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The Integration of Macro- and Microeconomic Relations in Dynamic Policy Models: The Case of Saving and Investment Behavior

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Abstract

This paper examines how two types of fiscal policy models, namely, dynamic macroeconomic models and applied general equilibrium models, have integrated macro- and microeconomic relationships within a framework of intertemporal equilibrium. After emphasizing the potential advantages of integrating macro- and microeconomic relations, the study discusses the limitations of intertemporal equilibrium models--in particular the weaknesses of saving and investment theories incorporated in the models. It concludes that, despite recent important advances, policymakers need to exercise caution when they interpret results derived from these models.

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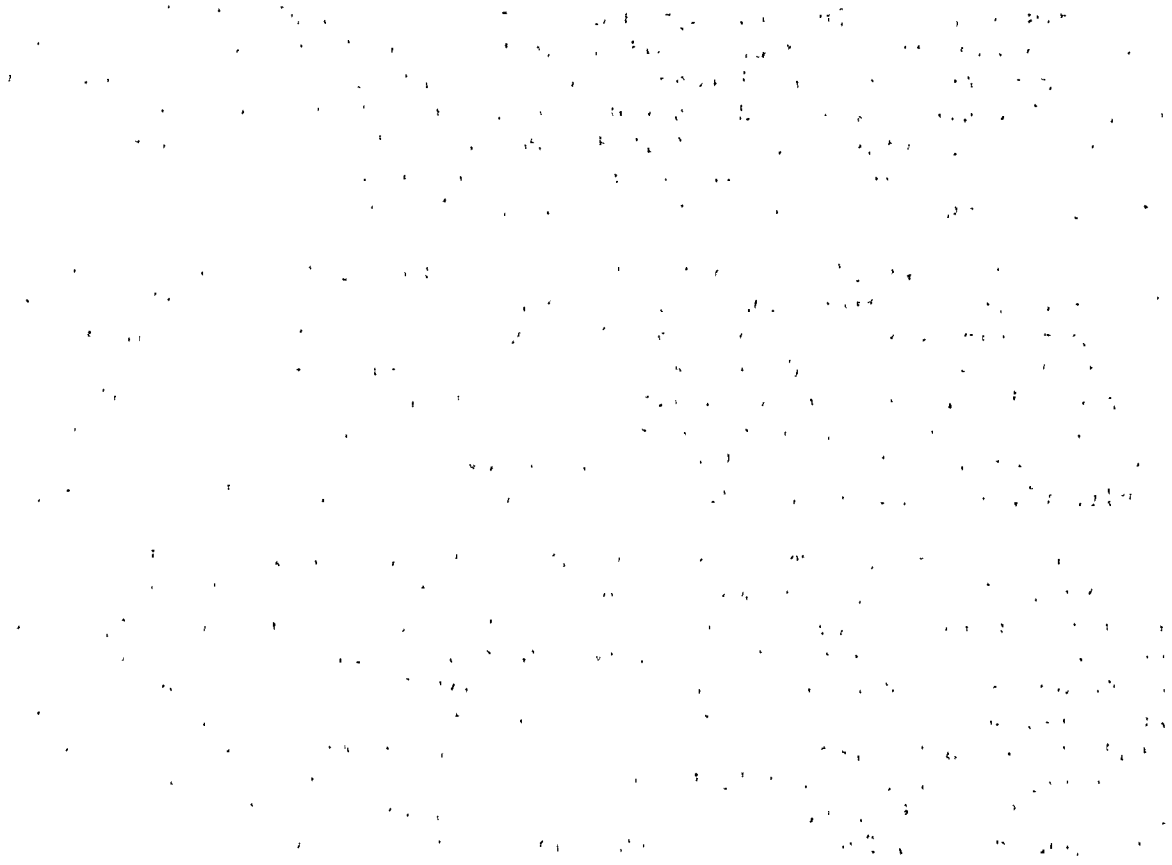
Summary

This paper examines how dynamic macroeconomic models of fiscal policy with a medium-term focus and applied general equilibrium models have integrated macroeconomic and microeconomic relationships. The paper suggests that both macroeconomic and applied general equilibrium modeling have moved toward intertemporal equilibrium models that explicitly derive saving and investment behavior from intertemporal optimization by decentralized agents that exhibit forward-looking behavior.

The study describes economic and theoretical developments that have led builders of macroeconomic models to pay more attention to the microeconomic relationships underlying their models. In contrast to macroeconomic models, applied general equilibrium models traditionally possess a more solid microeconomic foundation and account for more sectoral detail. Whereas these models once largely ignored intertemporal issues, several recent models studying fiscal policy have started to deal more explicitly with expectations, adjustment costs, saving, and investment.

The paper first emphasizes the potential advantages of moving to a framework that integrates macroeconomic and microeconomic relations. In this connection, it describes how recent advances have provided important new insights regarding fiscal policy, but also discusses the limitations of intertemporal equilibrium models. The empirical basis of the saving and investment theories incorporated in intertemporal equilibrium models tends to be rather weak. In light of these and other weaknesses, the usefulness of current models in analyzing policy remains limited. Accordingly, policymakers need to exercise caution when they interpret the results drawn from intertemporal equilibrium models.



I. Introduction

This paper examines how two types of policy models, namely, dynamic macroeconomic models and applied general equilibrium models, have integrated macro- and microeconomic relationships over the past decade. Specifically, the paper explores dynamic models of fiscal policy with a medium-term focus and concentrates on the modeling of saving, investment, and international capital flows--the main macroeconomic aggregates that have an important intertemporal dimension.

The paper is organized as follows. Section II discusses several reasons why recent macroeconomic models have paid increasing attention to microeconomic foundations. It describes several dynamic macroeconomic models that have sought to ground saving and investment behavior in dynamic optimizing behavior. Section III deals with applied general equilibrium models--a class of models traditionally based on a more solid microeconomic foundation. It shows that some models dealing with fiscal policy have started to emphasize intertemporal issues. In particular, several applied general equilibrium models have explored how dynamic optimizing behavior relates to the major macroeconomic aggregates: saving, investment, and, in open economies, international capital flows. A major theme of this paper is that a significant number of applied general equilibrium models and dynamic macroeconomic models have moved in the same direction--namely, toward intertemporal equilibrium models that explicitly derive saving and investment behavior from intertemporal optimization by decentralized agents who exhibit forward-looking behavior.

One purpose of this paper is to evaluate these developments. Sections II and III focus on the potential advantages of moving to an intertemporal equilibrium framework that integrates macro- and microeconomic relations. In this connection, it describes recent advances that have provided new insights regarding fiscal policy. Sections IV, V, and VI, in contrast, emphasize the limitations of intertemporal equilibrium models. Sections IV and V discuss the weaknesses of, respectively, the saving and investment theories incorporated in intertemporal equilibrium models--two major building blocks of these models. In light of these and other weaknesses, Section VI concludes that, despite recent important advances, policymakers need to exercise caution when interpreting results from intertemporal equilibrium models.

II. Microeconomic Relationships in Macroeconomic Models

Both economic and theoretical developments in the last two decades have led model builders to pay more attention to the microeconomic relationships underlying macroeconomic models. Following a dramatic increase in oil prices in the early 1970s, inflation and unemployment rose simultaneously. The experience of stagflation was not consistent with existing demand-oriented macroeconomic models and this focused the concern of policymakers on the supply side of the economy. In

particular, policymakers became increasingly aware of the adverse incentive effects associated with government intervention. Tax policy, for example, was increasingly analyzed in terms of its effect not only on aggregate demand but also on incentives to supply labor and capital. These developments provided a strong impetus for incorporating microeconomic relationships in macroeconomic models in order to integrate the incentive effects of government policies.

On the theoretical front, Lucas (1976) questioned the use of large Keynesian macroeconometric models to analyze changes in economic policy. In his classic criticism of econometric models, Lucas observed that these models basically extrapolate historical relationships, which are the result of past economic policies. Since these historical correlations are not necessarily invariant to changes in economic policy, policymakers should not use these past correlations, such as fixed saving ratios, to analyze the effects of changes in economic policy. This criticism led model builders to search for behavioral and technological parameters that are not affected by policy changes (i.e., "deep" parameters). As a result, model builders increasingly derived behavioral relationships from optimizing behavior instead of merely extrapolating them on the basis of historical observations.

Using intertemporal optimizing behavior at the micro level to identify macroeconomic relationships not only addresses the Lucas critique but yields other advantages as well. First, it allows the modeler to explore the welfare effects of alternative policies. Second, it provides a clearer bridge between microeconomic theory and macroeconomic policy. In particular, the behavior of macroeconomic aggregates can be interpreted in terms of optimizing microeconomic behavior and may, therefore, lead to new insights on how optimizing agents interact. Third, and related to the Lucas critique, modeling explicitly optimizing behavior may help to explore how economic agents respond to structural changes in the economic environment. To illustrate, intertemporal equilibrium models may be required to analyze the effects of particular policies on private saving because the liberalization of financial markets together with financial innovation and the growing integration of world financial markets has tended to invalidate historical correlations regarding saving behavior.

Intertemporal optimization also forces model builders to put a greater emphasis on the modeling of expectations, intertemporal budget constraints, and the credibility of public policy. 1/ The modeling of expectations regarding future policy used to focus almost entirely on expectations concerning monetary policy. However, expectations about fiscal policies moved to the fore when rising public debts and deficits heightened concerns about the sustainability and credibility of fiscal

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1/ This modeling approach also puts the issue of time inconsistent policies in focus whenever governments cannot credibly commit to future policies.

policies. Intertemporal budget constraints revealed that particular fiscal policies were likely to prove unsustainable. Therefore, if the private sector is aware of the budget constraints that bind government actions, the permanence of these policies is not credible. In such circumstances, the announcement of future spending cuts could stimulate private spending immediately, while reducing taxes without cutting expenditure would not be effective in stimulating private spending. 1/ More generally, models demonstrated that expectations about future tax increases (or spending cuts) were important determinants of the impact of fiscal policies. They allowed policymakers to investigate differences between anticipated and unanticipated, and between temporary and permanent, policies. They revealed that the effects of government policies vary substantially, depending on the extent to which the private sector anticipates them and projects their duration.

A new generation of macroeconomic models has adopted intertemporal optimizing behavior with forward-looking expectations. These models typically solve for a full intertemporal equilibrium in which agents are endowed with perfect foresight. The first macro models of this kind were largely theoretical in nature and had little empirical content. Brock and Turnovsky (1981) and Abel and Blanchard (1983) built stylized perfect foresight models of closed economies. Judd (1985) and (1987) developed a quantitative analysis of these models to determine the numerical effects of policy shocks and their sensitivity to technological and behavioral parameters.

Buiter (1986), van Wijnbergen (1986), Frenkel and Razin (1987), and Bovenberg (1989b) formulated similar models for interdependent open economies. 2/ These real models, which ignore monetary phenomena and assume continuous market clearing, emphasize the links between intertemporal and international trade as well as the intertemporal aspects of net trade flows and current account behavior; current account imbalances, which can be written as the gap between domestic saving and investment, are explicitly modeled as the outcome of rational intertemporal behavior in response to movements in prices (both intratemporal and intertemporal prices). These models suggest that intertemporal behavior is an important determinant of international trade flows and real exchange rates. 3/

1/ Nicoletti (1988) finds empirical evidence suggesting that the perceived urgency of budget adjustments strongly affects the importance of these effects. He finds that in countries with high public debt to gross domestic product (GDP) ratios, such as Italy and Belgium, economic agents take into account the intertemporal budget constraint of the public sector in formulating their consumption decisions.

2/ van Wijnbergen (1985) estimated a three-region econometric model based on an intertemporal equilibrium structure.

3/ Edwards (1987) and Gavin (1988) use these models to explore how tariffs affect the trade balance.

Numerical intertemporal equilibrium models of interdependent open economies with more empirical content were developed by Sachs (1983), Lipton and Sachs (1983), Minford et al. (1986), Sachs and Roubini (1987), and Masson et al. (1988). While adopting forward-looking expectations, several of these models incorporate a monetary sector and Keynesian features, such as slowly adjusting prices, unemployment, and liquidity constraints. 1/ These latter features are not derived from explicit optimizing behavior.

III. Saving and Investment in Applied General Equilibrium Models

Compared to traditional macroeconomic models, applied general equilibrium models have a more solid microeconomic foundation. These models explore the interaction among independent agents whose behavior is usually explicitly derived from microeconomic optimization. They generally feature more sectoral detail and deal with the welfare effects of public policies. 2/

Traditional applied general equilibrium models have paid relatively little attention to intertemporal aspects and dynamic issues of adjustment. The standard general equilibrium model pioneered by Harberger (1962) does not model time and assumes that adjustment occurs instantaneously. In particular, following a change in tax policy, a fixed economy-wide capital stock is immediately relocated across industries so that the rental rate on capital is equalized across all sectors.

More recent models have incorporated saving and investment behavior derived from intertemporal optimization in addition to modeling capital accumulation. Moreover, several of these models deal more explicitly with expectations and adjustment costs. More generally, several applied general equilibrium models have moved away from highly disaggregated static models toward dynamic models that feature less sectoral detail but instead disaggregate over several time periods.

Policymakers should welcome the increased emphasis on dynamic and adjustment issues for several reasons. First, following a slowdown in economic growth, policymakers have become increasingly concerned about intertemporal distortions induced by government intervention, particularly tax policies. Second, policymakers have increasingly focused on the effect of policy on intertemporal consumption decisions, partly because financial liberalization increasingly allows households to shift their consumption intertemporally in response to policy changes--sometimes with dramatic consequences for personal saving

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1/ Bryant et al. (1988) contrast several of these empirical macroeconomic models.

2/ Shoven and Whalley (1984) and Bovenberg (1987) survey these models.

ratios. Third, there has been growing interest in the macroeconomic effects of structural policies, particularly in the consequences of these policies for the current account of the balance of payments through their impact on saving and investment behavior. Fourth, several studies have shown that transitional effects tend to be important. Accordingly, models that deal with issues of adjustment should be more valuable for public policy analysis than those that ignore such effects.

Summers (1981a) formulated one of the first intertemporal equilibrium tax models by imbedding an overlapping-generations life-cycle model in a one-sector model of the U.S. economy. He found that introducing a consumption tax to substitute for the capital income tax would significantly boost long-run income. However, his results overstated the welfare gains because they ignored the transition to a new steady-state path. Moreover, Summers' model failed to consider adjustment costs in capital accumulation and, therefore, yielded an excessively high general equilibrium elasticity of capital formation with respect to taxation. 1/

Ballard, Shoven, and Whalley (1985) examined transitional effects in a multi-sector model of the U.S. economy but failed to incorporate forward-looking expectations. Jorgenson and Yun (1984) and Auerbach and Kotlikoff (1987), in contrast, integrated an analysis of the transition with a full intertemporal equilibrium approach. In intertemporal equilibrium models, agents are endowed with perfect foresight: current decisions are based on the future path of prices that will unfold over time (barring future unanticipated shocks in exogenous variables). 2/ The intertemporal equilibrium approach, which can be viewed as the dynamic equivalent of Walrasian general equilibrium theory, yields consistent dynamic welfare estimates. By including transitional effects, Auerbach and Kotlikoff (1987) found substantially smaller welfare effects from structural changes in tax policy than Summers (1981a) did.

Models that explicitly considered investment behavior further highlighted the importance of transitional effects. In contrast to traditional applied general equilibrium tax models, which assume that saving behavior drives investment, Bovenberg (1988) and Goulder and Summers (1989) derived explicit investment demand functions from intertemporal optimizing behavior of forward-looking firms. Using multi-sector models, these studies examined the implications of adjustment costs in sector-specific capital accumulation giving rise to imperfect intersectoral mobility of capital and separate investment functions for each industry. These studies found that, compared to models that assume perfect intersectoral mobility, changes in sector-specific tax rates

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1/ Evans (1983) shows that this elasticity is also very sensitive to the modeling of bequest behavior.

2/ Under an intertemporal equilibrium approach, it is no longer feasible to solve recursively through time because future prices directly affect current decision making.

tend to generate larger distributional but smaller efficiency effects. Intuitively, asset prices, rather than the intersectoral capital allocation, absorb short-term adjustments to unanticipated policy changes as slower adjustment results in significant capitalization effects. These results not only reveal that transitional effects are important but also suggest that the welfare gains from leveling the playing field may be smaller than previous models had suggested. 1/

Although theoretical analysis has demonstrated that the openness of an economy may substantially affect the impact of tax policies, most applied general equilibrium models have dealt exclusively with closed economies. Nevertheless, a few dynamic applied general equilibrium models of open economies have been developed. Goulder, Shoven, and Whalley (1983) found that the specification of international capital mobility significantly affects the national welfare effects of introducing a consumption tax to replace the income tax. This study, however, incorporated neither forward-looking expectations nor explicit investment behavior by producers. Goulder and Eichengreen (1989), in contrast, built a multi-sector model of an open economy incorporating forward-looking saving and investment behavior. In this model, international capital flows finance imbalances between domestic investment and saving. The study demonstrated that, in the presence of international capital mobility, saving- and investment-promoting policies differ significantly in their effects on net trade flows and the profitability of export-oriented and import-competing industries--both in the short and the long run. To illustrate, restoring investment tax credits tends to reduce the profitability of domestic export industries in the short run but improves it subsequently. Policies that promote saving generate the reverse time profile for the profitability of these sectors.

The model in Goulder and Eichengreen (1989) is rather similar to the numerical macroeconomic models discussed at the end of the previous section. Compared to these macro models, however, the industrial structure is more disaggregated. 2/ Goulder and Eichengreen (1989), however, abstract from Keynesian features and do not model a monetary sector.

IV. Saving Behavior

This section evaluates saving theories often implemented in intertemporal equilibrium models. After dealing with models of intergenerational altruism, it explores several versions of the life-cycle model.

1/ Hamilton and Whalley (1985), Jorgenson and Yun (1984), and Fullerton and Henderson (1986) used models with perfect intersectoral capital mobility to examine the welfare gains from reducing intersectoral differences in effective tax rates on capital income.

2/ Moreover, foreign and domestic assets are not necessarily perfect substitutes in portfolio demands.

It concludes that aggregate saving behavior is understood only imperfectly and remains difficult to model.

Intergenerational altruism, which has been popularized by Barro (1974), can be formalized as households that maximize intertemporal utility over an infinite horizon. It assumes that capital markets are perfect and that individuals internalize the welfare of their heirs and intend to leave bequests. The model is analytically convenient, which is one of the reasons why many intertemporal equilibrium models use it. 1/ The model also facilitates dynamic welfare analysis because the intertemporal utility function provides a natural way to measure social welfare. Moreover, while the laissez faire solution is not necessarily optimal in any meaningful sense in the life-cycle model (see Diamond (1970)), the model of intergenerational altruism produces an economy that functions efficiently in the absence of taxes. However, empirical studies have rejected several implications of the model of intergenerational altruism--in particular those regarding the so-called Ricardian equivalence hypothesis (see, e.g., Bernheim (1987), Boskin and Kotlikoff (1985), and Ebrill and Evans (1988)). According to this hypothesis, the intertemporal path of nondistortionary taxes does not affect the economy as long as government spending remains unchanged. These empirical results suggest that an alternative model may be appropriate, especially if policy significantly affects the intergenerational distribution of resources. 2/

The most popular alternative that allows for individuals with finite horizons is the life-cycle model of overlapping generations. Several models (see, e.g., Buiter (1986), Frenkel and Razin (1986), and van Wijnbergen (1985)) have adopted a version of the life-cycle model developed by Yaari (1965) and Blanchard (1985), because it generates relatively simple aggregate behavior. This version introduces life-cycle considerations by assuming that at each point in time individuals face a fixed probability of death. The uncertainty regarding the lifetime yields a private discount rate that exceeds the social rate of discount. 3/ Intuitively, in contrast to the government sector's tax revenue, the individual's income stream is subject to uncertainty. The

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1/ Examples are the following numerical studies: Sachs (1983); Lipton and Sachs (1983); Jorgenson and Yun (1984); Ballard, Shoven, and Whalley (1985); Goulder and Summers (1989); and Goulder and Eichengreen (1989). The analytical studies of Abel and Blanchard (1983), Judd (1985) and (1987), and Bovenberg (1988) and (1989b) also assume consumers who optimize over an infinite horizon.

2/ This is the case for many changes in tax policies. Auerbach and Kotlikoff (1987), for example, demonstrate that the introduction of a consumption tax or wage tax has major implications for the intergenerational distribution of resources.

3/ Empirical tests based on this relationship typically reject Ricardian equivalence under which the social and private discount rates should be equal. See van Wijnbergen (1985).

gap between the private and social returns causes the Ricardian hypothesis of debt neutrality to fail.

Whereas the Blanchard model is particularly tractable, the assumption that the probability of death does not depend on age is clearly invalid. 1/ Several intertemporal equilibrium models, including Summers (1981a) and Auerbach and Kotlikoff (1987), assumed that households maximize utility over a certain finite lifetime and do not leave bequests. These models allow policymakers to analyze how various policies, such as social security reform and government debt financing, affect the intergenerational distribution of resources.

Several empirical studies, however, have questioned a major tenet of the life-cycle model--namely, that households dissave during retirement and do not leave bequests--on the grounds that cross-section data indicated that the wealth of the elderly increases with age (see, e.g., Kurz (1984)). More recently, however, Bernheim (1987) and Hurd (1987) used panel data to demonstrate that the elderly dissave during retirement and that the propensity to consume varies with age. Whereas the elderly leave bequests, empirical studies have not yet resolved whether individuals intend to leave bequests or whether uncertainty about death combined with a weak market for private annuities causes individuals to end up leaving unspent savings to their offspring. The ambiguity about the bequest motive complicates the modeling of saving behavior--especially because the specification of intergenerational transfers significantly affects the interest elasticity of saving (see, e.g., Evans (1983)).

Several studies have observed that the close empirical relationship between consumption and income is difficult to explain by individuals maximizing intertemporal utility over a long time horizon (see, e.g., Hall and Mishkin (1982) and Poterba and Summers (1987)). Some attribute this finding to imperfect capital markets (and associated liquidity constraints), which prevent individuals from fully smoothing their consumption over time (see, e.g., Hubbard and Judd (1986)). 2/ Others explain the close relationship between current income and consumption by rejecting the basic premises of intertemporal utility maximization and farsightedness (see, e.g., Summers and Carroll (1987)). They argue that myopia, rules-of-thumb, habit, and so on play a dominant role in determining aggregate saving.

Modeling and estimating saving behavior is difficult because none of the simple theories is capable of, by itself, explaining aggregate

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1/ Barro has interpreted the probability of death as the probability of dynastic extinction (through childlessness) in a model in which the bequest motive is operative.

2/ Sachs and Roubini (1987) and Masson et al. (1988) account for liquidity constraints in an ad hoc fashion by including disposable income terms in consumption functions.

saving behavior. Instead, several elements play a role in explaining aggregate savings behavior, because different households seem to act in different ways: some behave as life-cycle optimizers, some as intergenerational planners, and others much more myopically than any of the intertemporal optimizing theories would suggest. 1/ Structural changes, such as financial liberalization, demographic change, and the development of the welfare state, may affect the relative importance of these various groups over time. Moreover, the effect of uncertainty on saving is not fully understood (see, e.g., Kotlikoff (1989)), thereby further complicating the estimation of parameters underlying saving behavior. 2/ In addition, cross-country differences in household saving patterns are particularly important.

Corporate saving--including retained earnings for replacement investment, that is, depreciation allowances--represents a major part of private saving in most countries. Almost all intertemporal equilibrium models do not separately model corporate saving but assume that households pierce through the "corporate veil;" the composition of private saving over personal and corporate saving does not affect the level of private saving, which is determined by intertemporal optimization at the household level. Empirical studies, however, suggest that households offset movements in corporate saving less than one-for-one because of various imperfections and constraints (see, e.g., Bovenberg (1989a) and Poterba (1987)).

V. Investment Behavior

This section critically evaluates the Q-theory of investment. Almost all intertemporal equilibrium models incorporating investment behavior adopt Q-theory--or its predecessor neoclassical theory--because it is grounded in intertemporal optimizing behavior. Moreover, Q-theory is not only particularly tractable but also consistent with lags in the investment process. The more empirically oriented macro models supplement this theory by accelerator and liquidity terms, which are not derived from optimizing behavior (see, e.g., Sachs and Roubini (1987) and Masson et al. (1988)).

1/ To illustrate, Boskin (1988) argues that the effect of changes in disposable income on current consumption is considerably less than the traditional Keynesian marginal propensity to consume of around 0.75. However, the effect significantly exceeds zero, which is the value the model of intergenerational altruism predicts, and about 0.05, which follows from a model with unconstrained intertemporal optimizing households.

2/ To illustrate, when estimating intertemporal elasticities of consumption, empirical studies find it difficult to distinguish between risk aversion and genuine intertemporal substitution.

The Q-theory of investment, introduced by Tobin (1969), predicts that firms invest as long as investment raises the market value of the firm by more than the replacement cost of the investment--that is, as long as Q, defined as the ratio of the market value to the replacement value of capital, exceeds one. 1/ Subsequently, Summers (1981b) and Hayashi (1982) demonstrated that a link between the market value of the firm and investment is consistent with dynamic optimizing behavior by price-taking firms that simultaneously determine capital intensity and output subject to an adjustment cost function. They also showed how capital income tax provisions modify the relationship between Q and investment. According to the adjustment cost function, which was introduced by Lucas (1967), Gould (1968), and Treadway (1969), adjustment costs associated with capital accumulation rise with the rate of investment. This technological relationship causes optimizing firms to approach the long-run capital stock in a gradual fashion.

Empirical estimates typically reveal a rather weak link between Q and investment. This may suggest that taxes have only a relatively small impact on investment behavior. 2/ Alternatively, however, the weak empirical link between Q and investment can be explained by misspecification of the effect of taxes on investment. Misspecification may arise for a number of reasons. Both empirical and theoretical studies have not adequately dealt with the firm's financing decision. 3/ Typically, the debt-equity ratio is fixed exogenously, while households equalize the return on debt to that on equity. Thus, arbitrage between debt and equity occurs at the household rather than at the firm level (see Bradford and Stuart (1984)). This procedure is inconsistent with optimizing behavior of firms, because optimizing firms are likely to change not only their level of investment but also their financing mix in response to changes in taxes (see, e.g., Auerbach (1983)).

More generally, dynamic models have not fully specified a full financial market equilibrium with endogenous portfolio and financing choices. 4/ This is an important issue in determining how personal taxes affect the relationship between investment and Q; if personal tax rates differ across households, the relevant personal tax rate depends on who owns the firm--a difficult question in the case of widely held corporations. In an open economy in which foreigners finance domestic

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1/ The intertemporal equilibrium models discussed here determine the market value of capital as the present value of dividends given perfect foresight regarding prices and tax policy.

2/ Empirical investment equations using the user cost of capital as an independent variable tend to confirm weak tax effects. See, for example, Masson et al. (1988).

3/ Hayashi (1985) shows that the financing regime affects the relationship between Q and investment.

4/ Galper, Lucke, and Toder (1986) model portfolio and financial choices under uncertainty in a static general equilibrium model with a fixed capital stock.

investments, foreign personal taxes may well be relevant. Financial intermediation, the existence of tax-favored financial institutions, and financial innovation, which allows high taxed income to be transformed into lower taxed income, such as capital gains, further complicate the role of personal taxes. These factors are becoming more important now that countries are increasingly integrated in world financial markets. Modelers have only just begun to model the effects of the internationalization of financial markets, which allows firms to borrow in foreign currencies or offshore in domestic currency and increases the scope for avoiding taxes by exploiting international differences in tax provisions through so-called tax arbitrage (see, e.g., Alworth (1988) and Gordon (1986)). 1/

The specification of dividend policy--in particular the choice between the old and the new views of dividend taxation--also affects the relationship between Q, personal taxes, and investment. According to the new view, retained earnings are the marginal source of equity finance as long as a firm pays dividends. The old view, in contrast, assumes that firms finance marginal equity investment by issuing new shares. These different views regarding equity policy have strikingly different implications for the effects of taxes on investment; in contrast to the old view, the new view predicts that dividend taxes are equivalent to lump-sum taxes and, therefore, do not affect the incentive to invest.

Relating investment to Q assumes that the adjustment cost function is homogeneous and that the productivity of capital does not depend on its vintage. In the presence of alternative adjustment cost technologies, such as a putty-clay technology, or heterogeneous capital due to capital obsolescence, fluctuations in Q do not necessarily affect investment. Noncompetitive market structures and agency costs due to imperfect information also affect the relationship between Q and investment.

Most studies have failed to incorporate many specific provisions of the tax code that almost certainly affect investment incentives. Examples of such provisions are dividend reliefs, minimum tax provisions, reserve deductions, local taxes, the provisions regarding the carry forward of losses, 2/ and stamp duties. In this connection, aggregation problems may well invalidate aggregate investment functions, which are typically based on the tax provisions pertaining to a representative investment undertaken by profitable firms, because effective

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1/ Almost all intertemporal equilibrium models of open economies assume that domestic and foreign assets are perfect substitutes. This may result in corner solutions, if tax provisions differ across countries.

2/ Models generally assume that firms are not "tax exhausted." Firms are tax exhausted, if they do not generate sufficient profits against which to claim tax deductions and tax credits.

tax rates on capital income tend to differ significantly across assets and industries (see, e.g., King and Fullerton (1984)) and a number of tax preferences (accelerated tax depreciation, investment tax credit, etc.) cannot be used by loss-making firms. In addition, legal tax provisions may measure actual effective tax rules only imprecisely due to lax enforcement and tax evasion. Furthermore, nontax factors that are not modeled may interact with and may largely offset the tax effects on investment. In many countries, for example, the public sector underwrites losses of particular industries and extends loans at subsidized rates.

VI. Conclusions

Intertemporal equilibrium models have made great strides in the past decade and have yielded new insights concerning the welfare effects of fiscal policy. They have illustrated, for example, how expectations concerning future fiscal policies modify the welfare effects of unsustainable fiscal policies associated with large budgetary imbalances. Furthermore, models accounting for adjustment costs and transitional effects examined the factors that determine the efficiency and equity effects of tax policies affecting saving and investment. Simulations with these models yielded significantly smaller welfare effects than long-run models had suggested earlier. Furthermore, open economy models showed that international capital mobility is an important determinant of the welfare effects of capital income taxation. Despite recent progress, a number of limitations restrict the usefulness of the current models for the analysis of policy. This concluding section discusses various areas in which further progress would be welcome.

The empirical basis for the models is generally weak. Empirical research has not yet been able to estimate certain key parameters and elasticities whose numerical values can have large effects on the results. Functional forms and other basic assumptions, such as complete information and the importance of the bequest motive in saving decisions, remain largely untested.

While models have started to deal with transitional effects and adjustment costs, they should also incorporate additional imperfections to improve the quantification of welfare effects. Models that abstract from adjustment costs, liquidity constraints, and risk tend to overestimate the elasticity of saving with respect to tax changes. Consequently, they tend to bias upward the welfare effects associated with changes in tax policy. Incorporating noncompetitive market structures and institutions (in product, capital, and labor markets), sticky prices, and rationing can also significantly affect policy results. 1/

1/ Harris (1984), for example, shows that models that ignore imperfect competition in product markets seriously underestimate the benefits associated with trade liberalization.

The modeling of human capital formation, endogenous technological change, and stochastic financial market equilibria in the presence of incomplete insurance markets constitutes another unresolved challenge. Modelers have just started to examine strategic behavior by the government and its effect on private sector expectations regarding public policy.

The usefulness of intertemporal equilibrium models is inherently limited in view of several intractable problems. One of these is the aggregation problem: microeconomic relations yield similar macroeconomic relationships between aggregate variables only under extremely restrictive assumptions. Another is the basic assumption of rationality and that of intertemporal optimization, in particular, which is only an approximation of actual behavior.

Modelers continue to face difficult trade-offs in modeling a complex economic reality. Recent models tend to focus on specific policy problems and have moved away from general purpose models, which try to incorporate all the details of an economic system. To illustrate, models studying the effects of capital income taxation typically feature a rich specification of the intertemporal nature of saving and investment behavior but tend to treat the labor market in a highly stylized way. Models studying the effects of high marginal tax rates on the incentive to supply labor, in contrast, pay careful attention to the labor market but often abstract from intertemporal aspects. Whereas developing issue-specific models appears to be a good strategy, it does require that modeler understand policy issues and the aspects of particular interest to policymakers. It also forces policymakers and modelers alike to be keenly aware of the limitations of the models.

Policymakers can use numerical intertemporal equilibrium models to estimate broad orders of magnitude when analyzing the dynamic allocative or distributional effects of particular policies. However, in light of several model weaknesses, they ought to interpret the results derived from intertemporal equilibrium models with judgment and care. Model users should be aware of the main qualifications and reflect on the results using their own economic intuition. Indeed, models can never replace sound judgment and economic reasoning. Instead, their function is to develop economic intuition by suggesting quantitative magnitudes and new lines of reasoning that, upon reflection, turn out to be plausible. In this respect, stylized models can complement large disaggregated models by helping modelers understand the main mechanisms that drive the results in more complex models.

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