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APPROACHES TO EFFICIENT CAPITAL TAXATION: LEVELING THE PLAYING FIELD vs. LIVING BY THE GOLDEN RULE

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ABSTRACT

In this paper we explore the efficiency gains from the Tax Reform Act of 1986 and prospective tax reforms, separating out the intersectoral and intertemporal efficiency consequences. To assess these effects, we employ a general equilibrium model that considers the effects of taxes on the allocation of capital across industries, assets, sectors, and time.

We find that the 1986 tax reform yielded only a small improvement in the intersectoral allocation of capital because the beneficial effects from its more uniform treatment of capital within the business sector are largely offset by adverse effects stemming from increased tax disparities between the business and housing sectors. The intertemporal efficiency effects of the reform, in contrast, are significant and negative. Hence the overall efficiency impact of the reform is negative as well.

Our results indicate that the economic margins offering the greatest scope for efficiency gains are different from those that received the most attention under the 1986 tax reform. While much of the 1986 reform concentrated on reducing tax disparities within the business sector, much larger efficiency gains would result from reducing tax disparities between the business and housing sectors and from general reductions in effective marginal tax rates on capital.

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I. Introduction

I.1. Overview

Efficient capital taxation has long been a principal objective of public finance economists. This objective helped fuel the drive fcr reform that culminated in the Tax Reform Act of 1986 (TRA86); it remains a critical consideration in current reform proposals.

There are many roads to efficient capital allocation. Supporters of TRA86 often emphasize that the reform has improved capital allocation by achieving greater tax neutrality, that is, more uniform rates of taxation of capital across its various uses. The 1987 Economic Report of the President lauded this aspect of TRA86 in stating that "(the reform's) more uniform tax rates on income from alternative capital investments will induce a more efficient allocation of investment funds." The underlying efficiency rationale is that when tax rates are equated across types and uses of capital, gross (as well as net) marginal products of capital tend to be equated; hence aggregate output is greater than when gross marginal products differ.

In retrospect, many have questioned how much TRA86 succeeded in improving capital allocation. Several issues arise here. One is whether the reform went very far in equalizing tax rates across the types and uses of capital that it concentrated on -- mainly business capital. There is evidence that although TRA86 did reduce disparities in tax rates across major industries and asset types (e.g., structures and equipment), substantial differences remain.[1] This raises the question of how large the efficiency gains were from the neutrality achieved from TRA86, and of how much larger these gains could be if tax rates across business capital types and uses were brought to equality.

A second issue is whether the reform helped reduce disparities across a sufficiently broad set of capital uses. Even if the 1986 reform achieved greater neutrality across business uses of capital, it may have done very little to reduce disparities in capital tax rates on the margin between business and housing capital, in particular. This raises the question of how large the additional efficiency gains might be from further reductions in disparities in tax rates.

A third and fundamental issue concerns the gains from intratemporal tax neutrality as compared with efficiency improvements along the intertemporal dimension. Capital income taxation matters not only for the allocation of capital across sectors, industries, and asset types; it matters also for the capital intensity of the economy, or, correspondingly, the intertemporal allocation of resources. A substantial theoretical literature provides backing for the notion that the U.S. income tax system (both prior to and subsequent to TRA86) is likely to distort intertemporal choices in such a way as to lead to excessive current consumption, insufficient saving and investment, and, consequently, a capital-output ratio below the social optimum (see, for example, Feldstein (1978), and Sinn (1987)). With this in mind, several analysts (e.g., Summers (1987a), Slemrod (1990)) have argued that the debate over TRA86 gave undue emphasis to static neutrality issues and too little attention to improving intertemporal resource allocation. This raises the issue of the magnitude of potential gains from improved intertemporal allocation as compared with the gains from greater (static) neutrality.

This paper addresses each of these issues. We perform simulation experiments aimed at measuring the intra- and intertemporal efficiency consequences of TRA86. In addition, we evaluate the effects of more extensive potential reforms that would achieve further capital tax neutrality by lessening remaining disparities in capital taxation within the business sector and by reducing variation in the taxation of business and residential capital. Throughout our investigation, we compare the efficiency effects from static neutrality with those from improvements in intertemporal allocation.

To assess these effects, we apply a disaggregated intertemporal general equilibrium model of the U.S. economy. A well-known virtue of general equilibrium models is their ability to treat consistently the interactions among industries, sectors, and asset types. While maintaining these important properties, the model also contains features that distinguish it from other applied general equilibrium models. In particular, the model incorporates a rigorous treatment of intertemporal aspects of decisionmaking by explicitly considering both household saving and producer investment decisions and by paying attention to capital adjustment dynamics. The model's integration of intra- and intertemporal decisionmaking makes it especially well suited to addressing efficiency consequences of capital taxation.

The remainder of this section briefly indicates the relationship of this model to other numerical models that have examined efficiency effects of recent tax reforms. Part II describes the model in more detail. Part III indicates data sources for this study and provides measures of the extent to which, prior to the 1986 reform, the U.S. tax system deviated from complete static neutrality. Part IV examines allocative and efficiency consequences of the Tax Reform Act of 1986. In Part V, we evaluate the effects of potential reforms that would go beyond TRA86 in instituting greater neutrality in capital taxation. Part VI contains an analysis of the sensitivity of our results to key parameters of the model. The final section presents conclusions.

I.2. Relationship to Other Studies

The present investigation is in the spirit of studies by Fullerton and Henderson (1989), Fullerton, Henderson, and Mackie (1987), and Jorgenson and Yun (1986, 1990a), who have employed highly sophisticated numerical general equilibrium models to address efficiency effects of actual and potential capital tax policies. However, the model used here differs from these and other models in several ways. First, it considers closely investment decisionmaking at the level of the firm. It is distinct among disaggregated general equilibrium models in deriving investment decisions explicitly from the intertemporal optimization problem faced by each firm. Second, it differs from other models by considering the adjustment costs associated with installing new capital and the associated imperfect mobility of capital across uses.

These features are important for assessing efficiency effects of tax reforms. Analytical studies have shown that the imperfect mobility of physical capital implies significant differences in the allocative effects of tax policies depending on the extent to which they are oriented toward new capital (as with changes in investment tax credits or depreciation rules) or toward new and old capital alike (as with changes in the statutory corporate income tax rate).[2] In models that disregard the imperfect mobility of capital, the distinction between taxes on old and new capital is obscured and the assessment of the effects of tax policy on investment and capital allocation becomes problematic. Changes in the relative burdens on old and new capital constituted a key feature of the 1986 tax reform and are important elements of proposed initiatives.

The attention to adjustment dynamics may be important in another way. Adjustment costs regulate the length of time necessary to achieve a new long-run equilibrium after a policy shock. Models which ignore such costs are likely to overstate the speed of adjustment and thereby exaggerate the rate at which intersectoral and intertemporal reallocation take place.[3] This can influence the measured efficiency gains or losses from policy changes.

A strength of the Jorgenson-Yun and Fullerton-Henderson models is that they distinguish different types of capital and allow for substitution between these types in production.[4] This model also distinguishes capital types -- structures and equipment -- but differs from these other models in the ways that such capital is demanded and manufactured.[5] First, each firm's demands for different types of productive assets are embedded within an intertemporal optimization decision rather than based only on current prices. In addition, the equipment and structures used in different sectors are produced with different technologies and by different industries (see Table 1), so that shifts in the demands for a given type of capital good (for example, housing structures) will particularly affect the industries involved in producing that good (for example, the residential construction industry). Capital assets cannot be transformed from one type to another after their manufacture, and assets of the same type are imperfectly mobile across the sectors or industries that use them. This contrasts with the other models above, in which different capital assets can instantly be converted from one type to another or from one use to another after a policy change.[6]

The model is original in its treatment of depreciation allowances and the depreciable capital stock basis. In contrast with the other models above, our model keeps track of different capital vintages, so that changes in depreciation rules will apply only to new capital, and not retroactively to capital already in place. This corresponds to the actual features of recent U.S. tax reforms.

Finally, the model differs from other disaggregated general equilibrium models in its treatment of housing. Homeowners' housing investment decisions, as well as their demands for housing services, are considered explicitly. Households' demands for housing services derive from utility maximization and influence the (explicit or implicit) rental prices of housing services. These prices affect the profitability of housing investment and thus influence the demands for new (or larger) homes by individuals and the supply decisions of the residential construction industry, which produces housing capital. The model also incorporates differences between the tax system's treatment of the housing sector and the business sector, permitting an examination of how tax policies affect capital allocation on the business-housing margin.[7]

Of course, the model also has some important limitations. It does not consider certain categories of capital assets, including intangible capital, inventories, and land.[8] Nor does it distinguish incorporated and unincorporated enterprises within the business sector.[9] Still, the features contained in the model are exceptionally well suited to analyzing efficiency effects of TRA86 and other reforms that directly alter saving and investment incentives, the relative burden on old and new capital, and the relative taxation of business and housing sector capital.

II. THE MODEL

II.1. Overview

There are six domestic industries: (1) agriculture and mining, (2) manufacturing, (3) services (other than housing), (4) non- residential construction, (5) residential construction, and (6) housing services. Each industry produces a single output using labor (L), capital (K) and domestic and foreign intermediate inputs (M) according to the function:

$$X = f[g(K,L),M] - AC \tag{1}$$

where AC represents capital adjustment costs; f(.) is Leontief and g(.) is CES. Adjustment costs are a convex function of the rate of investment. The outputs of the first three industries serve as intermediate inputs, as investment goods (new capital), and as consumption goods.[10] The construction industries produce only investment goods, and housing services are for final consumption only.

The representative firm in each sector behaves as a price-taker on the markets for its output and inputs. In each year, producers decide on cost-minimizing intensities of labor and intermediate inputs given the current stock of capital. They alter this stock of capital through investment designed to maximize the equity value of the firm. Optimal investment involves balancing the costs of new capital (acquisition and installation costs) against the higher future revenues made possible by a larger capital stock, as in Lucas (1967) and Treadway (1968).

Consumption, labor supply, and saving result from the decisions of an infinitely-lived representative household maximizing its intertemporal utility with perfect foresight. In year t it chooses a path of "full consumption" C to maximize

$$U_t = \sum_{s=t}^{\infty} (1+\omega)^{t-s} \frac{\sigma}{\sigma-1} C_s^{\frac{\sigma-1}{\sigma}} \tag{2}$$

where C is CES a composite of consumption of goods and services G and leisure L:

$$C_s = \left[G_s^{\frac{\upsilon-1}{\upsilon}} + \delta^{\frac{1}{\upsilon}} L_s^{\frac{\upsilon-1}{\upsilon}} \right]^{\frac{\upsilon}{\upsilon-1}} \tag{3}$$

In the equations above, ω is the rate of time preference, σ is the intertemporal elasticity of substitution, υ is the elasticity of substitution between goods and leisure, and δ is an intensity parameter for leisure. The household maximizes utility subject to the intertemporal budget constraint requiring that the present value of the consumption stream not exceed potential total wealth (current nonhuman wealth plus the present value of potential labor income and net transfers). In each period, overall consumption of goods and services (G) is allocated across 17 specific consumption categories according to fixed expenditure shares.[11]

The aggregate endowment of time is exogenous: it grows at a constant rate, g, which determines the long-run (steady-state) growth rate of the economy. This growth represents Harrod-neutral technical progress in producing labor or leisure services per unit of actual time. Labor is perfectly mobile across sectors.

The government collects taxes, distributes transfers, and purchases goods and services (producer goods). Overall government expenditure is exogenous and increases at the steady-state growth rate g.[12] In the base (or no-policy-change) case, there is a government deficit which grows at the nominal steady-state growth rate of the model; the ratios of the deficit to government debt and to GNP remain constant along the base case path. In revised-case (policy change) simulations, a constant ratio of government debt to government capital is maintained through adjustments to personal taxes.

The set of capital tax instruments applying to firms and investors includes the corporate income tax (τ), depreciation allowances (δ^T), investment tax credits (k), the effective tax on capital gains (κ), property taxes, and the tax on capital income at the individual level (θ). Together, these taxes determine the marginal effective tax rates (METRs) applying to real investment, as described in appendix A.

Equilibrium in each period satisfies four types of conditions: (1) the aggregate demand for labor equals the aggregate supply, (2) the demand for output from each industry equals its supply, (3) the aggregate demand by firms for loanable funds equals the aggregate supply by households, and (4) government tax revenues plus net borrowing equals government spending. The conditions are met through adjustments in output prices, in the interest rate, and in personal taxes.[13]

Since agents are forward-looking, equilibrium in each period depends not only on current prices and taxes but on future magnitudes as well. To obtain perfect foresight expectations, we repeatedly solve the model forward (usually for 75 one-year periods),[14] each time generating a path of equilibria under a given set of expectations. After each path of equilibria is obtained, we revise the expectations and solve for a new path. Using an approach similar to that of Fair and Taylor (1983), we obtain expectations that match actual outcomes and generate the consistent intertemporal equilibrium path.

II.2. Capital and Investment

One of our model's distinguishing features that is particularly important for the question of capital taxation is its intertemporal treatment of investment. Managers choose investment levels to maximize the equity value of the firm, which equals the present value of net payments to shareholders. The investment decision in each industry reflects forward-looking behavior under perfect foresight.

We extend the model of Goulder and Summers (1989) by distinguishing structures and equipment capital. In each industry, structures and equipment combine according to a CES function to form a capital composite, K. The capital composite enters production as in equation (1). Firms choose optimal investment levels for each type of capital, considering the contribution of each type to future profitability as well as the acquisition and installation costs. These choices are obviously not independent, as the marginal productivities of one type of asset depend on how much of the other type of asset has been installed. Appendix A describes the optimization problem and first-order conditions.

II.3. Depreciation

The model keeps track of the depreciable basis for each asset, defining a new "vintage" every time the depreciation rate changes. This is important for capturing tax reforms like that of 1986, where new depreciation rates apply prospectively: earlier rates continue to apply to previously purchased capital. In addition, the model incorporates an important non-neutrality of the tax system in that the depreciation basis reflects the nominal purchase price rather than the actual replacement cost.

A firm's total depreciation allowance is the sum of the depreciation allowances earned on its depreciable capital of all types and vintages. As shown in Appendix A, the value of the firm is positively related to its total depreciation allowance.

II.4. Housing

The model links demands for housing services with housing investment decisions. Housing services are one of the specific consumption commodities demanded by the household. Like all commodity demands, the demand for housing services stems from utility maximization. The price of these services equates the demand and supply of housing services. This price represents both the price of rental housing as well as the implicit price of the service flow from owner-occupied housing.[15] Owners of housing (both owner-occupants and landlords) make housing investment decisions to maximize the value of their housing assets. Housing services prices and housing investment demands are interconnected: higher service prices tend to raise the shadow value of new housing capital and make investment in additional housing more attractive. Correspondingly, higher rates of housing investment increase the supply of housing services and tend to depress housing service prices.

The basis for calculating the value of housing assets is the arbitrage requirement that net returns to owning (and either occupying or renting out) a house must be equal to the return that could be earned on other assets. As shown in appendix A, this yields an expression that equates the equity value of housing capital with the present value of the stream of its net earnings discounted at the risk- and tax-adjusted reservation rate of return. The net earnings from housing capital include implicit rentals as well as financial returns.

III. DATA AND INITIAL CONDITIONS

III.1. General

The model is benchmarked to the year 1983. Most of the data for the household, government, and foreign sector components of the model were drawn from the general equilibrium data set assembled by Scholz (1987). This is our source for production function elasticities, labor input taxes, intermediate input taxes, and sales taxes.

The elasticity of substitution in consumption between goods and leisure, υ, is set to yield a compensated elasticity of labor supply of .15: $\upsilon = .69$. The intensity parameter δ is set to generate a ratio of labor time on total time endowment equal to .44.[16] The intertemporal elasticity of substitution, σ, equals .50.[17] Calibrating the model to 1983 data leads to a value of .007 for time preference ω. These parameters imply a value of .179 for the elasticity of savings with respect to the rate of interest between the current period and the next.

Capital stocks in each sector and the matrix of trades of intermediate inputs among the six industries are derived from Bureau of Economic Analysis data. A component of the input-output matrix is also used to convert purchases of each type of capital asset into specific demands for the output of each sector.

Further industry and asset specific data, like economic depreciation rates, investment tax credits, and debt-capital ratios are obtained by aggregating detailed data for different capital assets. The weights are given by an unpublished matrix of endowments of 34 types of capital in 44 industries for 1977 used by Jorgenson and Sullivan (1981).

Appendix B offers detail on other data, including the depreciation rates and adjustment cost parameters. Tables 2 and 3 present the benchmark values for behavioral and tax parameters.

To this original data set we apply consistency procedures to reconcile expenditures and receipts; in addition, we calibrate the model to assure that it replicates the base case data set as an equilibrium on a steady-state growth path.

III.2. Marginal Effective Tax Rates: The Original Playing Field

The marginal effective tax rate (METR) for each capital asset is the difference between its social or pre-tax (internal) rate of return and its private rate of return after all business and individual taxes, divided by the pre-tax return. In a model where investment reflects intertemporal optimization in the presence of adjustment costs, the calculation of marginal effective tax rates requires a more complex formula than the conventional cost-of-capital formula.[18] Appendix A provides detail on the calculation of social rates of return and the METR's. The METR's depend not only on tax parameters but also on prices and interest rates. After a policy shock, interest rates and prices change; hence the METR's generally are not constant following a policy change.

We define static neutrality and intertemporal neutrality in terms of the METR's. **Static neutrality** is defined as the condition in which METR's are equal across all types and uses of capital. Arbitrage by capital owners leads to equality in expected after-tax returns to all forms of productive capital. When the METR's are equal, such arbitrage also causes pre-tax social rates of return to be equal. The dispersion in METR's is a measure of how far the tax system departs from static neutrality.

We define **intertemporal neutrality** as the condition in which METR's are zero for all capital assets in all uses. The basis for this definition is the fact that when the METR is zero, marginal capital income is not taxed and the relative price of current and future consumption is not affected by taxation -- the intertemporal margin is not distorted. The general magnitude of the METR's, as opposed to their dispersion, is a measure of how far the tax system deviates from intertemporal neutrality.

In certain hypothetical contexts, intertemporal neutrality is a condition for achieving the "modified Golden Rule" allocation, that is, the allocation that maximizes intertemporal utility of a representative household.[19] However, in an actual economy, neither intertemporal nor static neutrality is generally optimal. Given that the government must raise a certain amount of revenue, achieving intertemporal neutrality by eliminating marginal taxes on capital is likely to force the government to raise other distortionary taxes (such as taxes on labor) and expand inefficiencies on other margins (such as the labor-leisure margin). Hence it is not evident *a priori* whether policies that reduce inefficiencies on the intertemporal margin will improve economic efficiency overall. Moreover, if political or other considerations compel the government to impose positive taxes on marginal capital, static neutrality is not generally the most efficient way to satisfy this constraint. As discussed by Auerbach (1989) and others, uniform taxation is optimal if all assets are equally complementary to labor and capital is a primary factor of production. These conditions are not usually satisfied; hence there is generally no basis for concluding that neutral taxation is most efficient.

Thus, analytical approaches yield inconclusive results as to whether improvements in static or in intertemporal neutrality will improve overall efficiency in a real economy. The limitations of analytical approaches make evident the usefulness of numerical simulation.

The benchmark METR's for structures and equipment in our six domestic industries are shown in Table 4.[20] The data and tax code underlying these calculations correspond to 1983. As expected, METR's are higher for structures than for equipment, by eight percentage points or more. Comparing sectors, housing appears to be almost tax-free at the margin. The small rate for tangible capital in the services industry is surprising; this is due to this sector's higher debt-capital ratio which allows it to issue more tax-favored debt. The mean METR, weighted by net stocks of capital of each type, is 12.5 percent, much less than the sum of statutory corporate and individual income tax rates. It corresponds to a mean wedge between social and private internal rates of return of 1.2 percentage points. The substantial variation in METR's across asset types, industries, and sectors in 1983 suggests considerable scope for efficiency gains from policies that yield greater static neutrality. Table 4 also reveals that, in general, METR's are significantly above zero. This indicates that there may be room as well for improved allocation on the intertemporal margin through policies that lower the METR's.

IV. EFFICIENCY EFFECTS OF THE 1986 TAX REFORM

There are two main parts to our investigation. First we examine effects of the Tax Reform Act of 1986, emphasizing the extent to which it brought about more neutral capital taxation and its overall efficiency consequences. We then explore the potential additional efficiency gains that might be brought about by more extensive reforms.

IV.1. How Much Did TRA86 Level the Playing Field, and What Were the Gains from This Effort?

Changes in METR's. The Tax Reform Act of 1986 is modeled through changes in several tax parameters (see Table 3). Marginal tax rates on labor and capital income are lowered by approximately 12 percent (3 percentage points), the 60 percent exclusion on long-term capital gains is abandoned, the corporate income tax (CIT) at all levels of government is lowered from 51 percent to 39 percent, investment tax credits (ITC's) are repealed, and the present value of depreciation allowances is lowered by 46 percent for structures (4 percent for equipment). Accelerated depreciation is virtually abandoned for structures, although substantial acceleration remains for equipment.[21]

The implications of these changes for marginal effective tax rates are shown in Table 4. METR's are higher for practically all types of capital. The services industry is particularly hurt because the lower CIT is offset by much lower investment incentives in this industry, which starts off with a relatively low marginal product of capital. It appears that TRA86 moves in the direction of a more level playing field for business capital, particularly between structures and equipment, consistent with the intentions of many of its proponents. However, the reform has little effect on the METR's for housing services, which are now considerably below those of any industry in the business sector. When both housing and business capital are taken into account, the weighted dispersion of all tax rates rises under TRA86, implying lower overall static neutrality under our definition. In addition, the mean METR over all types of capital is up by more than six percentage points, indicating lower intertemporal neutrality.

Effects. The increase in METR's, as expected, tends to reduce investment. As shown in Table 5, aggregate private investment falls (relative to the no-policy-change reference path) by 4.1 percent in the first period ("short run") and by 8.2 percent in the new steady state ("long run"). In the short run, investment falls in every industry except housing services. The elimination of investment tax credits and scaling back of depreciation allowances lowers the METR's for business-sector capital (Table 4); the cutback in business-sector investment puts downward pressure on interest rates and helps "crowd in" investment in new housing. In the long run, the prolonged reduction in business-sector investment ultimately yields a significantly lower private capital stock, implying reduced real incomes, reduced demands for housing services, and lower housing investment.[22]

Investment is reduced for both structures and equipment. Non-residential investment in structures declines by 9.8 percent on impact and ends up 9.0 percent lower in the new steady state compared with the base case; it is pulled down by the strong decline in the services industry. Non-residential investment in equipment declines by 5.5 percent immediately and reaches a new balanced growth path 10.7 percent below its original path.

The effects on equity values stand in sharp contrast to the effects on investment. By eliminating the ITC and scaling back allowances for tax depreciation, TRA86 raised the tax burden on investment (new capital). As indicates, these changes discourage investment. However, TRA86 *lowered* the tax burden on existing (old) capital through reductions in the statutory corporate income tax rate. Consequently, equity values rise in all industries in the business sector, and the weighted average price of corporate equity rises by 19 percent.[23] The price of housing equity rises by 9 percent. These differing effects attest to the importance of carefully distinguishing old and new capital through consideration of investment decisions and the dynamics of capital adjustment.

The solid line in Figure 1 displays the effects of the reform on the path of goods and services consumption (G). By reducing investment incentives, the reform crowds in higher consumption on impact. However, in the long run, consumption falls relative to the base case, a consequence of a lower capital stock and the associated reduction in real incomes. The profile of full consumption (C) is similar: it is up by 0.8 percent initially but down by 0.7 percent in the new steady state.

Welfare effects are shown in Table 6. The equivalent variation associated with the changes in consumption is equal to -.20 percent of total initial wealth, or -$275 billion in 1983 dollars.[24] The decline in welfare can be attributed to the way TRA86 changes the relative taxation of old and new capital. As examined more closely below, the benefits in the static allocation of capital from more uniform METR's in the business sector are more than offset by intertemporal losses associated with a higher average level of the METR's. The shift of part of the tax burden from labor to capital discourages capital formation, while raising employment by about one percent. The overall output effect is a 1.8 percent reduction in GDP in the long run. The reduction in output and real income implies a smaller tax base and partly accounts for the fact that TRA86 is revenue-losing: the overall revenue loss is $1.1 trillion (1983) dollars in present value.[25]

IV.2 Decomposing the Effects of TRA86

To examine more closely the determinants of the overall welfare effects of TRA86, we perform several counterfactual simulations, with each simulation incorporating elements of the overall reform. The first simulation attempts to isolate the effects of the "leveling" component of TRA86, that is, the effects of the reform's changes in the variation in METR's. Here we alter the METR's on each asset and in each industry so as to generate the same dispersion of METR's as was generated by TRA86. The instrument we use to alter the METR's is the investment tax credit rate. All other tax parameters are maintained at pre-reform values. The level of the ITC rate for each asset is chosen so as to yield the same economy-wide average of METR's as before TRA86.[26]

The second counterfactual simulation concentrates on the intertemporal neutrality effects of TRA86. Here we maintain the variation of METR's, but change the levels to correspond to the average level that resulted following the actual reform.[27]

The final counterfactual simulation includes the other main component of TRA86 -- namely, the reduction in the tax rate on labor income.

Welfare effects from this set of simulations are shown in Table 6. The "leveling" component of TRA86 has a relatively small welfare effect: the equivalent variation is -.05 percent of full consumption when the transition is accounted for, and .01 percent of full consumption when only steady-state full consumption is considered. The "leveling" which occurred under TRA86 can be subdivided into (i) the reduction in disparities in METR's within the business sector, and (ii) the *increase* in the disparity in the METR's between the business and housing sectors. These elements were considered individually in simulations corresponding to lines 2a(i) and 2a(ii). Results from these simulations show that the adverse efficiency effect from the larger disparity between business and housing taxation effectively cancels the beneficial efficiency effect from more even taxation within the business sector; hence the overall static efficiency effect is fairly small.[28]

The second main component of the reform is the increase in average METR's under TRA86. This component worsens distortions on the intertemporal margin and yields a welfare loss. Relative to the effect under the leveling component, the welfare effect here is large. This welfare loss is associated with the reduction in investment and the capital stock. In the long run, this policy change reduces the total stock of business capital by 10 percent relative to the benchmark. As shown in Figure 1, in this experiment consumption rises relative to the benchmark in the first decade. Ultimately, however, the reduction in capital formation implies a lowering of output and real incomes, so consumption eventually falls.

The reduction in labor income tax rates in the third counterfactual experiment yields an increase in employment of 1.4 percent on impact and 1.2 percent in the long run. The lower cost of labor also encourages more investment, which increases by 1.0 percent on impact and yields a total capital stock 1.5 percent larger than in the initial steady state. Welfare increases by .29 percent (Table 6). Increased employment and a higher capital stock permit higher consumption in both the short and long run (Figure 1).

The sum of the welfare effects is -.23, as compared with -.20 for the actual reform. The discrepancy reflects interactions among the components that we considered.

This decomposition exercise indicates that TRA86's increases in the average rate of taxation of marginal capital (2b) and its enlarging of capital tax disparities between business and housing (2aii) together have adverse efficiency consequences that more than offset the beneficial effects associated with its achieving more uniform capital taxation within the business sector (2ai) and its cutting of marginal tax rates on labor income (2c). The welfare consequences might have been quite different if the reform had maintained revenue neutrality by increasing tax rates on old, rather than new, capital. We return to this issue in Section V.

Our results for TRA86 differ from those obtained in Jorgenson and Yun (1989) and Fullerton, Henderson and Mackie (1987). In these studies, TRA86 generally yields an overall improvement in welfare.[29] These studies suggest that the static efficiency improvements of TRA86 outweighed the losses on the intertemporal margin. It is difficult to pinpoint the source of the difference in our results from those of these earlier studies, in part because the earlier studies do not decompose the effects of TRA86 along the lines we discuss. It may be that our model's emphasis on intertemporal aspects of investment decisions enables it to bring out more serious costs on the intertemporal margin than appeared in the earlier analyses.

IV.3. Would TRA86 Have Increased Efficiency with "Full" Business-Sector Leveling?

TRA86 did not achieve complete static neutrality. This raises the question as to whether the welfare effect of the reform might have been positive if its "leveling" efforts had gone further. In this experiment, we test an alternative reform that differs from TRA86 in incorporating complete equality of METR's within the business sector. We accomplish this by setting the ITC for each type of corporate capital at a rate that equates the steady-state METR's in the five business-sector industries. The magnitude of the common METR is chosen so as to satisfy the requirement that the present value of the reform's total revenue loss is the same as that from TRA86. The METR that satisfies this condition is 28 percent.

As shown in Table 6, complete static neutrality in the business sector leads to a smaller welfare loss: -.15 percent, compared with -.20 percent under TRA86. This reform yields increases in full consumption in the initial periods, partly because of windfalls to equity values and the drop in investment and adjustment costs. However, beginning 15 years after this reform is introduced, full consumption falls (relative to the base case). Although the more extensive "leveling" under this policy leads to an improvement in welfare relative to the outcome under TRA86, the improvement is not great.

V. FURTHER "LEVELING" INITIATIVES

We now perform experiments intended to isolate the effects of new tax initiatives which would introduce greater static neutrality along various dimensions. The initial state of the economy in which we introduce these policies is the steady state after the 1986 tax reform.[30] All the experiments in this part start from that new steady state (called the baseline). In these experiments, the ITC is the instrument that is applied to make the METR's uniform. The (uniform) METR's are pegged to that level which generates the same present value of revenues as the baseline tax system.

V.1. Full Leveling within the Business Sector

In this experiment we bring all METR's for business capital into agreement. The uniform METR that satisfies the equal revenue yield requirement is 28 percent, very close to the mean METR for business capital in the baseline (see Table 4).

Although this policy is revenue-neutral in present value, in particular years it affects overall revenues. To compensate for these annual revenue effects, we adjust individual income taxes either in lump-sum fashion or through changes in marginal tax rates on individual labor income. Results are shown in Table 7. Because the annual revenue effects are small and sum to zero in present value, the results are very similar under the two revenue-adjustment assumptions (rows 1a and 1b). Consider the lump-sum adjustment case. In the long run, GDP is 0.1 percent above the baseline path. Structures investment rises by .65 percent in the short run (first period) and .88 percent in the long run. In contrast, equipment investment falls by .37 and .39 percent in the short and long run. The contrasting effects on structures and equipment capital are in keeping with the fact that, to equate the METR's without changing their mean value, it was necessary to lower tax rates for structures and raise them for equipment. Similar results obtain when marginal tax rates preserve the annual revenue yield (row 1b).

The welfare effects of this reform are small. Under both revenue replacement specifications, the welfare gain is equivalent to a 0.05 percent increase in base case steady-state consumption.[31] The small welfare change is consistent with the fact that TRA86 already went a long way toward achieving static neutrality. The small welfare effects are consistent with the small effects on goods and services consumption. The consumption effects are shown, for the lump-sum replacement case, in Figure 2.

V.2. Leveling a Larger Playing Field: Equal METR's in the Business and Housing Sectors

This experiment imposes static neutrality more broadly by equating the METR's not only within the business sector but also between business and housing. Thus it addresses the favored treatment of residential capital which was essentially ignored by the 1986 tax reform. The uniform METR that yields the same present value of revenue as the baseline is 19.6 percent, close to the mean METR in the baseline (19.1 percent).[32]

Again, effects are similar under the alternative revenue replacement assumptions, and for the same reasons. We discuss the case with lump-sum adjustment. This policy initiative raises METR's for the housing services industry. Investment by this industry is highly structures intensive and accounts for 54 percent of total structures investment in the baseline. Consequently, this policy reduces structures investment substantially (by 6.7 percent) on impact. In contrast, equipment investment rises. Investment in both structures and equipment rises in the long run, when capital reallocation is complete and the associated efficiency improvements yield higher incomes and asset demands.

The increase in welfare from this reform is .23 percent, more than four times larger than in the previous experiment and 50 percent larger than the gain from the "leveling component" of TRA86 discussed in IV.2. These results indicate that a significant share of potential efficiency gains from static neutrality was not realized by the 1986 reform.

V.3. Inframarginal Considerations: Integration of Housing

Integration Alone. Housing's preferential tax treatment is mainly inframarginal in that it applies primarily to returns to existing capital. Owner-occupants, who own 78 percent of the stock of housing capital, pay no taxes on implicit rental income.[33] In this next experiment, we examine the effects of integrating the housing sector by treating all owner-occupied housing symmetrically with noncorporate rental housing. This reform would tax owner occupants on their implicit rental income.[34]

In contrast with the preceding two reforms, which were constructed to be revenue-neutral in present value, this reform generates substantial revenues: $1020 billion in present value. Hence the revenue-replacement procedure is more significant here.

Under housing integration, much of the tax increase to homeowners applies to old capital, that is, the existing housing stock. However, integration also implies an increase in METR's for housing; these reach a level of 16.2 percent, as compared to 9.3 percent in the baseline. Under both revenue-replacement specifications, residential investment falls considerably.

The welfare effects of this policy depend on the method of revenue replacement. Under lump-sum replacement, integration implies a welfare loss of .16 percent. In contrast, it has a negligible welfare impact under marginal-tax replacement. The cut in marginal labor tax rates appears to yield efficiency gains that compensate for the losses associated with higher METR's in the housing sector.

Integration Combined with Reductions in METR's. In our final experiment, we consider a reform in which the additional revenues attributable to housing integration are offset by reductions in METR's. In addition to integrating housing as in the previous experiment, we lower the METR's in both business and housing sectors so that the tax wedge falls by the same amount in each industry and the overall policy is revenue-neutral in present value. The mean METR that results from this is 13.1 percent, considerably below the baseline value of 19.1 percent.

Although the policy is revenue-neutral in present value, there are small revenue effects in particular years. Again we employ two alternative ways to offset the revenue effects; results are quite similar under the two specifications. This reform raises welfare substantially -- by .45 and .46 percent under the lump-sum and labor tax replacement specifications, respectively. The large welfare gain stems from the fact that the reform achieves greater tax neutrality both between business and housing (from integration) and intertemporally (from the cut in METR's). In this policy, improvements on the intertemporal margin can be attained without increases in labor taxes (and associated labor market distortions), since the loss in revenue attributable to the lowered METR's is "financed" by new revenue from housing integration.

The welfare increase from this reform reflects increased consumption in the medium and long run, as shown in Figure 2 (for the lump-sum replacement case). In the short run, consumption is sacrificed to allow for the higher levels of investment made attractive by the METR cuts. In later periods, the higher capital stock yields larger incomes, making possible both higher investment and higher consumption (relative to the baseline).

These experiments indicate that achieving greater uniformity of capital taxation within the business sector offers relatively little scope for efficiency gains compared with the potential gains from a more even treatment across the business and housing sectors and from greater intertemporal neutrality. Substantial gains come from a policy that combines a lessening of disparities across business and housing and reduced METR's. In basic design, such a policy is the reverse of TRA86, which worsened allocation on the business-housing margin and intertemporally.

VI. SENSITIVITY ANALYSIS

Our final simulations examine the sensitivity of results to important model parameters. The parameters tested, along with their low, central, and high values, are as follows:

-- the intertemporal elasticity of substitution (σ):[35] .45, .50, 1.00
-- the goods-leisure elasticity of substitution (υ):[36] .35, .70, 1.40
-- the adjustment-cost coefficient (β):[37] .00, .19, .38
-- the structure-equipment elasticity of substitution (σ_{SE}): .5, 1.0, 2.0

Table 8 indicates the significance of these parameters for the effects of TRA86.[38] A higher value for the intertemporal elasticity of substitution gives more importance to the intertemporal margin and consequently enlarges the welfare losses from the reform.

The intratemporal elasticity of substitution between goods and leisure, (υ), regulates the potential for tax distortions on the labor-leisure margin.

A lower value of υ implies a lower labor supply elasticity. Hence with a lower υ the beneficial effect associated with TRA86's reductions in labor taxes is not as significant, and the overall welfare loss from TRA86 is greater.

Adjustment costs regulate the speed at which the economy approaches the new steady state following a policy shock. Smaller adjustment costs imply a more elastic investment function, which makes changes at the intertemporal margin more important. Since TRA86 worsens allocation on the intertemporal margin, the welfare loss from the reform is greater under low adjustment costs.[39]

The elasticity of substitution between structures and equipment (σ_{SE}) is directly related to the elasticity of demand for each capital asset. Higher values for σ_{SE} imply more elastic asset demands and a greater potential for efficiency improvements from the reduced disparities between the taxation of structures and equipment under TRA86. Welfare effects of TRA86 are indeed higher (that is, welfare losses are smaller) under higher values for σ_{SE}, but the differences across parameter values are very slight. This is consistent with the fact that the intertemporal efficiency effects of the reform are quantitatively much more significant than the static effects.

VII. CONCLUSIONS

This paper has examined efficiency effects of TRA86 and potential capital tax reforms using a model that considers in an integrated fashion the intra- and intertemporal effects of policy initiatives. We find that the overall efficiency consequences of TRA86 are negative -- that the efficiency gains from greater static neutrality within the business sector and from reduced labor taxes were more than offset by efficiency losses from heightened tax disparities between business and housing and from adverse efficiency effects on the intertemporal margin. Even if TRA86 had gone further in leveling the playing field by imposing complete static neutrality within the business sector, the gains from such an effort would not have been large enough to offset the other efficiency losses.

With regard to future reforms, our experiments indicate that there remains considerable scope for efficiency gains from greater tax neutrality on the business-housing margin and the intertemporal margin. A policy that combines housing integration with a 30 percent reduction (on average) of marginal effective tax rates is approximately revenue-neutral and yields a welfare improvement equivalent to a permanent .5 percent increase in consumption. In contrast, the potential gains from policies that would introduce further static tax neutrality within the business sector are relatively small.

These results should be kept in perspective. Our investigation abstracts from important distributional considerations. Nor does it consider potential effects that operate through international factor movements, of capital most notably. Nevertheless, our results support the notion that despite cuts in individual income tax rates, TRA86 worsened the overall efficiency of resource allocation. Moreover, they indicate that the margins offering the greatest potential for efficiency gains are different from those that received the most attention under the 1986 tax reform.

Endnotes

1. See, for example, Fullerton, Gillette, and Mackie (1987).

2. See Summers (1981) and Kotlikoff and Summers (1987).

3. For an analytical assessment of this issue, see Bovenberg (1986).

4. Jorgenson and Yun distinguish short- and long-lived capital assets. Fullerton and Henderson's model distinguishes 38 types of capital assets.

5. The distinct treatment of structures and equipment, both in demand and in their manufacture, constitutes an extension from the earlier version of the model applied in Goulder and Summers (1989).

6. The model also differs from the Fullerton-Henderson and Jorgenson-Yun models in the degree of industry disaggregation. The Fullerton-Henderson model distinguishes 18 industries, as compared with six in this model. The Jorgenson-Yun model does not specify separate industries, but distinguishes three sectors (household, corporate, and non-corporate).

7. In Goulder (1989), the model was employed to assess effects of components of the 1986 tax reform on housing investment and house values.

8. Fullerton and Lyon (1988) evaluate stocks of intangible capital and assess related interasset distortions.

9. The innovative model of Gravelle and Kotlikoff (1989) incorporates such distinctions.

10. Industry outputs are transformed into consumer goods according to a fixed-coefficient matrix. This transformation is necessary because the categories for production data differ from those of consumer expenditure data.

11. Each of the 17 consumption categories is a CES composite of domestically produced and foreign made goods in that category. Households choose the intensities of domestic and foreign goods in each composite in accordance with utility maximization.

12. Public goods are not included in the household's utility function. This reflects the difficulty of assessing household's utility from (or demand for) public goods. The omission is innocuous for welfare evaluations if public and private goods are separable in utility and if the supply of public goods is kept constant across experiments.

13. By Walras's Law, the required number of equilibrating variables is one less than the number of equilibrium conditions. The numeraire is the nominal wage, which is specified as growing exogenously at an annual rate of 4 percent. The growth rate of nominal wages determines the steady-state inflation rate, although the growth rates of all prices other than the wage rate are endogenous during the transition. Incorporating inflation in the

model enables us to capture non-neutralities of the U.S. tax system with respect to the rate of inflation. The non-neutral features include deductibility of nominal interest payments and depreciation deductions based on historical cost.

14. In general, the growth path of the economy approaches the balanced growth path well before the 75th period. Solving the model for a larger number of periods does not perceptibly change the results. The terminal conditions -- the expectations held in the final period -- are calculated by solving the model under steady-state constraints.

15. Although the model distinguishes owner-occupied, non-corporate rental, and corporate rental housing, it does not endogenize tenure choice, and thus the shares of the total housing stock devoted to each type of housing are exogenous. Tax rates applicable to housing services demands and housing investment decisions are weighted averages of the rates applying to each of the three types of housing. Berkovac and Fullerton (1989) develop a static general equilibrium model with endogenous tenure choice.

16. We estimate the total hours worked of the representative consumer at 40 hours/week, 48 weeks/year, for a total of 1920 hours. Total potential labor time is 4638 hours, following from the assumption that the consumer could work at most 12 hours per day and 7 days per week for all 52 weeks of the year.

17. Estimates for the elasticity tend to fall in the range from 0 to .08. See Hall (1988) for discussion of estimation issues and results.

18. The cost of capital approach was pioneered by Hall and Jorgenson (1967). King and Fullerton (1984) extend this approach by considering personal taxes and distinguishing effective tax rates at the levels of the firm and household.

19. See, for example, Sinn (1987), chapter 2.

20. Other calculations of METR's before and after the 1986 tax reform are contained in Henderson (1986) and Fullerton, Gillette, and Mackie (1987).

21. Annual geometric depreciation allowances fall from 12 percent to 4 percent for structures, and from 30 percent to 26 percent for equipment: they remain substantially above economic depreciation (Table 2), but not enough to offset the erosion of the historical basis. By lowering the CIT, TRA86 reduces the present value of depreciation credits from .29 to .12 for structures, and from .39 to .28 for equipment.

We do not model the tightening of accounting rules. Fullerton, Gillette, and Mackie (1987) indicate that the omission is not significant for economy-wide results, although it may be important for particular industries.

22. Similar short- and long-run effects on business-sector and housing-sector investment were obtained by Goulder and Summers (1989) and Goulder (1989).

23. Contrasting effects on investment and asset prices were also obtained in the simpler model of Goulder and Summers (1989).

24. This means that TRA86 lowers intertemporal utility by the same amount as would the permanent reduction of benchmark full consumption by .20 percent each year.

25. In the TRA86 simulations, annual budget balance is obtained through lump-sum adjustments to household income taxes.

26. We always compare steady-state METR's. Marginal effective rates during the transition can differ from the steady-state values, as they depend on current interest rates, prices, and marginal products. However, their variation over time is in fact quite small.

27. More precisely, we alter the ITC's on each asset and in each use so that the following two conditions are satisfied: (1) the mean pre-tax return is equal to the mean pre-tax return after the 1986 tax reform, and (2) for all assets and in every use, the absolute change from the benchmark in the pre-tax return is the same. This approach therefore concentrates on maintaining the dispersion of tax *wedges* rather than tax *rates*. This is most consistent with maintaining a given degree of static neutrality.

28. The sum of the effects of component policies 2a(i) and 2a(ii) is very close to the effects of the policy that combines them (2a); this indicates that there is relatively little interaction among the policy components.

29. In Jorgenson and Yun (1989), TRA86 yields a welfare gain under all parameter specifications except the case of 10 percent (high) inflation with lump-sum revenue replacement. In Fullerton, Henderson, and Mackie (1987), TRA86 improves welfare except in cases involving low substitution across assets.

30. We choose to perform experiments based on the new steady state rather than on any of the early transition years in order to distinguish the effects of the experiments from changes in economic magnitudes that are still due to TRA86. For the sake of comparison with earlier results, the dollar amounts will continue to be expressed in 1983 units.

31. Interestingly, this corresponds exactly to the difference between TRA86 and the experiment presented in IV.3.

32. As before, we achieve equality in the METR's by altering the ITC's on structures and equipment in the various sectors and industries.

33. In addition, homeowners can deduct interest costs and property taxes from individual income taxes.

34. Homeowners here can also deduct interest, maintenance, and property tax expenses at the same rate as that applied by noncorporate landlords.

35. Calibration with a smaller intertemporal elasticity of substitution yields implausible values for the rate of time preference.

36. The corresponding elasticities of labor supply, at benchmark prices and quantities, are -.08, .15, and .61.

37. The adjustment cost function is described in appendix C.

38. When the intertemporal elasticity of substitution or the adjustment cost parameters are changed, the baseline economic path changes. Welfare effects are based on a comparison of policy results with the results under the corresponding baseline.

39. The implication of lower adjustment costs for the overall efficiency impact of TRA86 is analytically ambiguous. Lower adjustment costs imply larger intertemporal efficiency losses but may allow for greater static efficiency improvements as well. Further decomposition experiments performed in the low and high adjustment cost cases confirm that the adverse efficiency effects on the intertemporal margin more than offset the positive efficiency effects on the intersectoral margin.

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Table 1

Relationships among Industries and Types of Capital

Industry	Capital used	Industry producing the capital
Housing services	Residential structures	Resid. construction
	Equipment	Manufacturing
All others	Non-resid. structures	Non-resid. construction
	Equipment	Manufacturing

Table 2
Benchmark Parameter Values

Industry	(1)	(2)	(3)	(4)	(5)	(6)
Dividend payout ratio (a)	0.700	0.490	0.586	0.400	0.328	1.000
Debt-capital ratio (b)	0.176	0.221	0.515	0.080	0.080	0.787
Rate of economic depr. (δ^R)						
Structures	0.041	0.034	0.028	0.027	0.027	0.013
Equipment	0.140	0.133	0.149	0.170	0.170	0.110
Elasticity of substitution						
Capital-labor	0.676	0.800	0.800	0.800	0.800	0.700
Structures-equipment (σ_{SE})	1.000	1.000	1.000	1.000	1.000	1.000
Growth rate of effective labor services (g) (steady-state real growth rate)				0.020		
Growth rate of nominal wages (π_0) (steady-state inflation rate)				0.040		
Intertemporal elasticity of substitution (σ)				0.500		
Rate of time preference (ω)				0.007		
Goods-leisure elasticity of substitution (υ)				0.694		

Table 3
Benchmark and TRA86 Values for Industry Tax Parameters

	Benchmark	TRA86
Present value of depr. allowances (z)		
Structures: Business	0.566	0.304
Residential	0.566	0.339
Equipment	0.764	0.731
Corporate income tax rate[1] (τ)	0.507	0.385
Effective capital gains tax rate[2] (κ)	0.026	0.057
Marginal income tax rates		
Labor income (θ_L)	0.259	0.230
Capital income (θ)	0.262	0.229
Property tax rates[3]		
Nonresidential	0.009	0.009
Residential	0.011	0.011
Investment tax credit (k)		
Structures, Services industry	0.064	0.000
Structures, Other industries	0.000	0.000
Equipment		
1. Agriculture	0.085	0.000
2. Manufacturing	0.096	0.000
3. Services	0.091	0.000
4. Non-res. Construction	0.094	0.000
5. Res. Construction	0.097	0.000
6. Housing Services	0.000	0.000

[1]Federal, State and local tax, from Jorgenson and Yun (1990b).

[2]Estimated as $(1/4)\cdot(1\text{-exclusion})\cdot\theta$, following Bailey (1969).

[3]From Buckley and Simonson (1987).

Table 4

Marginal Effective Total Tax Rates[1]

Industry	Benchmark Struc.	Benchmark Equip.	TRA86[2] Struc.	TRA86[2] Equip.
1. Agriculture and mining	37.2	26.6	36.1	33.1
2. Manufacturing	31.1	18.6	32.1	29.5
3. Services	13.2	5.1	25.3	24.6
4. Nonresid. construction	32.9	24.6	32.8	33.7
5. Residential construction	31.6	22.7	32.0	33.0
6. Housing services	7.8	8.3	9.3	9.3
Mean, business sector (industries 1-5):	21.3	12.1	28.7	27.3
Mean, business and housing sectors (all industries):	12.7	11.8	16.4	25.7
Mean, business sector, all assets:	16.6		28.0	
Mean, business and housing sectors, all assets:	12.5		19.1	
Standard deviation, all assets:	8.7		9.8	

[1]In percentage points.

[2]These rates correspond to the steady state. They are slightly different in the transition years: for example, the mean METR's are 16.6 for structures and 27.2 for equipment, or 19.7 for all assets, in the first year of the transition.

Table 5

Impact of 1986 Reform on Investment and Asset Prices[1]

Industry	Investment SR	Investment LR	Asset Price[1] SR	Asset Price[1] LR
Agriculture	-1.0	-3.1	20.3	21.8
Manufacturing	-4.7	-8.7	15.8	27.3
Services	-7.6	-12.6	22.3	52.5
Non-residential Construction	-4.9	-8.9	10.4	21.8
Residential Construction	-3.3	-8.2	14.3	22.3
Housing Services	1.6	-1.6	9.4	7.1
Total	-4.1	-8.2	13.9	20.8

[1]Percentage changes from 1983 base case.

[2]This is defined as the ratio of the equity value to the replacement cost of the stock of capital.

Table 6

Elements and Effects of the 1986 Tax Reform

	Present Value of Revenue Change (1983 $bn)	Equivalent Variation[1]	
		Transition Considered	Steady-state Comparison
1. Full Reform	-1093	-.20 (-3.55)	-.73 (-12.82)
2. Decomposition of Full Reform			
a. TRA86 "Leveling"	15	-.05 (-.81)	.01 (.09)
of which:			
(i) within business sector	87	.06	.10
(ii) betw. business & housing	-70	-.11	-.09
b. TRA86 Increase in Average METR's	622	-.47 (-8.25)	-1.18 (-20.65)
c. TRA86 Reduction in Labor Taxes	-1517	.29 (5.01)	.42 (7.24)
d. Total [(a) + (b) + (c)]	-880	-.23 (-4.05)	-.76 (-13.32)
3. TRA86 Plus Full Business Sector Leveling	-1089	-.15 (-2.69)	-.65 (-11.26)

[1]The top figure in each pair is the equivalent variation as a percentage of the present value of full consumption. It is equal to the change in annual full consumption that would yield the same welfare change as the reform. From the household's intertemporal budget constraint, the present value of full consumption is equal to the sum of the household's financial wealth and human wealth (where human wealth is the present value of the household's labor income and leisure time). The figures in parentheses express the equivalent variation as a percentage of financial wealth alone.

Figure 1

Decomposition of 1986 Tax Reform:
Consumption Dynamics

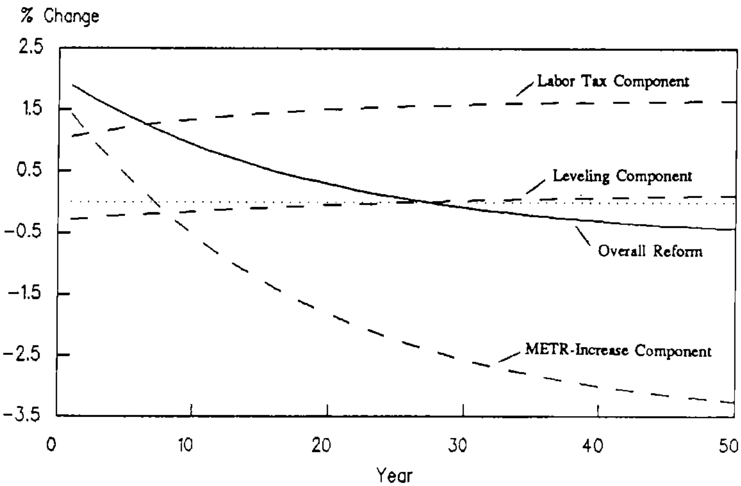

Figure 2

Further "Leveling" Initiatives:
Implications for Consumption

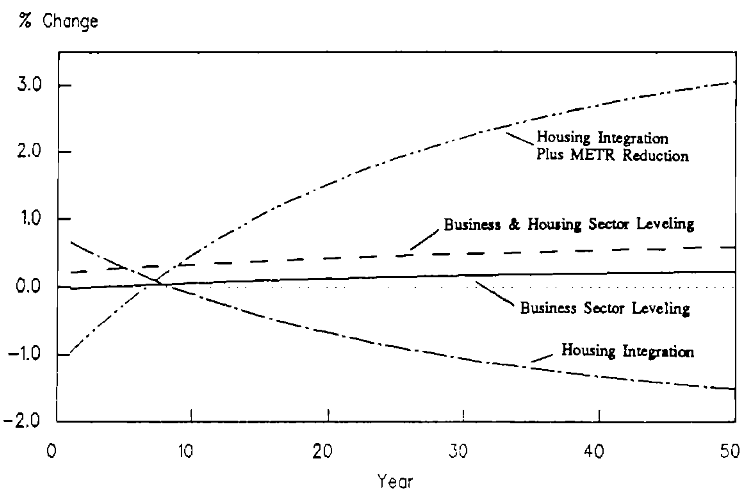

Table 7

Effects of Further "Leveling" Initiatives

	Structures Investment		Equipment Investment		Real GDP		Welfare[1]
	SR	LR	SR	LR	SR	LR	
1. Full Leveling within Business Sector							
a. Lump-Sum Tax Replacement	.65	.88	-.37	-.39	-.01	.10	.05
b. Labor Tax Replacement	.45	.91	-.42	-.36	-.07	.13	.05
2. Full Leveling of Business and Housing Sectors							
a. Lump-Sum Tax Replacement	-6.70	.55	2.54	6.64	-.06	1.05	.23
b. Labor Tax Replacement	-6.40	.59	2.65	6.68	8.07	1.08	.22
3. Housing Integration							
a. Lump-Sum Replacement	-7.63	-4.77	-.22	-.39	-.17	-1.00	.16
b. Labor Tax Replacement	-8.83	-3.87	-.50	.46	-.24	-.17	.01
4. Housing Integration Plus Revenue-Preserving Cut in METR'S							
a. Lump-Sum Replacement	7.70	8.31	3.03	7.04	.28	2.67	.45
b. Labor Tax Replacement	3.54	8.73	1.63	7.41	-1.04	3.03	.46

[1]Equivalent variation as percent of the present value of full consumption. Figures account for the transition as well as the new steady state.

Table 8

Sensitivity Analysis: The 1986 Tax Reform

	Present Value of Revenue Change (1983 $bn)	Equivalent Variation[1] as Percent of Present Value of Full Consumption	Equivalent Variation[1] as Percent of Financial Wealth
1. Central Case	-1093	-.20	-3.55
2. Intertemporal Elasticity of Substitution (σ)			
low	-983	-.16	-2.31
high	-1972	-.29	-9.51
3. Goods-Leisure Elasticity of Substitution (υ)			
low	-1376	-.30	-6.20
high	-1036	-.17	-.18
4. Adjustment Costs (β)			
low (zero)	-1243	-.26	-4.27
high	-890	-.12	-2.26
5. Structures-Equipment Elast. of Substitution (σ_{SE})			
low	-925	-.22	-3.44
high	-1224	-.20	-3.54

[1]Incorporating the transition.

APPENDIX TO:

Approaches to Efficient Capital Taxation:

Leveling the Playing Field vs. Living by the Golden Rule

A. THE MODEL OF THE FIRM

1) Returns and Equity Values

The following derivation of the value of a representative firm and the investment decision of its manager is the same for all industries in the business (non-residential) sector. For convenience, the industry index is omitted here.

The determination of the equity value of the firm stems from the arbitrage condition according to which shareholders must be able to earn the same return on equity as they could earn on bonds. The return from holding equity is the sum of after-tax capital gains and dividends:

$$(1-\theta)i_t = r_t = (1-\kappa)(V_{t+1}-V_t+SR_t)/V_t + (1-\tau_A)DIV_t/V_t \tag{A1}$$

where

- i is the interest paid on debt,
- θ is the personal income tax rate on interest income,
- κ is the effective personal income tax rate on capital gains,
- V is the equity-value of the representative firm at the beginning of the year (BoY),
- SR are share repurchases (SR<0 should be interpreted as new shares issues),
- DIV is dividend payments at the end of the year (EoY), and
- τ_A is the personal income tax rate applying to dividends.

Integrating the arbitrage condition subject to a transversality condition ruling out speculative bubbles yields an expression for the value of the firm as the present value of dividends plus share repurchases:

$$V_t = \sum_{s=t}^{\infty}\left[\frac{1-\tau_A}{1-\kappa}\cdot DIV_s + SR_s\right]\mu_t(s) \qquad \text{(A2)}$$

$$\mu_t(s) = \prod_{u=t}^{s}\left[1 + \frac{r_u}{1-\kappa}\right]^{-1} \qquad \text{(A3)}$$

The division of the tax on dividends and the discount rate by $1-\kappa$ reflects the fact that equity is "trapped" in the firm: it cannot be returned to shareholders without paying, at least, capital gains taxes.

For the firms' financial behavior we assume the "traditional view": firms pay dividends equal to a fixed fraction a of net profits, and they maintain a fixed ratio b of debt to the replacement value of their capital. Poterba and Summers (1984) compare this view of corporate finance with other views and present some evidence in its favor. The "traditional view" implies that, at the margin, investment is financed by new debt issue, by current earnings, and, as necessary, by new share issue. It also implies that the marginal dollar earned by the firm is "paid out" to shareholders as a capital gain.

Thus, dividends are a fixed proportion of profits net of the inflationary appreciation of the capital stock and its economic depreciation:

$$DIV_s = a\Pi_s + a\sum_{j=S,E}[(p^j_{Ks} - p^j_{Ks-1})K^j_s - \delta^{Rj}p^j_{Ks}K^j_s] \qquad \text{(A4)}$$

where

j is the index for capital types (S=structures, E=equipment),

a is the proportion of dividends in net profits,

Π is the after-tax profit,

p_K is the price of capital goods,

K is the stock of capital, and

δ^R is the (geometric) rate of economic depreciation.

All prices and flows are defined as EoY; stocks are BoY. Define A as the value of sales minus labor and material costs:

$$A_s = p_s f\left(g[h(K_s^S, K_s^E), L_s], M_s\right) - w_s L_s - p_{Ms} M_s \qquad (A5)$$

where

L is the input of labor,

M is a vector of intermediate inputs,

p is the output price (net of sales tax),

w is the wage rate (inclusive of payroll tax),

p_M is the vector of intermediate input prices (gross of intermediate input taxes),

h(·) is a CES function which aggregates the two types of capital,

g(·) is a CES value-added function, and

f(·) combines value-added and intermediate inputs in fixed proportions.

Profits after taxes and interest payments are given by:

$$\Pi_s = (1-\tau_B)\left[A_s - p_s \sum_j \Phi^j\left(\frac{I}{K}\right)_s^j \cdot I_s^j\right] - (1-\tau_C)(i_s DEBT_s + PROPTX_s) + \tau_B D_s \qquad (A6)$$

where

τ_B is the tax rate applying to profits,

τ_C is the tax rates applying to the deduction of interest payments and property taxes,

Φ is a capital-type specific adjustment cost, a convex function of the ratio of investment to the capital stock, and

D is the value of current depreciation allowances.

Adjustment costs are modeled as internal to the firm: higher rates of investment imply a loss of output. The notion is that in order to install new capital, resources must be diverted from producing the firm's output.

$$DEBT_s = \sum_j b p^j_{Ks-1} K^j_s \tag{A7}$$

$$PROPTX_s = \sum_j c p^j_{Ks-1} K^j_s \tag{A8}$$

$$D_s = \sum_j \delta^{Tj} KDEP^j_s \tag{A9}$$

where

b is the constant (sector specific) debt-to-capital ratio,

c is the property tax rate,

δ^T is the geometric equivalent of the rate of tax depreciation, and

KDEP is the depreciable stock of capital at historical costs.

Share repurchases in (A2) are given by the cash-flow identity that equates sources and uses of funds:

$$\Pi_s + BN_s = IEXP_s + DIV_s + SR_s \tag{A10}$$

where BN is the increment to debt, and IEXP is the net expenditure for investment (adjustment costs are counted separately in (A6)). These are defined as

$$BN_s = DEBT_{s+1} - DEBT_s = \sum_j b(p^j_{Ks} K^j_{s+1} - p^j_{Ks-1} K^j_s) \tag{A11}$$

$$IEXP_s = \sum_j (1-k^j) p^j_{Ks} I^j_s \tag{A12}$$

where k is the rate of the investment tax credit. Substitute (A11) and (A12) into (A10) and transform it so that

$$\frac{1-\tau_A}{1-\kappa} DIV_s + SR_s = \Pi_s + BN_s - \left(1 - \frac{1-\tau_A}{1-\kappa}\right) DIV_s - IEXP_s$$

$$= (1-\nu)\Pi_s + \sum_j b(p^j_{Ks} K^j_{s+1} - p^j_{Ks-1} K^j_s)$$

$$- \nu \sum_j (p^j_{Ks} - p^j_{Ks-1} - \delta^{Rj} p^j_{Ks}) K^j_s - \sum_j (1-k^j) p^j_{Ks} I^j_s \qquad \text{(A13)}$$

$\nu = a[1 - (1-\tau_A)/(1-\kappa)]$ is the effective tax for shareholders who receive the proportion a of their return in the form of dividends: $1-\nu = [a(1-\tau_A)+(1-a)(1-\kappa)]/(1-\kappa)$. Substituting (A13) into expression (A2) for the equity-value of the firm yields:

$$V_t = \sum_{s=t}^{\infty} \Big\{ (1-\nu)(1-\tau_B) A_s + (1-\nu)\tau_B D_s - \sum_j \Big[(1-\nu)(1-\tau_C)(i_s b+c) p^j_{Ks-1} K^j_s$$

$$- b[p^j_{Ks} K^j_{s+1} - p^j_{Ks-1} K^j_s] + \nu[(1-\delta^{Rj}) p^j_{Ks} K^j_s - p^j_{Ks-1} K^j_s] + (1-k^j) p^j_{Ks} I^j_s$$

$$+ (1-\nu)(1-\tau_B) p_s \Phi^j \cdot I^j_s \Big] \Big\} \mu_t(s) \qquad \text{(A14)}$$

Under the specification for production in (A5), the manager who maximizes the value of the firm can determine optimal levels of labor and intermediate inputs in each year with a view to maximizing current A. As the stock of capital and all prices are given, these choices depend only on current conditions. The same is not true for investment, because investment adds to durable capital and thereby affects returns in all future periods. Hence the investment decision is a fundamentally intertemporal problem.

The business sectors are assumed to be fully corporate, so

$$\tau_A = \theta \qquad \tau_B = \tau \qquad \tau_C = \tau$$

where τ is the corporate income tax rate. θ and τ need not be constant over time.

2) The Housing Sector

Residential services are supplied in the form of owner-occupied, landlord and corporate rental housing, in proportions α_1, α_2, and α_3, respectively. The tax code treats these forms of ownership differently. We assume that the services of owner-occupied and rental housing are perfect substitutes, that all types of owners maintain the same financial policy, and that the shares α are constant. Under these conditions, the three subsectors can be combined into a single one by simple addition of stocks and flows.

The arbitrage condition for the housing sector is

$$r_t = (1-\kappa)(V_{t+1}-V_t+H^*_t)/V_t + (1-\tau_A)H_t/V_t \qquad \text{(A1')}$$

The housing sector is assumed to pay out all of its net product in "dividends" (housing services), and not to repurchase shares. H is the net service flow that is taxed as income when the owners are corporations that pay dividends. H^* is the remainder of financial income that is not subject to any income tax.

By integration of (A1'), the value of housing equity is

$$V_t = \sum_{s=t}^{\infty}\left[\frac{1-\tau_A}{1-\kappa} H_s + H^*_s\right]\mu_t(s) \qquad \text{(A2')}$$

where

$$H_s = (1-\tau_B)\left[A_s - p_s\sum_j \Phi^j\left(\frac{I}{K}\right)^j_s \cdot I^j_s\right] - (1-\tau_C)(i_s DEBT_s + PROPTX_s) + \tau_B D_s$$

$$+ \sum_j[(p^j_{Ks}-p^j_{Ks-1})K^j_s - \delta^{Rj}p^j_{Ks}K^j_s] \qquad \text{(A6')}$$

$$H^*_s = BN_s - IEXP_s - \sum_j[(p^j_{Ks}-p^j_{Ks-1})K^j_s - \delta^{Rj}p^j_{Ks}K^j_s] \qquad \text{(A6'')}$$

and $\mu_t(s)$ is defined as before. The last term in both expressions above represents the nominal appreciation and real depreciation of the stock of capital over the period. It appears in H because corporations adjust their dividend according to that term, and it is deducted from H^* because it is not a financial flow to owners. This parallels the treatment in the business sectors.

Replacing (A6′) and (A6″) in (A2′) yields the same expression as (A14); hence we need not distinguish the housing sector from the business sector in the subsequent derivations. Note that $1-\nu = (1-\tau_A)/(1-\kappa)$, since $a = 1$ for the housing sector. The effective tax rates are:

$$\tau_A = \alpha_3\theta \qquad \tau_B = \alpha_2\theta + \alpha_3\tau \qquad \tau_C = (\alpha_1+\alpha_2)\theta + \alpha_3\tau$$

3) Investment

The present value of depreciation deductions in (A14), $\sum\tau_B D_s\mu$, can be split into $\sum Z^j_s p^j_{Ks} I^j_s\mu$, the present value of allowances on current and future investments, and B_t, the accrued allowances on existing capital. This enables us to write:

$$V_t = \sum_{s=t}^{\infty}\Bigg\{(1-\nu)(1-\tau_B)A_s - \sum_j\Big[(1-\nu)(1-\tau_C)(i_s b+c)p^j_{Ks-1}K^j_s$$

$$- b[p^j_{Ks}K^j_{s+1} - p^j_{Ks-1}K^j_s] + \nu[(1-\delta^{Rj})p^j_{Ks}K^j_s - p^j_{Ks-1}K^j_s]$$

$$+ (1-k^j-(1-\nu)Z^j_s)p^j_{Ks}I^j_s + (1-\nu)(1-\tau_B)p_s\Phi^j\cdot I^j_s\Big]\Bigg\}\mu_t(s) + \sum_j B^j_t \qquad \text{(A15)}$$

The manager maximizes the value of the firm under the capital stock adjustment rule:

$$K^j_{s+1} = (1-\delta^{Rj})K^j_s + I^j_s \qquad \text{(A16)}$$

Write the Lagrangian as

$$
\begin{aligned}
L_t = \sum_{s=t}^{\infty} \Bigg\{ & (1-\nu)(1-\tau_B)A_s - \sum_j \Big[(1-\nu)(1-\tau_C)(i_s b+c)p^j_{Ks-1}K^j_s \\
& - (b-\nu)[(1-\delta^{Rj})p^j_{Ks} - p^j_{Ks-1}]K^j_s + [1-b-k^j-(1-\nu)Z^j_s]p^j_{Ks}I^j_s \\
& + (1-\nu)(1-\tau_B)p_s\Phi^j \cdot I^j_s \Big] \Bigg\} \mu_t(s) + \sum_j B^j_t \\
& - \sum_j \left\{ \sum_{s=t}^{\infty} \lambda^j_s [K^j_{s+1} - (1-\delta^{Rj})K^j_s - I^j_s] \mu_t(s) \right\}
\end{aligned}
\qquad \text{(A17)}
$$

The first-order conditions for optimal investment in period s are given by $\partial L_t/\partial I^j_s = 0$ and $\partial L_t/\partial K^j_{s+1} = 0$, or

$$
[1-b-k^j-(1-\nu)Z^j_s]p^j_{Ks} + (1-\nu)(1-\tau_B)p_s\left(\Phi^j + \Phi^{j\prime} \cdot \frac{I^j_s}{K^j_s}\right) = \lambda^j_s \qquad \text{(A18)}
$$

$$
\begin{aligned}
& \left\{ (1-\nu)(1-\tau_B)\left[\frac{\partial A_{s+1}}{\partial K^j_{s+1}} + p_{s+1}\Phi^{j\prime} \cdot \left(\frac{I^j_{s+1}}{K^j_{s+1}}\right)^2\right] - (1-\nu)(1-\tau_C)(i_{s+1}b+c)p^j_{Ks} \right. \\
& \left. + (b-\nu)[(1-\delta^{Rj})p^j_{Ks+1} - p^j_{Ks}] \right\} \mu_t(s+1) = \lambda^j_s\mu_t(s) - (1-\delta^{Rj})\lambda^j_{s+1}\mu_t(s+1)
\end{aligned}
\qquad \text{(A19)}
$$

Equation (A18) defines λ, the current multiplier of the stock adjustment rule, as the marginal cost of a physical unit of investment for shareholders: it is the share of the investment cost not financed by debt, net of ITC and the present value of depreciation allowances, plus the marginal adjustment cost. λ is the shadow price of capital and corresponds to marginal q. The term in high brackets in (A18) is the marginal cost of adjustment; it is equal to tax-adjusted Q. The right-hand side of equation (A19) is the total product from a marginal increase in the stock of capital in the following period; it includes a term that reflects the fact that a higher stock of capital will imply lower adjustment costs for investment in that year as they depend on the ratio of investment to the capital stock.

4) Solving for Investment

To solve for investment over the transition period, we rely on an equation obtained by regrouping terms in (A19):

$$\lambda_s^j = \left(1+\frac{r_{s+1}}{1-\kappa}\right)^{-1}[M_{s+1}^j - (1-\nu)(1-\tau_C)(i_{s+1}b+c)p_{Ks}^j - (b-\nu)p_{Ks}^j] \qquad \text{(A19}'\text{)}$$

with:

$$M_{s+1}^j = (1-\delta^{Rj})\lambda_{s+1}^j + (1-\nu)(1-\tau_B)\left[\frac{\partial A_{s+1}}{\partial K_{s+1}^j} + p_{s+1}\Phi^{j\prime}\cdot\left(\frac{I_{s+1}^j}{K_{s+1}^j}\right)^2\right]$$

$$+ (b-\nu)(1-\delta^{Rj})p_{Ks+1}^j \qquad \text{(A20)}$$

To solve for investment, we first calculate the steady-state values for M by solving the model under steady-state constraints. We next employ an iterative procedure to determine the correct values for each M_{s+1} (s=1,...,T-1) during the transition. The first step of the iterative procedure is to posit values for each M_{s+1} and run the model with these posited values. That generates λ_s (from A19′). Inversion of the marginal adjustment cost function in (A18) then yields the level of investment. Temporal equilibrium is achieved when prices and investment levels equilibrate the excess demands for goods and funds. Each period's equilibrium generates an "actual" value for M_s, from (A20). Intertemporal equilibrium requires that actual values of M be the same as those which were posited to obtain them. We iterate on the posited values M_{s+1} until that condition is satisfied.

When there are no adjustment costs, equation (A18) cannot be inverted to yield the investment level. Rather, investment is only driven by the desire to bring today's stock of capital immediately to tomorrow's desired level. Thus we rewrite the value of the firm in terms of capital stocks only, using the stock adjustment rule to eliminate the investment variable:

$$I^j_s = K^j_{s+1} - (1-\delta^{Rj})K^j_s \tag{A16'}$$

$$V_t = \sum_{s=t}^{\infty}\Big\{(1-\nu)(1-\tau_B)A_s - \sum_j \Big[(1-\nu)(1-\tau_C)(i_s b+c)p^j_{Ks-1}K^j_s + (b-\nu)p^j_{Ks-1}K^j_s$$
$$- [1-b-k^j-(1-\nu)Z^j_s]p^j_{Ks}K^j_{s+1} - [1-k^j-(1-\nu)Z^j_s-\nu](1-\delta^{Rj})p^j_{Ks}K^j_s\Big]\Big\}\ \mu_t(s)$$
$$+ \sum_j B^j_t \tag{A21}$$

The manager chooses next year's level of capital to maximize the equity value of the firm:

$$\frac{\partial V_t}{\partial K_{s+1}} = \Big[(1-\nu)(1-\tau_B)\frac{\partial A_{s+1}}{\partial K^j_{s+1}} - (1-\nu)(1-\tau_C)(i_{s+1}b+c)p^j_{Ks} - (b-\nu)p^j_{Ks}$$
$$+ [1-k^j-(1-\nu)Z^j_s-\nu](1-\delta^{Rj})p^j_{Ks+1}\Big]\ \mu_t(s+1) + \lambda^j_s p^j_{Ks}\mu_t(s) = 0 \tag{A22}$$

$$\lambda^j_s = 1 - b - k^j - (1-\nu)Z^j_s \tag{A23}$$

To solve for investment over the transition, rewrite (A22) to group forward variables:

$$\Big[(1-\nu)(1-\tau_C)(i_{s+1}b+c)p^j_{Ks} + (b-\nu)p^j_{Ks} - \Big(1+\frac{r_{s+1}}{1-\kappa}\Big)\lambda^j_s p^j_{Ks}\Big]\cdot K^j_{s+1} = M^j_{s+1} \tag{A22'}$$

with

$$M^j_{s+1} = \left[(1-\nu)(1-\tau_B)\frac{\partial A_{s+1}}{\partial K^j_{s+1}} + [1-k^j-(1-\nu)Z^j_s-\nu](1-\delta^{Rj})p^j_{Ks+1}\right]\cdot K^j_{s+1} \tag{A24}$$

As before, we first posit values for M_{s+1}; the model solves simultaneously for current prices, the forward interest rate and investment given by K_{s+1} via (A16′); then it calculates the actual M_s, and iterates the transition path until all guessed M are equal to the derived actual M.

5) Integrating the First-Order Conditions

The marginal cost of investment must be compared with the present value of all extra returns made possible by the higher stock of capital, starting in the period following that of investment. An expression for the value of future returns can be obtained as follows. First, multiply both sides of (A19) by the integration factor $(1-\delta^{Rj})^{s-t}$ and by $[1+r_t/(1-\kappa)]$ to transform the discount factor to one that actualizes returns to the end of period t where the investment is made. Add up the resulting equations for $s=t,\ldots,\infty$:

$$\sum_{s=t}^{\infty}\left\{(1-\nu)(1-\tau_B)\left[\frac{\partial A_{s+1}}{\partial K^j_{s+1}} + p_{s+1}\Phi^{j\prime}\cdot\left(\frac{I^j_{s+1}}{K^j_{s+1}}\right)^2\right] - (1-\nu)(1-\tau_C)(i_{s+1}b+c)p^j_{Ks} + \right.$$
$$\left. + (b-\nu)[(1-\delta^{Rj})p^j_{Ks+1}-p^j_{Ks}]\right\}(1-\delta^{Rj})^{s-t}\mu_{t+1}(s+1) = \lambda^j_t \tag{A25}$$

We assume that the nested production functions in A (equation A5) are linear homogeneous and that firms are price-takers in all markets. The adjustment cost function is also homogeneous. Under these assumptions, the total marginal product of capital, which is equal to λ by (A25), is also equal to the average product of capital. Multiply both sides of (A18) by I^j_s; rewrite (A19) for $\partial L_t/\partial K^j_s$ and multiply both sides by $K^j_s/\mu_t(s)$.

Subtract the first equation from the second to obtain

$$(1-\nu)(1-\tau_B)\frac{\partial A_s}{\partial K_s^j}\cdot K_s^j - (1-\nu)(1-\tau_C)(i_s b+c)p_{Ks-1}^j K_s^j + (b-\nu)[(1-\delta^{Rj})p_{Ks}^j - p_{Ks-1}^j]K_s^j$$

$$- [1-b-k^j-(1-\nu)Z_s^j]p_{Ks}^j I_s^j - (1-\nu)(1-\tau_B)p_s\Phi^j\cdot I_s^j$$

$$= \left(1+\frac{r_s}{1-\kappa}\right)\lambda_{s-1}^j K_s^j - \lambda_s^j[(1-\delta^{Rj})K_s^j+I_s^j] \qquad \text{(A26)}$$

On the right-hand side use the capital accumulation rule (A16). Add equations (A26) for j = S,E and use the homogeneity assumptions. This yields:

$$(1-\nu)(1-\tau_B)A_s - \sum_j\Big[(1-\nu)(1-\tau_C)(i_s b+c)p_{Ks-1}^j K_s^j - (b-\nu)[(1-\delta^{Rj})p_{Ks}^j - p_{Ks-1}^j]K_s^j$$

$$+ [1-b-k^j-(1-\nu)Z_s^j]p_{Ks}^j I_s^j + (1-\nu)(1-\tau_B)p_s\Phi^j\cdot I_s^j\Big]$$

$$= -\sum_j\left[\lambda_s^j K_{s+1}^j - \left(1+\frac{r_s}{1-\kappa}\right)\lambda_{s-1}^j K_s^j\right] \qquad \text{(A27)}$$

The left-hand side is the return to shareholders in each year as it appears in the expression of V_t in equation (A17). Multiply (A27) by the integrating factor $\mu_t(s)$ and add up for $s = t,\ldots,\infty$:

$$V_t = \lambda_{t-1}^S K_t^S + \lambda_{t-1}^E K_t^E + B_t^S + B_t^E \qquad \text{(A28)}$$

Thus, the value of the firm equals the sum of the shadow value of each type of capital times its stock plus the value of accumulated depreciation allowances for each stock of capital.

6) Marginal Effective Tax Rates

The firm invests up to the point where the net cost of the last unit of investment is equal to the present value of all future returns on the marginal unit; see equations (A18) and (A25). Earnings are discounted at the shareholders' required rate of return, r_u for $u = t,\ldots,\infty$. Define $\bar{r}$, the constant discount rate that yields the same present value of returns. $\bar{r}^j$ is the private internal rate of return to shareholders on asset j.

The total cost of physical investment should account for the opportunity cost to bondholders as well as equity owners, and the returns should account for future interest payments (see Gravelle, 1985, and Fullerton, 1985). Bondholders contribute

bp_{Kt} in year t

$b[(1-\delta^{Rj})p^j_{Ks}-p^j_{Ks-1}](1-\delta^{Rj})^{s-t-1}$ in year $s \geq t+1$

They earn

$(1-\theta)i_s bp^j_{Ks-1}(1-\delta^{Rj})^{s-t-1}$ in year $s \geq t+1$

The internal rate of return to investors, r^{j*} for asset j, is defined as the constant discount rate that equates the stream of adjusted earnings with the adjusted cost:

$$\sum_{s=t+1}^{\infty}\left\{(1-\nu)(1-\tau_B)\left[\frac{\partial A_s}{\partial K^j_s} + p_s\Phi^{j\prime}\cdot\left(\frac{I^j_s}{K^j_s}\right)^2\right] - (1-\nu)(1-\tau_C)cp^j_{Ks-1}\right.$$
$$\left. + [(1-\theta)-(1-\nu)(1-\tau_C)]i_s bp^j_{Ks-1} - \nu[(1-\delta^{Rj})p^j_{Ks}-p^j_{Ks-1}]\right\}\cdot\frac{(1-\delta^{Rj})^{s-t-1}}{(1+r^{j*})^{s-t}}$$
$$= [1-k^j-(1-\nu)Z^j_t]p^j_{Kt} + (1-\nu)(1-\tau_B)p_t\left(\Phi^j + \Phi^{j\prime}\cdot\frac{I^j_t}{K^j_t}\right) \quad \text{(A29)}$$

$\bar{r}^j$ and r^{j*} are equal when the return required by investors on their shares is the same as the return they require on their bonds. To calculate social costs and returns, set all taxes and subsidies to zero in (A29). The social internal rate of return R^{j*} is the discount rate that equates the pre-tax returns and cost of the marginal investment. It is evaluated at the same level of investment:

$$\sum_{s=t+1}^{\infty}\left\{\frac{\partial A_s}{\partial K_s^j} + p_s \Phi^{j\prime} \cdot \left(\frac{I_s^j}{K_s^j}\right)^2\right\} \cdot \frac{(1-\delta^{Rj})^{s-t-1}}{(1+R^{j*})^{s-t}} = p_{Kt}^j + p_t\left(\Phi^j + \Phi^{j\prime} \cdot \frac{I_t^j}{K_t^j}\right) \qquad \text{(A30)}$$

The marginal effective total tax rate for investment of type j (in the sector under consideration) with perfect foresight is:

$$METR^j = (R^{j*} - r^{j*}) / R^{j*} \qquad \text{(A31)}$$

METR depends on the level of investment I_t^j and the investment rate through variable marginal products of capital and adjustment costs. Other terms in (A30) and (A31), such as prices and the interest rate paid on debt, are likely to change from one transition year to the other. Thus, METR's will not be constant over time but rather will converge gradually to a steady-state level. However, the experiments performed for this paper show that METR's are very close to their steady-state level from the first year.

Mean METR's are averages of the METR's weighted by the net capital stock of each asset, as in King and Fullerton (1984).

B. DATA DOCUMENTATION

The input-output (I-O) matrix describing the sales among the six industries of intermediate inputs is based on the Bureau of Economic Analysis's (BEA) detailed 1977 I-O tables. The 537x537 "use" and "make" matrices were aggregated to our categories and multiplied by each other. Then the resulting levels of sales were scaled up to 1983 using total intermediate input numbers by industry for 1977 and 1982. This extrapolation assumes that the use of all intermediate inputs by an industry increased in the same proportion, and that the proportions of each input made by each industry did not change.

The matrix transforming levels of investment in residential and non-residential structures and equipment into demands for the specific outputs of the six sectors is based on the BEA's detailed I-O "use" table and its capital flow table, both for 1977 [in Survey of Current Business, November 1985]. It is assumed that the coefficients in the matrix are the same for 1983 as for 1977.

Data on stocks of structures and equipment capital for each industry in 1983 come from BEA computer tapes. Further parameters are obtained by aggregation of detailed data, using weights from Jorgenson and Sullivan's (1981) unpublished matrix of endowments of 34 types of capital in 44 industries for 1977. Hulten and Wykoff's (1981) vector of economic depreciation rates, completed by Jorgenson and Sullivan, is aggregated to our two types of capital in six sectors. Investment tax credit rates are computed from the ITC rates for 34 types of capital in Auerbach (1983).

The ratios of debt capacities to the replacement values of capital are aggregated from Fullerton and Gordon's (1983) vector of 19 sectoral debt-capital ratios. To estimate the proportion of investment financed by debt, the industry's debt-capital ratio is applied. The same ratio is used for structures and equipment. In spite of the intuition that structures provide better collateral, we did not detect a relationship between debt and capital composition in our detailed raw data, not more than Auerbach (1985) in his data set.

The tax depreciation rates are computed as geometric rates over an infinite horizon, equivalent to the actual linear or declining balance methods in the tax code; the equivalence is defined in terms of the present value of depreciation allowances (Z). We considered the possibility that "churning" structures could allow tax savings, as discussed by Gordon, Hines and Summers (1987), but concluded that with our data firms would gain nothing from such a strategy: the recapture provisions of the tax code prove effective. Gordon, Hines and Summers found that "under current law corporations will seldom want to churn structures for tax reasons" (p.234). Adjustment costs per unit of investment take the form

$$\Phi(I/K) = \begin{cases} \frac{1}{2}\cdot\beta\cdot(I/K - \alpha)^2 / (I/K) & \text{for } I/K > \alpha \\ 0 & \text{for } I/K \leq \alpha \end{cases} \tag{B1}$$

That function was estimated by Summers (1981) for total domestic investment from a Q-investment relation over the period 1932-1978. Tax-adjusted Q is

$$Q = \Phi + \Phi'\cdot(I/K) = \beta\cdot(I/K - \alpha) \tag{B2}$$

We calibrate a function Φ for each type of capital by assuming that marginal adjustment costs are positive only for positive net investment (so $\alpha = \delta^R$); to assure that our adjustment costs add up to Summers's estimate, we set β equal to his estimate for all types of capital. Consequently, at benchmark investment-capital ratios, all of our Q's are equal to Summers's.