EFFICIENT TAXATION OF INCOME

by

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1. Introduction

In June 2001 President George W. Bush signed the Economic Growth and Tax Relief and Reconciliation Act into law, initiating a ten-year program of tax reductions. In January 2003 the President proposed a second round of tax cuts, leaving open the possibility, suggested by former Secretary of the Treasury Paul ONeill, that the Bush Administration would propose a thorough-going reform of our tax system. Tax reforms must be carefully distinguished from tax reductions. Former Secretary ONeill emphasized that any Bush Administration proposals for tax reform would be revenue neutral, so that the federal deficit would be unaffected.

Pamela Olson, Treasurys top tax official, reiterated the goal of revenue neutrality in a Washington Post interview in October 2002. This was an important objective of the last major tax reform in 1986 and insulated the two-year debate over reform from the contentious issue of the federal deficit. Olson has divided the Treasurys tax reform programs between short-run measures to simplify the tax code and long-run proposals to reform the tax system. It is important to emphasize that there is no conflict between these goals. Somewhat paradoxically, tax simplification is necessarily complex, since it would eliminate many, but not all, of the myriad special provisions of tax law affecting particular transactions. By contrast tax reform is relatively straightforward.

A major objective of tax reform is to remove barriers to efficient allocation of capital that arise from disparities in the tax treatment of different forms of income. The centerpiece of the Bush Administrations new round of tax cuts is the elimination of taxes on dividend income at the individual level. This would help to remedy one of the most glaring deficiencies in the existing U.S. tax system, namely, discriminatory taxation of corporate income. In the United States, as in most other countries, corporate income is taxed twice, first, through the corporate income tax and, second, through taxes paid by individuals on corporate dividends. Non-corporate income is

taxed only at the individual level. Eliminating individual taxes on dividends would move toward parity between corporate and non-corporate income.

To achieve revenue neutrality the dividend tax would have to be replaced by another source of revenue. One possibility would be to introduce a value-added tax levied on business revenues less expenses, including investment outlays on buildings and equipment. Purchases by individuals and governments are all that remain of business income after excluding business expenses. As a consequence, substitution of a value-added tax for the tax on dividends would have the effect of shifting the tax burden from corporate income to consumption. With Australia's adoption of a value-added tax in 1999, the U.S. remains the only industrialized country without such a tax. During the 1990s the Committee on Ways and Means of the U.S. House of Representatives held extensive hearings on consumption tax proposals, including the value-added tax, the Hall-Rabushka Flat Tax, and a National Retail Sales Tax. These differ primarily in methods for tax collection.

Substitution of a value-added tax for the tax on dividends would reduce one of the two main barriers to efficient capital allocation in our existing system. Exclusion of owner-occupied housing from the tax base is a second and more substantial deficiency. Shifting a dollar of investment from owner-occupied housing to rental housing in the corporate sector would double the rate of return to society, as measured by the return before taxes. Any proposal that leaves housing unaffected would sacrifice most of the gains from tax reform.

One advantage of a consumption tax is a low marginal tax rate, the rate that applies to the last dollar of consumption. This would provide powerful new incentives for work and saving. The U.S. corporate income tax rate is currently 40%, combining federal, state, and local taxes. This does not include taxes on corporate dividends and interest through the individual income tax. One popular proposal for replacing the existing income tax system by a consumption tax, the Hall-Rabushka Flat Tax, would reduce the marginal rate to 19%. However, a revenue-neutral Flat Tax that includes state and local as well as federal taxes would require a rate of 29%.

The Achilles heel of proposals to shift the tax base from income to consumption, at least so far, is the redistribution of tax burden. Recipients of income from property, including corporate bonds and shares, are generally much more affluent that recipients of income from work. Excluding property-type income from the tax base would shift the burden of taxation from the rich to the poor. Attempts to make a consumption tax progressive would drastically raise the marginal rate. Due to the redistribution of tax

burdens under a consumption tax, the second phase of the tax reform debate is likely to focus on improvement of our existing income tax system. The objectives would remain the same, namely, treat income sources symmetrically, reduce marginal rates, and retain progressivity. While this may sound suspiciously like trisecting an angle, these three objectives can be accomplished simultaneously by Efficient Taxation of Income.

Efficient Taxation of Income is a new approach to tax reform based on taxation of income rather than consumption. This would avoid a drastic shift in tax burdens by introducing different tax rates for property-type income and earned income from work. Earned income would be taxed at a flat rate of 10.9%, while property-type income would be taxed at 30.8%. Precisely the same distinction between earned and property-type income existed in the U.S. tax code between 1969 and 1982, so that no new tax loop holes would be created. Another important advantage of Efficient Taxation of Income is that Adjusted Gross Income for individuals and Corporate Income would be defined exactly as in the existing tax code. Individuals would continue to file the familiar form 1040 for individual income, while corporations would file corporate income tax retuns. Since the definitions of individual and corporate income would be unchanged, no cumbersome transition rules would be required. Efficient Taxation of Income could be enacted today and implemented tomorrow.

Deductions from taxable income, as well as tax credits and exemptions, would be unaffected by Efficient Taxation of Income. Businesses would continue to claim depreciation on past investments, as well as tax deductions for interest paid on debt. Mortgage interest and property taxes would be deductible from individual income for tax purposes. The tax treatment of Social Security and Medicare, as well as private pension funds, would be unchanged. The pension fund industry would not be eviscerated and pension plans would be unaffected. In short, Efficient Taxation of Income would preserve all the features of the existing tax code that have been carefully crafted by generations of lawmakers since adoption of the Federal income tax in 1913. At the same time this new approach to tax reform would remedy the glaring deficiencies in our tax system. These arise from differential taxation of corporate income and exclusion of owner-occupied housing and consumers' durables from the income tax base.

Another major concern is the impact of Efficient Taxation of Income on states and localities. Most states use the same tax bases as the federal corporate and individual taxes. Since these tax bases would not change, state and local income taxes would be unaffected and would continue to

generate the tax revenues that support schools, law enforcement, and other services provided by state and local governments. Finally, it is important to emphasize that there is no conflict between Efficient Taxation of Income and tax simplification. Somewhat paradoxically, tax simplification is necessarily complex, since it would eliminate many, but not all, of the myriad special provisions of tax law affecting particular transactions. By contrast tax reform is relatively straightforward.

The key to Efficient Taxation of Income is a system of investment tax credits that would equalize tax burdens on all sources of business income. Each dollar of new investment would generate a credit against taxes on business income. The rates for these tax credits would be chosen to equalize burdens. The average tax credits for corporations would be 4% on equipment and 19% on structures. Noncorporate businesses would receive smaller credits of 0.5% on equipment and 8% on structures. In order to equalize tax burdens on business and household assets, including housing and consumers' durables like automobiles, taxes on new investments by households would be collected by car dealers, real estate developers, and other providers. The rates would be 7% on new durables and 32% on new housing. This new source of revenue would precisely offset the new tax credits for business investment, preserving revenue neutrality.

Owners of existing homes would be deemed to have prepaid all taxes at the time of their original purchase, so that no new taxes would be imposed on housing already in place. The new taxes and tax credits would apply only to new investments. Taxes on new housing would protect property values from collapsing after tax reform is enacted. This is essential for enactment, since 68% of households own their homes and home owners are also voters who can express concerns about preserving property values at the ballot box. The tax credits for new investments in structures by corporations and noncorporate businesses would apply to new rental housing. These credits would provide incentives for real estate developers to expand the construction of rental housing. The added supply of housing would provide existing renters with more attractive and affordable options. It would also substantially reduce housing costs for newly formed households.

What are the gains from tax reform? This requires an answer to the question: How much additional wealth would be required to purchase the additions to consumption of goods and services, as well as leisure, made possible by the reform? Since consumption, not investment, is the goal of economic activity, this is the most appropriate yardstick for comparing alternative tax reform proposals. We estimate that gains from Efficient

Taxation of Income would be equivalent to 19 cents for every dollar of U.S. national wealth. The total gains would be a whopping $4.9 trillion. By comparison GDP was $8.1 trillion and National Wealth was $25.4 trillion in 1997, the base year for this comparison. These gains encapsulate the benefits of shifting investment to higher yielding assets. They also reflect greater investment and faster economic growth.

Instituting the new investment tax credits would stimulate investment, especially in the corporate sector. The revival of economic activity would raise both earned income from work and property-type income and also stimulate consumption. Efficient Taxation of Income would have a much greater impact than a revenue-neutral version of the Flat Tax. We estimate that the Flat Tax would yield $2.1 trillion by comparison with gains from Efficient Taxation of Income of $4.9 trillion. Tax reform proposals, like cherry blossoms, are hardy perennials of the Washington scene. Occasionaly, a new approach to tax reform appears and changes the course of the debate. President Reagan's proposal of May 1985 is the most recent example of a new approach to tax reform. Like Efficient Taxation of Income, this retained the income tax rather than shifting to a consumption tax. This is still the most fruitful direction for reform.

2. Income Tax Reform

The effects of taxation on the allocation of resources depend not only on size of tax wedges imposed on transactions but also on elasticities of substitution along the relevant margins. Moreover, tax distortion of resource allocation at one margin has further impacts at other margins. The analysis of taxation in terms of effective tax rates and tax wedges may be suggestive but incomplete as an economic analysis of the tax distortion of resource allocation. In certain contexts, it may even be inappropriate due to limitations of the typically static and partial equilibrium nature of the analysis.

To evaluate the economic impact of alternative tax reform proposals, we employ a dynamic general equilibrium model.[1] Equilibrium is characterized by an inter-temporal price system that clears markets for labor and capital services and consumption and investment goods. This equilibrium links the past and the future through markets for investment goods and capital services. Assets are accumulated through investments, while asset prices equal the present values of future services. Consumption must satisfy conditions for inter-temporal optimality of the household sector under perfect foresight. Similarly, investment must satisfy requirements for asset accumulation.

We employ our dynamic general equilibrium model to simulate the economic impact of alternative policies for reforming the taxation of capital income. For this purpose we have designed a computational algorithm for determining the time path of the U.S. economy following the reform. This algorithm is composed of two parts. We first solve for the unique steady state of the economy corresponding to the Tax Policy of 1996, our reference tax policy. We then determine the unique transition path for the U.S. economy, consistent with the initial conditions and the steady state. This is the base case for our analysis of changes in tax policy.

The second part of our algorithm is to solve our model for the unique transition path of the U.S. economy following tax reform. We first consider the elimination of differences in marginal effective tax rates among different classes of assets and different sectors — ten alternative programs for reforming the taxation of capital income in the U.S. We also consider the cost of progressivity in the taxation of labor income by comparing the existing labor income tax with a flat labor income tax These are the alternative cases for our tax policy analysis.

We compare the level of social welfare associated with each policy with

[1]This model updates the dynamic general equilibrium model presented in Jorgenson and Yun (1990). Additional details are given by Jorgenson and Yun (2001).

the welfare level in the base case. We translate these welfare comparisons into monetary terms by introducing an inter-temporal expenditure function, giving the wealth required to achieve a given level of welfare for the representative consumer in our model of the U.S. economy. Using this expenditure function, we translate the differences in welfare into differences in wealth.

In evaluating the welfare effects of various tax policies we require a reference economy with which the resource allocation and welfare under alternative tax policies can be compared. We take the U.S. economy under the tax laws effective in 1996 as the reference economy. The simulated dynamic path of the reference economy with an annual inflation rate of four percent is the "base case" for our simulation analysis. Since the base case serves as the reference for the evaluation of the performance of the economy under alternative tax policies, it is useful to describe its main characteristics. We describe the construction of the base case by presenting the exogenous variables that are common to all the simulations we consider.

We take January 1, 1997, as the starting point for all the simulations we consider. The main role of the initial year of the simulation is to determine the initial values of the stock variables and the scale of the economy. The stock variables determined by the starting year are the total time endowment (LH), capital stock (KL), and the claims on the government and the rest of the world (GL and RL). In our simulations, the starting values of LH, KL, GL, and RL are set in their historical values. Specifically, in 1997, $LH =$ \$17,571 billion, $KL =$ \$25,847 billion, $GL =$ \$3,784 billion. Since inflation is assumed to be 4 percent per year in the base case, we set PKL, PGL, and PRL at $(1 + 0.04)^{-1} = 0.96154$ dollar per unit. After 1997, we assume that the distribution of individuals among the categories distinguished by age, sex, and level of education will stabilize and hence the quality of time endowment, leisure, and the labor employed in the various sectors of the economy will not change. This implies that the growth rate of the total effective time endowment will be the same as the growth rate of population. We assume that population will grow at an annual rate of one percent per year and the efficiency of labor improves at the rate of productivity growth we estimated by pooling the entire producer model.

In table 2.1 we present the tax rates that describe the U.S. tax system in 1996. These include the marginal tax rates on individual capital income, the corporate income tax rate, the marginal tax rate on labor income and the average tax rate on personal income. The tax rates also include sales and property taxes, personal non-taxes, and wealth taxes. Capital consumption allowances are allowed only for corporate and noncorporate business sectors.

To estimate the average tax rates on labor and capital income of individuals, we use tables 2.2 and 2.3 based on Internal Revenue Service, *Statistics of Income1996*, *Individual Income Tax Returns*. First, we reconcile the total adjusted gross income (AGI) in the two tables by creating a zero tax rate bracket in table 2.3 and allocating the excess of total positive AGI in table 2.2 over that of table 2.3 (\$4,536.0–\$4,439.7 + 54.6 = 150.9 billion dollars) to the zero tax rate bracket.

Second, assuming that the marginal tax rate increases with the AGI bracket in table 2.2, we allocate the tax revenue of table 2.3 across the positive AGI brackets of table 2.3. We then allocate the tax revenue in each AGI bracket of table 2.2 between labor and nonlabor income, using the share of labor income in each AGI bracket (see column 3 of table 2.2). Third, we calculate the average federal labor income tax rate t_L^{af} by dividing the total tax revenue allocated to wages and salaries with the total wages and salaries in AGI. Similarly, we calculate the average federal nonlabor income tax rate and interpret it as the average federal income tax rate on individual capital income t_K^{af}. The results are: $t_L^{af} = 0.12970$ and $t_K^{af} = 0.18757$.

We note that our approach has a number of shortcomings. For example, AGI does not include income not reported in the tax returns; AGI excludes tax-exempt income; labor income of the self-employed is included in nonlabor income; and nonlabor income includes income other than capital income such as alimony, social security benefits, unemployment compensation, gambling earnings, etc. To offset some the biases that may be caused by these factors, we calculate the federal and state and local average tax rates on labor and capital income as:

$$t_L^a = \frac{t_P^a \cdot t_L^{af}}{t_P^{af}}$$

$$t_K^a = \frac{t_P^a \cdot t_K^{af}}{t_P^{af}} \ ,$$

where t_P^{af} is the average federal tax rate defined as the total tax revenue of 3.3 divided by the total positive AGI of 3.2, and t_P^a is the federal and state and local average personal income tax rates estimated from the National Income and Product Accounts. We estimate that $t_P^{af} = 0.14449$ and $t_P^a = 0.141$ for 1996. We assume the average tax rates are the same for dividents and interest income. The results are $t_L^a = 0.12657$ and $t_e^a = t_d^a = 0.18304$ as shown in table 2.1.

Table 2.1 Inflation and tax rates (1996)

1. *Marginal Tax Rates on Individual Capital Income*			
Inflation Rate	0.0	0.04	0.08
t_q^e	0.20166	0.20203	0.20228
t_m^e	0.28786	0.28786	0.28786
t_h^e	0.28786	0.28786	0.28786
t_q^g	0.05589	0.05589	0.05589
t_m^g	0.07196	0.07196	0.07196
t_h^g	0.00000	0.00000	0.00000
t_q^d	0.17096	0.18228	0.18971
t_m^d	0.22480	0.23003	0.23346
t_h^d	0.26910	0.26917	0.26921
t_g^d	0.19893	0.20252	0.20488
2. *Corporate Income Tax Rate*			
	t_q		0.38799
3. *Marginal Tax Rate on Labor Income*			
	t_L^m		0.26447
4. *Average Tax Rate on Personal Income*			
	t_L^a		0.12657
	t_e^a		0.18304
	t_d^a		0.18304
5. *Sales Tax*			
	t_C		0.05800
	t_I		0.05800
6. *Property Tax*			
	t_q^p		0.01201
	t_m^p		0.01137
	t_h^p		0.00912
7. *Others*			
	t_t		0.00675
	t_w		0.00083

Notation:
Note : We set $t_h^e = t_m^e$ and $t_h^g = 0$.

t_q^e, t_m^e, t_h^e: Average marginal tax rates of individual income accruing to corporate, noncorporate and household equities, respectively.

t_q^g, t_m^g, t_h^g: Average marginal tax rates of capital gains accruing to corporate, noncorporate and household equities, respectively.

t_q^d, t_m^d, t_h^d, t_g^d: Average marginal tax rats of interest income accruing to corporate, noncorporate, household, and government debts, respectively.

t_q: Corporate income tax rate (federal + state and local).

Table 2.1 continued

t_L^m:	Average marginal tax rate of labor income.
t_L^a:	Average tax rate of labor income.
t_e^a, t_d^a:	Average tax rates of personal capital income from equity and debt.
t_c, t_I:	Sales tax rates of consumption and investment goods.
t_q^p, t_m^p, t_h^p:	Property tax rates of corporate, noncorporate and household assets, respectively.
t_t:	Rate of personal non-taxes.
t_w:	Effective rate of wealth taxation.

Capital consumption allowances are allowed only for corporate and noncorporate business sectors. In table 2.4 we present the present value of these allowances for short-lived and long-lived assets under three alternative rates of inflation. We begin the calculation of the capital consumption allowances with the statutory depreciation schedules. We employ the after-tax nominal interest rate for discounting depreciation allowances. The nominal interest rate is the sum of the real interest rate and the inflation rate. The real interest rate is set equal to the average of the Baa corporate bond rate for our sample period 1970–1996, 0.048604. The rate of inflation varies with the simulation scenario and takes the values of zero, four, and eight percent per year. The after-tax nominal interest rate is calculated as $i \cdot (1 - t_q)$, where t_q is the corporate tax rate given in table 2.1.

In our model, the time horizon of the consumer is infinite and the model is consistent with a wide range of the steady-state configurations of the economy. From a practical point of view, this implies that the steady-state configuration of the economy can be very different from the initial conditions of the economy. We estimate the welfare effects of the alternative tax reform proposals under three alternative assumptions on the rate of inflation and four alternative methods of adjusting tax revenues. The adjustment of tax revenues is necessary to keep the government's real budgetary position on the same path as in the base case economy. This approach ensures that the government budget does not affect the measured differential welfare effects either through expenditures or through budget deficits/surpluses. However, it should be noted that when the revenue adjustment involves changes in the marginal rate of the adjusted tax, there will be substitution effects.

Table 2.2 Adjusted gross income and wages and salaries

Size of AGI (1,000 dollar)	AGI	W	S
	(billions of dollar)		
No AGI	− 54.6	7.2	—
under 5	38.3	33.8	0.88045
5−10	102.1	75.4	0.73816
10−15	165.2	122.0	0.73874
15−20	202.3	154.1	0.76212
20−25	217.9	176.0	0.80738
25−30	221.1	181.2	0.81975
30−40	436.4	362.3	0.83017
40−50	426.8	353.8	0.82907
50−75	871.8	715.5	0.82074
75−100	498.4	394.9	0.79240
100−200	603.7	433.7	0.71840
200−500	347.4	204.7	0.58926
500−1000	144.8	70.5	0.48675
1000 or more	314.4	91.7	0.29181
All Returns, Total	4536.0	3376.9	0.74446

Note:
1) AGI is net of deficit
2) All figures are estimates based on samples
Notations:

AGI: Adjusted gross income
W: Wages and salaries
S: Share of wages and salaries in AGI (W/AGI)
Source: Internal Revenue Service, *Statistics of Income—1996, Individual Income Tax Returns.*

Table 2.3 Tax generated at all rates by marginal tax rate (unit: %, billions of dollar)

Marginal tax rate	AGI	Tax generated at all rates, after credit
0.0	(150.9)	0.0
15.0	1681.8	128.9
28.0	1625.7	235.7
31.0	355.0	70.0
36.0	249.2	59.0
39.6	527.9	161.8
Total	4439.7	655.4

Source: Internal Revenue Service, *Statistics of Income—1996*, *Individual Income Tax Returns*.

Table 2.4 Present value of capital consumption allowances (1996)

Inflation rate	Corporate		Noncorporate	
	Short	Long	Short	Long
0.00	0.9299	0.5418	0.9347	0.4962
0.04	0.8801	0.4574	0.8878	0.3909
0.08	0.8360	0.3982	0.8460	0.3197

Table 2.5 Welfare effects of inflation under the law (billions of 1997 dollars)

Rate of inflation	Revenue adjustment	Welfare effect
	Lump sum tax	482.4
	Labor income tax	–89.5
0%	Sales tax	–96.8
	Individual income tax	–89.2
	Lump sum tax	0.0
	Labor income tax	0.0
4%	Sales tax	0.0
	Individual income tax	0.0
	Lump sum tax	–407.0
	Labor income tax	15.6
8%	Sales tax	31.6
	Individual income tax	19.0

Note: In 1997, the national wealth (beginning of the year) and GDP were $25,378 and $8,111 billion dollars, respectively.

Under the 1996 tax law, inflation increases the tax burden of corporate assets faster than that of noncorporate assets and the burden of noncorporate assets faster than that of household assets. But inflation has mixed effects on the absolute size of the intersectoral tax wedges where the tax wedges have negative sign. Table 2.5 shows the impact of inflation on the performance of the U.S. economy under the 1996 tax law. An increase in the rate of inflation reduces welfare under a lump sum tax adjustment, but enhances welfare under labor income tax, sales tax, and individual income tax adjustments. The welfare cost of the distortion of resource allocation by taxes can be measured as the improvement in the economic welfare of the economy when the tax wedges are eliminated. We first analyze the impact of distortions resulting from the taxation of income from capital. We consider the elimination of interasset, intersector, and intertemporal tax wedges. Specifically, we measure the efficiency gains from the following changes in the 1996 tax system:

1. Eliminate intra-sectoral tax wedges between short-lived and long-lived assets.

Table 2.6 Steady state of the base case (rate of inflation: 4%)

	Corporate		Noncorporate		Household	
	Short	Long	Short	Long	Short	Long
w	0.0868	0.2430	0.0178	0.2076	0.0968	0.3480
z	0.8801	0.4574	0.8878	0.3909	0.0000	0.0000
δ	0.1367	0.0175	0.1533	0.0112	0.1918	0.0107
PKS	0.2211	0.1066	0.2276	0.0849	0.2486	0.0602

Notations:
w: Share of capital stock
z: Present value of consumption allowances
δ: Economic depreciation rate
PKS: Price of capital services

2. Eliminate intersectoral tax wedges for short-lived and long-lived assets in the business sector — corporate and noncorporate.

3. Eliminate intersectoral tax wedges among all private sectors—corporate, noncorporate, and household.

4. Eliminate intersectoral and intra-sectoral tax wedges in the business sector.

5. Eliminate intersectoral and intra-sectoral tax wedges in the private sector.

6. Corporate tax integration.

7. Eliminate taxation of income from capital.

8. Eliminate capital income taxes and the sales tax on investment goods.

9. Eliminate capital income taxes and property taxes.

10. Eliminate capital income taxes, the sales tax on investment goods, and property taxes.

In order to eliminate tax wedges between a set of asset categories, we set their social rates of return to be equal. We achieve this objective by assigning an appropriate investment tax credit for each category. Note that equalizing

social rates of return across sectors is not equivalent to equalizing effective tax rates, since the private rate of return varies with the capital structure of each sector. However, equalizing the social rates of return to short-lived and long-lived assets within a given sector is equivalent to equalizing their effective tax rates. Table 2.6 shows the present value of capital consumption allowances z and the rates of economic depreciation δ. It also shows the allocation of capital stock w and the prices of capital services PKS in the steady state of the base case corresponding to the 1996 tax system.

The tax credits required for the first six sets of changes in the 1996 tax system given above are presented in panel 2 of table 2.7, along with the corresponding social rates of return and effective tax rates. Base case figures are presented in panel 1 for comparison. In the first tax change we equalize the social rates of return to short-lived and long-lived assets within each sector, by setting the social rates of return for short-lived and long-lived assets at their sectoral average in the steady state of base case, where the composition of capital stock in the steady state of base case in table 2.6 is used as the weight. Once the social rate of return for an asset is determined, the required rate of investment tax credit can be solved from the cost of capital formula.

There is, of course, no interasset tax wedge within the household sector, since no tax is levied on the income of the household sector and property tax rates are the same for short-lived and long-lived assets. In this tax change the intersectoral tax wedges among corporate, noncorporate, and household sectors are maintained. In the second tax change we follow the same procedure and equalize social rates of return of short-lived assets in the corporate and noncorporate sectors and similarly for long-lived assets, but the interasset wedges remain the same. The third tax change extends this analysis to the household sector. In the fourth tax change both interasset and intersectoral tax wedges in the business sectors are eliminated and the fifth extends the analysis to the household sector. We eliminate tax wedges in the first five tax changes given above by setting the relevant social rates of return at the average value in the steady state of the base case corresponding to the 1996 tax law. This assures that the resulting tax change will be approximately revenue neutral. We implement corporate tax integration, the sixth tax change given above, by setting the social rates of return for short-lived and long-lived assets in the corporate sector equal to their values in the noncorporate sector. This is not, of course, revenue neutral.

Table 2.7 Elimination of interasset and intersectoral tax wedges (rate of inflation: 4%

	Corporate		Noncorporate		Household	
	Short	Long	Short	Long	Short	Long
1. Base Case						
$\sigma - \pi$	0.0789	0.0884	0.0681	0.0733	0.0491	0.0491
e	0.3983	0.4625	0.3240	0.3715	0.1223	0.1223
k	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2. Alternative Policies						
(1) *No interasset wedges: Corporate and noncorporate sectors*						
$\sigma - \pi$	0.0859	0.0859	0.0729	0.0729	0.0491	0.0491
e	0.4470	0.4470	0.3680	0.3680	0.1223	0.1223
k	−0.0219	0.0216	-0.0163	0.0049	0.0000	0.0000
(2) *No intersector wedges: Corporate and noncorporate sectors*						
$\sigma - \pi$	0.0771	0.0814	0.0771	0.0814	0.0491	0.0491
e	0.3840	0.4167	0.4025	0.4342	0.1223	0.1223
k	0.0058	0.0604	−0.0308	−0.0981	0.0000	0.0000
(3) *No intersector wedges: All sectors*						
$\sigma - \pi$	0.0636	0.0673	0.0636	0.0673	0.0636	0.0673
e	0.2538	0.2947	0.2762	0.3159	0.3227	0.3599
k	0.0481	0.1829	0.0155	0.0718	−0.0600	−0.3392
(4) *No interasset and intersector wedges: All assets, corporate and noncorporate sectors*						
$\sigma - \pi$	0.0806	0.0806	0.0806	0.0806	0.0491	0.0491
e	0.4108	0.4108	0.4285	0.4285	0.1223	0.1223
k	−0.0053	0.0675	−0.0429	−0.0883	0.0000	0.0000
(5) *No interasset and intersector wedges: All assets, all sectors*						
$\sigma - \pi$	0.0666	0.0666	0.0666	0.0666	0.0666	0.0666
e	0.2868	0.2868	0.3083	0.3083	0.3528	0.3528
k	0.0388	0.1893	0.0053	0.0808	−0.0722	−0.3253
(6) *Corporate tax integration*						
$\sigma - \pi$	0.0681	0.0733	0.0681	0.0733	0.0491	0.0491
e	0.3030	0.3520	0.3240	0.3715	0.1223	0.1223
k	0.0340	0.1311	0.0000	0.0000	0.0000	0.0000

Notes :
$\sigma - \pi$: Social rate of return
e: Effective tax rate
k: Investment tax credit
π: Rate of inflation

In the seventh through tenth tax changes we evaluate the potential welfare gains from the elimination of intertemporal tax wedges. These are determined by capital income taxes, sales taxes on investment goods, and property taxes. The seventh tax change measures the welfare gain from elimination of the taxation of capital income for both individuals and corporations. We then move step-by-step to eliminate intertemporal tax wedges. In the eighth tax change we eliminate the sales tax on investment goods, as well as capital income taxes. In the ninth tax change we also eliminate property taxes. Finally, in the tenth change we eliminate capital income taxes, sales taxes on investment goods, and property taxes.

The welfare effects of the ten simulations are summarized in table 2.8. Beginning with the simulations with a lump sum tax adjustment, we find that the welfare gain from the elimination of the interasset tax wedges within sectors are $182.1 billion under the 1996 Tax Law. Under the lump sum tax adjustment, elimination of intersectoral wedges between the corporate and noncorporate assets yields a welfare gain of $45.1 billion.

The result of the third simulation suggests that there is potentially a very large welfare gain to be realized from eliminating the intersectoral wedges between the business and household sectors. The estimated gains are $1,616.8 billion under the 1996 Tax Law. This result is not surprising, given the large tax wedges between business and household assets. The welfare gains from eliminating the interasset and intersectoral wedges among business assets are estimated to be $127.6 billion under the 1996 Tax Law. The welfare gain from eliminating all the atemporal tax wedges in the entire private economy is estimated to be $1,692.7 billion under the 1996 Tax Law. Most of this welfare gain can be attributed to the elimination of the tax wedges between business and household sectors.

In the sixth simulation we eliminate the intersectoral tax wedges between the assets in the corporate and noncorporate assets by setting the social rates of return of corporate assets to be equal to the corresponding rates of return of the noncorporate assets in the reference case. The tax burdens on the corporate assets are unambiguously reduced without an offsetting increase in other marginal tax rates. The estimated welfare gains from this experiment are $1,067.4 billion under the 1996 Tax Law. These welfare gains are more than half of those attainable by eliminating all the atemporal tax wedges.

In the first six simulations we focused on the distortionary effects of atemporal tax wedges. However, in the following four simulations, we estimate the welfare cost of intertemporal tax distortions. For this purpose we measure the welfare gains from eliminating the distortions caused by the taxes

Table 2.8 Welfare effects of tax distortion: 1996 tax law (billions of 1997 dollars)

Eliminated wedges and method of revenue adjustment	Welfare effect	
	Additive	Proportional
(1) *Within Sector Interasset Distortion*		
Lump sum tax adjustment	182.1	182.1
Labor income tax adjustment	193.4	266.5
Sales tax adjustment	185.5	185.5
Individual income tax adjustment	184.6	252.0
(2) *Intersector Distortion: Corporate and Noncorporate Sectors*		
Lump sum tax adjustment	45.1	45.1
Labor income tax adjustment	–25.3	–59.0
Sales tax adjustment	–31.4	–31.4
Individual income tax adjustment	–32.2	–48.4
(3) *Intersector Distortion: All Sectors*		
Lump sum tax adjustment	1616.8	1616.8
Labor income tax adjustment	1716.8	1906.8
Sales tax adjustment	1709.5	1709.5
Individual income tax adjustment	1701.5	1849.6
(4) *Interasset and Intersector Distortion: Corporate and Noncorporate Sectors, All Assets*		
Lump sum tax adjustment	127.6	127.6
Labor income tax adjustment	80.4	67.0
Sales tax adjustment	70.5	70.5
Individual income tax adjustment	70.1	72.3
(5) *Interasset and Intersector Distortion: All sectors, All Assets*		
Lump sum tax adjustment	1692.7	1692.7
Labor income tax adjustment	1810.2	2015.0
Sales tax adjustment	1800.3	1800.3
Individual income tax adjustment	1789.6	1949.9
(6) *Corporate Tax Integration (Set* $\sigma^q = \sigma^m$*)*		
Lump sum tax adjustment	1067.4	1067.4
Labor income tax adjustment	282.8	–976.2
Sales tax adjustment	250.3	250.3
Individual income tax adjustment	280.4	–595.2
(7) *Capital Income Taxes (Business and Personal)*		
Lump sum tax adjustment	2691.5	2691.4
Labor income tax adjustment	362.9	–5480.2
Sales tax adjustment	493.0	493.0
Individual income tax adjustment	362.9	–5480.2

Table 2.8 continued

Eliminated wedges and method of revenue adjustment	Welfare effect	
	Additive	Proportional
(8) *Capital Income Taxes and Sales Tax on Investment Goods*		
Lump sum tax adjustment	3367.4	3367.4
Labor income tax adjustment	383.6	–8957.9
Sales tax adjustment	710.2	710.3
Individual income tax adjustment	383.6	–8957.9
(9) *Capital Income Taxes and Property Taxes*		
Lump sum tax adjustment	3723.2	3723.3
Labor income tax adjustment	–1085.0	—
Sales tax adjustment	-554.0	–554.0
Individual income tax adjustment	–1085.0	—
(10) *Capital Income Taxes, Sales Tax on Investment Goods, and Property Taxes*		
Lump sum tax adjustment	4309.5	4309.3
Labor income tax adjustment	–1101.0	—
Sales tax adjustment	–237.8	–237.9
Individual income tax adjustment	–1101.0	—

Notes:
1. Inflation is fixed at 4% per year
2. Under the additive tax adjustment, the average and marginal tax rates of labor income and the average tax rates of individual capital income are adjusted in the same percentage points. The marginal tax rates of individual capital income are adjusted in the same proportion as the marginal tax rate of labor income.
3. Under the proportional tax adjustment, average and marginal tax rates are adjusted in the same proportion.

on capital income, including property taxes and sales taxes on investment goods. In the seventh simulation we set the effective tax rates on all forms of capital equal to be zero. Social rates of return are not equalized across sectors, due to the differences in the debt/asset ratios and the property tax rates.

We find that elimination of capital income taxes at both individual and corporate levels generates a welfare gain of $2.691.5 billion under the 1996 Tax Law. Eliminating sales taxes on investment goods as well increases this gain to $3,367.4 billion. Eliminating capital income taxes and property taxes produces a gain of $3,723.2, while eliminating taxes on investments goods as well generates a gain of $4,309.0 billion. If we start with the 1996 Tax Law and eliminate all intertemporal tax wedges, the welfare gain is as large 53.1% of the U.S. GDP and 16.8% of the private national wealth in 1997.

Table 2.8 shows that the magnitudes of welfare gains under the distortionary tax adjustments are substantially different from those under the lump sum tax adjustment. Since the elimination of the tax wedges are not calibrated to be revenue neutral, the changes in the marginal tax rates due to the revenue adjustments can generate significant substitution effects. We find that the welfare effects from the elimination of tax wedges are very sensitive to the choice of the revenue adjustment method. The welfare effects are most sensitive to the choice between the lump sum tax adjustment and the distortionary tax adjustments. The results are also somewhat sensitive to the choice among the distortionary tax adjustments, especially when the size of the required revenue is large.

Note that when elimination of tax wedges implies tax cuts at the relevant margins, the welfare gains under the distortionary tax adjustments are substantially smaller than the corresponding gains under the lump sum tax adjustment. The logic underlying this observation is straightforward. The excess burden tends to increase more than proportionally with the required revenue increase. When elimination of tax wedges involves tax cuts with substantial revenue impacts, the welfare measures under the lump sum tax adjustment are best interpreted as the upper bounds of the welfare gains. Lowering marginal tax rates coupled with broadening the tax base is a successful strategy for improving the efficiency of resource allocation.

The fact that the estimated welfare gains from the elimination of the intertemporal tax wedges is in the range of $2,691.5–4,309.0 billion suggests that the potential welfare gain from replacing the current income taxes with consumption based individual taxes is potentially very large. At the same time, welfare gains under the distortionary tax adjustments are much

Table 2.9 Welfare cost of labor tax progressivity under efficient capital allocation (billions of 1997 dollars)

	Progressive		Proportional
Revenue adjustment	Additive	Proportional	Additive
Lump sum tax	1692.7	1692.7	4585.9
Labor income tax	1810.2	2015.0	4823.0
Sales tax	1800.3	1800.3	4899.9
Individual income tax	1789.6	1949.9	4857.8

Notes:
1. Inflation is fixed at 4% per year.
2. Under the additive tax adjustment, the average and marginal tax rates of labor income and the average tax rates of individual capital income are adjusted in the same percentage points. The marginal tax rates of individual capital income are adjusted in the same proportion as the marginal tax rate of labor income.
3. Under the proportional tax adjustment, average and marginal tax rates are adjusted in the same proportion.
4. The figures for the progressive labor income tax are the same as in Panel (5) of table 2.8.
5. Under the proportional labor income tax, additive and proportional tax adjustments are equivalent.

smaller, indicating that improvements in the efficiency of resource allocation can be best achieved by reducing distortions at the atemporal margins of resource allocation.

Our final simulation is intended to measure the distortions associated with progressivity of the tax on labor income. This produces marginal tax rates far in excess of average tax rates. Our point of departure is the elimination of all intersectoral and interasset tax distortions in Panel (5) of table 2.8. In table 2.9, we replace the progressive labor income tax by a flat labor income tax with the same average tax rate. Under a lump sum tax adjustment this generates a welfare gain of $4,585.9 billion, relative to 1996 Tax Law. We conclude that elimination of the progressive labor income tax, together with elimination of all intersectoral and interasset tax distortions, would produce the largest welfare gains of all the tax changes we have considered. These gains are even larger with distortionary tax adjustments as the lower marginal tax rate on labor income improves resource allocation and allows the marginal tax rates of the adjusted taxes to be lowered.

Table 2.9 presents a new approach to tax reform that we call Efficient Taxation of Income. This would avoid a drastic shift in tax burdens by intro-

ducing different tax rates for property-type income and earned income from work—a distinction that existed in the U.S. tax code between 1969 and 1982. Earned income would be taxed at a flat rate of 10.9%, while property-type income would be taxed at 30.8%. An important advantage of Efficient Taxation of Income is that income would be defined exactly as in the existing tax code, so that no cumbersome transition rules would be required. Individuals would continue to file the familiar Form 1040 for individual income, while corporations would file corporate income tax returns.

The key to Efficicient Taxation of Income is a system of investment tax credits presented in table 2.7 that would equalize tax burdens on all sources of business income. The average tax credits for corporations would be 4% on equipment and 19% on structures. Noncorporate businesses would receive smaller credits of 0.5% on equipment and 8% on structures. In order to equalize tax burdens on business and household assets, taxes on new investments by households would be collected by car dealers, real estate developers, and other providers. The rates given in table 2.7 would be 7% on new durables and 32% on new housing. The new revenue would precisely offset the tax credits for business investment, preserving revenue neutrality.

3. Consumption Tax Proposals

In the United States proposals to replace income by consumption as a tax base have been revived during the 1990s. These include the Hall-Rabushka (1983, 1995), Flat Tax Proposal, a European-style consumption-based value added tax, and a comprehensive retail sales tax on consumption. We compare the economic impact of these proposals, taking the 1996 Tax Law as our base case. In particular, we consider impact of the Hall-Rabushka Proposal and the closely related Armey-Shelby Proposal. We also consider the economic impact of replacing the existing tax system by a National Retail Sales Tax, levied on personal consumption expenditures at the retail level.

From the economic point of view, the definition of consumption is straightforward. A useful starting point is Personal Consumption Expenditures (PCE) as defined in the U.S. National Income and Product Accounts (NIPA). However, the taxation of services poses important administrative problems reviewed in the U.S. Treasury (1984) monograph on the value-added tax. First, PCE includes the rental equivalent value of owner-occupied housing, but does not include the services of consumers' durables. Both are substantial in magnitude, but could be taxed by the "prepayment method" described by Bradford (1986). In this approach, taxes on the consumption of services would be prepaid by including investment rather than consumption in the tax base.

The prepayment of taxes on services of owner-occupied housing would remove an important political obstacle to substitution of a consumption tax for existing income taxes. At the time the substitution takes place, all owner-occupiers would be treated as having prepaid all future taxes on the services of their dwellings. This is equivalent to excluding not only mortgage interest from the tax base, but also returns to equity, which might be taxed upon the sale of a residence with no corresponding purchase of residential property of equal or greater value. Of course, this argument is vulnerable to the specious criticism that home owners should be allowed to take the mortgage deduction twice—when they are deemed to have paid all future taxes and, again, when tax liabilities are actually assessed on the services of household capital.

Under the prepayment method, purchases of consumers' durables by households for their own use would be subject to tax. This would include automobiles, appliances, home furnishings, and the like. In addition, new construction of owner- occupied housing would be subject to tax, as would sales of existing renter-occupied housing to owner occupiers. These are po-

litical sensitive issues and it is important to be clear about the implications of prepayment as the debate proceeds. Housing and consumers' durables must be included in the tax base in order to reap the substantial economic benefits of substituting consumption for income as a basis for taxation.

Other purchases of services that are especially problematical under a consumption tax would include services provided by nonprofit institutions, such as schools and colleges, hospitals, and religious and eleemosynary institutions. The traditional, tax-favored status of these forms of consumption would be tenaciously defended by recipients of the services and, even more tenaciously, by the providers. For example, elegant, and sometimes persuasive arguments can be made that schools and colleges provide services that represent investment in human capital rather than consumption. However, consumption of the resulting enhancements in human capital often takes the form of leisure time, which would remain the principal untaxed form of consumption. Taxes could be prepaid by including educational services in the tax base.

Finally, any definition of a consumption tax base must distinguish between consumption for personal and business purposes. Ongoing disputes over exclusion of home offices, business-provided automobiles, equipment, and clothing, as well as business- related lodging, entertainment, and meals would continue to plague tax officials, the entertainment and hospitality industries, and users of expense accounts. In short, substitution of a consumption tax for the existing income tax system would not eliminate the practical issues that arise from the necessity of distinguishing between business and personal activities in defining consumption. However, these issues are common to the two tax bases.

The first issue that will surface in the tax reform debate is *progressivity* or use of the tax system to redistribute economic resources. We consider alternative tax reform proposals that differ in their impact on the distribution of resources. However, our simulations are limited to the efficiency impacts of these proposals.[2] One of our most important findings is that redistribution through tax policy is very costly in terms of efficiency. Unfortunately, there is no agreed-upon economic methodology for trading off efficiency and equity. It is, nonetheless, important to quantify the impact of alternative

[2]For distributional effects of fundamental tax reform, see Hall (1996, 1997), Fullerton and Rogers (1996), Feenberg, Mitrusi, and Poterba (1997), Gravelle (1995), and Gentry and Hubbard (1997). On transition and other issues, see McLure (1993), Sakar and Zodrow (1993), Poddar and English (1997), Fullerton and Rogers (1997), Engen and Gale (1997), Fox and Murray (1997), Hellerstein (1997), and Bradford (2000).

tax policies on the efficiency of resource allocation.

The second issue to be debated is *fiscal federalism*, or the role of state and local governments. Since state and local income taxes usually employ the same tax bases as the corresponding federal taxes, it is reasonable to assume that the substitution of a consumption tax for income taxes at the federal level would be followed by similar substitutions at the state and local level. For simplicity, we consider the economic effect of substitutions at all levels simultaneously. Since an important advantage of fundamental tax reform is the possibility, at least at the outset, of radically simplifying tax rules, it makes little sense to assume that these rules would continue to govern state and local income taxes, even if federal income taxes were abolished.

The third issue in the debate will be the impact of the *federal deficit*. Nearly two decades of economic disputation over this issue have failed to produce a clear resolution. No doubt this dispute will continue to occupy the next generation of fiscal economists, as it has the previous generation. An effective device for insulating the discussion of fundamental tax reform from the budget debate is to limit consideration to revenue neutral proposals. This device was critical to the eventual enactment of the Tax Reform Act of 1986 and is, we believe, essential to progress in the debate over fundamental tax reform.

3.1 Tax Reform Proposals

The subtraction method for implementing a consumption tax is the basis for the ingenious Flat Tax proposed by Hall and Rabushka (1995). The Hall-Rabushka (HR) proposal divides tax collections between firms and households. Firms would expense the cost of all purchases from other businesses, including purchases of investment goods, as in the subtraction method for implementing a consumption tax. However, firms would also deduct all purchases of labor services, so that labor compensation—wages and salaries, health insurance, pension contributions, and other supplements—would be taxed at the individual level. This would permit the introduction of allowances for low-income taxpayers in order to redistribute economic resources through the Flat Tax.

Taxation of business firms under the HR proposal is different from the current income tax system in three ways. First, a flat rate is applied to the tax base, hence the identification of this proposal as the Flat Tax. Second, interest paid by the firm is treated as part of property income and is no longer deducted from the tax base. Third, investment spending is recovered

through immediate write-offs rather than depreciation over time, so that the effective tax rate on capital is zero. The inclusion of interest payments in the tax base eliminates the differential tax treatment of debt and equity, insuring the financial neutrality of the tax system.

The federal tax rate proposed by HR is 19% for both businesses and individuals. However, if unused depreciation from capital accumulation predating the tax reform is allowed as a deduction from the tax base, the tax rate will rise to 20.1%. Personal allowances under the Hall-Rabushka proposal for 1995 are $16,500 for married taxpayers filing jointly, $14,000 for head of household, and $9,500 for single taxpayer. The allowance for each dependent is $4,500. A family of four with two adults filing jointly, for example, is entitled to a deduction of $25,500. Personal allowances are indexed to the Consumer Price Index (Hall-Rabushka, 1995, p. 144).

The Armey-Shelby (AS) proposal, introduced in the 104th Congress by Representative Richard Armey and Senator Dick Shelby, is best considered as a variant of the HR Flat Tax proposal. The principal differences between HR and AS are the Flat Tax rate and the level of personal allowances. The AS Flat Tax rate is 20% for the first two years and 17% thereafter. Compared with the HR tax rate of 19%, the AS rate is higher during the first two years by one percentage point, but lower by two percentage points thereafter. Personal allowances under AS are $21,400 for married taxpayers filing jointly, $14,000 for head of household, and $10,700 for single taxpayers. The allowance for each dependent is $5,000, so that a family of our with two adults filing jointly would be entitled to a deduction of $31,400.

The AS proposal is more generous to the taxpayer than the HR proposal in the sense that the Flat Tax rate is lower after the first two years and the family allowances are higher. The natural question is, would the AS proposal raise sufficient tax revenue to replace the income tax system? Since Hall and Rabushka have calibrated their proposal to the National Income and Product Accounts of 1993 and set the Flat Tax rate to make the HR proposal revenue neutral, it is clear that tax revenue under the AS would fall short of the level required for neutrality. We will show, however, that revenues raised under either Flat Tax proposal would be substantially below this level.

A proposal for replacing the income tax system with a National Retail Sales Tax has been introduced by Representatives Dan Schaefer, Bill Tauzin (ST), and others.[3] The ST proposal replaces personal and corporate income

[3]The ST proposal was first introduced in the 104-th Congress of 1996, and again in the 105-th Congress in 1997. See Schaefer (1997).

taxes, estate and gift taxes, and some excise taxes with a 15% national retail sales tax on a tax-inclusive consumption base. On this definition the tax base would include sales tax revenues as well as the value of retail sales to consumers. The tax rate would be lower on a tax-inclusive basis than a tax-exclusive basis, that is, where the sales tax base excludes the tax revenues. The tax rate under the ST proposal would be 17.6% on a tax-exclusive base. The ST proposal allows for a family consumption refund for qualified family units in order to redistribute economic resources.[4]

Americans for Fair Taxation (AFT) have advanced an alternative proposal for a National Retail Sales Tax. The AFT proposal replaces personal and corporate income taxes, estate and gift taxes, and the payroll tax with a 23% national retail sales tax on a tax-inclusive base similar to that of the ST proposal (29.9% on a tax exclusive base). The AFT proposal is more ambitious than the ST proposal in that it replaces the payroll tax, used to fund entitlements such as Social Security and Medicare, as well as the income tax system. This has two important implications. The first is that the unfunded liabilities of the entitlement systems would ultimately have to be funded through the sales tax. The second is that a revenue neutral tax rate would be very high.

Gale (1999) estimates that, assuming perfect compliance and no politically motivated erosion of the statutory tax base, the tax-exclusive sales tax rate has to be as high a 31.6% for the ST proposal and 53.6% for the AFT proposal to achieve revenue neutrality.[5] Comparison of these tax rates with the proposed rates of 17.6% and 29.9% reveals the dimensions of the potential revenue shortfall. Furthermore, if state and local income taxes are replaced along with the federal taxes, the tax rates have to be about 30% higher for the AFT proposal and 50% higher for the ST proposal.

A very high tax rate of the National Retail Sales Tax provides powerful incentives for tax evasion and renders effective tax administration difficult. Although it is possible to mitigate compliance problems, controlling the erosion of the tax base within a tolerable limit appears to be more problematical.[6] To achieve revenue neutrality through a National Retail

[4]The refund is equal to the tax-inclusive tax rate times the lesser of the poverty level and the wage and salary income of the family unit.

[5]See also discussions in Aaron, Gale, and Sly (1999).

[6]On tax evasion of consumption tax, see Murray (1997) and Mikesell (1997). To deal with the complicance problem Zodrow (1999) proposes withholding at the manufacturing and wholesale level, bringing the NRST closer to a VAT. To reduce the administative burden and insure the deduction of investment spending, he proposes a "business tax

Sales Tax, we consider a number of alternatives to the ST and AFT proposals. In all of these alternatives, the capital income tax would be eliminated. We construct a prototype NRST and then develop alternative proposals by varying the degree of progressivity and the division of revenues between a labor income tax and a sales tax. Both the sales tax and the labor income tax may be flat, that is, proportional to the tax base, or may be made progressive by introducing a system of family allowances. *3.2 Modeling the Tax Reform Proposals*

We maintain the role of the property tax in the existing U.S. tax system in all of our simulations. However, we consider alternative treatments of existing sales taxes on consumption and investment goods. The key tax parameter of the HR and AS proposals is the Flat Tax rate. If investment is expensed, the effective tax rate on capital income is equal to zero, whatever the Flat Tax rate, so that the choice of this rate does not affect inter-temporal resource allocation. On the other hand, the Flat Tax rate plays a very important role in the labor-leisure choice of households. It also affects the tax burden on capital assets already accumulated at the time of the tax reform

Provided that the value added by a business firm is greater than its compensation for labor input, the marginal and average tax rates are the same as the statutory flat rate. However, a large number of households are exempt from taxation due to personal allowances. For tax-exempt households, the average tax rate is zero and for most of them the marginal tax rate is zero as well. We represent the distribution of marginal tax rates between zero and the Flat Tax rate by the average marginal tax rate for labor income. At the same time, we measure the average tax burden on labor income by the average tax rate.

Under the HR proposal the statutory Flat Tax rate is 19%. Under the AS proposal a Flat Tax rate of 20% applies in the first two years after the tax reform, followed by a lower rate of 17% thereafter. These rates are chosen in order to replace federal tax revenues. In our model all three levels of government—federal, state, and local—are combined into a single government sector. If the federal income tax is replaced by a Flat Tax, we assume that the state and local income taxes are also replaced by a Flat Tax.

rebate" for inputs that can be used for both business and personal purposes. The purchaser of such an input would pay the tax at the time of the purchase, but business purchasers would be eligible for a tax rebate.

In addition, we assume that the state and local Flat Tax is deductible at the federal level. We then calibrate the Flat Tax system to the 1996 federal and state and local income tax revenues.

Specifically, we assume that the federal and state and local Flat Tax revenues are generated according to the equations

$$R_F^f = (B - R_F^s) \cdot t_F^f \tag{3.1}$$

$$R_F^s = B \cdot t_F^s \tag{3.2}$$

where B is the state and local flat tax base, t_F^f and t_F^s are the federal and the state and local Flat Tax rates and R_F^f and R_F^s are the corresponding tax revenues. The Flat Tax rate for the government sector, t_F, is defined as

$$t_F = t_F^s + t_F^f(1 - t_F^s), \tag{3.3}$$

where the expression in the parenthesis reflects the deduction of state and local taxes at the federal level.

Since the federal Flat Tax rate, t_F^f, is known, we first set federal and state and local revenues, R_F^f and R_F^s, equal to the federal and the state and local corporate income tax revenues of 1996, \$194.5 billion and \$34.5 billion, respectively. We then solve equations (3.1) and (3.2) for the state and local Flat Tax rate, t_F^s, and obtain the overall Flat Tax rate, t_F, from equation (3.3). The resulting Flat Tax rates are $t_F = 0.2164$ for the HR proposal and $t_F = 0.1943$ for the AS proposal. These rates may be compared with the corporate income tax rate $t_q = 0.3880$ at federal, state, and local levels, corresponding to the federal corporate income tax rate of 0.35 under the 1996 Tax Law.

The average marginal tax rate for labor income is defined as a weighted average of the marginal tax rates of individual taxpayers, where the share of labor income for each taxpayer in total labor income is used as the weight. The average tax rate is simply the total tax revenue divided by total labor income. Using the same National Income and Product Accounts for 1993 as Hall and Rabushka (1995, p. 57, table 3.1), we estimate that the average labor income tax rate is 0.0855 for the HR Flat Tax proposal.

In order to determine the average marginal tax rates for the HR and AS proposals on a consistent basis, we require the distribution of labor income by the marginal tax rate of the individual taxpayer. We use the 1996 Current Population Survey to estimate the average and the average marginal tax

rates on labor income for both the HR and AS Flat Tax proposals.[7] We find that the average tax rates on labor income at the federal level, t_L^{af}, are 0.1232 for HR and 0.0961 for AS, and the corresponding average marginal tax rates, t_L^{mf}, are 0.1797 and 0.1551, respectively.

In order to determine the average marginal tax rate on labor income for the government sector as a whole, we follow the same procedure as in calculating the marginal rate t_F. In place of the corporate income tax revenues, we use the individual income tax revenues for 1996. The results are that the average marginal tax rate, t_L^m, is 0.2114 for HR and 0.1834 for AS. The corresponding figure for the Tax Law of 1996 is 0.2645. We could have used a similar approach for estimating the average tax rates for the government sector. However, in order to reflect the realities of tax administration, we estimate the average tax rate, t_L^a, as

$$t_L^a = \frac{t_L^{af} \cdot t_{P96}^a}{t_{P96}^{af}} ,$$

where t_{P96}^a is the average tax rate of individual income in 1996 and t_{P96}^{af} is the average federal tax rate on individual income in the same year.[8] Our estimate of t_L^a is 0.1202 for HR and 0.0938 for AS. These figures may be compared with the corresponding figure of 0.1266 for the 1996 Tax Law, or with the federal tax rate of 0.0855 estimated by Hall and Rabushka.

We can summarize the tax rates as follows:

Hall-Rabushka

Business tax rate, average and marginal: $t_F = 0.2164$

[7]Suppose there are H taxable units indexed by h, $h = 1, \ldots, H$. Let W_k and A_k be the labor income and personal exemptions of taxable unit h. Then the average tax rate at the federal level, t_L^{af}, and the corresponding average marginal tax rate, t_L^{mf}, are defined as

$$t_L^{af} = \frac{\sum_{W_h - A_h > 0} (W_h - A_h) t_F^f}{\sum_{j=1}^H W_h} , \quad t_L^{mf} = \frac{\sum_{W_h - A_h > 0} W_h \cdot t_F^f}{\sum_{h=1}^H W_h}$$

where t_F^f is the statutory federal flat tax rate applicable to labor. We assume that married couples file jointly. We are indebted to. M.S. Ho for these calculations. For more details, see Ho and Stiroh (1998).

[8]Note that t_{P96}^{af} is estimated from a sample of tax returns in the Statistics of Income and t_L^{af} is based on the data from the Current Population Survey for 1996. We estimate that $t_{P96}^a = 0.1411$ and $t_{P96}^{af} = 0.1445$, based on the U.S. National Income and Product Accounts. This procedure adjusts the average tax rate of labor income for less than perfect tax compliance and administration.

Labor income tax rate, marginal: $t_L^m = 0.2114$
Labor income tax rate, average: $t_L^a = 0.1202$

Armey-Shelby

Business tax rate, average and marginal: $t_F = 0.1943$
Labor income tax rate, marginal: $t_L^m = 0.1834$
Labor income tax rate, average: $t_L^a = 0.0938$

Tax Law of 1996

Corporate income tax rate: $t_q = 0.3880$
Labor income tax rate, marginal: $t_L^m = 0.2645$
Labor income tax rate, average: $t_L^a = 0.1266$

We develop a number of alternative plans for the NRST by combining a sales tax on consumption and a labor income tax. In all of the alternative plans the capital income tax is eliminated. Although the existing sales taxes on investment spending may or may not be abolished, we prefer the policies with no sales tax on investment. As before, property taxes are left unchanged in our simulations. The alternative proposals differ in progressivity. They also differ in the division of revenue-raising roles between the sales tax and the labor income tax. This division has the effect of altering the relative tax burden between labor income and capital accumulated prior to the tax reform.

In order to develop alternative plans, we first construct a prototype sales tax and a prototype labor income tax. The labor income tax is based on the HR Flat Tax proposal. The sales tax is a Flat Tax rate with personal exemptions. We set the proportion of total exemptions in retail sales equal to the proportion of total exemptions in HR, which is 0.3516. Assuming that the federal sales tax rate is 17% as in Aaron and Gale (1996), table 1.1, we estimate that the corresponding average tax rate is 11.02%. In order to represent the current sales taxes, used mainly by the state and local governments, we add a Flat Tax of 5.8% to the progressive tax system we have derived. At this point, we have a progressive NRST with a marginal tax rate of 22.80% and an average tax rate of 16.82%.

We construct eight alternative NRST plans. Each plan consists of two parts—a sales tax and a labor income tax. The first two plans are limited to a sales tax, while the last two consist of a labor income tax alone. Although these two plans are not sales taxes in the usual sense, they provide benchmarks for analyzing the effects of the NRST plans on resource allocation and

economic welfare. We evaluate the efficiency of resource allocation under all of the eight plans. However, we consider plans involving a sales tax as the most interesting proposals for implementing the NRST.

In Plan 1, a progressive NRST replaces the capital and labor income taxes. Since the revenue requirement is very large in relation to the sales tax base, we start with tax rates twice as high as those of the prototype, that is

$$t_C = 2^*(0.17 + 0.058) = 0.4560 ,$$

and

$$t_C^a = 2^*(0.1102 + 0.058) = 0.3365 ,$$

$$t_L^m = t_L^a = 0 ,$$

where t_C is the average marginal tax rate and t_C^a is the average tax rate. These sales tax rates serve as the starting values for our simulations and will be adjusted to meet the budget constraints of the government sector.

In Plan 2, we remove the progressivity from the sales tax of Plan 1 and set the marginal tax rate equal to the average tax rate, so that

$$t_C = t_C^a = 0.3365 ,$$

$$t_L^m = t_L^a = 0 .$$

In Plan 3, we introduce the prototype labor income tax from the HR Flat Tax proposal and combine it with the prototype sales tax with the progressivity removed. As a consequence, the sales tax is flat while the labor income tax has the same progressivity as HR. Compared with Plan 1, the role of the sales tax as an instrument for tax collection and redistribution is substantially reduced. Specifically, we set

$$t_C = t_L^a = 0.1682 ,$$

$$t_L^m = 0.2114 ,$$

$$t_L^a = 0.1202 .$$

In Plan 4, we replace the current income tax system with the combination of a flat sales tax and a flat labor income tax. Since no attempt is made to redistribute economic resources through the tax system, this plan may be politically unpopular. On the other hand, the efficiency loss is minimal. In this sense, Plan 4 provides a useful benchmark for the possible trade-offs between equity and efficiency. The sales tax rate is set at the average tax

rate of the prototype NRST and the labor income tax rate is set at the average tax rate of the HR proposal, so that

$$t_C = t_C^a = 0.1682 \ ,$$

$$t_L^m = t_L^a = 0.1202 \ .$$

Plan 5 combines a progressive sales tax with a flat labor income tax. Although the sales tax redistributes economic resources, the revenue-raising function is shared with the flat labor tax and there is less redistribution than in Plan 1. The sales tax is the same as in the prototype sales tax plan and the rate of the labor income tax is set at the average tax rate of the HR proposal, so that

$$t_C = 0.2280 \ ,$$

$$t_C^a = 0.1682 \ ,$$

$$t_L^m = t_L^a = 0.1202 \ .$$

Plan 6 combines the prototype sales tax with the labor income tax of the HR proposal. Since both segments of the plan are progressive, the sacrifice of efficiency may be substantial. The tax parameters are

$$t_C = 0.2280 \ ,$$

$$t_C^a = 0.1682 \ ,$$

$$t_L^m = 0.2114 \ ,$$

$$t_L^a = 0.1202 \ .$$

In Plan 7, the labor income tax is flat and there is no sales tax. The average and the average marginal tax rates of labor income are equal. Since all the replacement tax revenue is raised by the tax on labor, we start with a labor income tax rate twice that of the HR Flat Tax proposal

$$t_C = t_C^a = 0 \ ,$$

$$t_L^m = t_L^a = 0.2404 \ .$$

Finally, in Plan 8, we introduce an element of progressivity into Plan 7 by setting the average marginal tax rate of labor income at the twice the level in the HR proposal

$$t_C = t_C^a = 0 \ ,$$

$$t_L^m = 0.4228 \ ,$$

$$t_L^a = 0.2404 \ .$$

Business investment is expensed in the HR and AS Flat Tax proposals. In the NRST proposals household investment is taxed as consumption, which may be interpreted as a prepayment of taxes on the services of household capital. To represent the Flat Tax proposals of HR and AS and the various NRST plans, we must determine the allocation of gross private investment among the three private sectors—corporate, noncorporate, and household. To determine the investment in each of these sectors, we first allocate total value of investment among the six asset categories in proportion to the capital stock. This is equivalent to assuming that the capital stocks in the three private sectors grow at the same rate.

Next we add the current value of economic depreciation to obtain the gross investment, VIG_i, in asset category i, so that

$$VIG_i = \left(\delta_i + \frac{VIN}{VK}\right) VK_i$$

where δ_i is the economic depreciation rate, VIN is the total value of net private investment, VK is the total current value of lagged private capital stock, VK_i is the current value of lagged capital stock in asset category i. In this expression VIN and VK are defined as

$$VIN = (IS - IG - IR) \cdot PI - D$$

$$VK = VKL(1 + \pi)$$

where IS is the total supply of investment goods, IG is the government demand for investment goods, IR is the demand from the rest of the world, PI is the price of investment goods, and D is economic depreciation on private capital. In a steady state the allocation of gross investment across the asset categories takes a simpler form:

$$VIG_i = [(1 - \alpha_T)(1 + n) - (1 - \delta_i)]VK_i$$

where $-\alpha_T$ is the rate of technical change, and n is the growth rate of time endowment.

We preserve revenue neutrality by requiring the government sector to follow the same time paths of real spending and government debt under all the tax reform proposals. We also fix the time path of the claims on

the rest of the world. These assumptions are necessary to separate the economic impacts of alternative tax policies from the effects of changes in the government budget and the balance of payments. Government revenues must be adjusted through changes in the tax policy instruments in order to satisfy the government budget constraints in every period along the transition path to a steady state.

In some simulations we take Flat Tax rate in the HR and AS proposals or the sales tax or labor income tax rates in the NRST plans to be fixed and vary other taxes in order to meet the government budget constraints. In other simulations we vary the tax rates themselves to meet these constraints, so that the rates we have derived serve only as starting values. For example, in the case of the HR and AS proposals, the simulation with adjustment of the Flat Tax rate, where t_F, t_L^m, and t_L^a are adjusted simultaneously and in the same proportion, will generate a configuration of the U.S. tax system that is revenue neutral. Similarly, in the analysis of an NRST plan, adjustment of the sales tax and the labor income tax rates achieves revenue neutrality. In the sales tax adjustment, t_C and t_C^a are adjusted in the same proportion; in the labor income tax adjustment, t_L^m and t_L^a are adjusted similarly.

In the HR and AS proposals the effective tax rate on investment is zero, reducing the tax wedge between returns to investors and earnings of savers. The remaining distortion at the inter-temporal margin of resource allocation is due to the property tax and the sales tax on investment goods. In the NRST all taxes on capital income are abolished and the sales tax on investment goods is abolished as well in some of the alternatives we consider. The only remaining source of inter-temporal distortions is the property tax. In our model the sales tax on investment goods affects the producer price of investment goods. Therefore, formulas for the cost of capital are not affected by the tax.

The price of capital services from one unit of capital, P_j , is:

$$P_j = \left[RD_j + \frac{1 - D \cdot t_F}{1 - t_F} \cdot t_s^P \right] \cdot q_j \ , \quad j = QS, QL, MS, ML \tag{3.4}$$

$$P_j = [RD_j + (1 - D \cdot t_L^m) t_j^P] \cdot q_j \ , \quad j = HS, HL \tag{3.5}$$

where RD is the gross discount rate, t_F is the Flat Tax rate, t_j^P is the property tax rate, q_j is the lagged price of a capital asset, the subscript j stands for the short-lived and long-lived assets in the corporate, noncorporate, and household sectors, and s stands for the three private sectors. Thus $s = q$ if

$j = QS, QL$; $s = m$ if $j = MS, ML$; and $s = h$ if $j = HS, HL$. $D = 1$ if property tax is deductible and $D = 0$, otherwise.

In the HR and AS Flat Tax proposals, the labor income tax is the only tax, other than property tax, that is collected directly from the household sector. Hence, we allow the property tax as a deduction from labor income. The gross discount rate, RD_j, is defined as the sum of the after-tax real discount rate and the economic depreciation rate adjusted for inflation:

$$\begin{aligned} RD_j &= (1-\beta_s)(\rho^e - \pi) + \beta_s(i-\pi) + (1+\pi)\delta_j \ , \\ j &= QS, QL, MS, ML, HS, HL \ \text{ and } \ s = q, m, h \end{aligned} \tag{3.6}$$

where ρ^e is the after-tax nominal rate of return to equity, i is the nominal interest rate, β_s is the debt/asset ratio, π is inflation rate, and δ_j is the rate of economic depreciation.

Equations (3.4)–(3.6) apply to the HR and AS proposals, as well as the NRST. However equation (3.5) must be interpreted with some care. Investment spending on household assets is included in the sales tax base under the NRST. The most important type of investment spending is the purchase of owner-occupied housing. We model the sales tax on household investment by imposing taxes on sales to the household sector. At the same time we increase the price of capital services by the amount of the sales tax. This treatment of the sales tax on household investment is equivalent to prepayment of the consumption tax on household capital services. Thus, we may interpret (3.5) as the "producer" price of household capital services, while the corresponding "consumer" price is defined as:

$$P_j^C = (1+t_C)[RD_j + t_h^P] \cdot q_j \ , \quad j = HS, HL \tag{3.7}$$

where we set $D = 0$.

3.3 Welfare Impacts of Fundamental Tax Reform

Table 3.1 summarizes the key tax parameters of the fundamental tax reform proposals and tables 3.2a and 3.2b report the estimated welfare effects. In table 3.2a, we present two sets of results. In the first set of simulations the corporate and individual income taxes of 1996 are replaced by the HR or AS Flat Tax, while sales taxes on consumption and investment goods remain unchanged (column 2). In the second set of simulations we replace the sales taxes as well, so that $t_C = t_C^a = 0$ and $t_I = 0$ (column 3). In the second

Table 3.1 Tax parameters of fundamental tax reform proposals—Lump sum tax adjustment, central cases

Tax Reform Proposal and Welfare Effect	t_q or t_F	t_L^m	t_L^a	t_C	t_C^a	t_I
1. Base Case						
(1) Tax Law of 1996	0.3880	0.2645	0.1265	0.0580	0.0580	0.0580
2. Flat Tax						
(1) Hall-Rabushka	0.2164	0.2114	0.1202	0.0580	0.0580	0.0580
(2) Armey-Shelby	0.1943	0.1834	0.0938	0.0580	0.0580	0.0580
3. National Retail Sales Tax						
(1) Progressive Sales Tax and No Labor Income Tax	0.0	0.0	0.0	0.4560	0.3365	0.0
(2) Proportional Sales Tax and No Labor Income Tax	0.0	0.0	0.0	0.3365	0.3365	0.0
(3) Proportional Sales Tax and Progressive Labor Income Tax	0.0	0.2114	0.1202	0.1682	0.1682	0.0
(4) Proportional Sales Tax and Proportional Labor Income Tax	0.0	0.1202	0.1202	0.1682	0.1682	0.0
(5) Progressive Sales Tax and Proportional Labor Income Tax	0.0	0.1202	0.1202	0.2280	0.1682	0.0
(6) Progressive Sales Tax and Progressive Labor Income Tax	0.0	0.2114	0.1202	0.2280	0.1682	0.0
(7) No Sales Tax, Proportional and Labor Income Tax	0.0	0.2404	0.2404	0.0	0.0	0.0
(8) No Sales Tax, Progressive Labor Income Tax	0.0	0.4228	0.2404	0.0	0.0	0.0

Notes:

1. In the central case, $t_C = t_C^a = t_I = 0.058$ for the flat tax (HR and AS), and $t_I = 0$ for the NRST.

2. In the cases of flat tax adjustment, the values of t_F, t_L^m, and t_L^a in the table are used as the starting values for iteration. Similarly for sales tax and labor income tax adjustment.

t_F: flat tax rate
t_L^m: average marginal tax rate of labor income
t_L^a: average tax rate of labor income
t_C: average marginal tax rate of retail sales
t_C^a: average tax rate of retail sales
t_I: sales tax rate of investment spending

Table 3.2a Welfare effects of fundamental tax reform—Flat tax (billions of 1997 dollars)

Tax reform proposal and revenue adjustment	Welfare effect	
	$t_C = t_C^a = t_I = 0.058$	$t_C = t_C^a = t_I = 0$
1. *Hall-Rabushka*		
Lump sum tax	3637.3	4991.6
Flat tax	2056.2	814.9
Sales taxes	2582.2	—
Flat tax and sales taxes	2240.1	—
2. *Armey-Shelby*		
Lump sum tax	4173.0	5392.2
Flat tax	1229.3	−756.0
Sales taxes	2476.2	—
Flat tax and sales taxes	1772.7	—

Note: Inflation is fixed at 4% per year.
t_C: Marginal sales tax rate of consumption goods
t_C^a: Average sales tax rate of consumption goods
t_I: Flat sales tax rate of investment goods

set of simulations, all the inter-temporal distortions, except for the property tax, are eliminated since $t_I = 0$.

With the initial Flat Tax rates both the HR and the AS proposals fall short of revenue neutrality. The welfare impact of these proposals depends on the tax instrument chosen for raising the necessary revenue. If sales taxes on consumption goods and investment goods are maintained, the welfare gains are in the ranges of \$2.06–3.64 trillion for HR and \$1.23–4.17 trillion for AS, measured in 1996 dollars. Converted into annual flows at the long run real private rate of return of 4.45%, the welfare gains are in the range of \$92–162 billion for HR and \$55–186 billion for AS. The largest welfare gains are obtained when a lump sum tax is used to compensate for the revenue shortfall. Since the lump sum tax is not available in practice, the welfare gains for the lump sum tax adjustment may be interpreted as the potential gains in welfare from a Flat Tax proposal.

If both income taxes and sales taxes are replaced by a Flat Tax and a lump sum tax is used to compensate for the revenue shortfall, the welfare gains are very substantial, \$3.64 trillion for HR and \$4.17 trillion for AS. If sales taxes, as well as corporate and individual income taxes, are replaced

Table 3.2b Welfare effects of fundamental tax reform—National Retail Sales Tax (billions of 1997 dollars)

Tax reform proposal and revenue adjustment	Welfare effect	
	$t_I = 0.058$	$t_I = 0$
1. *Grad Sales, no Labor Income Tax*		
Lump sum tax	1830.1	2583.9
Labor income tax	—	—
Sales taxes	3268.5	3323.6
Labor income tax and sales taxes	—	—
2. *Flat Sales, no Labor Income Tax*		
Lump sum tax	3500.8	4115.6
Labor income tax	—	—
Sales taxes	4540.8	4686.8
Labor income tax and sales taxes	—	—
3. *Flat Sales Tax, Graduated Labor Income Tax*		
Lump sum tax	1924.0	2678.3
Labor income tax	3413.0	3086.9
Sales taxes	2686.1	2871.3
Labor income tax and sales taxes	2992.9	2965.8
4. *Flat Sales, Flat Labor Income Tax*		
Lump sum tax	3838.3	4427.8
Labor income tax	4504.9	4697.3
Sales taxes	4545.5	4696.5
Labor income tax and sales taxes	4530.8	4697.3
5. *Graduated Sales Tax, Flat Labor Income Tax*		
Lump sum tax	2965.1	3633.8
Labor income tax	3666.8	3868.9
Sales taxes	3888.8	3946.0
Labor income tax and sales taxes	3796.9	3910.1
6. *Graduated Sales Tax, Graduated Labor Income Tax*		
Lump sum tax	769.3	1609.3
Labor income tax	2233.3	1802.7
Sales taxes	1694.0	1737.5
Labor income tax and sales taxes	1921.3	1766.5
7. *No Sales, Flat Labor Income Tax*		
Lump sum tax	4106.1	4664.3
Labor income tax	4354.6	4527.8
Sales taxes	—	—
Labor income tax and sales taxes	—	—
8. *No Sales, Graduated Labor Tax*		
Lump sum tax	–1806.8	–818.2
Labor income tax	–2869.3	–4447.9
Sales taxes	—	—
Labor income tax and sales taxes	—	—

Note: 1. Inflation is fixed at 4% per year.
t_I: Rate on investment goods

with a Flat Tax and a lump sum tax is used to raise the additional revenue, the gains are even larger, almost $5 trillion for HR and $5.39 trillion for AS. The welfare gains from the Flat Tax proposals are lower when distorting taxes are increased to meet the revenue requirement. The actual welfare gain depends critically on the taxes that are replaced and the tax distortions introduced to meet the revenue requirement. If the Flat Tax rate is adjusted to make up the revenue shortfall, substitution of the HR Flat Tax for corporate and individual income taxes would produce a welfare gain of only $2.06 trillion. If sales taxes are also replaced the gain falls to $0.81 trillion. The corresponding welfare gains for the AS Flat Tax are $1.23 trillion for replacement of income taxes and a negative $0.76 trillion for replacement of sales taxes as well. These results imply that the distortions resulting from the Flat Tax are worse than those from the sales tax at the margin.

The most interesting cases in table 3.2a are the simulations where personal allowances are held fixed and the Flat Tax rate is adjusted to make up lost revenue. The welfare gains are $2.06 trillion for the HR proposal and $1.23 trillion for AS proposal. The reason for the relatively poor performance of the AS proposal is the higher marginal tax rate on labor.[9] Recall that that the HR proposal has a higher tax rate than the AS proposal. However, given the constraint imposed by fixed time paths of government debt and real government spending, the more generous personal allowances in the AS proposal imply a higher tax rate. Table 3.2b reports the welfare effects of the six plans for replacing the corporate and individual income taxes with an NRST and the two additional plans for replacing income taxes with a labor income tax. We present two sets of simulations—one with the sales tax on investment goods and the other without. First, note that the case without a sales tax on investment goods is more in the spirit of the NRST, which exempts sales of investment goods from taxation. Unsurprisingly, the cases with sales taxes on investment removed are generally more efficient than those with sales taxes unchanged ($t_I = 0.058$).

Second, in Plans 1 through 6 where a sales tax is included as a part of the replacement tax policy, the tax parameters in Panel 3 of table 3.1, together with sales taxes on investment goods ($t_I = 0.058$ or $t_I = 0$), generate revenue surpluses and require either a negative lump sum tax or a decrease in tax rates. This explains the fact that welfare gains under the lump sum tax adjustment are lower than under other tax adjustments.[10] Third, except

[9] A high flat tax rate implies a heavy lump sum tax on "old" capital, offsetting the distorting effects of the tax on labor.

[10] Revenue shortfalls occur in Plan 7 with $t_I = 0$ and Plan 8 with either $t_I = 0.058$ or

for Plan 8 and possibly for Plan 6, the welfare gains are impressive. Plan 4 with flat sales and labor income taxes and no tax on investment goods ($t_I = 0$) attains a welfare gain of $4.70 trillion, more than five times the corresponding gain for the HR Flat Tax proposal. However, Plan 2 and Plan 7 are not far behind in terms of gains in welfare. Finally, the welfare gains attainable with the progressive Plans 1, 3, 5 are also much higher than those of the HR and AS Flat Tax proposals.

A second set of comparisons that is highly relevant to deliberations about tax reform is the cost of progressivity. One of the most attractive features of the HR and AS Flat Tax proposals is the possibility of introducing a system of family allowances in order to preserve the important function of the existing U.S. tax system in redistributing economic resources. Plan 1 for the NRST also retains this feature of the tax system, but generates welfare gains of $3.32 trillion, exceeding those of the HR Flat Tax proposal by more than fifty percent. Of course, a sales tax can be employed to compensate for the revenue shortfall of the HR Flat Tax, reducing the difference between the welfare gains. However, the NRST is clearly superior to the Flat Tax as an approach to tax reform when both retain an element of progressivity.

The costs of progressivity can be ascertained by comparing the welfare gains between Plan 1, a progressive sales tax, with Plan 2, a flat sales tax. With no sales tax on investment goods and adjustment of the sales tax on consumption goods to achieve revenue neutrality, the gain in welfare from eliminating progressivity is $1.36 trillion, added to the welfare gain of a progressive sales tax of $3.32 trillion for an overall gain of $4.69 trillion. Similar comparisons can be made between Plan 3 with a flat sales tax and a progressive labor income tax and Plan 4 with flat sales and labor income taxes. The welfare gains from eliminating progressivity are $1.61 trillion when the labor income tax is used to achieve revenue neutrality and $1.83 trillion when the sales tax is used for this purpose. Other comparisons between progressive and flat versions of the NRST given in table 3.2 generate estimates of the cost of progressivity that are similar in magnitude.

Since taxes distort resource allocation, a critical requirement for a fair comparison among alternative tax reform proposals is that all proposals must raise the same amount of revenue. It is well known that the ST and AFT sales tax proposals fail to achieve revenue neutrality and tax rates must be increased substantially above the levels proposed by the authors of the

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$TI = 0$.

plans.[11]. The authors of the HR Flat Tax proposal have calibrated their tax rates to the National Income and Product Account for 1993 in such a way that the resulting tax regime is revenue neutral. It is clear that the AS proposal falls short of revenue neutrality because it is more generous in personal allowances and applies a lower tax rate than the HR proposal. As it turns out, however, the HR proposal also raises too little revenue to be neutral.

Based on the federal Flat Tax rate proposed by Hall and Rabushka, we have estimated three tax rates under the assumption that the state and local income taxes are also replaced by a Flat Tax. Specifically, we start with the Flat Tax rate $t_F = 0.2164$, the marginal tax rate on labor income $t_L^m = 0.2114$, and the average tax rate on labor income $t_L^a = 0.1202$ (see table 3.1). In order to meet the government sector revenue requirement, these tax rates must be increased by a factor of 0.27–0.33 (column 5, table 3.3). It follows that the statutory federal Flat Tax rate must be increased from 19% to 24–25%. The problem is even severe with the AS proposal, where the tax rates must be increased by a factor of 0.60–0.67 (column 9, table 3.3), implying that the proposed federal Flat Tax rate must be increased from 17% to 27–28%.

The need for a major upward adjustment in the Flat Tax rate conflicts with the fact that HR is originally designed to be revenue neutral. The explanation is that the data set employed by Hall and Rabushka, the U.S. National Income and Product Accounts of 1993, was generated under a tax system with a significant tax burden on capital.[12] Unsurprisingly, they found a large tax base in the business sector. Although the Flat Tax imposes a lump sum tax on "old" capital accumulated before the tax reform, the Flat Tax does not impose any tax burden on "new" capital accumulated through investment after the reform. The tax base of the business portion of the tax shrinks dramatically and a large revenue shortfall emerges, requiring an increase in the Flat Tax rate.

From the point of view of efficiency the most attractive approach to tax reform we have considered is Plan 4 for the NRST, which combines a

[11]For example, see Aaron and Gale (1996) and Gale (1999)

[12]In 1993, the corporate income taxes were $138.3 billion for the Federal Government and $26.9 billion for the state and local governments. In the same year, the Federal Government collected $508.1 billion of income tax from individuals and the state and local governments collected $124.2 billion.

Table 3.3 Transition paths of tax rates: Flat taxes ($t_C = t_C^a = t_I = 0.058$)

	1. Hall-Rabushka				2. Armey-Shelby			
Year	t_F	t_L^a	t_L^m	ADJ	t_F	t_L^a	t_L^m	ADJ
1	0.2872	0.1595	0.2805	0.3273	0.3244	0.1566	0.3063	0.6699
2	0.2872	0.1595	0.2805	0.3272	0.3244	0.1566	0.3063	0.6700
3	0.2871	0.1595	0.2805	0.3270	0.3244	0.1566	0.3062	0.6698
4	0.2870	0.1594	0.2804	0.3266	0.3243	0.1565	0.3062	0.6694
5	0.2869	0.1594	0.2803	0.3260	0.3242	0.1565	0.3061	0.6688
6	0.2868	0.1593	0.2801	0.3254	0.3241	0.1564	0.3059	0.6680
7	0.2866	0.1592	0.2800	0.3246	0.3239	0.1563	0.3058	0.6672
8	0.2864	0.1591	0.2798	0.3237	0.3237	0.1562	0.3056	0.6661
9	0.2862	0.1590	0.2796	0.3227	0.3234	0.1561	0.3053	0.6649
10	0.2860	0.1589	0.2794	0.3217	0.3232	0.1560	0.3051	0.6637
12	0.2854	0.1586	0.2788	0.3192	0.3226	0.1557	0.3046	0.6606
14	0.2849	0.1583	0.2783	0.3167	0.3220	0.1554	0.3040	0.6576
16	0.2843	0.1579	0.2777	0.3139	0.3213	0.1551	0.3034	0.6541
18	0.2837	0.1576	0.2771	0.3109	0.3206	0.1548	0.3027	0.6504
20	0.2830	0.1572	0.2764	0.3078	0.3199	0.1544	0.3020	0.6465
25	0.2812	0.1562	0.2747	0.2997	0.3179	0.1534	0.3001	0.6364
30	0.2782	0.1545	0.2717	0.2857	0.3144	0.1518	0.2968	0.6185
35	0.2774	0.1541	0.2710	0.2822	0.3136	0.1514	0.2960	0.6142
40	0.2754	0.1530	0.2690	0.2729	0.3113	0.1502	0.2938	0.6022
45	0.2756	0.1531	0.2692	0.2738	0.3115	0.1504	0.2941	0.6035
50	0.2758	0.1532	0.2694	0.2745	0.3117	0.1504	0.2942	0.6042
60	0.2759	0.1532	0.2695	0.2751	0.3118	0.1505	0.2944	0.6050
70	0.2760	0.1533	0.2696	0.2753	0.3119	0.1505	0.2944	0.6053
80	0.2760	0.1533	0.2696	0.2754	0.3119	0.1505	0.2944	0.6054
90	0.2760	0.1533	0.2696	0.2753	0.3119	0.1505	0.2944	0.6053
100	0.2759	0.1532	0.2695	0.2749	0.3118	0.1505	0.2943	0.6048

Note: The flat tax rate is adjusted for revenue neutrality.
t_C: Marginal sales tax rate on consumption goods
t_C^a: Average sales tax rate on consumption goods
t_I: Sales tax rate on investment goods
t_F: Flat tax rate of the business sector
t_L^m: Marginal tax rate on labor income
t_L^a: Average tax rate on labor income
ADJ: Adjustment factor for tax rates

flat sales tax with a flat labor income tax and eliminates sales taxes on investment goods. In Panel 3 of table 3.4 we see that this requires an initial sales tax rate of 15.9 percent and a labor income tax rate of 11.3 percent with both rates gradually declining over time. The welfare gain would be diminished relatively little by shifting the burden toward the labor income tax, as in Plan 7. The combination of an NRST collected at the retail level and a labor income tax collected as at present would be administratively attractive and would generate welfare gains amounting to more than half of the gross domestic product in 1997, the benchmark year for our simulations.

4. Conclusion

Our final objective is to evaluate the cost of capital as a practical guide to reform of taxation and government spending. Our primary focus is U.S. tax policy, since the cost of capital has been used much more extensively in the U.S. than other countries. Auerbach and Jorgenson (1980) introduced the key concept, the marginal effective tax rate, early in the debate over the U.S. Economic Recovery Tax Act of 1981. They showed that the tax policy changes of the early 1980s, especially the 1981 Tax Act, increased barriers to efficient allocation of capital.

By contrast we showed that the Tax Reform Act of 1986 substantially reduced barriers to efficiency.[13] The erosion of the income tax base to provide incentives for investment and saving was arrested through vigorous and far-reaching reforms. Incentives were sharply curtailed and efforts were made to equalize marginal effective tax rates among assets. The shift toward expenditure and away from income as a tax base was reversed. Jorgenson's international comparisons of 1993 showed that these reforms had important parallels in other industrialized countries.

The cost of capital approach has also proved its usefulness in pointing the direction for future tax reforms. For this purpose information about the cost of capital must be combined with estimates of the substitutability among different types of outputs and inputs by businesses and households. The most

[13] Jorgenson and Yun (1990) and Yun (2000).

Table 3.4. Transition paths of tax rates: National retail sales tax

	Plan 1. Progressive Sales Tax No Labor Income Tax ($t_F = t_L^a = t_L^m = t_I = 0.0$)		Plan 2. Flat Sales Tax No Labor Income Tax ($t_F = t_L^a = t_L^m = t_I = 0.0$)	Plan 4. Flat Sales Tax Flat Labor Income Tax ($t_F = t_I = 0.0$)	
Year	t_C^a	t_C	$t_C^a = t_C$	$t_L^a = t_L^m$	$t_C = t_C^a$
1	0.2976	0.4034	0.2874	0.1132	0.1585
2	0.2977	0.4035	0.2875	0.1132	0.1584
3	0.2978	0.4036	0.2875	0.1132	0.1584
4	0.2978	0.4036	0.2875	0.1131	0.1583
5	0.2978	0.4036	0.2874	0.1131	0.1583
6	0.2978	0.4036	0.2874	0.1131	0.1582
7	0.2977	0.4035	0.2873	0.1130	0.1582
8	0.2977	0.4034	0.2872	0.1130	0.1581
9	0.2976	0.4033	0.2871	0.1129	0.1580
10	0.2975	0.4032	0.2870	0.1128	0.1579
12	0.2972	0.4028	0.2867	0.1127	0.1577
14	0.2970	0.4025	0.2864	0.1125	0.1575
16	0.2966	0.4020	0.2861	0.1124	0.1573
18	0.2963	0.4015	0.2858	0.1122	0.1570
20	0.2959	0.4010	0.2854	0.1120	0.1568
25	0.2948	0.3996	0.2843	0.1115	0.1561
30	0.2948	0.3996	0.2843	0.1111	0.1555
35	0.2944	0.3990	0.2838	0.1109	0.1552
40	0.2951	0.4000	0.2844	0.1108	0.1550
45	0.2953	0.4003	0.2846	0.1108	0.1551
50	0.2954	0.4004	0.2847	0.1109	0.1552
60	0.2956	0.4006	0.2848	0.1109	0.1552
70	0.2956	0.4007	0.2849	0.1109	0.1553
80	0.2957	0.4007	0.2849	0.1109	0.1553
90	0.2956	0.4007	0.2849	0.1109	0.1552
100	0.2959	0.4011	0.2851	0.1110	0.1553

Note: For revenue neutrality, the sales tax rate is adjusted for Plans 1 and 2.
For Plans 4 and 5, both the sales tax and the labor income tax rates are adjusted in the same proportion.

Notations:
t_C: Marginal sales tax rate on consumption goods
t_C^a: Average sales tax rate on consumption goods
t_I: Sales tax rate on investment goods
t_F: Flat tax rate of the business sector
t_L^m: Marginal tax rate on labor income
t_L^q: Average tax rate on labor income

Table 8.4 (continued) Transition paths of tax rates: National retail sales tax

	Plan 5. Progressive Sales Tax Flat Labor Income Tax ($t_F = t_I = 0.0$)			Plan 7. Flat Labor Income Tax ($t_F = t_I = 0.0$)
Year	$t_L^a = t_L^m$	t_C^a	t_C	$t_L^a = t_L^m$
1	0.1153	0.1614	0.2188	0.2533
2	0.1153	0.1614	0.2188	0.2532
3	0.1153	0.1614	0.2187	0.2530
4	0.1153	0.1613	0.2187	0.2529
5	0.1153	0.1613	0.2186	0.2527
6	0.1152	0.1612	0.2186	0.2526
7	0.1152	0.1612	0.2185	0.2524
8	0.1151	0.1611	0.2184	0.2522
9	0.1151	0.1610	0.2183	0.2520
10	0.1150	0.1610	0.2182	0.2518
12	0.1149	0.1608	0.2179	0.2514
14	0.1147	0.1606	0.2176	0.2510
16	0.1146	0.1603	0.2173	0.2506
18	0.1144	0.1601	0.2170	0.2501
20	0.1142	0.1598	0.2167	0.2496
25	0.1137	0.1592	0.2157	0.2483
30	0.1133	0.1585	0.2149	0.2463
35	0.1131	0.1582	0.2145	0.2457
40	0.1129	0.1580	0.2142	0.2443
45	0.1130	0.1581	0.2144	0.2445
50	0.1131	0.1582	0.2144	0.2445
60	0.1131	0.1583	0.2145	0.2446
70	0.1131	0.1583	0.2146	0.2447
80	0.1131	0.1583	0.2146	0.2447
90	0.1131	0.1583	0.2146	0.2447
100	0.1132	0.1584	0.2146	0.2447

substantial gains from tax reform are associated with equalizing tax burdens on all assets and all sectors. These gains produce a better balance of the tax burden between household assets, especially owner-occupied residential real estate, and business assets, especially plant and equipment in the corporate sector. Combining this with a proportional tax on labor income, Efficient Taxation of Income produces the largest welfare gains of any tax reform proposal that we consider.

During the 1990s, tax reformers have renewed their interest in replacing income by consumption as the basis for taxation. We have shown that the most popular Flat Tax proposals for achieving this objective would generate substantial welfare benefits. However, a National Retail Sales Tax would produce benefits that are fifty percent higher. The cost of maintaining a progressive rate structure within the framework of the National Retail Sales Tax is very large. The benefits of a National Retail Sales Tax with a flat rate structure are double those of a Flat Tax and almost comparable with those of the largest welfare gains from Efficient Taxation of Income.

Our overall conclusion is that the cost of capital and the closely related concept of the marginal effective tax rate have provided an important intellectual impetus for tax reform. The new frontier for analysis of tax and spending programs is to combine the cost of capital and the marginal effective tax rate with estimates of substitution possibilities by businesses and households. This combination makes it possible to evaluate alternative tax reforms programs in terms of economic welfare. We have illustrated this approach for a variety of fundamental tax reforms. Our hope is that these illustrations will serve as an inspiration and a guide for policy makers who share our goal of making the allocation of capital within a market economy more efficient.

Appendix: Elasticities and Non-Tax Parameters

The estimated values of the parameters in our models of consumer and producer behavior provide important information on the responses of consumers and producers to changes in tax policy. In this section we supplement this information by deriving price elasticities of demand and supply implied by our parameter estimates, including the compensated price elasticity of supply for labor services. We also provide elasticities of substitution in consumption and production, including the intertemporal elasticity of substitution, a constant parameter in our model of consumer behavior.

A.1 *Consumer Behavior*

In our model for consumer behavior the quantity index of full consumption is an index of consumer welfare. The compensated demand functions for the three components of full consumption are obtained by solving the share equations

$$v_D = \alpha_{PD} + B_{PD} \ln PD$$

$$v_H = \alpha_{PH} + B_{PH} \ln PH.$$

for the quantities demanded as functions of full consumption and the prices. As an illustration, we consider the compensated demand for consumption goods:

$$C = F \cdot \frac{PF}{PC} v_C \ ,$$

where v_C is the share of consumption goods in full consumption. We obtain the compensated own-price elasticity of demand for consumption goods, say ϵ_{CC}:

$$\epsilon_{CC} = v_C + \frac{\beta_{CC}}{v_C} - 1 \ .$$

Similarly, we obtain the cross-price elasticities of demand:

$$\epsilon_{CL} = v_{LJ} + \frac{\beta_{CL}}{v_C} \ ,$$

$$\epsilon_{CH} = v_{HD} + \frac{\beta_{CH}}{v_C} \ ,$$

where ϵ_{CL} is the elasticity of demand for consumption goods with respect to the price of leisure and ϵ_{CH} is the elasticity of demand with respect to the

price of household capital services. We calculate similar own-price and cross-price elasticities of demand for leisure and household capital services, using pooled estimates for our model of consumer behavior and average shares for the period 1970–1996. The results are presented in panel 2 of table A.1

Table A.1 Elasticities of consumer behavior

---

1. Basic Information

A. *Average shares 1970–1996*

$v_C = 0.24120$

$v_{LJ} = 0.68263$

$v_{HD} = 0.07617$

$v_{HS} = 0.56948$

B. *Second-order coefficients*

$\beta_{CC} = 0.10580$

$\beta_{CL} = -0.097349$

$\beta_{CH} = -0.0084549$

$\beta_{LL} = 0.14657$

$\beta_{LH} = -0.049217$

$\beta_{HH} = 0.057672$

$\beta^H_{SS} = 0.161082$

2. Compensated Elasticities

(with constant full consumption)

A. *Elasticities of demand*

$\epsilon_{CC} = -0.32015$

$\epsilon_{CL} = 0.27904$

$\epsilon_{CH} = 0.041112$

$\epsilon_{LC} = 0.098596$

$\epsilon_{LL} = -0.10266$

$\epsilon_{LH} = 0.0040659$

$\epsilon_{HC} = 0.13020$

$\epsilon_{HL} = 0.036441$

$\epsilon_{HH} = -0.16664$

B. *Elasticity of labor supply*

$\epsilon^S_{LL} = 0.31653$

3. Elasticity of Intertemporal Substitution

$\sigma^{-1} = 0.39145$

4. Elasticities of Intratemporal Substitution

$e_{CL} = -0.40907$
$e_{CH} = -0.26597$
$e_{LH} = -0.16753$
$e_{HD} = -0.34299$

The average share of leisure is more than sixty-eight percent of full consumption, while the share of consumption goods and services is slightly more than twenty-four percent and the share of household capital services is around seven and a half percent. The own-price elasticity of demand for consumption goods and services is around a third, while the own-price elasticity of demand for leisure is only 0.10 and the elasticity of demand for capital services is 0.17. Cross-elasticities of demand are substantial, especially the cross-elasticity of demand for goods with respect to the price of leisure of 0.28; the three commodity groups are substitutes rather than complements.

The compensated elasticity of labor supply is, perhaps, a more familiar parameter than the elasticity of demand for leisure. To derive the compensated elasticity of labor supply, we first consider the following identity for the value of the time endowment $PLH \cdot LH$:

$$\begin{aligned} PLH \cdot LH - PLJ \cdot LJ &= (1 - t_L^m)(PLD \cdot LD + PLG \cdot LG \\ &\quad + PLE \cdot LE + PLR \cdot LR) \, . \end{aligned}$$

Defining the value of labor supply $PL \cdot L$ as follows:

$$PL \cdot L = PLD \cdot LD + PLG \cdot LG + PLE \cdot LE + PLR \cdot LR \, ,$$

we obtain:

$$PLH \cdot LH - PLJ \cdot LJ = (1 - t_L^m) PL \cdot L \, .$$

Under the assumption that relative prices of the time endowment, leisure, labor supply, and the components of labor demand are fixed, we obtain the following expression for the compensated elasticity of labor supply, say ϵ_{LL}^S,

$$\epsilon_{LL}^S = -\epsilon_{LL} \frac{PLJ \cdot LJ}{PLH \cdot LH - PLJ \cdot LJ} \, . \tag{8}$$

We employ the average ratio of the values of leisure and labor supply for the period 1970–1996 in estimating this elasticity; the result, given at the bottom of panel 2, table A.1, is 0.31653. The elasticity of intertemporal

substitution in consumption is the inverse of σ, estimated from the transition equation for full consumption

$$\ln \frac{F_t}{F_{t-1}} = \frac{1}{\sigma}[\ln(1+r_t) - \ln(1+\tilde{r}] + \epsilon_{F_t}, \quad t = 1, 2, \ldots, T \; .$$

The estimate of this elasticity, reported in panel 3 of table A.1, is 0.39145. This parameter describes the rate of adjustment of full consumption to the difference between the real private rate of return and its long-run equilibrium value.

The elasticity of substitution between two consumption goods is defined as the ratio of the proportional change in the ratio of the quantities consumed relative to the proportional change in the corresponding price ratio. The prices of other components are held constant, while the quantities are allowed to adjust to relative price changes. Our estimates of elasticities of substitution are based on parameter values from the pooled estimation of the model of consumer behavior, using average shares for the 1970–1996 period.

We first consider substitution between consumption goods and leisure. Using the share equation for consumption goods we can express the elasticity of substitution, say e_{CL}, as follows:

$$e_{CL} = -1 + \frac{\partial \ln v_C}{\partial \ln\left(\frac{PC}{PLJ}\right)} - \frac{\partial \ln v_{LJ}}{\partial \ln\left(\frac{PC}{PLJ}\right)} \; .$$

Since we are holding the price of household capital services PHD constant, we can rewrite this elasticity in the form:

$$e_{CL} = -1 + \frac{\beta_{CC}}{v_C} - \frac{\beta_{CL}}{v_{LJ}} - \left(\frac{\beta_{CH}}{v_C} - \frac{\beta_{LH}}{v_{LJ}}\right)\left(\frac{\partial \ln PLJ}{\partial \ln \frac{PC}{PLJ}}\right) \; .$$

Differentiating $\ln\left(\frac{PF}{PLJ}\right)$ with respect to $\partial \ln\left(\frac{PC}{PLJ}\right)$ while holding PF and PHD constant, we obtain

$$\frac{\partial \ln PLJ}{\partial \ln\left(\frac{PC}{PLJ}\right)} = \frac{v_C}{v_{HD} - 1} \; .$$

Substituting this expression into our formula for the elasticity of substitution, we obtain:

$$e_{CL} = (\epsilon_{CC} - \epsilon_{LC}) - (\epsilon_{CH} - \epsilon_{LH})\frac{v_C}{v_{HD} - 1} \; . \tag{9}$$

Similarly

$$e_{CH} = (\epsilon_{CC} - \epsilon_{HC}) - (\epsilon_{CL} - \epsilon_{HL})\frac{v_C}{v_{LJ} - 1} ,$$

and

$$e_{LH} = (\epsilon_{LL} - \epsilon_{HL}) - (\epsilon_{LC} - \epsilon_{HC})\frac{v_{LJ}}{v_C - 1} .$$

We report estimates of the elasticities of substitution in panel 4 of table A.1. By definition these elasticities are symmetric. The elasticity of substitution between the services of the long-lived and short-lived household assets e_{HD} can be derived along similar lines and estimates are presented at the bottom of panel 4, table A.1. All of these elasticities are considerably less than one, so that the corresponding value shares rise with an increase in price.

A.2 *Producer Behavior*

As in our model of consumer behavior, we can define elasticities of substitution in production by allowing the relative quantities to adjust to changes in relative prices, while holding the prices of other inputs and outputs constant. We derive the formulas for the elasticities of substitution in production and estimate these elasticities, based on parameter values from the pooled estimation of our model of producer behavior and the average value shares for the 1970–1996 period.

We first consider the elasticity of substitution between labor input and consumption goods output, defined as[14]

$$e_{CL} = -1 + \frac{\partial \ln v_{CS}}{\partial \ln(PCS/PLD)} ,$$

where the other prices—PIS, PQD, PMD—are held constant. Making use of the share equation for the output of consumption goods, this elasticity of substitution can be rewritten as:

$$e_{CL} = -1 + \frac{1}{v_{CS}}\,\beta_{CC}\,\frac{\partial \ln PCS}{\partial \ln(PCS/PLD)} ,$$

where

$$\frac{\partial \ln PCS}{\partial \ln(PCS/PLD)} = \frac{1}{1 - v_{CS}} ,$$

[14]We treat inputs and outputs symmetrically and do not distinguish among substitution between outputs, and transformation from inputs to outputs.

so that

$$e_{CL} = -1 + \frac{\beta_{CC}}{v_{CS}(1 - v_{CS})} \ . \tag{10}$$

Similarly, we can derive elasticities of substitution between labor input and investment goods output and between labor and capital services inputs from corporate and noncorporate assets:

$$e_{IL} = -1 + \frac{\beta_{II}}{v_{IS}(1 - v_{IS})} \ ,$$

$$e_{QL} = -1 + \frac{\beta_{QQ}}{v_{QD}(1 - v_{QD})} \ ,$$

$$e_{ML} = -1 + \frac{\beta_{MM}}{v_{MD}(1 - v_{MD})} \ .$$

The formulas for the elasticities of substitution between outputs and inputs other than labor can be derived along the same lines as for substitution in consumption. It is convenient at this point to introduce symbols for price elasticities of factor demand and product supply, for example:

$$\epsilon_{II} = v_{IS} + \frac{\beta_{II}}{v_{IS}} - 1 \ , \tag{11}$$

and

$$\epsilon_{IC} = v_{CS} + \frac{\beta_{IC}}{v_{IS}} \ .$$

As an illustration, the elasticity of substitution between consumption and investment goods outputs is defined by

$$e_{CI} = -1 + \frac{\partial \ln v_{CS}}{\partial \ln(PCS/PIS)} - \frac{\partial \ln v_{IS}}{\partial \ln(PCS/PIS)} \ .$$

Holding the prices PQD and PMD constant, we can rewrite this elasticity as follows:

$$e_{CI} = (\epsilon_{CC} - \epsilon_{IC}) - (\epsilon_{CQ} + \epsilon_{CM} - \epsilon_{IQ} - \epsilon_{IM}) \frac{\partial \ln PIS}{\partial \ln(PCS/PIS)} \ ,$$

where

$$\frac{\partial \ln PIS}{\partial \ln(PCS/PIS)} = -\frac{v_{CS}}{v_{CS} + v_{IS}} \ .$$

Table A.2 Elasticities of producer behavior

1. Basic Information

A. Average shares

$v_{CS} = 0.94256$
$v_{IS} = 0.50597$
$v_{QD} = -0.30931$
$v_{MD} = -0.13897$
$v_{QS} = 0.41891$
$v_{MS} = 0.20617$

B. Second-order coefficients

$\beta_{CC} = 0.67559$
$\beta_{CI} = -0.58758$
$\beta_{CQ} = -0.035933$
$\beta_{CM} = -0.052074$
$\beta_{II} = 0.28858$
$\beta_{IQ} = 0.21940$
$\beta_{IM} = 0.079597$
$\beta_{QQ} = -0.20393$
$\beta_{QM} = 0.020463$
$\beta_{MM} = -0.047986$
$\beta_{SS}^{Q} = -0.081301$
$\beta_{SS}^{M} = 0.11168$

2. Elasticities of Substitution

e_{CL}	11.47882
e_{IL}	0.15449
e_{QL}	–0.49644
e_{ML}	–0.69683
e_{CI}	0.43277
e_{CQ}	–0.25525
e_{CM}	–0.58933
e_{IQ}	–2.43209
e_{IM}	–1.17369
e_{QM}	–0.46605
e_{QD}	–1.33399
e_{MD}	–0.31762

We report the results in panel 2 of table 2.2. We also give the elasticities of substitution between the capital services from the short-lived and long-lived assets in the corporate and noncorporate sectors, e_{QD} and e_{MD}. The relative value shares of labor and the two capital inputs rise with a price

increase if these elasticities of substitution are less than unity and fall with a price increase if the elasticities are greater than unity. The elasticities of substitution among inputs are less than unity; for example, the elasticities of substitution between labor and corporate capital and between the two types of capital are around a half, while the elasticity of substitution between labor and noncorporate capital is about 0.7.

A.3 *Non-Tax Parameters*

We conclude this section by assigning values to the parameters of our dynamic general equilibrium model of the U.S. economy that cannot be estimated from our econometric models of consumer and producer behavior. These include the ratio of government expenditures to gross domestic product, $SGOV$, the share of unemployed labor time in total labor supply, SLU, and the shares of government expenditures, net of interest payments on government debt—SCG, SIG, SLG, SEL, SER. These parameters are given in the first three panels of table A.3.

The next group of parameters includes the proportions of labor employed by government enterprises and net exports of labor services to the total labor supply—SLE and SLR. It also includes the production of consumption goods by government enterprises as a proportion of the total consumption goods produced by the business sector, SCE. Finally, it includes net exports of consumption goods as a proportion of the total domestic demand for consumption goods, SCR, and net exports of investment goods as a proportion of the total domestic production of investment goods, SIR. This group of parameters is given in the fourth and fifth panels of table A.3.

The third group of parameters includes the dividend pay-out ratio of the corporate sector, α, the debt/asset ratios of the corporate, noncorporate, and household sectors, β_q, β_m, and β_h, and the real interest rate. This group of parameters is given in the sixth panel of table A.3. The parameters—$SGOV$, SCR, SIR—are used to calibrate the size of government debt and claims on the rest of the world in the steady state of our model of the U.S. economy. All other parameter values are set at the averages for the sample period, 1970–1996.

Table A.3 Non-tax parameters

1. Size of Government	
SGOV = 0.2132	government expenditure including debt service/gross domestic product
2. Unemployment	
SLU = 0.0	share of unemployed time in total labor supply
3. Allocation of Government Expenditure, Net of Interest Payments (1970–1996 averages)	
SCG = 0.1738	share of consumption goods
SIG = 0.1837	share of investment goods
SLG = 0.4889	share of labor services
SEL = 0.1450	share of transfer payments
SER = 0.0085	share of transfer to foreigners
4. Government Enterprises (1970–1996 averages)	
SLE = 0.0198	share of labor used by government enterprises
SCE = 0.0298	ratio of consumption goods produced by government enterprises and the private sector
5. Export—Import	
$SCR = -0.0103$	net export of consumption goods as a fraction of total domestic demand for consumption goods
$SIR = 0.0128$	net export of investment goods as a fraction of total domestic production of investment goods
$SLR = -0.0001$	share of exported labor
6. Financial Variables (1970–1996 averages)	
$\alpha = 0.42620$	dividend payout ratio
$\beta_q = 0.16524$	debt/capital ratio in the corporate sector
$\beta_m = 0.19798$	debt/capital ratio in the non-corporate sector
$\beta_h = 0.28647$	debt/capital ratio in the household sector
$i_0 = 0.048604$	real interest rate
7. Other Parameters	
LH = 17571	total time endowment in efficiency units of 1997
$n = 0.01$	growth rate of time endowment
8. Wealth Composition (steady state)	
Government Debt/GDP = 0.20	
Claims on the Rest of the World/GDP = 0.10	

Table A.3 continued

9. Rates of Economic Depreciation (1996 values)	
$\delta_q^S = 0.1367$	short-lived corporate asset
$\delta_q^L = 0.0175$	long-lived corporate asset
$\delta_m^S = 0.1533$	short-lived non-corporate asset
$\delta_m^L = 0.0112$	long-lived non-corporate asset
$\delta_h^S = 0.1918$	short-lived household asset
$\delta_h^L = 0.0107$	long-lived household asset
10. Prices of Assets and Investment Goods (1997 values)	
$PK_{QS} = 4.8798$	short-lived corporate asset
$PK_{QL} = 10.5343$	long-lived corporate asset
$PK_{MS} = 4.8316$	short-lived non-corporate asset
$PK_{ML} = 12.5564$	long-lived non-corporate asset
$PK_{HS} = 4.3224$	short-lived household asset
$PK_{HL} = 15.6756$	long-lived household asset
$PI = 1.0683$	investment goods
11. Relative Prices of Labor (1980–1996 averages, relative to PLD)	
$A_{LH} = 1.0101$	time endowment (before tax)
$A_{LJ} = 1.0044$	leisure (before tax)
$A_{LG} = 1.0049$	labor employed in general government
$A_{LE} = 0.9824$	labor employed in government enterprises
$A_{LR} = 1.0$	exported labor (assumption)
$A_{LU} = 1.0$	unemployed time (assumption)

The fourth group of parameters is given in panels 7 and 8 of table A.3. These are important determinants of the size and rate of growth of the U.S. economy. These include the time endowment, LH, and its growth rate, n. They also include steady-state values of government debt and claims on the rest of the world, relative to the U.S. gross domestic product. The time endowment is set at the historical value in 1997; the growth of the time endowment reflects the growth of population as well as changes in the quality of labor.[15]

During our sample period, 1970–1996, the average annual growth rate of the U.S. time endowment was 1.72 percent per year. However, we assume

[15]Changes in the quality of the time endowment are due to changes in the composition in the population by age, sex, education, and class of employment. We define separate quality indexes for the time endowment, leisure, labor employed in the business, government, government enterprises, and rest-of-the-world sectors. Further details are given by Jorgenson, Gollop, and Fraumeni (1987).

that population growth and changes in labor quality will decline in the future and set the growth rate, n, at one percent per year. The initial values of the quantity indexes of the capital stock, government debt, and claims on the rest of the world are set at their historical values in 1997. This procedure guarantees that the size of our simulated economy is equal to that of the U.S. economy in 1997.

The ratio of government debt to the U.S. gross domestic product has shown a distinct downward trend after the two World Wars. The recent increase in this ratio may be seen as an aberration from the longer-term perspective. Accordingly, we set the steady-state ratio of government debt to the gross domestic product at 0.2, close to the post-war low. On similar grounds we set the steady-state ratio of the U.S. claims on the rest of the world to the gross domestic product at 0.10. We treat the paths of government debt and claims on the rest of the world as exogenous.

Our fifth group of parameters includes the rates of economic depreciation. We distinguish among corporate, noncorporate and household sectors and two types of assets, short-lived and long-lived, within each sector. For the corporate and noncorporate sectors the short-lived asset includes producers' durable equipment, while the long-lived asset includes structures, inventories, and land. For the household sector the short-lived asset includes thirteen types of consumers' durables, while the long-lived asset includes structures and land.

The rates of economic depreciation of the six classes of assets, two classes within each of the three sectors, are weighted averages of their components with capital stocks at the end of 1996 as weights. For example, the rate of economic depreciation of the long-lived corporate asset is the average depreciation rate of twenty-three categories of non-residential structures, residential structures, non-farm inventories, and land employed in the corporate sector. Economic depreciation rates for the six categories of assets are shown in panel 9 of table A.3.

Finally, we present two sets of relative prices in panels 10 and 11 of table A.3. The relative prices of the six categories of assets in the corporate, noncorporate, and household sectors and the price of investment goods are the first of these. We set the relative prices of the six categories of assets and investment goods at their 1996 values, adjusted for the inflation of 1997. The relative prices of the time endowment, leisure, and labor employed in the various sectors of the economy and the rest of the world are set at historical averages for the period 1980–1996.

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