CBO MEMORANDUM

TWO PAPERS
ON
FUNDAMENTAL
TAX REFORM

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PREFACE

This memorandum presents two papers on fundamental tax reform prepared for a symposium sponsored by the Joint Committee on Taxation and held on January 17, 1997.

Questions about the papers may be addressed to Diane Rogers, Kent Smetters, or Jan Walliser. This memorandum and other CBO products may be found on CBO's Web site (http://www.cbo.gov).

INTRODUCTION

In the past two years, there have been a significant number of proposals for comprehensive reform of the federal tax system. The current system relies largely on a progressive tax on individual income, a tax on corporate income, and a proportional or flat tax on wages (the payroll tax that finances Social Security and Medicare) up to a taxable maximum. Most of the interest has been in reforming the income tax portion—by flattening the rate structure and eliminating many of the deductions and exclusions permitted under current law, integrating business and personal taxes, and eliminating the tax on capital income by taxing consumption instead of income.

Such proposals are put forward largely because reform is thought to offer economic benefits such as removing disincentives for saving and investment and increasing economic efficiency. Analyzing and quantifying the benefits of fundamental tax reform is challenging. Because such reform would necessarily go beyond historical experience, evidence from previous reforms would be of only limited help. Therefore, any analysis of the current proposals must also depend on theoretical models of economic behavior. Unfortunately, many theoretical issues remain unresolved, and competing economic models give different answers about the economic effects of tax reform.

This Congressional Budget Office (CBO) memorandum brings together two papers that analyze the effects of tax reform using computational economic models. The paper by Diane Rogers of CBO describes simulation results using the Fullerton and Rogers (FR) model.[1] The paper by Alan Auerbach of the University of California at Berkeley, Laurence Kotlikoff of Boston University, and Kent Smetters and Jan Walliser of CBO presents results based on a significantly enhanced version of the Auerbach and Kotlikoff model constructed by the four authors (hereafter referred to as the AKSW model).[2] Although CBO staff members wrote or cowrote both papers, the papers do not necessarily reflect the views of the Congressional Budget Office.

THE MODELING SYMPOSIUM OF THE JOINT COMMITTEE ON TAXATION

Both papers were contributions to a project organized by the Joint Committee on Taxation (JCT). In a yearlong effort to learn more about the economic modeling of tax policies, the JCT gathered together a number of modeling experts who were asked to examine certain hypothetical but carefully specified fundamental tax reforms. The culmination of that project was a symposium held on January 17, 1997, at which the modelers presented their findings. They and other economists then discussed the similarities, differences, and policy implications of those results.

1. See the appendix to this memorandum and also Don Fullerton and Diane Lim Rogers, *Who Bears the Lifetime Tax Burden?* (Washington, D.C.: Brookings Institution, 1993).

2. Alan J. Auerbach and Laurence J. Kotlikoff, *Dynamic Fiscal Policy* (Cambridge, England: Cambridge University Press, 1987).

Besides the two models discussed in this memorandum, other models were presented at the JCT symposium by Roger Brinner of Data Resources, Inc./McGraw-Hill; Eric Engen of the Federal Reserve Board; Jane Gravelle of the Congressional Research Service; Joel Prakken of Macroeconomic Advisers; Gary Robbins of Fiscal Associates, Inc.; Peter Wilcoxen of the University of Texas at Austin (with Dale Jorgenson of Harvard University); and John Wilkins of Coopers and Lybrand. Those papers presented the findings of the authors, not necessarily their institutions.

TWO VERSIONS OF FUNDAMENTAL TAX REFORM

The two papers in this memorandum use the FR and AKSW general-equilibrium models, respectively, to focus on the implications of two particular versions of fundamental tax reform, as specified in the JCT project. The first type of reform would replace the current multirate income tax with a single-rate system. It would also broaden the base of income taxes and integrate business taxes with personal taxes. The base broadening would be comprehensive, bringing in many of the items currently excluded from tax. Thus, it would eliminate deductions for mortgage interest, charitable contributions, and state and local income and property taxes. It would also tax currently exempt fringe benefits such as health insurance.

The second type of reform would substitute a broad-based consumption tax for the current personal and corporate income taxes. The proposal defines that base somewhat indirectly, by taxing incomes at a flat rate and allowing businesses to deduct their capital expenditures immediately rather than as their equipment depreciates. Businesses would also deduct their wages and costs for fringe benefits, and those payments to labor would be taxed at the personal level rather than the business level.

Both reforms are intended to be revenue neutral, meaning that they should raise the same amount of tax revenue in each year as the current system. The alternative tax systems would also include a substantial personal exemption or tax credit. Consequently, even without graduated tax rates, they would achieve some degree of overall progressivity in the personal tax system, although not as much as the current system does.

USING TWO GENERAL-EQUILIBRIUM MODELS TO EVALUATE TAX REFORM

A proper evaluation of those two versions of tax reform requires a model that can capture how taxes affect decisions about both labor supply and the timing of consumption. The FR and AKSW models are well suited for that purpose because they explicitly specify those decisions, which are based on the life-cycle theory of consumption in which people borrow or save to achieve an optimal timing of consumption over their lifetime. The models also illustrate how the effects of taxes depend on the extent to which consumers are sensitive to the changes in relative prices caused by tax reform. In both models, consumption-based taxes look more attractive as the sensitivity of decisions about the timing of consumption increases, all else being constant. Yet the models are quite different in other respects: such as their characterizations of the current tax system as well as other factors that determine behavioral responses. As a result, they provide some different conclusions about the relative effects of the two reforms.

Although both models indicate that the switch from the current income tax system to a single-rate consumption tax would raise national saving and economic output, they come to dramatically different conclusions about the effects of a switch to a single-rate income tax. The FR simulations suggest that such a switch could produce increases in output similar in size to those under the consumption tax. The AKSW simulations, by contrast, predict that an income-based single-rate tax would reduce economic output.

In the FR model, both reforms would raise economic output by substantially broadening the tax base and reducing distortions among different assets and sectors of the economy. The mix of outputs and the allocation of total capital among its different types would both change substantially as a result of greater neutrality in the tax system. Although the switch to a flat income tax leads to an increase in the cost of capital facing the owner-occupied housing sector, under both reforms the base broadening and subsequent reductions in marginal tax rates would be significant enough to cause the overall effective tax rate on capital to fall. When consumers are very sensitive in their timing of consumption, the switch to a consumption tax leads to larger increases in capital accumulation than does the switch to a flat income tax. However, as that sensitivity is reduced, the income-based version leads to similar effects on total capital accumulation. The FR model predicts that the income-based and consumption-based replacements would be similar in their effects on labor supply as well, although those labor responses would be quite small.

In contrast, although the AKSW model also captures the base-broadening effects of both types of fundamental tax reform, it nonetheless predicts a bigger difference between the consumption- and income-based versions. A switch to the single-rate consumption tax would stimulate saving and economic output. But under the single-rate income tax, the effective tax rate on capital would increase, causing capital accumulation and output to decrease. That difference from the FR result is at least partly attributable to differences in how each model specifies costs of capital and the treatment of housing. It also partially stems from the substitution among different outputs and capital types that occurs under the FR model but not the AKSW model.

Another reason for the different effects of the two reforms under the AKSW model is that labor supply responds very positively to the single-rate consumption tax but negatively to the single-rate income tax. Most of the response in labor supply under the consumption tax is from the redistributive effects of the tax on existing wealth. In addition, the consumption-based replacement eliminates an important distortion on the timing of consumption and hence induces people to increase current labor supply in order to increase future consumption. The income-based replacement lacks both of those features. Moreover, in the AKSW model, its effects on incentives are driven by an increase in the overall marginal tax rate.

Thus, the incentives both to save and work increase under the consumption-based reform but decrease under the income-based reform. Although the FR model also accounts for the effects of the consumption tax on existing wealth and its removal of the distortion on the timing of consumption, it nonetheless does not predict as large of an effect on labor supply. The divergence in the prediction for labor supply is probably a result of differences in the specifications of labor productivity, the current marginal tax rate schedule, the exemption level under each of the tax reforms, and the degree of consumer foresight.

Additional differences between the two models explain why the AKSW model predicts larger gains from the switch to a single-rate consumption tax, both relative to the income version and to the predictions of the FR model. First, bequests in the

AKSW model respond to price changes. As a result, their presence increases the responsiveness of saving to changes in the interest rate. In contrast, bequests in the FR model are fixed with respect to price. As a result, their presence dampens the saving response. Second, the FR model specifies minimum required consumption levels that also do not vary with price changes. Again, the result is to reduce the sensitivity of total consumption and saving. Third, the AKSW model more accurately characterizes the current tax system's graduated marginal rates. The FR model misses the differences in marginal rates faced by taxpayers at different income levels. Hence, the model misses the effects from reducing the number of marginal rates to one. Finally, some of the differences in gains may be the result of the differences in assumed consumer foresight. In the FR model, myopia (in which people assume that future prices will equal current prices) leads consumers initially to overreact to the increased rate of return on capital by dramatically increasing their saving. That increase in turn drastically reduces the size of the tax base and therefore increases the level of the replacement tax rate. Perfect foresight in the AKSW model avoids that unlikely response.

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These two papers, taken together, help to advance an understanding of the economic effects of fundamental tax reform and the influence of model structure and assumptions on the predicted effects. Of course, neither model addresses all of the issues raised by fundamental tax reform. Each is designed to emphasize particular mechanisms. The results of the two models must be taken in conjunction with findings from other models—and with careful attention to theory and data—to arrive at a comprehensive view of the effects of tax reform. CBO has addressed some of the economic issues surrounding such major reforms in a recent study, *The Economic Effects of Comprehensive Tax Reform*, published in July 1997.

ASSESSING THE EFFECTS OF FUNDAMENTAL TAX REFORM WITH THE FULLERTON-ROGERS GENERAL EQUILIBRIUM MODEL

by

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The opinions expressed are those of the author and do not necessarily represent the views of the Congressional Budget Office. I thank Don Fullerton for all of his earlier work in developing and writing about the Fullerton-Rogers model.

As part of the JCT project on tax modeling, this paper examines the economic effects associated with fundamental tax reform using the Fullerton-Rogers general equilibrium life-cycle model. The results are based on simulations that replace current corporate and personal income taxes with comprehensive income, consumption, and wage taxes.

Although the various tax reform proposals come under many different labels, they share much in common in their economic effects. Most proposals move away from the taxation of capital income by adopting something more like a consumption base than like an income base. In addition, most proposals, whether consumption-based or not, move toward an efficiency-enhancing "flattening" of the rate structure, both in terms of lower rates and in terms of a leveling of rates across different goods and factors.

DESCRIPTION OF THE FULLERTON-ROGERS MODEL

The Fullerton-Rogers model specifies lifetime optimization on the part of consumers according to the life-cycle theory. Consumers maximize lifetime utility by borrowing and saving so that consumption is smooth relative to annual income. Capital markets are assumed to be perfect. Consumers are distinguished into twelve groups according to the levels of their lifetime incomes, which allows the analysis of the distributional effects of taxes. For each group, we have a separately-estimated lifetime wage profile, and separate amount for inheritance and bequest.

All groups have the same nested, lifetime utility function with several levels of decision-making. After consumers calculate the present value of the lifetime labor endowment ("lifetime income"), they decide how much of it to "spend" in each period. Then, within each period, consumers decide how to allocate that spending between leisure and consumption. That period's endowment minus leisure determines labor supply, and income minus consumption determines saving. The labor-supply response to a change in tax policy depends on the substitutability of consumption for leisure and the savings response depends on the substitutability of consumption across periods. The size of these responses can be altered by changing the values of certain parameters (elasticities of substitution) in the model.

In later stages of the utility-maximization problem, the consumer allocates that period's consumption among the available consumer goods. The model specifies minimum required purchases and shares of discretionary purchases for 17 different consumer goods by consumer age, resulting in consumption bundles that differ across age and lifetime-income categories.[1] Even though all consumers have the same utility function, those with low income spend relatively more on goods with high

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1. See chapter 5 of Fullerton and Rogers (1993) for a full description of the parameterization of this subutility function. Parameter values were estimated from the Consumer Expenditure Survey.

minimum purchases. Thus, the distribution of the tax burden depends on how the different groups spend their incomes, in addition to how they earn them. In addition, consumers can substitute between corporate and noncorporate versions of each consumer good. The imperfect substitutability of corporate and noncorporate goods explains their coexistence despite the higher tax burdens placed on corporate production under current tax law.[2]

Compared to a simpler life-cycle specification, two of the features on the consumption side work to produce a lower responsiveness of saving to changes in the rate of return. First, bequests are exogenously determined; hence, a large fraction of the capital stock (over 40 percent) is insensitive to relative price changes. Second, the specification of minimum required consumption at each age limits the degree of substitution across time (and for leisure as well).

The model also specifies a disaggregate production side, with corporate and noncorporate producers, 19 industries, five types of capital, and labor. The profit-maximizing decisions of producers are made on an annual basis. Producers can substitute between capital and labor as well as among different types of capital. Resources can flow between the corporate and noncorporate sectors. The switch to consumption tax and the greater neutrality of the tax system will affect economic effciency by reducing the substitutions caused by taxes. In addition, the fundamental

2. Gravelle and Kotlikoff (1993) also model imperfect substitutability of corporate and noncorporate outputs.

reform will contribute to tax incidence through effects on both sources and uses of income. The resulting redistribution of income can have feedback effects on economic variables such as saving and output. The model accounts for all of these effects in the general-equilibrium calculations.

Appendix B to this paper provides a more detailed description of the Fullerton-Rogers model. For more detail still, see Fullerton and Rogers (1993).

MODEL SIMULATION RESULTS

In the model's 1993 benchmark, the marginal tax rates on corporate and personal income are set at .395 and .25, respectively, based on economy-wide weighted-average calculations. The values for other tax parameters such as depreciation allowances and tax credits are set to reflect tax law as of 1993. We choose to model the current personal income tax with a single marginal tax rate plus varying lump-sum grants. We thus capture the current level of progressivity, where average tax rates rise with income, but with the computational convenience of linear budget constraints.[3]

3. See Fullerton and Rogers (1993) for greater detail on the specification of the cost of capital and the characterization of the current progressive income taxes.

For the JCT exercise, six different tax replacements are considered, under two different parameterizations, for a total of twelve simulations. The six tax replacements are flat-rate (single marginal tax rate) income, consumption, and wage taxes, with and without exemption levels. All are comprehensive replacements in that their tax bases are as broad as possible and impose a single tax rate on everything in those tax bases. The two parameterizations vary the intertemporal and leisure-consumption elasticities of substitution. Under the "high elasticity" case, both elasticities are set to .50. Under the "low elasticity" case, both elasticities are set to .15.[4]

To characterize the tax replacements, we specify that consumption-based taxes are collected at the point of purchase, and wage and capital income taxes are collected from the firm. For tax reforms that involve an exemption, we again avoid the computational problem of nonlinear budget constraints by using linear tax schedules with negative intercepts identical for everyone. That is, the effect on progressivity of a $10,000 exemption is approximated by a lump-sum grant set equal to the tax rate times $10,000 per household. This specification allows a very low income household to have a negative tax liability, so our tax reforms with "exemptions" are more generous to low-income households than a true exemption would be.

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4. The econometric evidence on savings and labor-supply responses surveyed in Randolph and Rogers (1995) seems to be more consistent with the lower-elasticity assumptions.

Most of the current proposals for fundamental tax reform call for the wholesale repeal of federal income taxes and their replacement with the proposed alternative. Thus, the simulations replace both personal and corporate income taxes with versions of the taxes that are revenue-neutral on an annual basis.[5] The tax rates required for revenue neutrality are determined within the general-equilibrium framework. They depend not only on the size of the replacement tax base specified, but also on the behavioral responses generated by the tax replacement, which in turn depend on assumptions about the sizes of the relevant elasticities.

"Initial"-period results correspond to an equilibrium immediately following the tax change. "Long-run" results correspond to an equilibrium that is about 100 years after the tax change, by which time relative prices have remained unchanged (i.e., in "steady state") for about 35 years.[6]

The JCT requested results on a number of economic variables, but many of these variables are not relevant within the Fullerton-Rogers model. For example, the Fullerton-Rogers model imposes annual trade and budget balance, and specifies a unified government sector (with no separation of state and local from federal). Of the requested variables, those that could be generated from the model are shown in Tables 0-6.

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5. This neutrality accounts for changes in the price level, so that the real value of government purchases is held constant.

6. In fact, relative prices fluctuate very little after about 45 years following the tax change.

The Effects Associated With Tax Base

In general, the simulations reveal that differences across alternative replacement tax bases do cause some differences in the effects on economic variables, including economic efficiency, but in many respects the differences are quite small. The fundamental characteristic of all of these tax bases is one they share in common: they are all broader and more neutral than the current income-tax base. For this reason, any one of these tax base reforms would contribute positively to economic growth and steady-state welfare.

At a more detailed level, however, some interesting differences remain. One difference among the consumption, wage, and income bases is in the size of the tax base. At any point in time within an economy, the income base is larger than the consumption base (where the difference is savings), and the consumption base is larger than the wage base (where the difference is consumption of the return to existing capital). The initial replacement tax rates shown in Table 0 reflect these size differences. Under the standard (higher-elasticity) assumptions, the initial replacement tax rate under the proportional income tax is less than 16 percent, while those of the proportional consumption and wage taxes are close to 18 percent and 21 percent, respectively. Under the low-elasticity assumptions in this model, the difference between the income and consumption bases narrows, with initial rates of

14.4 percent and 14.8 percent, respectively, because the change in personal saving is lower when the intertemporal elasticity is lower. On the other hand, a low intertemporal elasticity implies that a larger share of the capital stock must be explained by intergenerational transfers of capital rather than life-cycle savings. With relatively more consumption from the return to inherited capital, the difference between the consumption base and the wage base widens. Thus, under low elasticities, the initial tax rates required for revenue neutrality are 14.8 percent for the consumption tax and 18.2 percent for the wage tax.

In the long run, however, the size of replacement tax bases and the required tax rates depend on how the economy has responded to the tax reform. These economic responses depend on what we assume about elasticities, but the sensitivity to these elasticities also differs across the alternative tax bases. Comparing the long-run replacement tax rates, we find that the higher elasticities eventually boost the size of the consumption base and allow it a lower long-run replacement tax rate, but slightly reduce the growth of the wage and income bases and thus reduce the decline in the long-run replacement tax rates. In this respect, the consumption base appears relatively more attractive under more generous assumptions about behavioral response.

Tables A-F emphasize the effects on capital accumulation and allocation. All of the simulations show increases in the overall capital stock (to varying degrees), and all suggest substantial reallocation of the capital stock across different sectors of the economy. First note the effects of the tax replacements on the costs of capital for the corporate, noncorporate, and owner-occupied housing sectors. For all tax reforms, the effective tax rate for corporate capital falls more than for noncorporate capital or housing capital. All reforms reduce the personal marginal tax rate, and all would eliminate the extra layer of tax on the corporate sector. Under both sets of elasticity assumptions, the effective tax rates fall more under the consumption tax or wage tax than under the income tax, since the income tax still applies to capital income.[7] Even the comprehensive income taxes reduce the cost of corporate and noncorporate capital due to the reduction in marginal tax rates, but increase the cost of owner-occupied housing because of the increased taxation of the flow of housing services.[8] Under all of the replacements, the net-of-all-tax rate of return to capital increases sharply initially but then declines as capital accumulates. This decline is greater under higher elasticities, because capital accumulates faster.

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7. These effective tax rates are comparable across sectors and assets, but they are hard to compare across tax reforms because they depend on the level of the net rate of return, relative to the wage rate. Our numeraire is the net wage paid by firms, and the tax reforms are modelled as extra taxes paid by firms, so the gross wage rises. To maintain the relative costs of labor and capital to the firm requires an increase in the nominal price of capital.

8. Under current law, owner-occupied housing is tax favored relative to rental housing and other forms of capital. Homeowners take mortgage interest deductions despite the fact that their imputed rental income is not taxed. The pure proportional income tax replacement does tax imputed rents.

   Even though all of the proportional replacements remove the differential federal tax treatment of capital across sectors and asset types, a difference remains across corporate, noncorporate, and housing costs of capital because of the continued existence of property taxes.

Tables 1-6 show that with other economic variables as well, the relative advantage of the consumption base over the other tax bases depends on what we assume about the savings and labor-supply responses. With high elasticities, the percentage increases in steady-state capital-labor ratios and labor productivity (output/labor) are largest for the consumption tax and smallest for the income tax. Under all of the proportional taxes, the relatively-high intertemporal elasticity of .50 produces huge increases in savings rates in the initial period (335 percent, 278 percent, and 202 percent for the consumption, wage, and income bases, respectively), yet more moderate increases in the steady state (20 percent, 18 percent, and 11 percent respectively). Changes in other economic variables such as labor supply and productivity are smaller. Note that initial-period responses are unrealistically dramatic in the Fullerton-Rogers model because the behavior of households is myopic in nature.[9]

Under low-elasticity assumptions, however, both the magnitude of these changes and the relative advantages of the consumption base decrease sharply. Both initial and long-run savings rates, and the long-run capital-labor ratio, increase least for the consumption base.

9. More specifically, the initial-period savings response is huge because people overreact to the initial-period increase in the net rate of return to capital. With myopic expectations, people change their savings behavior based on the assumption that the net rate of return will forever equal that initial value; i.e., they do not anticipate that the rate will come down as capital accumulates. See Ballard and Goulder (1985) for an analysis of the role of foresight in determining the size of savings response.

The Significance of Redistribution

Although a detailed description of tax burdens across households is beyond the scope of this paper, these patterns of tax incidence do affect the economic variables discussed here.[10] In particular, the intergenerational distribution of the tax burden is highly relevant, because of the differences in propensities to consume across households of different ages. If households behave as life-cycle consumers, any redistribution of income away from older generations toward younger ones will tend to increase the aggregate saving rate of the economy. This would seem to make the consumption tax the winner in terms of its stimulus to saving.

But surprisingly, it is not always true that the consumption tax that produces the largest increase in personal saving. Under certain conditions, the wage tax does. This result appears to contradict a prediction of Kotlikoff (1995). He argues that the positive effect on savings from a switch to a consumption tax is in large part due to the implicit tax on existing capital that takes from the old, with relatively large propensities to consume, and gives to the young with greater propensities to save. The wage tax does not include the redistributionary effect of the capital levy, so the increase in saving would be smaller. This result does indeed follow in a model that distinguishes households by age, such as in Auerbach and Kotlikoff (1987) and in

10. A closer examination of the incidence of these tax replacements is found in Fullerton and Rogers (1996). In particular, that paper also discusses incidence across lifetime income categories, which is not discussed here.

Fullerton and Rogers (1993). In both of these models, the tax on existing capital helps boost saving through intergenerational redistributions.

But the income effects occuring as a result of fundamental tax reform are not merely redistributive in nature. The gains to some individuals do not have to be offset by losses to others; in fact, among age and income groups alive in the long run, everyone can be made better off. When people feel better off, they increase consumption of goods and services, and they increase their leisure time. Thus, the increases in saving or labor supply that result from the substitution effects (caused by decreased marginal tax rates) can be offset by decreases in savings and labor supply that result from positive income effects (also caused by decreased marginal tax rates). The fact that the consumption base is broader than the wage-income base implies that the marginal tax rates are lower under the consumption base, which in turn implies that the positive income effects are larger under the consumption base. The wage tax can produce greater increases in savings rates when income effects tend to dominate substitution effects. Thus, we see the wage tax producing a larger increase in the savings rate under the "low elasticity assumptions", in which case substitution effects are relatively less important. Under low elasticities we see the income effect dominating, implying that the higher marginal tax rate of the wage tax produces greater increases in labor supply and savings than does the lower marginal tax rate of the consumption tax.

Another reason why a wage tax could lead to larger increases in savings is that in*tra*generational redistributions may matter as well. In the Fullerton-Rogers model, savings propensities are a function of age alone, because everyone has the same lifetime utility function, so this is not an issue with the results presented here. But people differ not only by age but also by level of lifetime income, and a more general model might allow savings propensities to vary with *both* characteristics. More specifically, the tax on existing capital not only hits the old harder than the young, but also hits the lifetime rich harder than the lifetime poor.[11] If the capital levy hits the rich, and if the rich have higher propensities to save, the consumption tax might not necessarily help the savings response more than the wage tax.

For all of the replacements, the basic intergenerational pattern of burdens is similar—greater relative gains to the young. This pattern is expected for the switch to a consumption tax, but may be surprising for the switch to wage and income taxes. The usual story about intergenerational burdens for these tax changes is focussed on the sources side, namely, that switching from an income base to a wage-tax base redistributes from the young who are taxed on their wages to the old who are relieved of tax on their capital. But this sources-side story is based on a simple model with initial tax neutrality and consumer homogeneity. In this more-detailed model,

11. In the Fullerton-Rogers model, the consumption and wage bases also differ due to the presence of bequests. The lifetime rich receive larger inheritances, which allow their present value of consumption to exceed the present value of labor income. This feature also makes the consumption tax more progressive than the wage tax, and it reinforces the intragenerational effect on total savings that occurs when those with high savings propensities are hit by the capital levy.

however, the initial income tax is not neutral, so the switch to a more neutral wage or income tax can have various effects on relative prices of consumption goods. In addition, consumers of the same age are heterogeneous, so they buy different bundles of commodities. Thus the distributional patterns of tax burdens will depend on effects operating through the uses side as well.

In fact, the Fullerton-Rogers model suggests that the elderly can actually be made worse off by the switch to a more neutral tax, even a wage tax. The reason is that the relative prices of consumer goods change in a way that burdens the old more than the young. For example, the elimination of preferential treatment of housing raises sharply the cost of shelter. Also, the removal of capital taxation under either the wage tax or the consumption tax raises the relative price of labor-intensive goods such as health care and financial services. Even with the switch to a proportional income tax, the latter effect holds because of the removal of the double-taxation of dividend income. These changes in the relative prices of consumer goods cause intergenerational redistribution, because these goods are precisely the ones that make up a large fraction of older-households' budgets in our model.[12]

On net, under the wage tax, the elderly are only slightly worse off because this effect on the uses side is offset by the usual intergenerational effect on the sources-side of switching from an income tax to a wage tax. Under the income-tax

12. These uses-side effects are emphasized in Fullerton and Rogers (1997).

replacement, the elderly are relatively worse off compared to the wage tax, because that sources-side story is not as strong.[13]

All of the replacements that use a consumption base, however, show a much more pronounced redistribution of income away from older generations, towards younger ones. Consumption taxes entail the greatest intergenerational redistribution, because of the tax on existing capital. These basic distinctions across tax bases in terms of the patterns of intergenerational burdens do not change much with the values of elasticities.

The addition of annual exemption levels affects the pattern of burdens differently depending on which base is chosen. In particular, adding an exemption level to a consumption tax increases the intergenerational redistribution, while adding an exemption level to either a wage or income tax does not. The exemption requires a higher rate of tax for revenue neutrality, which strengthens the effect on the uses side just discussed. Prices rise more for the elderly. Moreover, this stronger intergenerational redistribution has important implications for saving and efficiency, as discussed below.

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13. Because the old have more capital income than the young, however, and because capital taxes fall more than labor taxes with the removal of the double-taxation of dividend income, even the switch to a neutral income tax provides some relative gain to the old on the sources side.

Effects on Economic Welfare

Most economists support fundamental tax reform because of the expected improvements in economic efficiency. The current income-tax system is highly distortionary, because it taxes income at different rates depending on the sources or uses of the income. Taxes on capital income are fingered as a major culprit, because: (i) capital income is difficult to measure accurately, and hence difficult to tax uniformly across different types of assets, and (ii) even with perfectly-uniform capital taxation, such a tax creates an intertemporal distortion. Established tax preferences such as the mortgage interest deduction also contribute to the distortions among different sources or uses of income. Hence, many economists believe that the most effective way to enhance the efficiency of the tax system would be to move toward a consumption-based tax with a flatter rate structure and broader, more neutral base.

To go all the way, we could move to a proportional, single-rate consumption tax. This switch can be said to have several distinct effects on efficiency. First, the "flattening" of the progressive tax rate structure reduces individual disincentives. Second, the leveling of the playing field is expected to reduce the distortionary effects of taxes. Third, the switch from an income base to a consumption base involves a reduction in the intertemporal distortion in exchange for a larger labor-supply distortion, and so may increase or decrease the inefficiency of the tax system.

Most economists seem to expect a positive overall effect on efficiency from such a tax change, especially when combined with lower rates.

Calculations of welfare effects within the Fullerton-Rogers model (see Tables G and H) suggest that a switch to a proportional consumption tax will increase economic efficiency as long as the two elasticities are not too low.[14] The gains are fairly modest, however—less than one percent of lifetime income when defined using our method which calculates the present value of welfare changes relative to the present value of incomes over all generations. The efficiency calculation is smaller than are steady-state levels of utility increases, because the losses of earlier generations are added, and indeed, given greater weight because of discounting.

The smaller efficiency gain under the wage-income tax indicates that the wealth component of the consumption base is important in contributing to whatever gains exist. The consumption base is larger than the wage base due to consumption out of existing capital, and the capital levy present under the consumption tax permits lower marginal tax rates and hence smaller economic distortions. While the efficiency advantage of the proportional consumption tax over the proportional wage tax remains under all of the elasticity assumptions, the advantage of the consumption

14. Our efficiency measure is based on a present-value calculation across all generations. We discount at a rate of 4 percent, which is the net-of-all-tax rate of return in the model. Discounting puts greater weight on the negative utility changes of older generations than on the positive utility changes of younger generations. A lower discount rate would thus raise the efficiency gain. This measure is somewhat arbitrary, as it does not reflect a formally-defined social-welfare function, and it does not employ the "lump-sum redistribution authority" of Auerbach and Kotlikoff (1987). For this reason, Tables G and H also show the utility changes to the steady-state generation only.

tax over a broad-based income tax disappears if the intertemporal elasticity is low, and even if the labor supply elasticity is also low. In general, the efficiency gain from switching to a consumption tax is very sensitive to the value of the intertemporal elasticity.[15] Note that some other indicators of economic welfare, such as real output, and the real after-tax wage rate (both also shown in Tables G and H), suggest similar rankings among the various replacements.

Even a substantial gain in efficiency caused by a flattening of tax burdens would seem unsurprising and unsatisfying, however. If one role of taxation is redistributive, then we may want to consider tax replacement designs that maintain the current level of progressivity and at the same time improve efficiency. Surprisingly, the addition of exemption levels is not always efficiency-reducing. We would expect that because exemption levels necessitate higher tax rates for revenue neutrality, distortions would be greater and efficiency gains lower. The efficiency gains also depend, however, on the intergenerational redistributions mentioned earlier. Under a consumption tax base, because of the uses-side effects, the

15. The welfare gains associated with a switch from a progressive income tax to a proportional consumption tax are expected to be positively-related to the magnitude of the intertemporal elasticity because gains from the proportionality and the change in base are positively related to this elasticity. However, the gains are ambiguous with respect to the magnitude of the labor-supply elasticity because, while gains from proportionality are positively related to this elasticity, gains from the switch in base are inversely related to it. This is why the efficiency advantage of the consumption base is much more sensitive to the value of the intertemporal elasticity than to the value of the consumption-leisure elasticity.

Gravelle (1991) also finds that the efficiency gains associated with a consumption-tax replacement depend heavily on the intergenerational redistribution that takes place, and that the gains are more sensitive to the intertemporal elasticity than to the consumption-leisure elasticity. The Fullerton-Rogers model has been used to highlight these points as well (Randolph and Rogers, 1995, and Rogers, 1996).

exemption level causes greater redistribution of income away from old to the young, and this effect works to enhance efficiency. In fact, when the leisure-consumption elasticity is low, the net efficiency gains are higher under the exemption-level version of the consumption tax, because the higher labor-supply distortion resulting from the higher marginal tax rate becomes less important than the income redistribution.

In general, it appears that the efficiency gains associated with fundamental tax reform are more sensitive to differences in the nature of tax bases than to the differences in tax rates via exemptions. In particular, the capital-levy advantage of the consumption base seems to stand out.

Some caveats: Overall, the efficiency gains shown here seem rather small, in fact smaller than other economists have found. It should be emphasized that the efficiency calculations depend on the specification of our model as well as on certain assumptions built into our present-value calculation of gains over all generations, both of which tend to point toward an understatement of efficiency gains. For example, our characterization of the benchmark income-tax system did not include graduated marginal tax rates, but just increasing average tax rates, so some of the gains from switching to flatter tax systems are likely to be understated. In addition, the "exemption-level" taxes modeled here are really negative-intercept taxes (proportional taxes plus lump-sum grants), so the tax treatment of lower-income households is more generous than under a true exemption-level tax. Thus, for revenue neutrality, overall marginal tax rates are higher in our simulations than would be the case without negative taxes. Since the present-value calculation of efficiency gains is dependent on our choice of a 4 percent discount rate, a lower rate would raise the weight on gains to later generations and thus raise the efficiency numbers. These are some reasons to expect that our efficiency numbers might err on the low side.

On the other hand, some other implicit assumptions could lead to overstatement in some of our efficiency gains. For example, Ballard and Goulder (1985) have shown that greater foresight on the part of consumers may lead to reduced efficiency gains associated with consumption-based taxation. We have assumed myopic expectations in our simulations. Also, in examining the various tax systems, we have ignored administrative costs and measurement problems. Under the comparison of proportional consumption and proportional income taxes, for example, we implicitly assume that capital income could be measured perfectly under the income tax. This is no doubt an unrealistic assumption. The finding here that the income tax is likely to be just as efficient under a low intertemporal elasticity holds only to the extent that truly neutral income taxation is possible.

CONCLUSION:
COULD THE MODEL BE USED FOR REVENUE ESTIMATION?

At the most fundamental level, the Fullerton-Rogers model is simply a computational, bells-and-whistles version of the analytical Harberger (1962) model. It is not a macroeconometric forecasting model, and thus cannot be used to predict the actual effects of tax reform along with the changes in macroeconomic variables such as inflation or unemployment. Instead, it is designed to answer conceptual questions about the effects of tax reform on real incomes, prices, and factor allocations, all else equal—with *no* changes in such macroeconomic variables. The model assumes away all trade and budget deficits, market imperfections, transaction costs, factor immobility, and liquidity constraints. All its computations are based on the allocations that result once all markets are in equilibrium, and the model implicitly suggests that such equilibria are immediately attained. The model also specifies that households have myopic expectations about prices (people's expectations of future prices are simply current prices), so such expectations are only fulfilled once the model has found a new steady state. And the model is too stylized to capture many of the detailed changes to the tax code that could occur under tax reform. For all these reasons, the model is best suited for the analysis of the *long*-run effects of *major* tax restructuring. On its own, it is ill-suited for revenue forecasting.

As with the Harberger model, the real usefulness of the Fullerton-Rogers model comes in its ability to highlight how various economic parameters influence the effects of tax reform on relative prices and the allocation of resources. Harberger's model featured an analytical representation of what happens to the net return to capital relative to the wage rate, so that the influence of the various parameters (substitution elasticities, capital-intensity, etc.) could be seen directly in a formula. The Fullerton-Rogers model is too large to analytically solve, so it is numerically solved, and numerical sensitivity analysis (varying the values of the behavioral parameters) substitutes for analytical partial derivatives.

Although the model cannot stand alone as a revenue-forecasting model, it could provide an important piece of the answer. The more-limited role for this sort of model in the revenue-estimating process might be to provide predictions about changes in relative prices, which could then be fed into a forecasting model.

In the context of fundamental tax reform, the Fullerton-Rogers model has a comparative advantage in making several points, including the following:

- All proposals for fundamental tax reform, whether consumption-based or income-based, tend to reduce the overall effective tax rate on capital and hence encourage capital accumulation. But in addition to an overall increase in the capital stock, the mix of capital in the economy is likely to change because of the switch to more neutral taxes.

- Whether or not a consumption tax produces larger economic gains compared with a comprehensive income tax depends critically on how responsive people are in terms of intertemporal and labor-supply decisions. Lower responsiveness (in the form of lower elasticities of substitution) reduces the superiority of the consumption base.

- The economic effects of fundamental tax reform depend to a large extent on how incomes are redistributed across generations. This intergenerational incidence in turn depends not only on how different generations obtain their income and how much they save, but also on how they spend their money on different goods and services. This is because fundamental tax reform affects not only the relative returns to factors of production, but also relative goods prices.

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Table 0 -- Tax Replacements, Tax Rates, and Efficiency Gains from the Fullerton-Rogers General-Equilibrium Model

Description of tax replacement	Tax rates under high-elasticity assumptions* (initial, long run)	Efficiency gains (as % of lifetime income) under high-elasticity assumptions*	Tax rates under low-elasticity assumptions* (initial, long run)	Efficiency gains (as % of lifetime income) under low-elasticity assumptions*
Comprehensive Income Tax (CIT)	.16, .14	.70%	.14, .14	-.05%
Progressive Comprehensive Income Tax (PCIT) -- has $10,000 exemption level	.23, .22	.61%	.20, .20	-.06%
Value-Added Tax (VAT) -- consumption-based tax	.18, .14	.97%	.15, .14	-.05%
Progressive Value-Added Tax (PVAT) -- has $10,000 exemption level	.28, .20	.96%	.21, .20	-.04%
Wage Tax (WT) -- mimics a consumption-based tax w/ transition relief	.21, .18	.86%	.18, .17	-.20%
Progressive Wage Tax (PWT) -- has $10,000 exemption level	.35, .31	.70%	.28, .26	-.89%

*High-elasticity assumptions correspond to simulations using leisure-consumption and intertemporal substitution elasticities of .50. Low-elasticity assumptions use values of .15 for these elasticities.

Table 1 -- Income-Tax Replacements Under High Elasticities (eps1=eps2=.50)
Fullerton-Rogers model -- replace existing corporate and personal income taxes
(all figures are percentage changes from baseline)

	Proportional Income Tax		Income Tax w/ Exemption	
	Initial	Long Run	Initial	Long Run
1. Output (total domestic demand; includes intermediates)	+4.48	+4.61	+3.64	+3.77
2. Consumption as share of GDP	-6.69	+0.90	-5.56	+0.76
3. Exports (& imports) as share of GDP	-16.20	-12.74	-20.15	-17.30
5. Government spending as share of GDP	-3.75	-5.43	-3.09	-4.52
6. Net investment (=net saving) as share of GDP	+201.5	+11.31	+167.3	+9.46
7. Capital stock	0.00	+14.09	0.00	+11.78
8. CCA (depreciation)	-7.89	+5.81	-8.11	+3.28
10. Residential capital stock	-10.03	+1.11	-9.61	-0.32
12. Labor supply	+2.98	+0.70	+2.17	+0.26
Capital/Labor ratio of economy	-2.81	+13.40	-2.04	+11.61
13. Real after-tax wage rate (w/p)	+14.92	+21.45	+8.82	+14.13
15. Real after-tax rate of return (r/p)	+35.07	+11.03	+27.90	+8.60
17. Price level (consumer prices)	+16.01	+9.77	+22.51	+16.81
23. Total wage income (line 12 x line 13)	+18.35	+22.31	+11.17	+14.43

Table 2 -- Consumption-Tax Replacements Under High Elasticities (eps1=eps2=.50)
Fullerton-Rogers model -- replace existing corporate and personal income taxes
(all figures are percentage changes from baseline)

	Proportional Cons. Tax		Cons. Tax w/ Exemption	
	Initial	Long Run	Initial	Long Run
1. Output (total domestic demand; includes intermediates)	+6.07	+6.03	+5.84	+5.81
2. Consumption as share of GDP	-11.53	+0.99	-12.63	+0.88
3. Exports (& imports) as share of GDP	-4.83	+0.06	-4.32	+0.79
5. Government spending as share of GDP	-4.65	-7.14	-4.32	-7.02
6. Net investment (=net saving) as share of GDP	+334.6	+19.58	+361.7	+21.46
7. Capital stock	0.00	+22.46	0.00	+23.81
8. CCA (depreciation)	-7.13	+14.87	-7.02	+16.29
10. Residential capital stock	-13.01	+4.38	-14.02	+4.41
12. Labor supply	+4.08	+0.52	+3.69	+0.01
Capital/Labor ratio of economy	-3.92	+21.82	-3.56	+23.81
13. Real after-tax wage rate (w/p)	+12.45	+24.61	+3.89	+18.73
15. Real after-tax rate of return (r/p)	+30.75	+0.48	+20.80	-8.71
17. Price level (consumer prices)	+18.54	+6.98	+28.31	+12.28
23. Total wage income (line 12 x line 13)	+17.04	+25.26	+7.72	+18.74

Table 3-- Wage-Tax Replacements Under High Elasticities (eps1=eps2=.50)
Fullerton-Rogers model -- replace existing corporate and personal income taxes
(all figures are percentage changes from baseline)

	Proportional Wage Tax		Wage Tax w/ Exemption	
	Initial	Long Run	Initial	Long Run
1. Output (total domestic demand; includes intermediates)	+5.14	+5.41	+4.30	+4.66
2. Consumption as share of GDP	-9.50	+0.89	-9.48	+0.67
3. Exports (& imports) as share of GDP	-19.66	-14.15	-27.19	-21.31
5. Government spending as share of GDP	-3.97	-6.40	-3.23	-5.74
6. Net investment (=net saving) as share of GDP	+277.6	+17.81	+272.0	+19.43
7. Capital stock	0.00	+20.22	0.00	+20.72
8. CCA (depreciation)	-8.33	+11.44	-8.77	+11.23
10. Residential capital stock	-11.53	+3.98	-11.75	+3.70
12. Labor supply	+3.39	+0.30	+2.42	-0.61
Capital/Labor ratio of economy	-3.20	+19.99	-2.29	+21.59
13. Real after-tax wage rate (w/p)	+10.45	+20.18	-0.41	+9.32
15. Real after-tax rate of return (r/p)	+56.62	+18.84	+56.09	+18.25
17. Price level (consumer prices)	+20.70	+10.93	+33.86	+22.00
23. Total wage income (line 12 x line 13)	+14.19	+20.54	+2.00	+8.65

Table 4- Income-Tax Replacements Under Low Elasticities (eps1=eps2=.15)
Fullerton-Rogers model -- replace existing corporate and personal income taxes
(all figures are percentage changes from baseline)

	Proportional Income Tax		Income Tax w/ Exemption	
	Initial	Long Run	Initial	Long Run
1. Output (total domestic demand; includes intermediates)	+1.31	+1.86	+1.26	+1.84
2. Consumption as share of GDP	-1.65	+0.40	-1.57	+0.39
3. Exports (& imports) as share of GDP	-13.21	-12.37	-17.06	-16.17
5. Government spending as share of GDP	-1.41	-2.46	-1.34	-2.41
6. Net investment (=net saving) as share of GDP	+61.19	+3.78	+58.36	+3.83
7. Capital stock	0.00	+5.43	0.00	+5.44
8. CCA (depreciation)	-8.63	-3.44	-8.63	-3.41
10. Residential capital stock	-8.79	-4.69	-8.66	-4.60
12. Labor supply	+0.37	+0.01	+0.30	-0.05
Capital/Labor ratio of economy	-0.36	+5.43	-0.30	+5.50
13. Real after-tax wage rate (w/p)	+16.76	+18.98	+11.53	+13.79
15. Real after-tax rate of return (r/p)	+33.54	+24.91	+27.55	+19.45
17. Price level (consumer prices)	+14.19	+12.08	+19.56	+17.21
23. Total wage income (line 12 x line 13)	+17.19	+18.98	+11.87	+13.73

Table 5 -- Consumption-Tax Replacements Under Low Elasticities (eps1=eps2=.15)
Fullerton-Rogers model -- replace existing corporate and personal income taxes
(all figures are percentage changes from baseline)

	Proportional Cons. Tax		Cons. Tax w/ Exemption	
	Initial	Long Run	Initial	Long Run
1. Output (total domestic demand; includes intermediates)	+1.25	+1.76	+1.17	+1.72
2. Consumption as share of GDP	-1.72	+0.40	-1.66	+0.39
3. Exports (& imports) as share of GDP	-1.28	-0.85	-1.19	-0.77
5. Government spending as share of GDP	-1.47	-2.42	-1.38	-2.37
6. Net investment (=net saving) as share of GDP	+63.32	+3.54	+61.32	+3.53
7. Capital stock	0.00	+5.23	0.00	+5.23
8. CCA (depreciation)	-8.52	-3.52	-8.63	-3.52
10. Residential capital stock	-9.42	-5.41	-9.51	-5.58
12. Labor supply	+0.37	+0.00	+0.28	-0.06
Capital/Labor ratio of economy	-0.48	+5.12	-0.40	+5.18
13. Real after-tax wage rate (w/p)	+16.24	+18.71	+10.65	+13.36
15. Real after-tax rate of return (r/p)	+29.95	+21.66	+23.69	+16.17
17. Price level (consumer prices)	+14.73	+12.34	+20.54	+17.65
23. Total wage income (line 12 x line 13)	+16.61	+18.67	+10.91	+13.24

Table 6-- Wage-Tax Replacements Under Low Elasticities (eps1=eps2=.15)
Fullerton-Rogers model -- replace existing corporate and personal income taxes
(all figures are percentage changes from baseline)

	Proportional Wage Tax		Wage Tax w/ Exemption	
	Initial	Long Run	Initial	Long Run
1. Output (total domestic demand; includes intermediates)	+1.32	+2.37	+1.29	+2.58
2. Consumption as share of GDP	-2.17	+0.43	-2.30	+0.42
3. Exports (& imports) as share of GDP	-15.74	-14.28	-21.98	-20.04
5. Government spending as share of GDP	-1.38	-3.09	-1.31	-3.29
6. Net investment (=net saving) as share of GDP	+77.44	+7.15	+80.91	+8.80
7. Capital stock	0.00	+8.69	0.00	+10.19
8. CCA (depreciation)	-9.32	-0.70	-9.55	+0.54
10. Residential capital stock	-9.08	-2.98	-8.97	-2.11
12. Labor supply	+0.38	-0.10	+0.28	-0.22
Capital/Labor ratio of economy	-0.50	+8.68	-0.40	+10.32
13. Real after-tax wage rate (w/p)	+13.22	+17.08	+4.82	+9.42
15. Real after-tax rate of return (r/p)	+50.43	+35.24	+54.27	+34.56
17. Price level (consumer prices)	+20.59	+13.92	+27.25	+21.89
23. Total wage income (line 12 x line 13)	+13.59	+16.91	+5.06	+9.13

Table A. Effects on Capital Accumulation and Allocation
From Replacing the Income-Tax System With Comprehensive Income Taxes
Fullerton-Rogers Model, High Elasticities*

	Comprehensive Income Tax w/ No Exemption		Progressive Comprehensive Income Tax w/ Exemption	
% change in:	Initial	Long-Run	Initial	Long-Run
saving rate	+202%	+11.3%	+167%	+9.46%
capital stock	0.00%	+14.1%	0.00%	+11.8%
residential capital stock	-10.0%	+1.11%	-9.61%	-0.32%
effective tax rate on corporate capital	-57.2%	-54.4%	-49.5%	-47.6%
effective tax rate on noncorporate capital	-30.0%	-24.6%	-18.8%	-15.1%
effective tax rate on owner-occupied housing	+13.6%	+25.0%	+25.6%	+34.0%
after-tax rate of return divided by after-tax wage rate (r/w)	+18.9%	-7.55%	+18.9%	-3.77%
capital-labor ratio of economy	-2.81%	+13.4%	-2.04%	+11.6%

*Intertemporal and leisure-consumption elasticities set equal to .50.

Table B. Effects on Capital Accumulation and Allocation
From Replacing the Income-Tax System With Consumption-Based Taxes
Fullerton-Rogers Model, High Elasticities*

	Consumption Tax w/ No Exemption		Progressive Consumption Tax w/ Exemption	
% change in:	Initial	Long-Run	Initial	Long-Run
saving rate	+335%	+19.6%	+362%	+21.5%
capital stock	0.00%	+22.5%	0.00%	+23.8%
residential capital stock	-13.0%	+4.38%	-14.0%	+4.41%
effective tax rate on corporate capital	-77.1%	-68.5%	-76.9%	-67.7%
effective tax rate on noncorporate capital	-58.7%	-43.6%	-58.4%	-42.3%
effective tax rate on owner-occupied housing	-16.4%	+10.5%	-15.8%	+12.7%
after-tax rate of return divided by after-tax wage rate (r/w)	+16.3%	-19.4%	+16.3%	-23.1%
capital-labor ratio of economy	-3.92%	+21.8%	-3.56%	+23.8%

*Intertemporal and leisure-consumption elasticities set equal to .50.

Table C. Effects on Capital Accumulation and Allocation From Replacing the Income-Tax System With Wage Taxes
Fullerton-Rogers Model, High Elasticities*

	Wage Tax w/ No Exemption		Progressive Wage Tax w/ Exemption	
% change in:	Initial	Long-Run	Initial	Long-Run
saving rate	+278%	+17.8%	+272%	+19.4%
capital stock	0.00%	+20.2%	0.00%	+20.7%
residential capital stock	-11.5%	+3.98%	-11.8%	+3.70%
effective tax rate on corporate capital	-80.8%	-73.6%	-82.6%	-75.7%
effective tax rate on noncorporate capital	-65.2%	-52.6%	-68.4%	-56.2%
effective tax rate on owner-occupied housing	-28.6%	-5.31%	-34.5%	-11.8%
after-tax rate of return divided by after-tax wage rate (r/w)	+43.4%	-0.00%	+58.5%	+9.38%
capital-labor ratio of economy	-3.20%	+20.0%	-2.29%	+21.6%

*Intertemporal and leisure-consumption elasticities set equal to .50.

Table D. Effects on Capital Accumulation and Allocation
From Replacing the Income-Tax System With Comprehensive Income Taxes
Fullerton-Rogers Model, Low Elasticities*

	Comprehensive Income Tax w/ No Exemption		Progressive Comprehensive Income Tax w/ Exemption	
% change in:	Initial	Long-Run	Initial	Long-Run
saving rate	+61.2%	+3.78%	+58.4%	+3.83%
capital stock	0.00%	+5.43%	0.00%	+5.44%
residential capital stock	-8.79%	-4.69%	-8.66%	-4.60%
effective tax rate on corporate capital	-58.1%	-57.2%	-51.9%	-51.2%
effective tax rate on noncorporate capital	-31.3%	-29.5%	-22.3%	-20.9%
effective tax rate on owner-occupied housing	+12.8%	+16.8%	+22.2%	+25.7%
after-tax rate of return divided by after-tax wage rate (r/w)	+14.4%	+4.99%	+14.4%	+4.97%
capital-labor ratio of economy	-0.36%	+5.43%	-0.30%	+5.50%

*Intertemporal and leisure-consumption elasticities set equal to .15.

Table E. Effects on Capital Accumulation and Allocation
From Replacing the Income-Tax System With Consumption-Based Taxes
Fullerton-Rogers Model, Low Elasticities*

	Consumption Tax w/ No Exemption		Progressive Consumption Tax w/ Exemption	
% change in:	Initial	Long-Run	Initial	Long-Run
saving rate	+63.3%	+3.54%	+61.3%	+3.53%
capital stock	0.00%	+5.23%	0.00%	+5.23%
residential capital stock	-9.42%	-5.41%	-9.51%	-5.58%
effective tax rate on corporate capital	-76.5%	-74.7%	-76.5%	-74.7%
effective tax rate on noncorporate capital	-57.6%	-54.4%	-57.6%	-54.4%
effective tax rate on owner-occupied housing	-14.5%	-8.75%	-14.5%	-8.68%
after-tax rate of return divided by after-tax wage rate (r/w)	+13.2%	+3.78%	+13.2%	+3.78%
capital-labor ratio of economy	-0.48%	+5.12%	-0.40%	+5.18%

*Intertemporal and leisure-consumption elasticities set equal to .15.

Table F. Effects on Capital Accumulation and Allocation From Replacing the Income-Tax System With Wage Taxes

Fullerton-Rogers Model, Low Elasticities*

	Wage Tax w/ No Exemption		Progressive Wage Tax w/ Exemption	
% change in:	Initial	Long-Run	Initial	Long-Run
saving rate	+77.4%	+7.15%	+80.9%	+8.80%
capital stock	0.00%	+8.69%	0.00%	+10.2%
residential capital stock	-9.08%	-2.98%	-8.97%	-2.11%
effective tax rate on corporate capital	-80.0%	-77.1%	-81.5%	-78.2%
effective tax rate on noncorporate capital	-63.8%	-58.7%	-66.4%	-60.7%
effective tax rate on owner-occupied housing	-26.0%	-16.5%	-31.0%	-20.1%
after-tax rate of return divided by after-tax wage rate (r/w)	+34.6%	+17.0%	+49.1%	+24.5%
capital-labor ratio of economy	-0.50%	+8.68%	-0.40%	+10.3%

*Intertemporal and leisure-consumption elasticities set equal to .15.

Table G. Welfare Effects of Tax Reform
Fullerton-Rogers Model, High Elasticities*

	Comprehensive Income Taxes		Consumption Taxes		Wage Taxes	
	Proportional	With Exemption	Proportional	With Exemption	Proportional	With Exemption
% change in output (initial, long-run)	+4.48, +4.61	+3.64, +3.77	+6.07, +6.03	+5.84, +5.81	+5.14, +5.41	+4.30, +4.66
% change in labor supply (initial, long-run)	+2.98, +0.70	+2.17, +0.26	+4.08, +0.52	+3.69, +0.01	+3.39, +0.30	+2.42, -0.61
% change in long-run real after-tax wage rate	+21.5	+14.1	+24.6	+18.7	+20.2	+9.32
% change in utility to steady-state generation	+1.90	+1.81	+3.33	+3.84	+1.84	+1.68
overall efficiency gain (present value over all generations, based on 4% discount rate)	+0.70%	+0.61%	+0.97%	+0.96%	+0.86%	+0.70%

*Intertemporal and leisure-consumption elasticities set equal to .50.

Table H. Welfare Effects of Tax Reform
Fullerton-Rogers Model, Low Elasticities*

	Comprehensive Income Taxes		Consumption Taxes		Wage Taxes	
	Proportional	With Exemption	Proportional	With Exemption	Proportional	With Exemption
% change in output (initial, long-run)	+1.31, +1.86	+1.26, +1.84	+1.25, +1.76	+1.77, +1.72	+1.32, +2.37	+1.29, +2.58
% change in labor supply (initial, long-run)	+0.37, +0.01	+0.30, -0.05	+0.37, +0.00	+0.28, -0.06	+0.38, -0.10	+0.28, -0.22
% change in long-run real after-tax wage rate	+19.0	+13.8	+18.7	+13.4	+17.1	+9.42
% change in utility to steady-state generation	+0.70	+0.95	-0.04	-0.03	+0.77	+1.11
overall efficiency gain (present value over all generations, based on 4% discount rate)	-0.05%	-0.06%	-0.05%	-0.04%	-0.20%	-0.89%

*Intertemporal and leisure-consumption elasticities set equal to .15.

FUNDAMENTAL TAX REFORM
AND MACROECONOMIC PERFORMANCE

by

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INTRODUCTION

Fundamental tax reform would substantially alter the structure of incentives in the US economy. Understanding the consequences of shifting to a flat income or consumption tax therefore requires careful consideration of the changes in microeconomic behavior in order to assess the effects on macroeconomic variables. Our modeling approach accordingly starts with households and firms as the fundamental units of decision making in the economy. All changes in macroeconomic variables are then derived from changes in household labor supply, consumption, and saving decisions. Since the intra generational distribution of income and wealth is important due to the progressive structure of the current tax system, we distinguish households by age and earnings class.

The Joint Committee on Taxation (JCT) asked participants of this conference to examine two basic tax reforms. The first reform involves moving from the current progressive income tax system to a flat (proportional) income tax with an exemption level equal to $10,000 plus $5,000 for each dependent. Such reform would flatten tax rates, remove the double taxation of capital income and eliminate many tax preferences including the housing interest deduction, additional personal itemized deductions, personal tax credits, the deductibility of state income taxes and the favorable (consumption) tax treatment of retirement saving accounts. The second reform involves moving from the current tax income tax system to a consumption tax with uniform tax rates. In this reform, expected capital income is exempted from taxation by a move to full expensing.

Our numerical simulations reveal that the two reforms have very different implications for the economy. Under the income tax, most people earn less; and in the long run, the capital stock declines by 10.5 percent and the production of goods and services falls by 3 percent. Moving to a consumption tax, on the other hand, raises wage rates; the capital stock climbs 32 percent and output expands by 7.5 percent in the long run. Despite the fact that the flat income tax rate has a broader base (income minus deductions) than the flat consumption tax rate (consumption minus deductions), the tax rate in the consumption tax experiment eventually falls to 22.4 percent which is substantially below the long run tax rate of 25.0 percent in the income tax experiment. As the paper will explain, the difference stems from the fact that moving to a consumption tax (unlike moving to a proportional income tax) imposes a lump sum tax on existing wealth and eliminates the taxation of capital income.

The following section discusses the features of the substantially enhanced Auerbach-Kotlikoff life cycle model and our initial calibration. Section 3 explains the main results in light of our modeling approach. Although the model handles a great deal of complexities, it leaves out some portions of reality as reviewed in

Section 4. This suggests viewing the model's results cautiously. Nonetheless, the simulation analysis reported herein does paint important brush strokes, even if broad ones.

THE MODEL

Our simulation model is based on the Auerbach-Kotlikoff (1987) life cycle model. It features 55 overlapping generations. Each agent lives for 55 years (ages 20 to 75). The model calculates the rational expectations (perfect foresight in our deterministic model) steady states as well as transition paths of factor prices, consumption, labor supply, tax rates, and other economic variables. There are three sectors: households, firms, and the government. The model does not have a monetary sector and all variables are real variables. The simulation results presented in this paper also assume a closed economy.

The model makes a number of important innovations to the Auerbach and Kotlikoff model. First, the model incorporates multiple lifetime income classes. This feature affords an analysis of the intra generational distributional impact of fiscal policy in addition to the *inter*generational distributional impact analyzed by Auerbach and Kotlikoff (1987) and Auerbach (1996). Characterizing the intra generational distribution of wealth and income also allows for a more realistic analysis of fiscal policy, since the macro impact of a tax cut may depend on the initial distribution of lifetime income endowments and bequests. Second, the model incorporates an intergenerational bequest motive with bequests distinguished by income cohort. Third, the model includes a tax deduction against wage income. This requires the consumer to solve the lifetime optimization problem with a kinked budget constraint. We handle this complicated problem by assigning virtual marginal tax rates to consumers locating at the kink. Fourth, the model is carefully scaled to dollar units which makes it easy to match the model tax rates (and its Social Security replacement rates) to actual data. Fifth, the model incorporates a more realistic hybrid tax system as well as a more realistic Social Security system with the statutory earnings ceiling and the statutory bend-point formula applied over covered earnings. Sixth, the model incorporates labor-augmenting technological progress.

The Household Sector

Our model is particularly rich in modeling household decision making. Households decide how much to consume and how much to work in each period for given current and future after tax wages and interest rates. Households may—if they desire—not supply any labor at all in a given year and thereby retire or withdraw from the labor force. Following the lead of Fullerton and Rogers (1993), we divide households into

12 lifetime income classes. Classes 1 and 12 reflect the bottom and top 2 percent of lifetime income with classes 2 and 11 making up the remaining 8 percent of the bottom and top lifetime income decile. Classes 3 through 10 represent the intermediate lifetime income deciles. Wages for each lifetime income class grow according to a predictable fixed age-wage profile. We estimated these age-wage profiles from the PSID. Our procedure differs from Fullerton and Rogers (1993) in two main points: First, we control for a "cohort-effect" by including a birth-year indicator in our regression. This removes the effect of wage growth over time. Second, we sort wage profiles by individuals rather than by household wage income.[1] (For this purpose we exclude non-workers.) To see the difference, consider the following example. Suppose a person makes $100,000 per year and is married to someone who makes $20,000. In Fullerton and Rogers (1993), this household would be represented by a single agent who makes $60,000 per year since this is the amount of money available to each spouse if the household wage income is divided equally. In our model, on the other hand, the two agents would be modeled separately. Our procedure increases the dispersion of wage income which, under a progressive tax system, allows for a more accurate calculation of the tax rates faced by rich agents in the economy.

1. Accordingly, we treat each agent as an individual when we apply the tax code later on.

All households maximize a time-separable CES utility function with an intratemporal elasticity of substitution of 0.8 and an intertemporal elasticity of substitution of 0.25. The first parameter determines to what extent households are willing to substitute consumption for leisure in any given period while the second value determines how easily households substitute consumption (leisure) today for consumption (leisure) tomorrow. We also assume that households have a pure rate of time preference—that is the value at which future utility from future consumption and leisure is discounted—of 1.5 percent. These figures are the same as used by Auerbach and Kotlikoff (1987) who also review the relevant empirical literature. We incorporate an income class specific utility weight for bequests in our model in order to reflect the substantial differences in bequests across income classes. In particular we calibrate bequests in the initial steady state to reproduce the empirically observable size of bequests (Fullerton and Rogers [1993], p.99) by income class relative to mean income in the economy. Population growth is exogenous and set equal to 1 percent.

Production

Firms are perfectly competitive and employ labor and capital such that profits are maximized. There is only one production sector and therefore only a single good that can alternatively be used for investment and consumption. Firms in our economy produce according to a Cobb-Douglas technology. Since the production function is defined net of depreciation, we choose a capital share of 25 percent which accords well with most empirical research using this specification (see Auerbach and Kotlikoff [1987]). Technology is labor augmenting and grows at 1 percent per year.

Government

The government collects revenues for its spending on goods, services, transfers and interest payments via consumption taxes, wage taxes, income taxes, and capital income taxes. Each of these taxes may be modeled as proportional or progressive via a quadratic tax function. In addition, the government levies a payroll tax on wages to finance transfers to the elderly via Social Security and Medicare.

The Current Hybrid Tax System. We approximate the hybrid nature of the current US tax system by splitting the federal income tax into a progressive wage tax, a flat capital income tax, and a flat consumption tax. Following Auerbach (1996), capital income is taxed at a flat rate of 20 percent (a weighted average of the effective marginal tax rates on housing and non-housing capital) and we allow firms to expense 20 percent of new investment in order to reflect the accelerated deprecation allowance under current law. Together, these assumptions imply an effective marginal tax rate on capital income equal to 16 percent. Since contributions to pension funds under current law are part of labor compensation but receive consumption tax treatment, we levy a 2.5 percent tax on consumption and reduce taxes on wages accordingly. (The reader is referred to Auerbach [1996] for the derivation of these numbers.) An ordinary least squares regression is used to approximate the statutory wage tax schedule for individual filers with a quadratic function. The regression achieves a very good fit with an R^2 equal to 0.998. This function is then applied to wage income above the federal personal exemptions and standard deduction which, in total, equals $9662.[2] To account for itemized deductions, we used the IRS *Statistics of Income* to compute how itemized deductions (not including the mortgage interest deduction which was already factored into the 20 percent tax rate on capital income) rises with income. We find that itemized deductions increase by $0.0755 for every dollar of income above the combined standard deduction and exemption level. That estimate is derived from a regression with an R^2 of 0.99.

Our calibration also includes state and local taxes as well as the remaining federal taxes. State taxes are represented with a flat income tax of 3.7 percent.

2. We add the standard $4,000 deduction, personal exemptions of $2,550 and exemptions of $3110 for the 1.2 children of an average agent in the model (consistent with the 1 percent population growth rate) to arrive at this figure. The computation of the marginal tax rate applied to wage income includes interest income.

Consistent with NIPA values, we collect an additional consumption tax of 8.8 percent which reflects indirect business taxes and excise taxes. Thus the total tax on consumption under current law is assumed to be 11.3 percent. We ignore property taxes following the view that property taxes equal benefits received at the local level.

Tax Evasion. Because we are using a very close approximation to the statutory code to parameterize our tax functions, we have, up to this point, ignored the possibility of evasion. Without any correction for tax evasion, government revenues in our model would be higher than those found in the NIPA accounts—and indeed exceed their NIPA values by almost exactly the amount of tax evasion estimated by Slemrod and Bakija (1996). We corrected for evasion with a negative proportional income tax rate of 2.6 in the initial steady state which reduces the average and marginal income tax rates for all agents in the economy. (The marginal and average tax rates are still positive for all agents however since, at a minimum, everyone faces a flat state income tax of 3.7 percent.) For both tax reform experiments, we assume that evasion reduces the taxable base (income net of standard deductions and exemptions) by the same percentage before and after the reform.[3]

3. Since the taxable base shrinks due to higher exemptions in both experiments we set our downward adjustment of flat income taxes due to evasion to 1.4 percent after the tax reform. Note that this may be an optimistic approach if evasion occurs mostly among agents with higher income.

Social Security, Medicare, and Other Transfers. We calculate the OASI replacement rates for covered earnings using the statutory bend point formulas. Benefits are also scaled in order to reflect survivor benefits. The endogenous OASI payroll tax necessary to finance these benefits equals 9.8 percent which is close to the 1995 value of 10.52 net of the trust fund contributions of 0.7 percent of payroll.[4] Trust fund contributions are included in other non social security-related wage taxes. We assume that payroll taxes are only partly distortionary up to the maximum taxable earnings of $61,700. In particular, we set the perceived link between the present value of taxes and the present value of future benefits to 25 percent. Thus, agents consider only 75 percent of the payroll tax as a tax on labor.[5] Agents with labor supply above the maximum taxable earnings face a marginal payroll tax of zero, thus the payroll tax is non-distorting for them. We model Medicare (HI) as a non-earnings related transfer to agents age 65 and older and disability insurance (DI) benefits as a lump-sum transfer to agents below age 65. These benefits are financed through payroll taxes of 2.9 percent (HI) and 1.9 percent (DI) which equal their current statutory values. In contrast to the DI tax and the OASI tax, the HI tax is not subject to the earnings ceiling. In addition to modeling the social insurance system, we rebate about 1.8 percent of national income to agents as a (wage-indexed) lump

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4. See Social Security Administration (1995).

5. See Auerbach and Kotlikoff (1987), Chapter 10, for more detail on this issue.

sum transfer. This transfer accounts for other transfer programs as AFDC and Medicaid.

Government Debt Service. Finally, we select the level of government debt in the initial steady state to set the real interest payments on government debt equal to 1.5 percent of national income, its 1995 level. Targeting interest payments correctly is important in order to accurately reflect any gains from lower debt service should interest rates fall after tax reform. Our model does not explain the equity premium and therefore has only a single interest rate, the (real) net rate of return to capital, which is substantially higher than the real rate of return to government bonds. The ratio of debt to national income is consequently about half of that observed for the US economy. The results would be the same if we used a lower interest rate for government debt that moved one-for-one with the real rate on capital.

Description of Initial Steady State

The model does a good job at generating endogenous values of variables which match their real-world counterparts. The generated economy lines up well with the actual economy even though most of the model's parameters are picked either according to the estimates in the literature or according to statutory code.[6]

In terms of aggregate values, we obtain an economy-wide average marginal tax rate on wage income equal to 21.5 percent which is close to the TAXSIM calculations reported in Auerbach (1996) while our economy-wide average tax rate on wage income equals 13.3 percent. Total government revenue net of payroll taxes, is 24.4 percent of NI (national income), matching the value found in the 1995 NIPA accounts less property tax revenue. The model generates a pre-tax interest rate equal to 9.6 percent. The net saving rate equals 5.3 percent. The capital-NI ratio is 2.6 which is close to the 2.8 value derived from the 1994 balance sheets published by the Federal Reserve Bank.[7] Simulated consumption comprises 73.2 percent of NI (whereas the actual value was 74.3 percent for 1995 in the NIPA accounts), net investment equals the saving rate of 5.3 percent (which equals its actual value at an economy-wide depreciation rate equal to 5.0 percent), and government spending on goods and services accounts for the remaining 21.5 percent which is equal to government revenues net of interest payments on the debt and the lump sum transfer noted earlier.

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6. The only real unobservable "free parameter" in the model is the weighting parameter placed on consumption versus leisure. We choose the value of this parameter—as is traditionally done—in order to generate a reasonable average 35 hour work week. All of the other utility parameter choices follow Auerbach and Kotlikoff (1987) who discuss their empirical foundation.

7. Total reproducible assets equaled $15.6 trillion in the Fed's 1994 balance sheets. This included $5.8 trillion of residential structures, $2.5 trillion of consumer durables, $6.1 trillion of nonresidential fixed private capital and $1.2 trillion in inventories. National income equaled $5.5 trillion in 1994.

The wage rate of an individual at age 45, which corresponds to the peak earning age for all of the income classes, is $4.00, $14.70 and $79.53 for income class 1, income class 6, and income class 12, respectively. Class 1 represents the lifetime poorest, and classes 6 and 12 reflect median earners and the lifetime richest group. Annual labor income—endogenously derived from leisure choices—ranges between $9,700 and $160,000 at around age 45. The model generates a net national income per capita of all agents between ages 21 and 75 equal to around $39,000, which is very close to its empirical value of about $38,500 derived by dividing 1995 national income by the sum of the labor force and retired individuals.

The average tax rate on wage income, averaged across individuals of all ages in income class 12, equals 20.4 percent, while the average marginal tax rate equals 29.5 percent with top marginal tax rates of 35 percent. For income class 6, these average and average marginal rates are 11.3 percent and 19.9 percent, respectively, while for class 1, the rates are 0 percent and 2.9 percent.[8] The proportion of income derived from wage and interest income across these groups also match the *SOI* data rather closely.

8. Lifetime poorest face a positive average marginal tax rate across their lifetime because of a few periods where those agents are at the 'kink' and face positive shadow marginal taxes.

Unified Flat Income Tax

In accordance with the specifications given by the JCT, the first experiment replaces the progressive federal income tax with a flat income tax on wage income and capital income. The total of personal exemption and deduction is raised to $16,101.[9] Itemized deductions are eliminated. The OASDI and HI programs remain the same. Any positive or negative budget savings from changes in interest rates are reflected in replacement tax rates. Replacement tax rates are set to finance the same amount of government spending for goods and services in the new tax regime as in the initial steady state. The consumption tax is reduced from 11.3 percent to 8.8 percent to reflect the loss of the consumption tax treatment of retirement saving accounts. The expensing rate for investment remains at 20 percent. The state and local income tax rate is increased from 3.7 percent to 4.4 percent to reflect the loss of deductibility of state and local income taxes from the federal income tax base.[10] As described before, we assume that tax evasion as percent of the taxable base stays the same. Table 1 presents the effects of this tax reform on major macroeconomic variables. We assume

9. This is consistent with a non-refundable exemption of $10,000 plus $5,000 per dependent. Each agent has $(1.01)^{20} \approx 1.22$ dependents and so the exemption equals $10,000 + $5,000·$(1.01)^{20}$ = $16,100.95.

10. Since the model has a single unified government sector it is irrelevant for the results that these additional revenues would in reality accrue at the federal level.

that the reform is implemented on January 1, 1997. 1996 therefore represents the pre-reform economy.

Our results show that reform reduces the labor supply and the capital stock by 1.0 percent and 0.5 percent, respectively, in the first year of the transition. The saving rate drops from 5.3 percent to 3.9. In the simulations, a flat income tax rate of 23.5 percent is sufficient initially to finance government spending and the increase in the exemption level. After 9 years, the capital stock has dropped by 4.2 percent, labor supply has dropped by 0.9 percent and output has fallen by 1.7 percent. Eventually, the capital stock ends up 11.5 percent smaller than its original value and output and wage rates are reduced by 3.0 percent and 2.6 percent, respectively. Even in the long run the saving rate does not fully recover and remains at 4.9 percent (down from 5.3 percent). Furthermore, due to the decrease in the tax base, an income tax rate of 25.0 percent is needed in the long run which is higher than the rate needed immediately after the reform.

What accounts for these results? Essentially, the decline in labor supply and saving stems from the increase in marginal tax rates for a number of income classes under the reform. Although the reform repeals a number of tax preferences in the current system, that is not sufficient to finance the increase in the personal tax exemption. Only classes 1 and 2 will be totally exempt from taxes due to the higher deductions; the rest will face higher marginal tax rates on labor income over at least part of their life. In addition, the effective marginal tax rate on all capital (including housing) under the reform increases from 16 percent to 20.0 percent.[11] As a result of higher marginal tax rates, this reform proposal reduces the incentives to work and save which slows economic activity and causes the tax base to contract. That contraction of the capital stock and labor supply reinforces itself along the transition path of the economy as the shrinking tax base increases the marginal tax rates needed to finance government spending at its original level, leading to further contraction of the capital stock and labor supply.

Flat Consumption Tax

The second experiment involves moving from the current tax system to a consumption tax. Technically, the experiment is identical to the one described above except that firms can fully expense new capital investment. The results of this experiment are shown in Table 2.

Since the experiments presented in this paper assumes away adjustment costs, full expensing of investment will cause the value of existing capital to drop

11. Our model has only a single production sector and, thus, does not explicitly capture any substitution between housing capital and non-housing capital that tax reform might induce.

immediately.[12] With full expensing, new capital receives favorable treatment compared to existing capital. Thus, if the owners of existing capital offer their assets for sale, they have to compete with the tax favored investment in new capital. Because old and new capital are assumed to be perfect substitutes, the price of existing assets must fall by the amount of the tax incentive and the owners of old capital must experience a capital loss under a tax system that provides full expensing.

Our model shows that households react to the drop in their wealth by reducing their consumption of both goods and leisure. Put differently, they increase both their saving and their labor supply to make up for the lower value of their wealth. In addition to the wealth effect, the labor supply and saving responses can be explained as a result of intertemporal substitution. Since after-tax interest rates rise shortly after tax reform and then fall subsequently, people face incentives to work and save more assets shortly after the reform.[13] On the other hand, higher marginal tax rates on many people's labor income offset some of the positive effects on labor supply.

In the simulations, labor supply initially increases by 2.5 percent, which boosts output by 1.2 percent. At the same time, the removal of the capital income tax and the drop in the value of existing assets leads to an increase in the saving rate

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12. In a model with a realistic level of adjustment costs, the initial labor supply response is attenuated because existing wealth would be partly (possibly fully) shielded from the lump-sum tax. See Auerbach (1996).

13. Experiments which reduce the loss in wealth with some transition relief as, for example, a lump sum tax rebate let us believe that the wealth effect dominates the labor supply response.

from 5.3 percent to 9.0 percent in the short run. Labor supply decreases slowly over time and its level in the long run barely exceeds its original level. In the medium and long run, the growth in output is mostly driven by capital accumulation. Four years after the reform, the capital stock is 7.2 percent larger, and by year 9, it has increased 14 percent above baseline. Eventually, the capital stock exceeds its initial level by 31.5 percent. Accordingly, output is 2.4 percent larger than baseline in year 4 and 4.0 percent larger in year 9. In the long run, output increases by 7.5 percent.[14] In response to the changes in long run factor supply, the interest rate falls from 9.6 percent to 7.8 percent and (before-tax) wages increase by 7.1 percent above the baseline.

Our findings indicate that the proportional tax rate on consumption would have to be initially 25.8 percent.[15] Note that this rate is tax inclusive. It is higher than the initial tax rate under the uniform flat income tax experiment reported earlier (because the consumption base is smaller than the income base) but is about 5 percentage points lower than what the tax rate would have been without a lump-sum

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14. Our long run marginal tax rate including the additional consumption tax of 2.5 percent rate is roughly midway between the marginal rates found by Auerbach (1996) for the Armey-Shelby Plan and the Hall-Rabushka Plan experiments. Our predicted output growth also falls between the figures reported by Auerbach for his simulations.

15. This is the statutory tax rate before taking evasion into account.

tax on existing wealth.[16] Because the reform increases output, the consumption tax rate drops to 26.3 percent after 9 years and 22.4 percent in the long run. After around 30 years, the revenue from higher output overcomes the initial base narrowing and thus the replacement tax rate falls below that found in the flat income tax experiment. The economy grows above the baseline despite the increase in marginal tax rates on the labor income for many households. That result follows from the fact that a consumption tax removes the tax on capital income which stimulates saving and investment.

16. The consumption tax base is about 75 percent of the size of that under the income tax base. Without the tax on existing wealth therefore the replacement tax rate would have to be about $(3/4)^{-1}$ times 23.5 percent (the initial tax rate under a uniform income tax), or about 31 percent.

SHORTCOMINGS OF THE MODEL

The model incorporates many complex details of the real economy and relies on only a few exogenous so-called "deep" parameters specifying the utility and the production function. We think that these features are especially important for assessing the effects of fundamental tax reform. However, as in any model, our model abstracts in some ways from reality. As a result, we urge a cautious interpretation of our exact quantitative results. We outline below some of the omissions we consider most important.

No Differentiation of Production Sectors

The model assumes a single production sector which produces both consumption and investment goods. Thus, the model cannot distinguish among different sectors. Other models used in this conference, specifically those of Fullerton and Rogers (1993) and Jorgenson and Wilcoxen (1997), feature multiple sectors and can therefore capture the substitution between housing and non-housing capital as well as the effect of reducing the tax-differential between corporate and non-corporate activities. We may therefore underestimate possible efficiency gains in the flat income tax experiment which eliminates distortions among different types of capital.

No Borrowing Constraints

The overlapping generations model underlying our simulations allows consumers to borrow against future resources without constraint. Some empirical evidence, however, suggests that as much as 20 percent of the population faces binding borrowing constraints (e.g. Hayashi [1987], Mariger [1987]). Introducing binding borrowing constraints would not alter our results much because only the bottom 2 percent of earners in our model occasionally hold negative contemporaneous asset (net worth) positions.[17] Since this group accounts only for a tiny part of accumulated wealth, incorporating borrowing constraints would not significantly alter the results presented above.

The empirical evidence could also be interpreted as evidence for rule-of-thumb savers who consume a certain percentage of their income independent of future wages and interest rates. Incorporating such behavior would likely dampen the savings response to tax reform. It is unclear, however, how to derive such a rule-of-thumb. Additionally, such consumers may change their rule after a fundamental tax reform in unpredictable ways. Finally, most of our short-run results in the consumption tax experiments are driven by the labor supply response to the lump-

17. Much of the borrowing in the actual economy is for homes and education. Home borrowing however does not lead to a negative net worth position and so many households in our economy with positive assets can be interpreted as having borrowed for a home. Borrowing which leads to a negative net worth involves mortgaging one's own future human capital. This typically takes the form of education loans which our model does not incorporate and so our model is presumably underestimating borrowing of this type.

sum tax on existing wealth rather than by a saving response. For example, in another experiment we performed (not reported) which partly shielded existing assets against taxation, gains to aggregate variables were significantly attenuated.[18]

No Uncertainty Regarding Wage Income and Longevity

Our model employs fixed wage efficiency profiles for each earnings class and does not incorporate wage income uncertainty. Since uncertainty about future wages may induce agents to build up a stock of precautionary wealth ("buffer stock") our model may over-predict the post-reform saving response because precautionary saving are not sensitive to changes in the interest rate (see, e.g., the contribution to this Conference by Eric Engen [1997]).

Our assumption of a certain lifespan until age 75 implies the availability of actuarially fair annuities (Blanchard [1985]; Feldstein [1988]). In reality those annuities do not exist and the lack of annuities should give rise to additional saving against longevity uncertainty which is not reflected in our model. However, Social

18. This implies that intertemporal substitution alone cannot explain the relatively strong responses in our model. Recall that we use an intertemporal substitution elasticity over *full* consumption (consumption and leisure) equal to only 0.25. Whereas Robert Hall (1978), for example, found that the intertemporal substitution elasticity over consumption *alone* is very small (around 0.10)—although subsequent work found larger values—Dale Jorgenson and Peter Wilcoxen (this conference), for example, use a value of 1.0, Eric Engen (this conference) uses 0.33 based on his own estimates and Diane Lim Rogers (this conference) considers both 0.15 and 0.50.

Security and Medicare are both annuity programs. Since they replace a large part of income for the median earner, the lack of an annuity market may not distort our results to a major extent. Nonetheless, a realistic incorporation of longevity uncertainty would be a very useful extension to our model.[19]

No Explanation of the Equity Premium

It is theoretically unclear whether a model without *aggregate* level uncertainty should target the risk free rate of return or the rate of return to capital since the latter reflects a premium for uncertainty which itself has not been explained sufficiently (i.e., the so-called "equity premium puzzle"). Smetters (1996) shows that responses to fundamental tax reform depends crucially on which rate of return is targeted. Models, such as ours, which target the equity rate tend to produce larger responses than those targeting the risk free rate. However, without jointly explaining the risk free interest rate and the equity rate, this issue cannot be resolved.

19. Models featuring lifetime uncertainty need to explicitly solve the dynamic programming problem of children who anticipate a bequest which is not perfectly deterministic in either size or timing. We are not aware of any model that does so. If bequests are distributed lump sum across the entire population (as in some models) or confiscated by the government (as in some other models), longevity uncertainty only augments the rate of time preference.

WHAT ACCOUNTS FOR THE DIFFERENCES IN RESULTS AMONG MODELS?

Although most of the models in this conference produce similar qualitative results, the models differ—sometimes significantly—in their quantitative conclusions, especially regarding the effects of the consumption tax. This section outlines what we believe are the key reasons why the simulation results of our model differ from both those of the other intertemporal models and from the reduced-form equation models.

Intertemporal Models

Jorgenson-Wilcoxen Model. The key difference between the J-W model and our model is the initial effects of the consumption tax on labor supply. The J-W model produces a 7 percent increase while our model produces a 3 percent increase. This, in turn, explains why the J-W produces a first-year increase in output equal to 4 percent, whereas our model produces only an 1 percent increase. The J-W model produces a large labor supply response because they assume that the utility of their representative agent can be represented by the natural log of full consumption, which implies an intertemporal substitution elasticity (IES) that is four times larger than the value that we use. Higher values for the IES increase the responsiveness of labor supply to changes in the after-tax rate of return to capital. This result occurs because agents choose to work more today in order to increase saving in an attempt to take advantage of the increase in the after-tax rate of return to capital.[20]

Fullerton and Rogers Model. Our model is most similar to the model of Fullerton and Rogers but differs in four important ways. Those differences explain why the long-run gains in output from a consumption tax are smaller in the F-R model, even when the F-R model assumes a value for the intertemporal substitution elasticity that is twice the size of ours. First, every agent in the F-R model faces the same marginal tax rate regardless of income. By contrast, our model has a progressive income tax system and some of the gains to output come flattening the current tax structure. Second, intergenerational bequests are fixed in the F-R model—and so they do not respond to changes in relative prices—whereas bequests in our model are endogenous and respond to those chances. That feature reduces the sensitivity of total saving to the rate of return in the F-R model but enhances that sensitivity in our model. Third, the F-R model utilizes a Stone-Geary utility function that requires a minimum purchase of certain commodities in each period. Using a Stone-Geary utility function tends to reduce the long-run saving response somewhat since the consumer's choice is narrowed down to that between leisure and *discretionary*

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20. This effect is partly offset by the fact that the J-W model assumes away any intergenerational redistribution of wealth from old retirees to young workers. In our model, the intergenerational redistribution accounts for much of the labor supply response. The J-W model cannot reflect such redistributions because the entire household sector is represented as a single infinitely lived agent.

spending.[21] Fourth, our model, but not the F-R model, incorporates an initial level of government debt. A shift to a consumption tax produces lower interest rates that, in turn, reduces the government's cost of debt service. Because the policy changes are assumed to be revenue neutral, the government's debt level is unaffected by tax reform and so a reduction in debt service lowers replacement tax rates, which increases output in the long run.

Engen's Model. In Engen's model, precautionary saving accounts for about 60 percent of total wealth whereas it is non-existent in our model. As a result, saving in our model tends to be more sensitive to the after-tax interest rate in our model than in Engen's model.

Our model, however, includes saving for an intentional bequest that is distributed to one's heirs, whereas the Engen model incorporates an accidental bequest that is distributed evenly throughout the economy. The intentional bequest feature of our model may not be particularly important for most poor households and for some middle income class households but it is important for modeling the behavior of the wealthy top 10 percent of households who own almost 70 percent of the capital stock (Survey of Consumer Finances [1992]) and for whom precautionary

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21. Enforcing a minimum consumption level is important in the F-R model because the Inada condition—i.e., that marginal utility tends to infinity as consumption approaches zero—is not applied to each consumption item. It is unclear how important such a constraint would be in our model which enforces the Inada condition over total consumption. In our simulations, the Inada condition already prevents consumption from becoming very small in any given period.

saving may or may not be an important saving motive. The incorporation of an intentional bequest motive increases the sensitivity of saving to the after-tax interest rate and the distribution of bequests to one's own family members—rather than to society at large—would reduce saving for precautionary reasons.

The importance of both intentional bequests and precautionary saving has received great scrutiny in the literature and many economists come down on each side of both issues. Indeed, some economists believe that *neither* motive for saving is very important. But most economists would probably agree that an ideal model would include both of these saving motives. Incorporating both features, however, is very difficult to do at this point. Yet both models render very similar qualitative—though not identical quantitative results—regarding tax reform.

Reduced-Form Equation Models

An advantage of the reduced-form equation models presented in this conference is their reliance on simple equations instead of complex mathematical programming problems, like those in our model. But that simplicity makes their models vulnerable to a significant criticism.

Elasticity Driven Models: Coopers and Lybrand, Gravelle, and Robbins and Robbins. The simulation results of the Coopers and Lybrand (C-L), Gravelle and Robbins and Robbins (R-R) models are primarily driven by the values they choose for the saving and labor supply elasticities. The authors gather those elasticities from the literature and from their own estimation. These elasticities are used instead of the intertemporal substitution elasticities and intratemporal elasticities in our model.

The critical assumption made by the C-L, Gravelle and R-R models is that these elasticities will remain constant after a policy change. But those saving and labor supply elasticities are *derived* parameters that combine both consumers' preferences and policy. In principle, those parameters will vary as policy is changed. (This criticism is called the "Lucas critique.") By contrast, the parameters in the intertemporal models—the intertemporal substitution elasticities and intratemporal elasticities—are "deep" parameters that describe household preferences and are not affected by changes in policy.

Simulation analysis suggests that the derived parameters can vary radically from one policy change to the next. For example, when we use our model to simulate the growth in pay-as-you-go Social Security over the past several decades, we find a *negative* relationship between aggregate consumption and wealth and a negative relationship between aggregate consumption and contemporaneous interest rates. The reason is that an increase in pay-as-you-go Social Security reduces wealth which, in turn, increases interest rates in our simulated economy. But the growth in Social Security also increases aggregate consumption as resources are transferred from higher saving workers to lower saving retirees. Clearly, saving elasticities whose values are estimated from historical variation in wealth and interest rates could be seriously biased. It is not surprising therefore that Joel Prakken found little historical relationship between labor supply and wealth, as he reported in this symposium. The major sources of historical variation would tend to produce correlations between consumption, labor supply and aggregate economic variables that are weaker than that we expect to observe under tax reform.

For the purpose of obtaining accurate parameters, what matters is not so much the length of sampling period or the *size* of the variations in aggregate variables in the historic times series but the *source(s)* of these variations. But there has not been anything close to fundamental tax reform in US history like the ones being considered for the JCT symposium.

An additional problem with the C-L, Gravelle and R-R models is that they ignore the lump-sum tax on existing wealth of a consumption tax. (Recall that this lump-sum tax was a significant contributor to the short-run increase in saving and labor supply in our model.) By ignoring this lump-sum tax, the predictions of those models about the responsiveness of the capital stock and output to tax reform will be biased downward.

The R-R model produces much larger increases in the capital stock and output in both the short and long run after a switch to a consumption tax than the other models. The reason is that the R-R model assumes that a move to a consumption tax will be met with a large net capital inflow that will equalize the *after-tax* interest rate across countries. But, as Jane Gravelle (1996) points out, the response of the capital inflow in the R-R model would be smaller if the R-R model had allowed for the fact that foreigners normally do not pay U.S. taxes on interest, dividends and capital gains.

<u>The Large Macroeconomic Models: DRI and MA.</u> These two models are subject to the same criticisms as the above reduced-form equation models. Like the above models, both models assume that the parameters in their reduced-form equations would remain constant after a switch to a consumption tax. (They differ somewhat from the C-L, Gravelle, and R-R models in that their supply elasticities are chosen so their models track the historical performance of the economy; the other models choose their elasticities from the empirical literature.)

The consumption function used in the MA model is probably the most realistic of the two models because it is a reduced-form equation of the life cycle model. The consumption function used in the DRI model is atheoretic. Nonetheless, even the MA model fails to satisfy the Lucas critique. The reason is that the model's reduced-form parameters are a function of the distribution of assets across different age cohorts. The MA model assumes that this distribution remains constant after a switch to a consumption tax whereas, in fact, the distribution changes significantly in all of the intertemporal life cycle models discussed earlier, including our own. This assumption tends to bias the results of the MA model downward.

While both models attempt to include some measure of the lump-sum tax on existing wealth of moving to a consumption tax, neither model is able to properly capture the intergenerational redistributive aspects of moving to a consumption tax. That redistribution is a driving force in the intertemporal models. As a result, both the DRI and MA models predict gains to moving to a consumption tax that are smaller than those reported using our model.

CONCLUSION

This paper evaluates two tax reform proposals in a extended and improved version of the Auerbach-Kotlikoff life cycle model with 55 overlapping generations. We find that replacing the current tax code with a flat income tax that does not exempt housing capital is likely to reduce the levels of the capital stock, output and wages in the long run. However, moving to a flat tax that exempts capital income from taxation would substantially raise output and wages. Our model exhibits relatively large increases in the labor supply due to the reduction of progressivity in the tax schedules and, most importantly, due to the lump-sum tax on existing wealth when moving to full expensing. Taxation of existing wealth reduces the consumption of all normal goods including leisure. Those increases in labor supply are likely to be greatly diminished if a consumption tax is combined with some kind of transition relief to ease the burden on people who hold existing assets.

Our model includes a large number of complex processes by explicitly solving for the exact transition path of an economy with 55 utility maximizing overlapping generations, each divided into 12 income classes. The model incorporates many important and complex aspects of reality but, as any model, excludes some parts of reality. Like the results of any simulation model therefore the results should be viewed cautiously. Nonetheless, the model seems to capture some important effects of tax reform due to its systematic footing in consumer optimization. Most notably, the model shows that a tax on existing assets can significantly increase labor supply and output in the short run, and demonstrates the importance of analyzing transition provisions in any proposal to reform the tax code.

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Table 1
Flat Income Tax: With Deduction

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010	2025	2055	2145
Composition of National Income														
Consumption[t]	0.732	0.738	0.737	0.735	0.734	0.733	0.731	0.730	0.729	0.728	0.722	0.713	0.708	0.708
+ Net Investment[t]	0.053	0.038	0.039	0.039	0.039	0.040	0.040	0.040	0.040	0.040	0.042	0.045	0.047	0.047
+ Government[t]	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
+ Exports[t]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Imports[t]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
= Total Income*	1.000	0.991	0.990	0.989	0.988	0.987	0.986	0.985	0.984	0.983	0.979	0.973	0.970	0.970
Capital Stock, Labor Supply and Total Labor Income														
Capital Stock*	1.000	0.995	0.990	0.985	0.980	0.975	0.971	0.967	0.962	0.958	0.941	0.911	0.896	0.895
Labor Supply*	1.000	0.990	0.990	0.991	0.991	0.991	0.991	0.991	0.991	0.991	0.992	0.994	0.995	0.996
Labor Income*	1.000	0.991	0.990	0.990	0.988	0.987	0.986	0.985	0.984	0.983	0.979	0.972	0.970	0.971
Net Saving Rate														
Net Saving Rate	0.053	0.039	0.039	0.040	0.040	0.040	0.040	0.041	0.041	0.041	0.043	0.046	0.049	0.049
Factor Prices: Wage Rate and Interest Rates														
Before-Tax Wage*	1.000	1.001	1.000	0.999	0.997	0.996	0.995	0.994	0.993	0.992	0.987	0.978	0.974	0.974
After-Tax Wage[‡]	0.774	0.736	0.735	0.733	0.731	0.730	0.729	0.727	0.726	0.725	0.718	0.706	0.701	0.701
Before-Tax Interest	0.096	0.096	0.096	0.097	0.097	0.098	0.098	0.098	0.099	0.099	0.100	0.103	0.104	0.104
After-Tax Interest	0.079	0.074	0.075	0.075	0.075	0.075	0.076	0.076	0.076	0.076	0.077	0.079	0.079	0.080
Unified Government Debt														
Debt*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tax Revenue, Replacement Income Tax Rate and Payroll Tax Rate														
Revenue[ff]	0.244	0.244	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.245	0.246	0.246
Replacement Tax Rate	n/a	0.235	0.235	0.236	0.237	0.237	0.238	0.238	0.239	0.240	0.242	0.248	0.250	0.250
Payroll Tax Rate	0.147	0.148	0.149	0.149	0.149	0.149	0.149	0.149	0.149	0.150	0.150	0.150	0.149	0.149

Notes:

t The components of national income (NI) sum to income (i.e., they are not percentages of NI except, of course, for year 1996 when NI = 1.0).

* Because many aggregate variables grow without bound along the balanced-path equilibrium, these variables are represented as per-effective labor unit which implies that they remain constant in the baseline steady state. Variables with an * indicate that they are indexed with a baseline value of 1.00 in 1996.

‡ The After-Tax Wage rate is computed as $(1-\tau)\cdot$(Before-Tax Wage) where τ is the economy-wide effective average marginal tax rate on wage income.

ff Percent of base Total Income.

Table 2
Flat Consumption Tax: With Deduction

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010	2025	2055	2145
Composition of National Income														
Consumption[t]	0.732	0.705	0.701	0.702	0.706	0.711	0.716	0.721	0.725	0.729	0.745	0.773	0.786	0.787
+ Net Investment[t]	0.053	0.091	0.101	0.103	0.103	0.101	0.100	0.098	0.097	0.095	0.091	0.079	0.073	0.072
+ Government[t]	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215	0.215
+ Exports[t]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Imports[t]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
= Total Income*	1.000	1.012	1.017	1.021	1.024	1.028	1.031	1.034	1.037	1.040	1.050	1.067	1.074	1.075
Capital Stock, Labor Supply and Total Labor Income														
Capital Stock*	1.000	1.019	1.038	1.055	1.072	1.087	1.102	1.115	1.128	1.140	1.191	1.276	1.312	1.315
Labor Supply*	1.000	1.025	1.010	1.004	1.001	1.000	1.000	1.000	1.001	1.001	1.001	1.000	1.000	1.000
Labor Income*	1.000	1.023	1.017	1.017	1.018	1.021	1.025	1.028	1.031	1.034	1.045	1.063	1.070	1.071
Net Saving Rate														
Net Saving Rate	0.053	0.090	0.099	0.101	0.101	0.099	0.097	0.095	0.093	0.092	0.086	0.074	0.068	0.067
Factor Prices: Wage Rate and Interest Rates														
Before-Tax Wage*	1.000	0.998	1.007	1.013	1.017	1.021	1.025	1.028	1.030	1.033	1.044	1.063	1.070	1.071
After-Tax Wage[‡]	0.774	0.711	0.699	0.699	0.702	0.708	0.715	0.720	0.725	0.731	0.749	0.783	0.797	0.799
Before-Tax Interest	0.096	0.097	0.094	0.093	0.092	0.090	0.090	0.089	0.088	0.087	0.085	0.080	0.079	0.078
After-Tax Interest	0.079	0.097	0.094	0.093	0.092	0.090	0.090	0.089	0.088	0.087	0.085	0.080	0.079	0.078
Unified Government Debt														
Debt*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tax Revenue, Replacement Income Tax Rate and Payroll Tax Rate														
Revenue[ff]	0.244	0.232	0.244	0.248	0.250	0.251	0.251	0.250	0.250	0.250	0.249	0.247	0.246	0.246
Replacement Tax Rate	n/a	0.258	0.276	0.280	0.279	0.276	0.273	0.269	0.266	0.263	0.252	0.233	0.225	0.224
Payroll Tax Rate	0.147	0.144	0.145	0.145	0.145	0.145	0.145	0.144	0.144	0.144	0.144	0.143	0.141	0.141

Notes:

t The components of national income (NI) sum to income (i.e., they are not percentages of NI except, of course, for year 1996 when NI = 1.0).

* Because many aggregate variables grow without bound along the balanced-path equilibrium, these variables are represented as per-effective labor unit which implies that they remain constant in the baseline steady state. Variables with an * indicate that they are indexed with a baseline value of 1.00 in 1996.

‡ The After-Tax Wage rate is computed as $(1-\tau)\cdot$(Before-Tax Wage) where τ is the economy-wide effective average marginal tax rate on wage income.

ff Percent of base Total Income.

APPENDIXES

APPENDIX A
DESCRIPTION OF THE POLICY EXPERIMENTS

In January 1997, the Joint Committee on Taxation (JCT) held a symposium on tax reform and invited a number of economic modelers to present analyses of the macroeconomic impacts of two plans for restructuring the U.S. tax system. The first would replace the current tax system with a broad-based unified income tax; the second would replace it with a consumption-based tax. Each modeler was asked to adopt a common set of assumptions to facilitate comparisons of the results. CBO staff contributed two papers to the symposium, which are included in this memorandum.

The income tax proposal would broaden the tax base and replace the current tax system with a single rate tax on income above certain minimum levels. The proposal would broaden the tax base by eliminating all itemized deductions, personal tax credits, and deductions and exclusions for non-wage compensation, including those for 401(k) plans, employer paid payroll taxes, and health insurance. Standard deductions and exemptions under current law would be replaced with a $10,000 personal exemption and a deduction of $5,000 for each dependent. A single tax rate would then be applied to all taxable individual income. Corporations would face the same tax rate. Corporate income would not be taxed at the personal level and thus the double taxation on corporate earnings under current law would be eliminated.

Modelers were asked to implement the consumption-based tax either as a consumption- based value added tax (VAT) or a consumption-based flat tax. Both approaches have identical long run effects on the economy. The paper by Diane Rogers analyzes a VAT. Under that specification, all corporate and income taxes under current law would be repealed, and a VAT would be imposed on domestic business enterprises on the value of goods and services sold less the cost of goods and services purchased from other firms. (Labor costs are not deducted). The VAT would also be applied to compensation paid by federal, state, and local governments as well as non-profit organizations. Taxpayers would receive a nonrefundable tax credit that provides the same benefit as the exemptions and deductions described for the unified income tax.

The second paper by Alan Auerbach, Laurence Kotlikoff, Kent Smetters, and Jan Walliser analyzes the consumption-based flat tax. That proposal was modeled as an income tax with full expensing of new investment. Other tax preferences would be eliminated. Taxpayers would receive a $10,000 personal exemption and a deduction of $5,000 for each dependent.

The JCT also asked modelers to simulate the consumption tax with and without transition relief. Experiments without transition relief repeal all present-law deductions for existing investment and net operating loss carry forwards. Experiments with transition relief allow the continuation of both present-law deductions. Experiments with transition relief identify the effect of the one-time tax on existing wealth imposed by a consumption tax. Rather than explicitly change the rules of depreciation the paper by Diane Rogers isolates the effect of the taxation of existing wealth by simulating the effects of a wage tax. Like a consumption tax, a wage tax as does not tax capital income. However, unlike a consumption tax, a wage tax does not tax existing wealth. Hence, comparing the effects of a wage tax with those of a consumption tax allows to identify the importance of the one time tax on existing wealth imposed by a consumption tax.

Both experiments assumed that real (inflation-adjusted) spending by federal, State, and local government spending would remain unchanged and that the proposals would raise the same amount of revenue as under current law. Tax rates were calculated endogenously to finance the same percentage of government spending as under baseline. Hence, deficits are unchanged and any savings due to a change in the interest rate and the concomitant change in financing costs for existing debt are reflected in lower tax rates.

APPENDIX B
THE FULLERTON AND ROGERS GENERAL-EQUILIBRIUM MODEL[1]

The Fullerton-Rogers model uses measures of lifetime income based on longitudinal data, and classifies households according to lifetime-income categories. By specifying functions that describe consumer utility and industrial production, the model is able to calculate the general-equilibrium effects of tax changes on the prices and quantities of goods and factors. It also measures the subsequent effects on economic efficiency and the welfare of each income category.

LIFETIME INCOMES

The Fullerton-Rogers model incorporates data on lifetime incomes, requiring longitudinal data for many individuals over many years. Although no data set spans the entire lifetimes of individuals, the University of Michigan's Panel Study of Income Dynamics (PSID) has been asking the same questions of the same individuals now for over 20 years. From the PSID, Fullerton and Rogers drew a sample of 500 households that included 858 adult individuals, with information on wages, taxes, transfers, and various demographic variables for the years from 1970

1. Don Fullerton and Diane Lim Rogers, *Who Bears the Lifetime Tax Burden?* (Washington, D.C.: Brookings Institution, 1993).

through 1987. They included heads of households and wives in the sample, and for simplicity in defining the lifetime of a "household," they excluded households whose marital status varied over the sample period. For heads of households and wives separately, they estimated the wage rate as a nonlinear function of age. As a result, for each individual in the sample they were able to predict the wage rate for the years that come after as well as before the sample period; multiply the actual or estimated wage rate by a total number of hours per year (for example, 4,000) to get the value of the individual's labor endowment; and calculate the present value of this endowment over the individual's lifetime.

Thus, the level of well-being in the Fullerton-Rogers model is defined by potential earnings, including the value of leisure. Those levels are used to classify individuals into twelve groups according to lifetime ability-to-pay, in which an individual's lifetime income is defined to be the average of the head's and wife's (if any) lifetime incomes. The groups are constructed by starting with the 10 deciles, but the poorest 2 percent is separated from the next poorest 8 percent, and the richest 2 percent from the next richest 8 percent.

For a given level of lifetime income, the timing of income matters: the shape of an individual's profile for lifetime income determines savings and therefore the composition of any year's annual income. Therefore, Fullerton and Rogers reestimate the profiles of wages by age separately for each of the 12 groups. In addition, they estimate the time paths of personal income taxes paid and transfers received. In that way, they set up a consistent benchmark data set with a path of consumer spending out of total available after-tax income.

MODEL STRUCTURE AND NUMERICAL SPECIFICATION OF PARAMETERS

The general-equilibrium approach to tax analysis accounts for behavioral effects and excess burdens caused by taxes. It can capture the important influences of taxes on diverse household choices about labor supply, savings, and the consumption of different commodities. Consumers supply labor and capital and purchase goods and services in a way such that well-being is maximized. The assumption that producers will maximize profits determines the demands for labor and capital and the effects of taxes on those demands. As the model solves for the prices establishing general equilibrium, it captures the net impact of taxes when those consumer and producer behaviors are considered simultaneously.

In the Fullerton-Rogers model, consumer decisions maximize the lifetime economic well-being of individuals. To begin, the individual calculates the present value of potential lifetime earnings. That endowment is then supplemented by government transfers, reduced by taxes, discounted at the after-tax interest rate, and augmented by a fixed initial inheritance. For computational simplicity, the model assumes "myopic" expectations about future prices—in other words, the consumer expects the current interest rate to prevail in all future periods.

One part of the lifetime endowment must be saved for a bequest upon death. Fullerton and Rogers avoid the many possible motivations for individual bequests, or the many ways in which taxes might affect the size of those bequests. Instead, the Fullerton-Rogers model simply acknowledges that life-cycle saving by itself can only explain about half of the observed capital stock. In the model, part of the capital stock is attributable to individuals receiving a fixed level of inheritances and then being required to leave comparable bequests at the end of life. The incidence of capital taxes thus depends on the differences in those inheritances among groups. To achieve balanced growth, each group must add some additional savings to their inheritance before they make their bequest.

The rest of the present value of income is available for spending. Decisions are made in stages. In the context of fundamental tax reform, the first two stages are the most important because they define the saving and labor-supply responses.

At the first stage, the consumer chooses how much to spend each period. That choice depends on assumptions about the form of lifetime utility and the values of certain key parameters. Lifetime utility is specified as a "constant-elasticity-of-substitution" (CES) function:

$$U = \left[\sum_{t=1}^{T} a_t^{\frac{1}{\varepsilon_1}} x_t^{(\varepsilon_1 - 1)/\varepsilon_1} \right]^{\varepsilon_1/(\varepsilon_1 - 1)},$$

where T=60 (chronological age 79) is the individual's certain date of death, ε_1, is the intertemporal elasticity of substitution, and x_t is the amount of "composite commodity" (a combination of a composite consumption good and leisure) at economic age t. The weighting parameter, a_t reflects the consumer's subjective rate of time preference, which is set at 0.005.

Although the Fullerton and Rogers study used a central-case intertemporal elasticity equal to 0.5, that elasticity is varied from a low of 0.15 up to 0.5 in the present study's examination of efficiency gains. The consumer's choice about how much to spend each period is also affected by changes in the net rate of return (which is set at 0.04 in the central case).[2]

At the second stage, the consumer allocates one period's "spending" between leisure and other consumption goods, according to the CES function:

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2. Fullerton and Rogers, *Who Bears the Lifetime Tax Burden?*, Chapter 8. The book discusses the sensitivity of calculations of incidence to these parameter values. The current study emphasizes the importance of the intertemporal elasticity in determining the efficiency gains from a switch to consumption-based taxation.

$$x_t = \left[\alpha_t^{1/\varepsilon_2}\,\bar{c}_t^{(\varepsilon_2-1)/\varepsilon_2} + (1-\alpha_t)^{1/\varepsilon_2}\, l_t^{(\varepsilon_2-1)/\varepsilon_2}\right]^{\varepsilon_2/(\varepsilon_2-1)},$$

where $\bar{c}_t$ is the amount of composite consumption good consumed at t, l_t is the amount of leisure taken at t, and ε_2 is the elasticity of substitution between consumption and leisure. The decision about how much labor to supply depends on what is assumed about the value of this consumption-leisure elasticity of substitution. Fullerton and Rogers set that elasticity at 0.5 in their central case, but for the purposes of this study that elasticity is varied from 0.15 to 0.5 (just as the intertemporal elasticity is varied). In the general-equilibrium model, individuals can "buy" more leisure at a price equal to the forgone after-tax wage, instead of buying other goods. Both taxes and age affect that choice. Individuals in that model never fully retire. The weight on leisure increases with age after they reach 60 in a way that reflects actual choices.

In the third stage, individuals decide how to allocate current consumption spending among 17 particular goods (such as food, alcohol, tobacco, utilities, housing, and so forth), according to the function:

$$\bar{c}_t = \prod_{i=1}^{N} (c_{it} - b_{it})^{\beta_{it}},$$

where N is the number of consumer goods (=17), and c_{ift} is the amount of consumer good i consumed at age t. That function is of the "Stone-Geary" form, which means that a consumer at a given age has to buy a set of "minimum required purchases" (b) and then allocates remaining spending according to a set of "marginal expenditure shares" (β). In this model, those 34 (17 x 2) parameters are estimated for each of 12 age categories using data from the Consumer Expenditure Survey, as described thoroughly in the Fullerton and Rogers book.

The Stone-Geary framework has several important implications. By making a portion of spending nondiscretionary, it reduces the sensitivity of total consumption and saving to the net rate of return. In addition, because discretionary income may be spent in proportions different from minimum requirements, the proportion of total income spent on any particular good will vary with total income. Required spending is relatively high for housing and gasoline, while discretionary spending is relatively high for clothing, services, and recreation. Thus, the rich and the poor buy different bundles, and bear different tax burdens because of those differences in how they spend their incomes.[3]

In the fourth stage of the consumer's allocation process, the expenditure on each consumer good is divided by fixed coefficients among components drawn from

3. This framework also allows Fullerton and Rogers to use the same utility function for everyone in the model. In previous efforts, rich and poor individuals spend in different proportions because they have different preferences. But then the rich and the poor differ in fundamental characteristics and not just by the amount of income they receive. With differences in utility functions, if the poor were to receive additional income, they would still spend it as if they were poor, according to their unchanged proportions. Fullerton and Rogers argue that it seems more natural that a poor person with more money would begin to behave like a rich person. That is, the primary distinction between rich and poor is the amount of income they receive. Therefore, in their model, everyone has the same preference parameters. The poor spend more on goods with high minimum required expenditures, because they are poor, and the rich spend more on goods with relatively high marginal expenditure shares.

a list of industries. No real "decision" is made here, but that step allows the matching up of consumption data using one definition of commodities with production data using a different definition. For example, expenditures on the consumer good "appliances" is composed of portions from metals and machinery, transportation, and the trade industry.

Then, in the fifth and final stage of the decision process, the consumer takes the spending on each industry output and allocates it between the corporate sector and the noncorporate sector, according to the CES function:

$$\bar{Q}_j = \left[\gamma_j^{1/\varepsilon_3} (Q_j^{c})^{(\varepsilon_3-1)/\varepsilon_3} + (1-\gamma_j)^{1/\varepsilon_3} (Q_j^{nc})^{(\varepsilon_3-1)/\varepsilon_3}\right]^{\varepsilon_3/(\varepsilon_3-1)},$$

where Q_j^{c} is the amount of corporate production of producer good j , Q_j^{nc} is the amount of noncorporate production of producer good j , and ε_3 is the elasticity of substitution between corporate and noncorporate outputs in consumption. Corporate output is assumed to be slightly different from the noncorporate output in the same industry. Hand-carved furniture, for example, is not the same as manufactured furniture. The consumer chooses the amount of each, using a weighing parameter γ based on initial corporate and noncorporate shares of production within each industry (as observed in the data), and using another elasticity of substitution (ε_3, which is set to 5.0 in the central case). That specification is consistent with the observed coexistence of both sectors within an industry, despite different tax treatments. If the outputs were identical, then a higher tax rate would drive one sector out of production. The elasticity of substitution reflects the degree of similarity. The other purpose of that specification is to capture ways in which changes in corporate taxes affect relative product prices and quantities demanded of the outputs of each sector.

A similar process characterizes the behavior of producers in each sector of each industry. Many competitive firms produce each output according to multistage production functions with constant returns to scale. Also, to keep the computation simple, the model assumes no externalities, no adjustment costs, and no uncertainty.

In the first stage of production, output is composed of a fixed-coefficient combination of value added and intermediate inputs. Each of the 19 industries uses the outputs of all other industries in fixed proportions. Thus, changes in the price of one product affect many other product prices. In the second stage, value added is a function of labor and composite capital, according to the function:

$$VA = \varphi\left[\zeta^{1/\sigma_1} L^{(\sigma_1 - 1)/\sigma_1} + (1-\zeta)^{1/\sigma_1} \bar{K}^{(\sigma_1 - 1)/\sigma_1}\right]^{\sigma_1/(\sigma_1 - 1)}.$$

The weighting parameters (ζ) are based on observed labor L and capital $\bar{K}$ in each industry, and the elasticity of substitution (σ_1) varies by industry (between 0.68 and 0.96 in the central case). Thus, a tax on labor can induce the firm to use more capital instead, and vice versa. It also raises the cost of production, and thus the price of output in any industry that uses a high proportion of the taxed factor.

In the third and final stage of production, composite capital is a CES function of five asset types (K_k)—equipment, structures, land, inventories, and intangibles:

$$\bar{K} = \left[\sum_{k=1}^{N_k} (\psi_k)^{1/\sigma_2} (K_k)^{(\sigma_2 - 1)/\sigma_2} \right]^{\sigma_2/(\sigma_2 - 1)} .$$

Those types are defined by important tax differences such as the investment credit for equipment and the expensing of new intangible assets created through advertising or research and development. The weighting shares (ψ_k) are again based on observed use of assets in each industry, and the response to tax differences is again specified by an elasticity of substitution (σ_2, = 1.5 in the central case).

Government in the model conducts several functions. It pays transfers to individuals according to the estimated lifetime transfer profiles discussed above. It produces an output for sale through an industry called "government enterprises," and it also produces a free public good by a combining its use of labor, capital, and purchases of each private industry output. The weights in that combination are based on observed government purchases, and the elasticity of substitution is one. The level of that public good is held fixed in all simulations, as any tax change involves an adjustment that ensures a constant yield of real revenues. A final government function, of course, is to collect taxes. Simplifying assumptions of the model are that the government balances its budget in each period, and that only one level of government exists (that is, no distinctions are made among federal, state, and local levels).

Each tax instrument enters the model as a wedge between the producer's price and the consumer's price. The payroll tax, for example, applies at an ad valorem rate to each producer's use of labor. Consequently, the gross wage paid by the producer is higher than the net wage received by the worker. Similarly, sales and excise taxes appear as an ad valorem rate on each consumer good. Therefore, the gross price paid by the consumer exceeds the net price received by the seller.

The modeling of the personal income tax is a bit more complicated when used to capture that tax's progressive structure of burdens. The actual U.S. personal income tax system imposes higher effective tax rates on higher incomes through a graduated rate structure with a changing marginal tax rate.

Ideally, one would calculate the effects of individual choices at each different possible marginal tax rate to determine the behavior that would maximize utility. For computational tractability, however, Fullerton and Rogers use a set of linear tax functions that approximate the U.S. system with a negative intercept for each group and a single marginal tax rate (0.25 in the 1993 benchmark). Although all individuals face the same marginal tax rate, average tax rates still increase with income because of the negative intercepts. Fullerton and Rogers do not model the myriad exemptions and deductions. Those simpler, linear tax functions can replicate the observed data on personal taxes actually paid by each group.

Property taxes and income taxes at all levels of government raise the producer's gross cost of capital for each type of asset compared with the investor's net rate of return. The cost of capital corresponding to each type of asset depends on the statutory corporate tax rate (set at 0.395 to reflect federal and state taxes in the 1993 benchmark), depreciation allowances at historical cost, how the real value of those allowances is eroded by the rate of inflation (set at 0.04), the rate of investment tax credit (set at zero after the Tax Reform Act of 1986), and the required net rate of return for the firm. That required rate of return depends, in turn, on the going market rate and the personal taxation of interest (at rate 0.246), dividends (0.292), and capital gains (0.13).

The simulations described in this study assume the "old view" of taxing dividends, in which the personal-level taxation of dividends affects the cost of capital for marginal investments.[4] A similar cost of capital formula applies to the noncorporate sector. That treatment allows the producer's choice among assets to depend on relative tax rules, and the price of output in each industry to depend on the relative use of assets with different tax treatments.

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4. See Fullerton and Rogers, *Who Bears the Lifetime Tax Burden*, pp. 210-213, for discussion of how adopting the alternative "new view" affects the efficiency and distributional effects of the various U.S. taxes.

Other assumptions help to close the model in a way that accounts for all flows and that helps facilitate computation. The model ignores international mobility of labor or capital, but allows for the trade of industrial outputs. Also, the value of imports must match the value of exports; the government's expenditures and transfer payments must match tax revenue; and the value of personal savings must match the value of expenditures for investment. Producer investment is not the result of a firm's decisions about the timing of investment, but instead results from the levels of personal saving that consumers choose. The amount of personal saving is growing over time because consumers' earnings from labor are growing as a result of population and technical change. On the steady-state growth path, the capital stock grows at exactly the same rate as the effective labor supply.

Data used within the Fullerton-Rogers model derive from many sources, adjusted to represent 1993 as the base year.[5] In addition to the survey data used to estimate wage profiles and preference parameters, they use the national income and product accounts for an input-output matrix, labor compensation by industry, government purchases, and international trade. Those published data are combined with other unpublished data on capital allocations and inheritances.

5. The benchmark specified in the Fullerton-Rogers book is based on earlier (1984) data.

For some parameters, such as the elasticities of substitution, particular values are assumed. For other parameters, such as the Stone-Geary preferences, econometric estimates are used. Finally, some remaining parameters are "calibrated" from data on actual allocations. Demand functions and all initial prices and observed quantities are used to solve backward for the value of the parameter that would make that quantity the desired one. That procedure establishes a "benchmark" equilibrium, with existing tax rules and prices. As a result, all consumers are buying the desired quantities and supplying the desired amounts of each factor, while producers are using their desired amounts of factors to produce the desired output.

Thus, using all of those parameters together, one can solve for an equilibrium with unchanged tax rules that replicates the benchmark's consistent data. That ability provides an important check on the procedure for solution. Then starting from that verified benchmark, any particular tax rule can be altered and one can determine how much more or less that consumers want to buy of each good. The model's algorithm then raises the price of any good in excess demand, and lowers the price of any good in excess supply, until it finds a set of prices at which the quantity supplied equals the quantity demanded for every good and factor. It simulates the effect of the tax change to calculate all new prices, quantities, and levels of consumer utility. The measure of the change in tax burden is the "equivalent variation," the dollar value of the change in utility measured in terms of benchmark prices. Gains in efficiency from a tax change are calculated as the present value of equivalent variations added over all income groups and all generations relative to the present value of lifetime incomes.

Results characterized as "short run" or "initial" correspond to an equilibrium immediately after the simulated policy change. Results characterized as "long run" or "steady state" reflect allocations and prices after 30 equilibria are achieved, calculated five years apart from each other. Although the 30th equilibrium is 145 years after the time of the tax change, that equilibrium is virtually identical (in terms of allocation of resources and relative prices) to an equilibrium that is 35 to 50 years out, at least in terms of the simulations discussed in this study.

APPENDIX C
TRANSITION RELIEF IN THE AUERBACH-KOTLIKOFF-SMETTERS-WALLISER MODEL

Switching to a consumption tax imposes a one-time levy on existing wealth and that plays an important role in explaining the policy's positive effects on saving and economic growth. Taxing existing wealth redistributes income from older people to younger people who have not yet accumulated a large amount of assets. Because the lump-sum tax on the old permits a reduction in marginal and average tax burden of the young, their incentives to work and save increase, and in turn the economy accumulates capital at a higher rate. As a consequence, the one-time tax on existing wealth and can increase the size of the economic pie permanently.

Many tax reform plans offer some kind of transition relief which reduces the one-time tax on existing capital. The size of the transition relief determines the size of the capital levy implied by a move to a consumption-based tax. As a consequence, generous transition relief may substantially reduce the impact a consumption tax has on saving and growth since a smaller capital levy coincides with higher taxes on younger working age cohorts and diminishes the intergenerational redistribution to their benefit.

In most cases those plans continue depreciation allowances on existing capital and the Joint Committee on Taxation chose this form of transition relief in its specification of tax reform experiments. Under current law and with current inflation, the present value of remaining depreciation allowances per dollar of net nonresidential capital is approximately half the value of assets (see Auerbach, 1996). In the AKSW model the transition relief is modeled by reducing the cash-flow tax on non-residential capital in half compared to the simulation without transition relief. As a result, the taxation of existing wealth is also reduced in half. Table C-1 displays the major economic variables under this assumption.

Not surprisingly, the results show that transition relief reduces the increase in labor supply and savings from a consumption tax. In the long run labor supply, the capital stock, and output grow by less than half compared to a consumption tax without transition relief. This result emphasizes that the taxation of existing wealth is an important factor in understanding the economic effects of a consumption tax. It also reveals that taxing existing wealth has permanent effects on savings and output.

How is the effect of transition relief transmitted to the economy? As mentioned above, the capital levy on existing assets under a consumption tax reduces the income tax rate on younger generations' labor income and entices them to work harder and save more. This positive effect of the capital levy is reduced if transition relief is permitted. As Table C-1 shows, the flat tax rate necessary to finance government spending increases from 27.9 percent to 30.1 percent in year 2000 and

26.3 percent to 28.6 percent in year 10 compared to the simulations without transition relief. In the long run the tax rate is 2.7 percentage points higher than in the experiment without transition relief. The higher tax rates necessary to finance government spending reduce the incentives to work and save for the young generation and diminish effects on output.

An important lesson of the transition relief experiment is that any reduction in the pain involved in fundamental tax reform also reduces the gains from such a reform. A large portion of the gains are not due to increased efficiency but the redistribution from the elderly to the young involved in taxing consumption. Any measures that reduce the redistribution of wealth to younger cohorts diminish the growth effects of the reform.

Table C-1
Flat Consumption Tax: With Deduction and Transition Relief

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2010	2025	2055	2145
Composition of National Income														
Consumption[t]	0.732	0.715	0.717	0.720	0.722	0.725	0.727	0.729	0.731	0.733	0.741	0.754	0.759	0.761
+ Net Investment[t]	0.053	0.076	0.075	0.074	0.074	0.073	0.072	0.072	0.071	0.071	0.068	0.064	0.062	0.061
+ Government[t]	0.215	0.214	0.214	0.214	0.214	0.214	0.214	0.214	0.214	0.214	0.214	0.214	0.214	0.214
+ Exports[t]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
- Imports[t]	0	0	0	0	0	0	0	0	0	0	0	0	0	0
= Total Income*	1.000	1.005	1.006	1.008	1.010	1.012	1.013	1.015	1.016	1.018	1.023	1.032	1.036	1.036
Capital Stock, Labor Supply and Total Labor Income														
Capital Stock*	1.000	1.014	1.023	1.031	1.038	1.045	1.051	1.057	1.063	1.068	1.091	1.129	1.151	1.153
Labor Supply*	1.000	1.003	0.999	0.999	0.999	0.999	0.999	0.999	0.999	0.999	1.000	1.000	0.998	0.998
Labor Income*	1.000	1.006	1.005	1.007	1.009	1.010	1.012	1.013	1.015	1.016	1.022	1.031	1.034	1.035
Net Saving Rate														
Net Saving Rate	0.053	0.076	0.075	0.074	0.073	0.072	0.071	0.071	0.070	0.069	0.067	0.062	0.060	0.059
Factor Prices: Wage Rate and Interest Rates														
Before-Tax Wage*	1.000	1.003	1.006	1.008	1.010	1.011	1.013	1.014	1.016	1.017	1.022	1.031	1.036	1.037
After-Tax Wage[‡]	0.774	0.731	0.730	0.733	0.736	0.738	0.741	0.743	0.745	0.747	0.755	0.769	0.776	0.778
Before-Tax Interest	0.096	0.097	0.096	0.095	0.095	0.094	0.094	0.093	0.093	0.093	0.091	0.089	0.088	0.087
After-Tax Interest	0.079	0.097	0.096	0.095	0.095	0.094	0.094	0.093	0.093	0.093	0.091	0.089	0.088	0.087
Unified Government Debt														
Debt*	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Tax Revenue, Replacement Income Tax Rate and Payroll Tax Rate														
Revenue[ff]	0.244	0.238	0.240	0.240	0.240	0.240	0.240	0.239	0.239	0.239	0.239	0.238	0.237	0.237
Replacement Tax Rate	n/a	0.286	0.299	0.302	0.301	0.298	0.295	0.292	0.289	0.286	0.276	0.259	0.252	0.251
Payroll Tax Rate	0.147	0.147	0.147	0.147	0.147	0.147	0.147	0.146	0.146	0.146	0.145	0.144	0.145	0.145

Notes:

- t — The components of national income (NI) sum to income (i.e., they are not percentages of NI except, of course, for year 1996 when NI = 1.0).
- * — Because many aggregate variables grow without bound along the balanced-path equilibrium, these variables are represented as per-effective labor unit which implies that they remain constant in the baseline steady state. Variables with an * indicate that they are indexed with a baseline value of 1.00 in 1996.
- ‡ — The After-Tax Wage rate is computed as $(1-\tau)\cdot$(Before-Tax Wage) where τ is the economy-wide effective average marginal tax rate on wage income.
- ff — Percent of base Total Income.