of dimensionality returns as a binding constraint.

The introduction of adjustment costs adds another significant complication to the model. With capital being less than perfectly mobile in the economy, different rates of return on capital will exist in different sectors. This is a difficult problem to tackle conceptually in the absence of uncertainty. Also, in the real world, producer maximization choices include also its choice of financial ratios (debt/equity), and payout rates (dividend/retained earnings). These financial subjects are difficult and much of this behavior is still taken as exogenous by the modellers. We will come back to these issues below.

3.3 Government behavior

Two issues dominate the modelling of government behavior. First, government behavior has been typically seen in the CGE literature for tax policy evaluation as constrained by yearly balanced budgets (see, for example, Ballard-Fullerton-Shoven-Whalley (1985)). The analysis of government deficits and public debt in a CGE context requires a dynamic setting. Second, the level of government expenditures is either exogenously given as in Auerbach-Kotlikoff (1984, 1987), Bovenberg (1984, 1985), Feltenstein (1984, 1986), and Jorgenson-Yun (1984), or endogenously (but not optimally) determined by the balanced budget conditions as in Ballard-Fullerton-Shoven-Whalley (1985), Andersson (1987), Erlich-Ginsburgh-Heyden (1987), Goulder (1985), and Goulder-Summers (1987). In the second case, the composition of public expenditures is often optimally determined. However, the level of government expenditures can only be endogenously and optimally determined if the government is seen as an optimizing agent and is allowed to run deficits.

The first attempts to deal with the government deficits in CGE tax models are due to Auerbach-Kotlikoff (1984), and Feltenstein (1984). In Auerbach-Kotlikoff (1984), government expenditures are exogenous. They grow at the rate of growth of population. However, given the tax structure and tax revenues, yearly deficits and surpluses are allowed, subject to an intertemporal constraint that the present value of future tax revenues equals the present value of future expenditures.

In Feltenstein (1984, 1986), government expenditures are also exogenously given. He also allows the government to run deficits to finance expenditures in excess to tax revenues. However, surpluses are returned to consumers in the form of transfers. Accordingly, government is not subject to any constraint regarding the future repayment of public debt.

In Goulder (1985), the government maximizes a static social welfare function subject to a balanced budget constraint. This follows the optimal allocation of government expenditures along the lines of Ballard-Fullerton-Shoven-Whalley (1985). The model is generalized to allow for exogenous changes in the time path of government expenditures. Two financing alternatives are considered and contrasted: additional tax revenues and bond issuance.

Pereira (1986b, 1987d), attempts to address both the incorporation of deficits and the determination of government expenditures. The path of government expenditures and the path of deficits/surpluses (and therefore the path for debt) are endogenously and optimally determined. The government is seen as maximizing an intertemporal social welfare function given the tax structure. Optimization is subject to a sequence of recursive equations of motion reflecting the evolution of the public debt, allowing for government budget imbalances. It should be stressed that this specification of the government constraint is equivalent to the specification in Auerbach-Kotlikoff (1983, 1987) when no liquidity constraints affect government behavior.

The extra richness in the treatment of government behavior allows the examination of government debt policies in a truly dynamic setting. Also, financial crowding out effects induced by government deficits can be analyzed (see Auerbach-Kotlikoff (1987), Feltenstein (1986), and Pereira (1986b, 1987d)).

3.4 Foreign sector

Most of the open economy models follow the assumptions of balanced trade with import and export net demands characterized by constant elasticities along the lines of Ballard-Fullerton-Shoven-Whalley (1985). Such is the case of Ballard (1983), Ballard-Goulder (1985), and Goulder-Summers (1987). In Feltenstein (1985), the rest of the world is treated as

an additional consumer group.

Bovenberg (1986), develops a model in which two economies are considered, each following intertemporal perfect foresight paths. These economies meet in the international forum. Their trade relationships are characterized by yearly balanced trade accounts.

None of the new generation of dynamic CGE tax models has yet incorporated the international capital flows as done in Goulder-Shoven-Whalley (1983) for the earlier Ballard-Fullerton-Shoven-Whalley (1985) model. This is unfortunate as there is an important intertemporal aspect to international lending. The first attempts along these lines are due to Andersson (1987), and Erlich-Ginsburgh-Heyden (1987). Andersson (1987), in his model of the Swedish economy, adopts a closed economy approach in which rates of return in the domestic economy are largely determined by the international capital markets. Fixed interest rates induce international capital flows, which determine and finance the international trade imbalances. In turn, in Erlich-Ginsburgh-Heyden (1987), foreign trade is generated according to an intertemporal trade welfare function with constant import and export elasticities. In the short-run they allow international trade imbalances which generate capital flows to the domestic households. In the long run, however, trade balance is assumed.

3.5 The need for financial markets

A dynamic economic structure not only provides the ideal environment to model many features of economic behavior, it also permits one to incorporate the financial side of the economy. If the government is allowed to run deficits, the question of deficit financing automatically follows. If investment is optimally determined and returns to capital are different across sectors, problems of investment financing arise. If there are several financial assets in the economy - government

bonds, private bonds, and equity (or simply physical capital installed in different sectors), the problem of allocation of saving among assets with potentially different returns arises.

The papers surveyed vary greatly with respect to the extent of their attention to the financial side of the economy. At one extreme are the models in Ballard-Fullerton-Shoven-Whalley (1985), Andersson (1987), Ballard (1983), Ballard-Goulder (1985), Bovenberg (1985, 1986), and Erlich-Ginsburgh-Heyden (1987), which are devoted exclusively to the real side of the economy. In turn, Auerbach-Kotlikoff (1984, 1987), Feltenstein (1984, 1986), and Goulder (1985), allow for government debt. In these models saving finances changes in government debt and physical capital. Private and public assets are perceived by the households as perfect substitutes. The allocation of saving merely adjusts to the relative demands for funds.

Feltenstein (1984, 1986) is the only model surveyed which introduces money. Government deficits are financed by issuing money and bonds according to an exogenously given rule. Money is demanded by consumers for transaction motives and an exogenously given fraction as a store of value. On the other hand, government bonds and physical capital are the vehicles for the intertemporal transfer of wealth.

Summers (1985), and Goulder-Summers (1987) introduce a whole menu of financial assets - firm specific equity capital. Different assets earn different rates of return. However, such rates are equal up to constant and exogenous sector specific risk premia. Therefore, the introduction of constant exogenous risk premia, as helpful as it may be in the context of calibration, does not solve the main issue of the non-optimality of the allocation of saving. Also, talking about risk premia in a deterministic context is somewhat unsatisfactory.

Pereira (1986b, 1987d), also introduces a whole menu of assets, private and public bonds and firm specific equity. However, all the assets are expected to yield the same rate of return, and therefore perceived as perfect substitutes. The different asset types allow consideration of

exogenous debt/equity and dividend/retention rules and therefore several sources of investment financing: bonds, equity and retained earnings.

The non-optimality of the allocation of saving, and the absence or exogeneity of corporate financial rules is a reflection of the limitations of the deterministic approach. Either in a context of perfect anticipation of the future prices, or, in general, within the realm of point price expectations, all the papers follow a deterministic approach. Under such circumstances, consumers either expect different rates of return (inclusive of risk premium) across assets, in which case they will buy only one asset (that with highest rate), or they expect equal rates of return, in which case they are indifferent about the asset composition of their portfolio. There is no way of trading-off rates of return and risks to obtain an optimal interior solution to the problem of the allocation of saving.

The most advanced contribution in the modelling of saving allocation in a CGE setting is due to Stiemrod (1980, 1983), in the context of a static one-period model. In his model, consumers act according to a two stage separable decision process. They first decide on how much to save. Then they decide on the allocation of saving according to an indirect utility function dependent on the rates of return and variances offered by the different assets in the economy. The source of riskiness in the economy comes from an uncertain marginal product of capital. On the other hand, aside from portfolio decisions, the rest of the economy is insulated from uncertainty.

The most complete contribution in terms of the treatment of the corporate financial rules is Fullerton-Gordon (1983). In a variant of the Ballard-Fullerton-Shoven-Whalley (1985) model, Fullerton and Gordon have capital intensity and optimal financial decisions jointly determined through a two stage process. The cost of financing capital is minimized by trading off the tax advantages of debt against the expected real bankruptcy costs inherent with high debt/equity ratios. Given the optimal debt/equity ratio, the level of investment is chosen such that at the margin the

return on equity equals the return on bonds plus an exogenous risk premium.

3.6 Market assumptions, equilibrium and expectations

Virtually all of the papers are characterized by Walrasian market clearing assumptions. All markets are perfectly competitive. Atomistic competition among agents is assumed even though only a finite number of agents is considered. Virtually, no market disequilibria or price stickiness are considered. The only exception is Erlich-Ginsburgh-Heyden (1987). In their model of the Belgium economy, the wage rate is fixed in the short-run. Therefore, in the short-run disequilibrium in the labor market will generate endogenous unemployment. However, in the long-run all prices including the wage rate are flexible, and, accordingly, all markets clear.

Given the dynamic nature of behavior in the economy, market-clearing prices in each period depend on expectations of future prices and on tax variables in the economy. There are essentially two ways of interpreting the economic equilibrium in such a dynamic context. If future prices are perfectly anticipated (i.e. expectations are self-fulfilling), a perfect foresight equilibrium prevails. Then, future actions are merely the implementation of current decisions for future periods. However, if price expectations are not perfect (i.e. agents make mistakes with respect to future prices), then a temporary or short-run equilibrium prevails. Markets clear, and clearing prices depend on future price expectations. Current plans about the future are typically not precisely implemented. They will be revised as more or better information becomes available to the economic agents. See Grandmont (1982), for a comprehensive survey of the temporary equilibrium literature.

With the exception of Goulder (1985), and Pereira (1986b, 1987d), all the models surveyed adopt the concept of a perfect foresight equilibrium. In turn, Ballard-Goulder (1985), considers a

flexible amount of foresight in terms of the number of years over which price movements are foreseen. Pereira's model (1986b, 1987b) is flexible in a somewhat different way in that it can include any range of foresight from myopia to perfect foresight.

The choice between the perfect foresight and temporary equilibrium is ultimately to be made on philosophic grounds. It can be argued that less than perfect expectations imply that agents are irrational in some way (see Auerbach-Kotlikoff (1987 p. 10)). However, the reverse argument can be made. One can question whether agents are really rational and perfectly knowledgeable about future prices.

Recent evidence of Ballard (1987), Ballard-Goulder (1985), Goulder (1985), and Pereira (1986b, 1987d), suggests that the choice in modelling expectations is an important one. They show that the degree of foresight into the future (ranging from perfect foresight to myopic expectations) may have dramatic impacts on the policy conclusions of the model. Accordingly, the best research strategy may be to design models which are flexible enough to allow for different rules regarding the formation of expectations. With the exception of the articles just mentioned, sensitivity analysis have previously not been performed along this dimension.

In terms of implementation, the two concepts of equilibrium - perfect foresight and temporary equilibrium - have different implications. The dimensionality of the equilibrium solution algorithm is involved. Suppose we have a model with ten markets to be run for a period of 50 years. Aside from normalization, a perfect foresight model implies computing prices in 500 dimensions, while a temporary equilibrium model requires solving 50 equilibria, each in ten dimensions. Given that computational speed often varies with the cube of the number of dimensions, the temporary equilibrium formulation is potentially strikingly more feasible. However, Ballard (1987), and Goulder-Ballard (1985) have developed techniques to greatly speed the computation of a perfect foresight equilibrium.

4. Implementation and issues on policy evaluation

4.1 Calibration and equilibrium comparisons

CGE models are typically parameterized by the use of a calibration procedure. Some parameters are exogenously given. However, some crucial parameters are determined in such a way that the model replicates the data for a given base year. See Mansur-Whalley (1984) for an extensive discussion of this issue.

Calibration in a dynamic context is generally interpreted as requiring two properties. First, replication of base year data is required. Second, the model is parameterized to simulate an intertemporal balanced growth path when the base policy is maintained. This is the approach followed by Ballard (1983), Ballard-Goulder (1985), Goulder (1985), and Summers-Goulder (1986). It follows the practice of Ballard-Fullerton-Shoven-Whalley (1985) with their sequential equilibrium dynamics.

Other authors Auerbach-Kotlikoff (1983, 1984, 1987), Bovenberg (1984, 1985, 1986), and Pereira (1986b, 1987d), follow what we call a qualitative calibration. The structural parameters are exogenously chosen so that the economy follows a reasonable path into the future. That has to do with the fact that given the recursive nature of the dynamic economy, and aside from such structural parameters, only initial stock values are needed to run these models. Given initial conditions on the stocks of say, private wealth, capital, and government debt, agents will optimize and thereby generate a first round of net demands and equilibrium conditions. In turn, the equilibrium prices will determine the evolution of the stock variables into the next period.

There are several potential problems with calibration in the context of dynamic models. The assumption of a steady-state growth path in the base case can be questioned. First, while

steady-state is a possibility, it certainly is not the only meaningful solution to dynamic models. Even in the case of a perfect foresight equilibrium, the model implies an equilibrium path which may or may not involve balanced growth. The model, not the modeller, should dictate the nature of the base case path. Second, in the context of a temporary equilibrium path, a steady state solution is not a likely model outcome. In fact, unless expectations are static, short run behavior consistent with a steady-state evolution will, in general, not be generated. On the other hand, if static expectations are self-fulfilling, we have in fact a perfect foresight model. Third, even the base year replication requirement may cause problems in the context of temporary equilibrium. Any calibration parameter would be conditional on expectation rules, which is probably an undesirable feature.

The nature of the two-requirement calibration strategy is very much in the spirit of the traditional design of the comparison of alternative equilibria: comparison between a steady-state base case on one hand, and alternative paths including a transition period and a final steady-state on the other hand. Pereira (1986b, 1987d) compares different (not necessarily steady-state) equilibrium paths. The arguments against such a procedure are based on the idea that the impact of policy changes can be observed most easily, since all departures from the steady-state can be attributed to the alternative policy. On the other hand, the base case so defined as a steady-state is consistent with previous work in a 'less dynamic' setting and therefore allows a common standard for comparing model results.

4.2 Computation algorithms

We are still at a stage in which basically each author uses a different computational technique. The development of dynamic models - in particular with adjustment costs and/or perfect foresight -

has corresponded with the decline in the use of fixed point algorithms. In fact, given the relative large dimensions inevitably involved, such algorithms tend to be very inefficient at the best and often prohibitively slow. See Stone (1985) and Preckel (1985) for a comparative assessment of different computation techniques. Among the models surveyed, only Ballard-Fullerton-Shoven-Whalley (1985), and Feltenstein (1985) use Merrill's variant of the fixed point algorithm technique.

Auerbach-Kotlikoff (1983, 1984, 1987), follow a three stage procedure. They first compute a base case steady-state, then a revised case steady state, and finally a transition path for the economy between these two steady-states. In all stages, a Gauss-Seidel iterative procedure is used.

Ballard (1982), Ballard-Goulder (1985), Goulder (1985), and Summers-Goulder (1986), use a method developed by Ballard and Goulder which is similar in many aspects to the Fair-Taylor (1983) algorithm. Short-run equilibria are calculated (using Merrill's algorithm) parametric on price expectations. The model is then iterated to generate self-fulfilling intertemporal expectations and the corresponding perfect foresight equilibrium. In a relatively similar approach, Andersson (1987) uses a simulation program, SIMNON, developed in the University of Lund. This program can handle two-point boundary problems in a fashion consistent with the multiple shooting algorithm (see Lipton-Poterba-Sachs-Summers (1982)).

Bovenberg's computational approach (1985, 1986) differs from the other models surveyed in that he relies heavily on analytical techniques. Computations are done by using a dynamic version of Johanson's linearization method. Being essentially determined by the continuous time nature of the model, this linearization model has the disadvantage of confining the analysis to infinitesimal changes around the base case equilibrium (see Bovenberg (1985) p. 53).

Pereira (1986b, 1987d) uses an optimization algorithm - NPSOL - developed by Gill-Murray-Saunders-Wright (1986). This algorithm is used to compute the sequence of

short-run temporary equilibrium which makes up the intertemporal equilibrium path. The equilibrium conditions are seen as nonlinear equality constraints in the minimization of an artificial objective function. The prices are normalized to the unit simplex by an additional linear equality constraint.

Erlich-Ginsburgh-Heyden (1987) follow a unique approach in that they use a variant of the optimization technique introduced by Negishi (1960). The economic equilibrium can be generated as a solution of a mathematical program the objective function of which is a weighted sum of the utility functions of the various agents, while the constraints set consists of the market clearing conditions. Ginsburgh-Heyden (1985) have extended Negishi's result to the case of downward price rigidities.

Finally, the paper by Jorgenson-Yun (1984) is also unique in that it is the only econometrically estimated model. Different blocks for the consumption and production side of the model are separately estimated, to provide the necessary structural parameters.

The diversity of computation techniques is yet another indicator of the exploratory nature of the body of literature surveyed in this article.

4.3 Equal yield comparisons

The link between a base case and counterfactual simulations is usually provided by the concept of equal yield. Shoven-Whalley (1977) discuss the meaning of equal yield in a general equilibrium context when government is not allowed to run deficits. Equal yield is interpreted to mean constant 'public utility'. Government base case utility is maintained in the counterfactual experiments. With balanced budgets, the concept of equal yield is unambiguous. The new equilibrium prices and the balanced budget condition will determine the minimal expenditure and taxes needed to maintain base

case public utility. Accordingly, in general, equal yield is inconsistent with equal nominal tax revenue. Some change in tax revenue is necessary. Different tax replacement schemes are considered to assure that enough tax revenue is collected. This is the approach essentially followed by most of the papers surveyed. Only Feltenstein (1985), Goulder (1985), and Jorgenson-Yun (1984), chose not to follow an equal yield strategy.

The question is of how to interpret the concept of equal yield when the government is allowed to run deficits. The optimal level of expenditure for base case public utility can now be tax-financed, bond financed or financed by a mix of bonds and taxation. We have several versions of equal yield. In particular, equal yield may now be consistent with equal tax revenue. Furthermore, some measure of financial crowding out effects of government deficits can be inferred from the comparison of the several equal yield alternatives. These issues are extensively discussed in Pereira (1987b).

4.4 Price expectations and the dynamic generalization of compensation indicators

The sum of equivalent and compensation variations over households is the most widely used aggregated measure of efficiency gains or losses. In the context of steady-state comparisons and/or when complete future markets exist and/or perfect foresight is assumed there are no difficulties associated with the use of the standard Hicksian indicators. In fact, correct future prices are known in these cases.

If expectations are not self-fulfilling and/or future markets are not available, a dynamic generalization is necessary. Ballard-Goulder (1985) provide some steps in that direction by defining an indicator that accommodates periods far into the future when households do not have perfect foresight but a steady-state prevails. On the other hand, this issue is more fundamental in

the context of a general temporary equilibrium framework. In such circumstances, Pereira (1986a) develops a dynamic generalization which is obtained as the present discounted value of a sequence of short-run optimal expenditure functions consistent with a base case expected future stream of utilities.

5. Empirical evidence from selected policy issues

Dynamic tax models have generated several important results which escaped static modellers.

The following is a selected set of issues which stress the marginal benefits of dynamic modelling of economic behavior in innovative areas of analysis. The discussion of a consumption tax emphasizes the benefits of dynamic household behavior and intergenerational aspects. The study of the elimination or the re-introduction of the investment tax credits is made meaningful by the dynamic modelling of production behavior. Modelling government in a dynamic contexts allows the modeller to study the impact of government deficits. Finally, a dynamic framework lets us appreciate the relevance of consumer expectations in terms of the evaluation of policy alternatives

5.1 Consumption Tax

By its very nature a consumption tax can not be adequately investigated with a static model. Fullerton-Shoven-Whalley (1983) use the model of the U.S. economy as described in Ballard-Fullerton-Shoven-Whalley (1985) to evaluate the movement from the current U.S. tax system to a progressive consumption tax. Since their model incorporates a labor/leisure choice, where leisure is an untaxed commodity, their results reflect the fact that both the consumption tax and the present system are distortionary.

Concentrating on the intertemporal distortions, they show that sheltering more saving from the current U.S. income tax could improve economic efficiency even if marginal tax rate increases are necessary in order to maintain government revenue. At first you have a revenue shortfall. However, the economy moves to a higher sustained growth path, and ultimately lower tax rates can generate the same revenue path. Also, wages increase in the long run with this policy. The

present value of welfare gains for a policy of complete saving deduction with marginal rate adjustments (consumption tax) is simulated to be around \$500 billion to \$600 billion of 1973 dollars.

They also investigate the length of time it takes the economy to adjust to these policy changes. Roughly, they estimate the 'long run' to be thirty years, although this figure is very sensitive to the specification of the savings elasticity - a crucial parameter in this model.

5.2 Investment Tax Credit

Goulder-Summers (1987) address the impact of eliminating the Investment Tax Credit (ITC) on intersectoral capital formation, and on economic growth. Their model is particularly adequate to address this issue in that it postulates a forward looking investment motive with adjustment costs. They show that the eliminating the ITC causes a reduction in the rate of investment. Investment is estimated to fall by about 7% in the short-run and by about 12% in the new long run steady state. In turn, a previous policy announcement lowers the overall attractiveness of investment and leads to a downward shift of the investment profile. On the other hand, the combined effect of a 'revenue neutral' simultaneous elimination of the ITC and reduction of the corporate tax rates is a long run reduction of the capital stock by 3.5%. This pattern suggests that a revenue neutral increment in both the corporate tax rates and the investment tax credits would be preferable to the formula adopted in the U.S. Tax Reform Act of 1986.

Pereira (1987d), addresses the impact of the ITC from the stand point of the current tax system under the Tax Reform Act of 1986. Given the concern over the potential depressive effects upon savings and investment of the new tax system in conjunction with deficit reduction mechanisms of the Gramm-Rudman type, a pertinent question is, should the ITC be re-introduced? In the context

of his model of the U.S. economy, Pereira focuses on the trade-off between the distortion in the intersectoral allocation of capital induced by the ITC, the lower tax revenues it generates, and potential financial crowding-out effects on one hand, and the positive effects of lowering the relative price of new capital goods on the other hand. Preliminary results confirm the qualitative results in Goulder-Summers (1987), suggesting a welfare gain of about .2% of the present value of GNP in the best scenario of absence of replacement taxes. Furthermore, preliminary results show an important time pattern to welfare gains, with the average benefits increasing the further you look into the future. This pattern is due to the presence of constraints to intersectoral mobility of capital and inertia in the adjustment towards the optimal capital levels as reflected by the presence of adjustment costs.

5.3 Financial crowding out effects of government deficits

Auerbach-Kotlikoff (1987), in the context of their intergenerational model of the U.S. economy, consider the impact on savings, capital formation, and interest rates, of deficit policies and balanced budget increases in government consumption. They conclude that deficit finance and government consumption can significantly crowd out capital formation and lower the welfare of future generations. However, crowding out from deficit finance is a very slow process because it results from increased government spending over potentially long horizons. Also, deficit policies may substantially influence the long-run interest rates, while leaving the short-run rates essentially unaffected. Finally, and in opposition to the central role adjustment costs seem to play in both Goulder-Summers' and Pereira's models, Auerbach-Kotlikoff suggest that the time path of interest rates induced by a policy of deficit financing seems to be insensitive to the presence of adjustment costs.

5.4 The role of consumer expectations

The expectations analysis has uncovered one of the benefits of dynamic modelling. Ballard-Goulder (1985) find that the appeal of adopting a consumption tax depends on the level of foresight possessed by the consumers. Furthermore, additional foresight may be welfare worsening. This is a second best type of result. This tends to occur under policies that lead to capital deepening and declining rate of return to capital over time. To the extent that consumers have more foresight, they will be better equipped to anticipate the fall in the rental price of capital. Consequently, if a saving incentive is enacted, people save more with myopia than with perfect foresight. Given the existence of taxes on capital and the discrepancy between the private and social returns to capital, the greater savings with myopia is better socially. Ballard-Goulder find that the welfare gains from a consumption tax are reduced by about 10% when we move from myopia to perfect foresight. Therefore, the attractiveness of adopting a consumption tax seems fairly robust across these foresight specifications.

6. The power and weaknesses of dynamic modelling: the example of corporate tax integration

The issue of corporate tax integration allows us to show the strengths and weaknesses of the dynamic approach. Empirical evidence using CGE techniques indicates that, depending on the precise scheme of integration and the tax replacement methods, integration may have substantial effects. In the work of Fullerton-King-Shoven-Whalley (1980, 1981), total integration was found to yield an annual static efficiency gain of \$4 to \$8 billion in 1973 dollars. Simulated dynamic gains may be as large as \$695 billion or about 1.4% of the present value of future consumption and leisure in the U.S. economy. These gains result primarily from interindustry reallocations of investment and an improved intertemporal allocation of consumption.

More recent work emphasizes how consumers' asset portfolio decisions and firms' financial decisions affect the efficiency gains from integration. Slamrod (1980), focusing on consumers' asset portfolio decisions, finds static efficiency gains which are about twice as large as those reported by Fullerton-King-Shoven-Whalley (1981). Fullerton-Gordon (1983), focus on the firms' financial decisions. They report efficiency gains of .5% of GNP from the elimination of the tax distortions favoring debt. However, when they eliminate the corporate tax and replace it with increased personal income taxes, additional distortions are created in the optimal labor-leisure decisions. These distortions tend to dominate the analysis, such that the overall effects of complete integration are very modest. Galper-Lucke-Toder (1986), address simultaneously consumers' asset portfolio decisions and the firms' financial decisions. They also find very modest efficiency gains from integration.

The above results are important, but may be severely biased. There are several aspects of economic behavior and modelling crucial for the study of income tax integration which have not been

captured in any of the above papers. One aspect is the absence of government deficits - a balanced budget is assumed. It is true that resource crowding out is captured in these models but financial crowding out induced by government spending is not. Second, investment is not derived from optimization behavior. Investment behavior passively accommodates endogenous saving decisions. As a consequence, the differential impacts of policies in the incentives to save and to invest are not captured. Also, full capital mobility across sectors is assumed with instantaneous capital adjustments towards optimal levels. This assumption rules out different costs of capital across sectors and therefore differentiated reactions to tax policies changes. Finally, the modelling of both government deficits and of endogenous real and financial investment decisions necessitates the consideration of a dynamic framework and the introduction of financial assets, government bonds and private financial assets. A dynamic framework also highlights the efficiency effects of integration on the optimal intertemporal decisions. The above models are either static (Siemrod's and Galper-Lucke-Toder's) or a dynamic sequence of otherwise static models.

Pereira (1986b), develops a dynamic applied general equilibrium model - to study the efficiency effects of integration on the growth and allocation of investment across sectors. Special attention is paid to the structural effects of resource and financial crowding out induced by government spending and deficits and to the real and financial investment reactions across industries to both tax integration and financial crowding out. His model departs from previous work on income tax integration, and for that matter from most of the CGE literature for tax policy evaluation, in several directions. It encompasses an endogenous sequential equilibrium structure founded on dynamic behavior with flexible expectations. Government deficits are optimally determined. Investment decisions are forward looking and the result of optimizing behavior. Several financial assets - public and private - are considered.

Simulation results indicate that the welfare gains from integration under large deficits are, at

best, modest when measured in terms of the GNP. The elimination of the corporate tax and its replacement by increased income tax rates, yields long run benefits which are never larger than .2% of the present value of future consumption and leisure under the previous tax regime, and .1% under the current tax regime. However, the short run welfare effects of full integration tend to be very low and in some scenarios even negative. This is a new intertemporal pattern of efficiency effects which reflects an adjustment lag in the interindustry investment decisions due to the existence of costs of adjustment. On the other hand, partial integration achieved by excluding dividends from the corporate tax base systematically yields negative efficiency effects. In the long run these can be as high as .3% of present value of the future value of consumption and leisure. This is a new second best effect suggesting that less than complete integration may have perverse efficiency effects.

The dynamic structure of Pereira's model allowing for an improved treatment of real investment decisions and government deficits, provides a potential setting for a more accurate measure of the costs and benefits of integration. The simulation results suggest lower benefits and an intertemporal pattern of growing benefits.

Simulation results also clearly suggest robust negative effects from partial integration. How reliable is this result? If dividends were deductible from the corporate tax base (as are interest payments), the preferential treatment of debt over equity would be eliminated. Corporations should be expected to react by decreasing the optimal debt/equity ratio. However, corporate financial decisions are exogenously set in Pereira's model as in all of the other models surveyed that go as far as dealing with the issue.

Also, withdrawing dividends from the corporate tax base is a way of eliminating the double taxation of dividends at both the corporate and personal income levels. How will the optimal allocation of household saving accommodate that change in the relative return to corporate equity?

However, household portfolio decisions are exogenously set in Pereira's model as in all of the other models surveyed go as far as dealing with the issue.

It is safe to say that the evaluation of the benefits of partial integration, as defined above, are severely underestimated. Meanwhile, the distortions generated by the increase in the marginal personal tax rates designed to raise the revenue foregone by the dividend exclusion, are fully accounted for. A good measure of the costs of integration together with a poor evaluation of the benefits may very well be the reason why partial integration is simulated to yield negative efficiency gains.

On a different vein, as most of the model surveyed here, Pereira's is a closed economy model. It is legitimate to wonder how the results would change if international capital flows were allowed. This almost certainly would affect financial crowding out, since a good deal of the capital inflows could be used to finance public debt.

For these various reasons, the results should be treated as preliminary, but they strongly suggest that the dynamic structure provides valuable new insights into the corporate tax integration issue.

7. Concluding remarks

What has been accomplished this far? The success of the CGE research in tackling the challenge of dynamic modelling can not be denied.

Great progress in the modelling of household behavior has been achieved. Promising developments in the modelling of production and government behavior have also been accomplished. Interesting innovations in the concept of equilibrium and computation techniques were discussed.

The policy analysis was greatly enriched by considering transitional effects together with longer run steady-state equilibrium paths, generalized equal yield strategies accomodating different financial crowding out impacts, and generalized dynamic policy evaluation indicators.

An important set of issues have been addressed by the models surveyed. Traditional issues focusing on the effects of capital taxation and consumption taxes have been pursued. In terms of capital taxation, for example, the intertemporal nature of the issue was enhanced by allowing an optimal evolution of capital stock in the economy and forward looking optimal investment decisions. In Andersson (1987), Goulder-Summers (1987), and Pereira (1986b, 1987d) this is coupled with a improved treatment of several tax provisions like investment tax credits and depreciation allowances. In terms of the consumption taxes, developments in the specification of intertemporal household behavior, the introduction of overlapping generations and the modelling of intergenerational links via bequest motives, as well as a closer attention to demographic evolution, provided a much improved economic setting for the understanding of the several aspects of the problem.

Furthermore, dynamic modelling has permitted the addressing of a set of new issues. Policy issues ranging from dynamic tax policy analysis to the evaluation of exogenous changes in government expenditures, to the impact of different methods of financing government expenditure, to

the importance of financial crowding out, to the relevance of consumers expectations in the policy results, have been addressed.

Despite all of the progress and, in part due to such progress, several avenues are wide open for much needed additional research. The following seem to be the most interesting and promising areas. First, the specification of liquidity constraints to household behavior may help to obtain a better understanding of policy changes that affect directly the interest rates in the economy. Second, major attention needs to be paid to the incorporation of a foreign sector (with open capital markets). Third, some efforts are needed in terms of finding adequate computation techniques, now that dynamic modelling really makes the curse of dimensionality worse than ever.

The modelling of financial markets is the single most unsatisfactory aspect of the dynamic models surveyed here. The problems associated with providing a more adequate treatment of financial markets and, in general, endogenous and optimal financial decisions - both at the corporate and at the personal levels - have to be addressed. That necessarily requires introducing uncertainty into the models. To be adequate, this must go well beyond the mere assumption of point expectations, with the whole array of modelling, implementation, and evaluation problems that generates.

REFERENCES

- Abel, A. and O. Blanchard, 1983, 'An Intertemporal Model of Saving and Interest' Econometrica 51 pp. 675-92.
- Andersson, K., 1987, 'Taxation of Capital in Sweden - A General Equilibrium Model', Ph. D. Dissertation, University of Lund, Sweden.
- Auerbach, A., L. Kotlikoff, 1983, 'National Savings, Economic Welfare, and the Structure of Taxation', in M. Feldstein ed., Behavioral Simulation Methods in Tax Policy Analysis, Chicago: University of Chicago Press.
- Auerbach, A., L. Kotlikoff, 1984, 'Social Security and the Economics of Demographic Transition', in H. Aaron and G. Burtless eds., Retirement and Economic Behavior, Washington, D.C.: Brookings Institution.
- Auerbach, A., L. Kotlikoff, 1987, Dynamic Fiscal Policy, Cambridge: Cambridge University Press.
- Auerbach, A., L. Kotlikoff, and J. Skinner, 1983, 'The Efficiency Gains from Dynamic Tax Reform', International Economic Review 24, pp. 81-100.
- Ballard, C., 1983, 'Evaluation of the Consumption Tax with Dynamic General Equilibrium Models', Ph. D. Dissertation, Stanford University.
- Ballard, C., 1987, 'Tax Policy and Consumer Foresight: A General Equilibrium Simulation Study', Economic Inquiry 25, pp. 267-284.
- Ballard, C., and L. Goulder, 1985, 'Consumption Taxes, Foresight, and Welfare: a Computational General Equilibrium Analysis', in J. Piggott, and J. Whalley, eds., New Developments in Applied General Equilibrium Analysis Cambridge: Cambridge University Press.
- Ballard, C., D. Fullerton, J. Shoven, and J. Whalley, 1985, A General Equilibrium Model for

Tax Policy Evaluation, NBER, University of Chicago Press.

Borges, A. (1987) 'A Survey of Computational General Equilibrium Models' OECD Economic Studies 8.

Bovenberg, L., 1983, 'Imperfect Capital Mobility in a Perfect Foresight Harberger Model,' Mimeo, UC Berkeley.

Bovenberg, L., 1984, 'Capital Accumulation and Capital Immobility: Q-theory in a Dynamic General Equilibrium Framework', Ph.D. dissertation, University of California at Berkeley.

Bovenberg, L., 1985a, 'Dynamic General Equilibrium Tax Models with Adjustment Costs,' in A. Manne ed., 1985, Economic Equilibrium: Model Formulation and Solution. Mathematical Programming Study 23. Amsterdam: North-Holland.

Bovenberg, L., 1985, 'Capital Income Taxation in Growing Open Economies' Journal of Public Economics 31, pp. 347-376.

Bovenberg, L., and W. Keller, 1981, 'Dynamics and Nonlinearities in Applied General Equilibrium Models' Internal Report M1-81-208, Department for Statistical Methods, CBS., Voorburg, The Netherlands.

Chamley, C., 1981a, 'The Welfare Cost of Capital income Taxation in a Growing Economy,' Journal of Political Economy 89, 3, pp. 468-496.

Chamley, C., 1981b, 'Efficient Tax Reform in a Dynamic Model of General Equilibrium,' Mimeo., Yale University.

Chamley, C., 1982, 'On the Optimal Taxation in Stylized Models of Intertemporal General Equilibrium,' Mimeo., Yale University.

Decaluwé, B. and A. Martens, 1985, 'Pays en Développement et Modèles Calculables D'Equilibre Général - Une Revue de la littérature empirique', Monographie Serie B, Volume 3, Centre de Recherche et Développement Economique, Université de Montréal.

Erlach, S., V. Ginsburgh, and L. van der Heyden, 1987, 'Where do Real Wage Policies Lead Belgium? - A General Equilibrium Analysis,' European Economic Review (forthcoming).

Fair, R. and J. Taylor, 1983, 'Solution and Maximum Likelihood Estimation of Dynamic Nonlinear Rational Expectations Models' Econometrica 51, pp. 1169-1186.

Fel'denstein, A., 1984, 'Money and Bonds in a Disaggregated Economy,' in Scarf, H., J. Shoven Eds., Applied General Equilibrium Analysis, Cambridge University Press, Cambridge.

Fel'denstein, A., 1986, 'A Dynamic General Equilibrium Analysis of Financial Crowding Out: Theory with an Application to Australia,' Journal of Public Economics 31, No. 1.

Fullerton, D., R. Gordon, 1983, 'A Reexamination of Tax Distortions in General Equilibrium Models,' in M. Feldstein Ed. Behavioral Simulation Methods in Tax Policy Analysis. Chicago: University of Chicago Press.

Fullerton, D., J. Shoven, and J. Whalley, 1983, 'Replacing the U.S. Income Tax with a Progressive Consumption Tax,' Journal of Public Economics 20, pp.3-23.

Fullerton, D., Y. Henderson, J. Shoven., 1984, 'A Comparison of Methodologies in Empirical General Equilibrium Models of Taxation' in Scarf, H., J. Shoven Eds., Applied General Equilibrium Analysis, Cambridge University Press, Cambridge.

Fullerton, D., A. King, J. Shoven, and J. Whalley, 1981, 'Corporate Tax Integration in the United States: a General Equilibrium Approach,' American Economic Review 71, pp. 677-691.

Galper, H., R. Lucke, E. Toder, 1986, 'Taxation, Portfolio Choice, and the Allocation of Capital: A General Equilibrium Approach,' Mimeo.

Gill, P., W. Murray, M. Saunders, M. Wright, 1986, 'User's Guide for NPSOL (Version 4.0): A Fortran Package for Nonlinear Programming' Technical Report SOL 86-2, Department of Operations Research, Stanford University.

Ginsburgh, V., and L. van der Heyden, 1985, 'General Equilibrium with Wage Rigidities: An

Application to Belgium,' in A. Manne, ed., Economic Equilibrium: Model Formulation and Solution.
Mathematical Programming Study 23. Amsterdam: North-Holland.

Gould, J., 1968, 'Adjustment Costs in the Theory of the Firm,' Review of Economic Studies 35,
pp.47-55.

Goulder, L., 1985, 'Tax-Financed versus Bond-Financed Changes in Government Spending,'
Mimeo., Harvard University.

Goulder, L., J. Shoven, and J. Whalley, 1983, 'Domestic Tax Policy and the Foreign Sector: The
importance of alternative foreign policy formulations to results from a general equilibrium tax
analysis model'. In Behavioral Simulation methods in the taxation of income from capital, ed Martin
Feldstein. Chicago: University of Chicago Press

Goulder, L., L. Summers, 1987, 'Tax Policy, Asset Prices, and Growth: A General Equilibrium
Analysis,' NBER Working Paper No. 2128.

Grandmont, J., 1982, 'Temporary General Equilibrium Theory,' Ch 20 in Handbook of
Mathematical Economics, Vol II, North-Holland.

Harberger, A. 1959, 'The Corporate Income Tax: An empirical Appraisal. In Tax Revision
Compendium, Vol I House Committee on Ways and Means. Washington D.C.: Government Printing
Office.

Harberger, A., 1962, 'The Incidence of the Corporate Income Tax,' Journal of Political
Economy 70, pp. 215-240.

Harberger, A., 1964, 'Taxation Resource Allocation and Welfare,' In The Role of Direct and
Indirect Taxes in the Federal Reserve System. Princeton: Princeton University Press.

James, J., 1985, 'New Developments in the Applications of General Equilibrium models to
Economic History' in Piggott and Whalley Eds.

Jorgenson, D., and K. Yun, 1984, 'Tax Policy and Capital Allocation' Harvard Institute of

Economic Research, WP 1107.

Judd, K., 1985, 'Short-Run Analysis of Fiscal Policy in a Simple Perfect Foresight Model', Journal of Political Economy pp. 298-319.

Lipton, D., J. Poterba, J. Sachs, and L. Summers, 1982, 'Multiple Shooting in Rational Expectations Models,' Econometrica 50, 1329-1333.

Manne, A., ed., 1985, Economic Equilibrium: Model Formulation and Solution. Mathematical Programming Study 23. Amsterdam: North-Holland.

Manne, A., 1985, 'On the Formulation and Solution of Economic Equilibrium Models' in A. Manne, ed., Economic Equilibrium: Model Formulation and Solution. Mathematical Programming Study 23. Amsterdam: North-Holland.

Mansur, A., and J. Whalley, 1984, 'Numerical Specification of Applied General Equilibrium Models,' in Scarf, H., J. Shoven Eds., Applied General Equilibrium Analysis, Cambridge University Press, Cambridge.

Merrill, O., 1972, 'Applications and Extensions of an Algorithm that Computes Fixed-Points of Certain Upper Semi-continuous Point to Set Mappings,' Ph.D. Dissertation, University of Michigan.

Negishi, T., 1960, 'Welfare Economics and Existence of an Equilibrium for a Competitive Economy,' Metroeconomica 12, 92-97.

Pereira, A., 1985, 'On the Existence and Uniqueness of Optimal Output Path for CRTS Firms in Adjustment Costs Technologies,' Mimeo., Stanford University.

Pereira, A., 1986a, 'Consumer Expectations and the Cost of Utility in an Intertemporal Framework,' Mimeo., Stanford University.

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Pereira, A., 1987c, 'A Dynamic Applied General Equilibrium Model for Tax Policy Evaluation: Complete Documentation,' Mimeo., University of California, San Diego (in progress).

Pereira, A., 1987d, 'Should the Investment Tax Credit be Re-introduced?,' Mimeo, University of California, San Diego (in progress).

Piggott, J., and J. Whalley, eds., 1985, 'New Developments in Applied General Equilibrium Analysis' Cambridge: Cambridge University Press.

Preckel, P., 1985, 'Alternative algorithms for computing economic equilibria', in A. Manne Ed

Radner, R., 1983, 'Equilibrium under Uncertainty' In K. Arrow, M. Intriligator eds., Handbook of Mathematical Economics, North-Holland.

Robinson, S., 1986, 'Multisectoral Models of Developing Countries: a Survey' Division of Agriculture and Resources, UC Berkeley, WP 401.

Scarf, H., 1967, 'The approximation of fixed points of a continuous mapping' SIAM Journal of Applied Mathematics 15, pp. 1328-43.

Scarf, H., with T. Hansen, 1973, On the Computation of Economic Equilibria, New Haven: Yale University Press

Scarf, H., J. Shoven Eds., 1984, Applied General Equilibrium Analysis, Cambridge University Press, Cambridge.

Shoven, J., 1976, 'The Incidence and Efficiency Effects of Taxes on Income from Capital,' Journal of Political Economy 84, pp. 1261-83.

Shoven, J., 1983, 'Applied General Equilibrium Tax Modelling,' IMF Staff Papers 30.

Shoven, J., and L. B. Simon, 1986, 'Share Repurchases and Acquisitions: An Analysis of which Firms Participate' NBER Working Paper No. 2243.

Shoven, J., and J. Whalley, 1972, 'A General Equilibrium Calculation of the Effects of Differential Taxation of Income from Capital in the U.S.,' Journal of Public Economics 1, pp.281-321.

Shoven, J., and J. Whalley, 1973, 'General Equilibrium with Taxes: a computation procedure and an existence proof' Review of Economic Studies 40, pp. 475-490.

Shoven, J., J. Whalley, 1977, 'Equal Yield Tax Alternatives: A General Equilibrium Computational Technique,' Journal of Public Economics 8, pp. 211-224.

Shoven, J., J. Whalley, 1984, 'Applied General-Equilibrium Models of Taxation and International Trade: An Introduction and Survey,' Journal of Economic Literature 23, pp. 1007-1051.

Slemrod, J., 1980, 'A General Equilibrium Model of Capital Income Taxation,' Ph. D. Dissertation, Harvard University.

Slemrod, J., 1983, 'A General Equilibrium Model of Taxation with Endogenous Financial Behavior,' in M. Feldstein ed., Behavioral Simulation Methods in Tax Policy Analysis, Chicago: University of Chicago Press.

Stone, J., 1985, 'Sequential Optimization and Complementarity Techniques for computing Economic equilibrium' in A. Manne Ed.

Summers, L., 1981, 'Taxation and Corporate Investment: a q-Theory Approach,' Brookings Papers on Economic Activity, pp. 67-127.

Summers, L., 1985, 'Taxation and the Size and Composition of the Capital Stock: An Asset Price Approach,' Mimeo., Harvard University.

Whalley, J., 1975, 'A General Equilibrium Assessment of the 1973 United Kingdom tax reform' Economica 42, pp. 139-61.

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