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NON-NEUTRAL TAXATION AND THE EFFICIENCY GAINS OF THE 1986 TAX REFORM ACT - - A NEW LOOK

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ABSTRACT

The Tax Reform Act of 1986 considerably altered the differentials between taxes on corporate and noncorporate capital. Conventional wisdom, relying on various incarnations of the Harberger model, suggests rather small efficiency effects from these changes in corporate tax wedges. But the Harberger models appear to understate greatly the efficiency effects of changes in the corporate tax wedge because they do not admit production of the same good by both corporate and noncorporate firms.

A new model which allows corporate and noncorporate firms to coexist within the same industry suggests a significant efficiency gain from the Tax Reform Act. The model predicts that the new law reduced excess burden by at least $31 billion and eliminated about half of the total distortion from non-neutral taxation. Most of this gain occurs because the Tax Reform Act, while keeping the aggregate effective tax rate constant, considerably narrowed these differentials in industries where there is substantial noncorporate production.

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I. Introduction and Summary

The Tax Reform Act of 1986 was a sweeping change in capital income taxation. The new law greatly altered effective tax rates on capital income, by simultaneously reducing tax rates and special incentives. Debate during consideration of the Act focused on narrowing the differentials between taxes on different types of physical assets. Most notably, the repeal of the investment credit raised the tax rate on equipment, which was heavily favored under prior law. The rate reductions favored other assets, especially land and inventories.

Little attention, by contrast, was focused on the classic distortion between corporate and noncorporate capital, even though the corporate tax wedges were altered considerably. In some industries, such as agriculture, the new tax law reduced by over one quarter the wedge between corporate and noncorporate gross of tax return. In other industries, such as mining, the corporate tax wedge actually increased.

Conventional wisdom, relying on various incarnations of the Harberger (1962,1964) model, suggests rather small efficiency effects from these changes in corporate tax wedges. But the Harberger models appear to understate greatly the efficiency effects of changes in the corporate tax wedge because they do not admit production of the same good or collection of goods by both corporate and noncorporate firms. The Harberger model is, essentially, a model of differential taxes placed on capital used to produce a particular good, rather than a tax on corporate capital per se.

Gravelle and Kotlikoff (1989) present a two sector model in which corporate and noncorporate firms coexist within the same industry. The model has a very high within-industry elasticity of substitution between corporate and noncorporate output and implies an excess burden from corporate taxation that is many times larger than that predicted by the Harberger Model.1/ The new model suggests that the efficiency gains from changes in corporate tax wedges in the 1986 Tax Reform Act may be much larger than those previously estimated such as in Fullerton, Henderson, and Mackie (1987).2/

Gravelle and Kotlikoff (1988b) present a multi-sector, dynamic version of their model which can be used to estimate long run equilibria. This study is an empirical implementation of that model for the U.S. economy, which also introduces a method of estimating the efficiency effects from the reallocation of capital.

The model predicts that the new law reduced excess burden by at least $31 billion and eliminated about half of the total distortion from non-neutral taxation. Most of this gain occurs because the Tax Reform Act, while keeping the aggregate effective tax rate constant, considerably narrowed the differentials between corporate and noncorporate tax burdens in three industries where there is substantial noncorporate production -- rental housing, agriculture, and trade.

This reduction in tax wedges can be traced primarily to the repeal of the investment credit, the revenue from which was used to lower tax rates. The investment credit was restricted to equipment, which is a relatively unimportant component of the capital stock of industries which feature substantial noncorporate production. Moreover, because the investment credit was allowed in the form of a credit, it had a much smaller effect on the differentials than would an incentive provided in the form of a deduction. Since statutory tax rates are higher in the corporate sector, an incentive in the form of a deduction would have a greater value to the corporate sector relative to the noncorporate sector, and reduce the tax differential by a larger amount.

This paper's model features mutual production of the same good by corporate and noncorporate firms in 8 of the 11 industries. In these industries there is an upward sloping supply of noncorporate output reflecting the less than perfectly elastic supply of entrepreneurial talent available for running noncorporate enterprises in that industry. Increases in corporate tax wedges within these industries lead current proprietors to expand output and less able entrepreneurs to establish proprietorships in these industries. But the new proprietorships do not drive out corporate production. While they are at a tax disadvantage, corporations are still able to compete with less able entrepreneurs. A second feature of the model, namely the requirement that corporate firms produce above a minimum scale, ensures that corporate production cannot be repackaged into small proprietorships and thereby avoid the corporate tax. These two features notwithstanding, corporate and noncorporate firms in each of the 8 mutual production industries produce with the same constant returns to scale production function.

In addition to permitting mutual production of a variety of goods by corporate and noncorporate firms, the new model also has a number of other features. First, the model uses a fixed coefficient input-output table to take account of intermediate goods. Second, it takes account of personal as well as corporate marginal taxation of capital income and of differences across industries in marginal corporate tax wedges. Thirdly, it models owner occupied housing as a differentiated consumption product. Some or all of these characteristics appear in other models.3/ Unlike existing models, however, the model also deals explicitly with depreciation in the production function and with the pricing and production of heterogenous capital goods. In addition, the model merges statics with dynamics through a 55 period life cycle model of inter-temporal choice.

While an inter-temporal life cycle model is consistent with the U.S. economy and most appropriate for estimating the effects on relative prices and output, one must be concerned not to confuse inter-generational redistribution with economic efficiency when calculating welfare gains. While it is reasonably easy to compute steady states in inter-temporal models, gains in welfare of individuals living in the steady state can reflect losses of earlier generations as factor incomes change. In order to calculate the efficiency effects in this dynamic model, this study employs a fixed asset value for capital in order to measure efficiency arising from the reallocation of a fixed quantity of resources. Such an equilibrium can be produced through a specific redistribution scheme. If there were no adjustment costs, such a scheme would produce equal compensating variations for all generations.

The paper proceeds in Section II with the presentation of the model. Section III describes the calibration and solution of the model, Section IV presents results, and Section V concludes the paper.

II. The Model

A. Production and Choice of Occupation

The model has three factors of production: capital, labor, and managerial input (entrepreneurial input in the case of noncorporate firms). Each agent in the model chooses whether to be a corporate manager, a worker, or to set up a proprietorship. There are 11 industries corresponding to rental housing, agriculture, oil and gas, mining, construction, transportation, trade, services, manufacturing, utilities, and owner-occupied housing. The manufacturing and utility industries are totally corporate. Each good is produced using fixed proportions of value added and intermediate input. Value added in owner-occupied housing differs from the other industries in that it only uses a single input, capital.

Q_{ci} is output in the corporate sector and q_{ci} is output per manager, determined according to a Constant Returns to Scale (CES) production function of the form:

$$(1)\quad q_{ci} = (H_i/\mu_i)\left[(1-a_i-b_i)D_i^{(1-1/\sigma_i)} + a_i l_{ci}^{(1-1/\sigma_i)} + b_i k_{ci}^{(1-1/\sigma_i)}\right]^{\sigma_i/(\sigma_i-1)} \qquad i=1,11$$

This function is indexed from 1 to 11 because owner occupied housing, while noncorporate, behaves in a manner functionally equivalent to corporate production. That is, for q per owner in housing, the function is $H_i k_{ci}/\mu_i$. In (1), D_i is the managerial efficiency coefficient (identical for all managers), l_{ci} is labor per corporate manager, k_{ci} is capital per corporate manager, μ_i is the fixed ratio of value added to output, and σ_i is the factor substitution elasticity.

Capital input, k_{ci}, is a composite of three capital goods -- structures/land (produced by the construction industry, 5), equipment (produced by the manufacturing industry, 9), and inventories (produced by the industry itself). These capital goods are used in fixed proportions in any given industry, but the proportions are industry specific.4/

Noncorporate firms produce with the same technology so that output per entrepreneur is:

$$(2)\quad q_{ni} = (H_i/\mu_i)\left[(1-a_i-b_i)A_i^{(1-1/\sigma_i)} + a_i l_{ni}^{(1-1/\sigma_i)} + b_i k_{ni}^{(1-1/\sigma_i)}\right]^{\sigma_i/(\sigma_i-1)} \qquad i=1,8$$

In (2), l_{ni} is the amount of labor hired by the entrepreneur and k_{ni} is the amount of capital used by the entrepreneur. The efficiency coefficient, A_i, varies by entrepreneur.

In equilibrium, only entrepreneurs of high ability will set up shop. Let $\underline{A}_i$ index the least able entrepreneur in industry i. Agents with coefficients less than $\underline{A}_i$ for all i's will be better off as workers or managers. The profit of the marginal entrepreneur will just equal the wage rate.

Entrepreneurial profits are proportional to the entrepreneurial efficiency parameters. An entrepreneur with an efficiency coefficient twice that of the marginal entrepreneur will earn a profit twice the wage rate, produce twice the output, and hire twice the amounts of labor and capital.

Unlike the corporate sector, noncorporate production is subject to an increasing cost function. Even though they operate with the same production function, existing entrepreneurs can expand through increased inputs of labor and capital but cannot increase their own input. New entrepreneurs have lower efficiency coefficients and must also produce at a higher cost.

In maximizing profits, both corporate and noncorporate firms set the marginal revenue product of capital equal to the rental rate. The rental rate of corporate capital is:

$$(3)\quad R_{ci} = r(P_i x_i + P_5 y_i + P_9(1-x_i-y_i)/(1-t_{ci}) + P_5 y_i \delta_{i5} + P_9(1-x_i-y_i)\delta_{i9}$$

In (3) x_i is the share of capital stock of ith industry in inventories, y_i is the share of capital stock in structures/land, δ_{i5} is the structures/land depreciation rate in industry i, and δ_{i9} is the equipment depreciation rate in industry i. P denotes prices. The other two factors of production, workers and managers, have an identical factor prices denoted by the wage rate W.

The rental rate for capital in the noncorporate sector is identical to (3) except that the noncorporate tax rate, t_{ni}, is used. Workers in the noncorporate sector also receive the wage rate, W.

Entrepreneurs consider the profits to be made in all occupations. The marginal entrepreneur with efficiency coefficient $\underline{A}_i$ will earn the wage rate and the entrepreneur with coefficient A will earn $A_i/\underline{A}_i$ times the wage rate. Agents who are indifferent between being entrepreneurs in industry i and industry j must earn the same profit and satisfy the condition, $A_i/\underline{A_i} = A_j/\underline{A}_j$. To assign entrepreneurs to their industries, the distribution function must be specified. This study employs an independent exponential density function of the form $\Gamma_i(\exp(-\Gamma_i A_i))$ for each sector.

B. The Demand Side and Dynamic Equilibrium

The model employs a continuous time additive utility function in which agents live for 55 years (from age 20 to age 75) and work for 40 years, similar to that employed by Auerbach and Kotlikoff (1987):

$$(4)\quad U = J/(1-1/\Omega) \int_0^{55} e^{-pt}\, \Omega \left[\left[\sum_{i=1}^{11} g_i\, c_{i,t}^{(1-1/\phi)} \right]^{1/(1-1/\phi)} \right]^{1-1/\Omega} dt$$

where Ω is the inter-temporal substitution elasticity, ϕ is the intra-temporal substitution elasticity, and $c_{i,t}$ is the consumption of good i at time t. The term p is the time preference rate.

The first order conditions for consumption of a particular good in different time periods are:

$$(5) \quad c_{i,t} = c_{i,0}\, e^{-(p-r\Omega)t} \qquad i = 1,11$$

Taxes are assumed to be rebated to individuals as a lump sum payment. Accordingly, the steady state budget constraint for a worker or manager is:

$$(6) \quad \sum_{i=1}^{11} P_i c_{i,0} \int_0^{55} e^{-(r/(1-u)+p-r\Omega)t}\, dt = W \int_0^{40} e^{-(r/(1-u)t}\, dt$$

For an entrepreneur, W would be replaced by profits.

If the population grows at rate n, we can sum all of the workers and all of the consumption, and substituting in for (6) derive the steady state equilibrium relationships between labor income, consumption, and the rate of return.

$$(7) \quad \frac{\sum_{i=1}^{11} P_i C_i}{\sum_{i=1}^{11} \mu_i P_i Q_i - R_{ci} K_{ci} - R_{ni} K_{ni}} = \frac{(1-e^{-(n+p-r\Omega)55})(1-e^{(-r/(1-u)40)})(p+r/(1-u)-r\Omega)n}{(1-e^{-(p+r/(1-u)-r\Omega)55})(1-e^{-n40})(n+p-r\Omega)(r/(1-u))}$$

where C_i refers to total consumption of the ith good. The denominator of the left hand side of (7) refers to labor income which is calculated as a residual of value added minus payments to capital, due to the presence of profits.

Equation (7) is the substitute in a dynamic model for the fixed capital stock constraint which is typically used in a static model. In dynamic equilibrium changes in capital can occur as rates of tax are altered or as factor incomes change.

C. Measuring Excess Burden

A dynamic model presents difficulties in measuring the excess burden from differential taxation which do not arise in a static model. An excess burden calculation in a static model can rely on the implicit assumption that all individuals are identical in their shares of factor incomes, as well as in their preferences for consumption, (or that redistribution to restore original incomes through lump sum taxes can easily be made). Such static models typically employ a constraint of a fixed capital stock to complete the model, as well as a fixed labor supply, so that the excess burden calculation will reflect the reallocation of a fixed quantity of resources. These static models assume a homogeneous capital stock and thus cannot deal explicitly with production, growth, pricing, and depreciation of capital or how tax changes affect the allocation of resources through its effect on the relative cost of producing capital goods.

In a life cycle model, individuals necessarily differ in their factor incomes: younger individuals have a larger share of wage income and older individuals have a larger share of capital income. Tax changes will induce changes in savings behavior and changes in capital stocks through both price and income effects. As shown above, one can compute the long run steady state equilibrium to which the economy will move in a dynamic model, but that equilibrium cannot be used to measure welfare gains because that welfare gain may reflect redistribution of income across the generations. Some of the gain of individuals living in the long run equilibrium, for example, may reflect the losses of individuals alive at the time the policy change is introduced. To measure welfare effects precisely would require tracing the transition.

In some ways, a static model is better suited to evaluating efficiency effects from non-uniform as compared to uniform capital income taxation. But such a model is inconsistent with the inclusion of heterogeneous, reproducible capital goods. To fit such a model to the U.S. economy, which is obviously a dynamic one, presents difficulties since a fifth of resources is devoted to the production of capital goods for either replacement or growth. Moreover, alterations in tax burdens affect the cost of producing capital goods differently and these prices should be reflected in the general equilibrium solution.

The solution used in this study is to use a constraint in the form of a capital goods index, which fixes the value of the new and old capital goods, in new prices. (A virtually identical solution would result from an index which fixes the value in old prices). Such a constraint allows the mix of capital goods to change, without altering their aggregate value, and produces, for purposes of measuring efficiency effects, the following substitute for equation (7):

$$(8) \quad \sum_{i=1}^{11} P_i K_i = \sum_{i=1}^{11} P_i K_i^*$$

Where K_i (K_i^*) is capital produced by industry i in the new (old) equilibrium and P_i is the price in the new equilibrium.

Equation (8) basically fixes the capital stock in a similar fashion as in a static model. Such an equilibrium solution can, in fact, be obtained by a compensation scheme which taxes away the change in factor incomes (taxing the capital income as a tax rate rather than a lump sum payment so as to fix the net rate of return, or inter-temporal price) and distributes the proceeds so as to allow individuals to consume their old bundle of goods and also to receive a share of the change in output proportional to their share of consumption. This scheme is explained in more detail in the Appendix.

II. Calibration and Solution of the Model for the Steady State

In the initial observed equilibrium, all inputs are measured in units so that all eleven prices, W, r, and all Di's can be set to one. The rental rates are larger than one owing to depreciation and taxes; these rental rates in the observed equilibrium are denoted as Rci* and Rni* so as to distinguish them from the new equilibrium values.

Table 1 presents the equilibrium equations for solving the model in their functional forms. Equation (9) is the fixed labor supply constraint. Note that the integral terms after the product sign check that the entrepreneurs and their accompanying labor are allocated to the industry which earns them the highest profit. Equations (10)-(12) are the supply and demand equations which require that output add up to demand for intermediate use, consumption, and investment goods.

Equations (13) - (15) are versions of the first order conditions from the corporate production function. In the case of owner occupied housing, there is only one first order condition and one equation, (13). Equations (16)- (19) are derived from the two first order conditions from the noncorporate production function in (2), the function itself, and the substitution of those functions into the requirement that the marginal entrepreneur earn the wage rate, which produces the value for $\underline{A}_i$. The price equation includes the price of intermediate inputs and the cost of value added which is derived by substituting the first order conditions back into the corporate production function. (Note that the term v_{ji} is the fixed ratio of intermediate good j used in the production of good i.) Finally, equation (21) is the measure of consumption as it relates to consumption expenditure, C, which is the numeraire.

The final equation needed to complete the model is either (7) or (8), depending on whether the model is to be solved to estimate the long run equilibrium or to measure welfare gains. The model is solved for the case where entrepreneurs are variable and also where they are fixed. In this latter case, the expansion of noncorporate production with the imposition of a corporate tax is solely due to the expansion of output by existing noncorporate firms and all of these entrepreneurs may earn profits in excess of the wage rate. In this version, there is no need to calculate the values of $\underline{A}_i$ or Γ_i.

A. Calibration of the Model

Data used to calibrate the model, other than the input output coefficients, are contained in Appendix Table A-1. They include for each industry the share of output which is noncorporate (Qci/Qi), the distribution of value added across industries, s_i, the aggregate shares of capital income by industry, β_i, the share of labor income by industry, α_i, corporate and noncorporate effective marginal tax rates by industry, t_{ci} and t_{ni}, average and asset specific depreciation rates by industry, and the composition of capital type by industry. The terms β_{ci} and β_{ni} refer to the capital shares of income in the corporate and noncorporate sectors respectively. Because of tax differentials, the capital share of income by industry will differ between the corporate and noncorporate sectors (other than in the Cobb-Douglas case). The labor share of income is the same. These shares are related to the underlying coefficients in the production function by:

$$(22) \qquad \alpha_i = a_i^{\sigma_i} \; H_i^{(\sigma_i - 1)}$$

(23) $\beta_{ci} = R_{ci}^{*\,(1-\sigma_i)}\ b_i^{\ \sigma_i}\ H_i^{\ (\sigma_i-1)}$

(24) $\beta_{ni} = (R_{ci}^*/R_{ni})^{\ (\sigma_i-1)}\ \beta_{ci}$

Given these relationships the corporate share of capital in industry i is:

$$(25)\quad K_{ci}/K_i = \frac{(Q_{ci}/Q_{ni})}{(1-Q_{ci}/Q_{ni}) + (R_{ni}^*/R_{ci}^*)^{\sigma_i}\ (Q_{ci}/Q_{ni}))}$$

and given Kci/Ki, Kni/Ki and β_i:

$$(26)\quad \beta_{ci} = \beta_i\ \frac{(K_{ci}/K_i\ +(R_{ni}^*/R_{ci}^*)^{\sigma_i}\ (K_{ni}/K_i))}{(K_{ci}/K_i) + (R_{ni}^*/R_{ci}^*)(K_{ni}/K_i)}$$

Finally to obtain the shares of total capital in the eleven industries:

$$(27)\quad K_i/K = \frac{s_i\beta_i/(K_{ci}/(K_i(1-t_{ci}))+K_{ni}/(K_i(1-t_{ni}))\ +\ \delta_i)}{\sum_{i=1}^{11} s_i\beta_i/(K_{ci}/(K_i(1-t_{ci}))+K_{ni}/(K_i(1-t_{ni}))\ +\ \delta_i)}$$

This process results in all 19 allocations of capital (10 K_{ci}'s, 8 K_{ni}'s and K_{11}) as a share of an as yet unknown total capital stock.

To proceed further, refer to the equilibrium equations in Table 1, setting R_{ci} and R_{ni} equal to the starred, observed, values and W equal to 1. Equations (13) and (20) can be used to solve the model for the total level of capital stock, given that the sum of value added is equal to GNP. The ratio of k_{ci} to q_{ci} is equal to the ratio of aggregate K_{ci} to Q_{ci} and the ratio of $k_{ni}(A)$ to $q_{ni}(A)$ is equal to the ratio of aggregate K_{ni} to Q_{ni}. Value added is defined as $\mu_i Q_i$. Thus, the sums of value added are rewritten as the sums of capital stocks multiplied by functional relationships. Dividing by total K results in a solution for total capital stock as a function of prices, capital shares, and GNP. Once total capital is measured, the total levels of the 19 capital stocks can be determined. Next we can measure M_{ci} (equal to K_{ci}/k_{ci}), L_{ci} (equal to $M_{ci}l_{ci}$), and L_{ni} (since L_{ni}/K_{ni} equals $l_{ni}(A)/k_{ni}(A)$. We can also use equations (13) and (16) to solve for output.

The next step in calibrating the model is to determine the total labor force L and the eight values of Γ_i. Total L is the sum of the already measured values of M_{ci}, L_{ci} and L_{ni} and the entrepreneurs. The integral in equation (9) contains two parts, the first measuring the entrepreneurs and the second noncorporate labor. Considering the first part, the entrepreneurs can be written as functions of the eight values of Γ_i and total L. Thus total L can be written in terms of the known values of workers and managers and the unknown values of the Γ_i's. Noncorporate capital in each sector can also be written as a function of L and the Γ_i's, by substituting for k_{ni} (using equation (19)) in the second part of the integral in (9). Since the total value of noncorporate capital is known, there are eight equations in eight unknowns which can be solved by iteration for the values of Γ_i. Once these values are known, solve for the entrepreneurs and for the total labor force. Another version of the model is solved with the assumption that entrepreneurs are fixed. In this case, the labor force exclusive of the entrepreneurs is held fixed and the integral expressions themselves are held constant.

At this point all the levels of labor, capital, and output are known. We can now use equations (10) - (12) to determine the amounts of consumption for each of the eleven commodities. The eleven equations in (21) can be used to solve for the eleven g's. Finally, we can use equation (7) to solve for the time preference factor p. In using this last equation, we must express rates of return and growth rates as pure rates on the right hand side of (7). While we are free to set r to any value, including one, by defining capital in appropriate units (and must also conform measures of depreciation flows and net investment flows accordingly) in the present value formulation in (7), r and n must represent pure rates. This is a simple procedure. If r measured as a rate is .05 and our units of capital are measured as twenty dollar units, the rate of return used in the right hand side of equation (7) must be .05 and the n set similarly.

B. Solving the Model

To solve the model when a new set of tax rates is introduced, first pick a value of r and a value of W. Using the eleven forms of equation (20), solve for the eleven prices which are consistent with those values. Because the model includes capital asset prices, these equations are non-linear and must be solved by iteration. The new set of prices can in turn be used to calculate the values of R_{ci} and R_{ni}, and thus the values of $\underline{A}_i$. Next solve for the levels of noncorporate capital, output, labor, and entrepreneurs, since all of these solely depend on calibrated values and the levels of r, W, prices, and tax rates. Given the prices and the assumption of fixed expenditure on consumption, the consumption of each good can also be set.

Since corporate capital, K_{ci}, can be written in terms of corporate output Qci, via equation (13), the eleven supply and demand equations in (10)- (12) can be used to solve for the eleven values of Q_{ci} (treating owner occupied housing functionally equivalent to corporate output), and in turn for the values of corporate capital, managers, and workers. All of the allocations of capital, labor and output have now been made. When right values for r and W have been chosen, the resulting allocations will satisfy the labor constraint in

(9) and either equation (7) or (8). The new and old values of consumption can be used to measure the compensating variation, which determines how much consumption levels must be increased in the old equilibrium to gain the utility in the new equilibrium.

IV. Incidence, Excess Burden and the Effect of the Tax Reform Act

The Tax Reform Act of 1986 had a relatively small effect on the aggregate tax burden. At fixed allocations of capital, the overall effective tax rate on income from capital is estimated at 32 percent prior to the Tax Reform Act and 31 percent after the Tax Reform Act.5/ There were, however, major changes in the allocation of tax burdens across assets and sectors. The corporate statutory tax rate was reduced from 46 percent to 34 percent; the average marginal personal tax rate on capital income fell from about 30 percent to about 23 percent due to statutory rate reductions. As a trade off for these rate reductions, the investment tax credit, which primarily benefited equipment and public utility structures, was repealed and depreciation was made somewhat less liberal, particularly for structures. As a result of these changes, effective marginal tax rates were increased for equipment and lowered for other assets, particularly land and inventories where there was no loss of marginal tax incentives to offset the reduced statutory rates.

Because of these changes in relative tax rates, corporate tax wedges were increased in some industries and reduced in others, although in most cases they were reduced. One reason that tax wedges were reduced without sacrificing revenue was the repeal of the investment tax credit. Because this incentive was allowed as a credit, it reduced effective tax rates proportionally more on noncorporate investments (subject to a lower statutory tax rate) than on corporate investments. Basically, the credit was an across the board reduction in asset prices and as such had a very small effect on the corporate/noncorporate tax differential. Thus the credit tended to waste opportunities to reduce the corporate tax distortion; its repeal allowed rate reductions which did reduce the distortion.

The second reason that the Tax Reform Act reduced the distortions from the corporate tax differential is that in general the industries which tend to be highly noncorporate are those industries which use assets where the corporate tax wedge (measured as $(t_c-t_n)/((1-t_c)(1-t_n))$) was reduced the most. Rental housing uses only land and structures; agriculture is also a very intensive user of land. These two industries account for 64 percent of noncorporate capital, and their tax wedges were reduced, respectively, from .59 to .42 and from .69 to .49. Trade also had significant reductions in the tax wedge, from .69 to .54, owing to the importance of inventories in the capital stock, and these three industries account for 77 percent of noncorporate capital. Only services, which has virtually no inventories, had an increase in the tax wedge, from .41 to .49. Of the remaining sectors the tax wedge changed relatively little or even increased, but there is very little noncorporate capital in these sectors. (These changes for oil and gas, mining, construction, and transportation were respectively from .39 to .34, from .34 to .47, from .51 to .49, and from .39 to .46.)

Table 2 reports the estimated effects of the Tax Reform Act of 1986 on wages, after tax returns, prices, and capital stocks and provides a measure of the compensating variation. These results are based on Cobb-Douglas production and utility functions. Results are reported for equilibrium with and without the redistribution scheme, as well as for variable entrepreneurs and a fixed stock of entrepreneurs. The results for the case with redistribution (where the capital stock is essentially fixed) confirm the static results that the

Tax Reform Act had a relatively small effect on after tax capital income, since wage and after tax, net of depreciation, rentals were not changed very much. Thus, the exclusion of inter-temporal efficiency effects is not very important for evaluating the efficiency effects of capital income tax changes in the Tax Reform Act. The case without redistribution suggests that the Tax Reform Act would have relatively little effect on the capital stock (indeed, a negligible effect in the case of variable entrepreneurs).

The results also indicate significant efficiency gains from the Tax Reform Act as one might expect given the significant reductions in tax wedges. The compensating variations, measured as a percentage of consumption expenditure, are 2 percent in the variable entrepreneurs case and .85 percent in the fixed entrepreneurs case. At 1988 levels of GNP they would correspond to approximately $72 billion and $31 billion respectively. (The compensating variations are expressed as a percentage of consumption; as a percentage of GNP they would be 1.16 percent and .68 percent respectively). The compensating variation for individuals living in the long run equilibrium are slightly larger in the case without redistribution, although this difference is negligible in the case of variable entrepreneurs.

It is useful to compare these efficiency gains in the Tax Reform Act with the potential gains from eliminating the corporate tax distortion entirely. Table 3 compares the excess burden in the case with redistribution to two other policies -- the elimination of all tax differentials and the elimination of the excess corporate tax. These comparisons are done for the unitary elasticity case and also for three other cases where the elasticities are varied.

In the variable entrepreneurs case, the Tax Reform Act eliminates about two thirds of the total distortion from differential taxation; in the fixed entrepreneurs case it eliminates slightly under half of the distortion. Thus, the changes in the structure of taxes in the Act were a substantial step in reducing these tax distortions. These results also suggest that removing the excess corporate tax, as shown in the last column, would eliminate most of the tax distortion. Of course, removing the excess corporate tax also reduces the tax distortion arising from the preferential treatment of owner occupied housing. But even if we set tax rates equal to a weighted average of corporate and noncorporate taxes in each sector, the efficiency gain would be 2.4 percent for the variable entrepreneurs and 1.39 percent for fixed entrepreneurs; if we set all tax rates equal to corporate rates these gains would be 2.3 percent and 1.3 percent respectively. These results indicate that most of the excess burden arises from differentials between corporate and noncorporate firms within an industry rather than differentials across sectors.

Excess burdens are not extremely sensitive to reasonable changes in substitution elasticities; they tend to be largest when the noncorporate sectors have relatively low factor substitution elasticities and the remaining sectors have higher elasticities consistent with Gravelle and Kotlikoff (1989). Excess burdens are much higher in the variable entrepreneurs case, however, regardless of the elasticities.

Since excess burden in this model is quite large, it in turn implies large shifts in capital. Table 2 shows the significant reductions in noncorporate capital particularly in the case of variable entrepreneurs, where aggregate noncorporate capital (outside of owner occupied housing) contracts by 62 percent. In the case of fixed entrepreneurs, noncorporate capital contracts by 25 percent. The largest shifts occur in rental housing, which is a very capital intensive industry.

Are these large shifts plausible? While changes in capital are significant, we have in fact observed fairly significant changes in the share of corporate output over time. For example, the corporate share of output in agriculture more than tripled -- from 9 percent to 29 percent -- since the late fifties (see Gravelle and Kotlikoff, 1989). The corporate share of output in most other industries also increased, in some cases by a significant amount. While many factors may have contributed to these changes in shares, they coincided with a period in which the corporate excess burden fell in most industries.

A comparison of the predictions of the model with actual observations of changes in shares seemed an exercise which could at least suggest whether the estimated shifts in capital produces plausible results. Accordingly, tax rates for 1957 were constructed and used to estimate the shifts in output shares which would be expected due to changes in the corporate tax wedge. In the case of variable entrepreneurs, this experiment produced implausible results with output becoming completely noncorporate in rental housing, agriculture and mining. The fixed entrepreneurs case produced a corner solution for rental housing, but rental housing was very close to fully noncorporate in the late fifties. (In order to calculate equilibrium with a fully non-corporate sector, the model must be solved by iteration for W, r and the output price of the fully noncorporate sector since the last term in equation (20) is no longer applicable in that sector). The model thus sets the corporate share of capital in rental housing in 1957 at zero, whereas it was actually 3 percent.

In other industries, the results were quite plausible. In four industries the model predicted shifts in the direction of less corporate output but under-predicted these shifts. While the corporate share of agriculture was 9 percent in 1957, the model predicted a 15 percent share, both contrasted to a current share of 29 percent. Construction, currently with a corporate share of 73 percent had a actual share of 56 percent in 1957; the model predicted a 71 percent share. Trade, with a current corporate share of 83 percent, had a 63 percent share in 1957; the model predicted a 79 percent share. Services, with a current corporate share of 66 percent, had a 47 percent in 1957; the model predicted a 63 percent share. In transportation the model predicted a shift towards more corporate output which actually occurred, but over-predicted it: transportation, with a current level of 82 percent, had a share of 86 percent in 1957; the model predicted an increase to 90 percent. In the remaining two industries the directions were different; in oil and gas the current share is 85 percent as compared to an actual share in 1957 of 74 percent; the model predicted a share of 90 percent. In mining, the current share is 84 percent as compared to an actual share in 1957 of 87 percent and a predicted share of 77 percent.

Many other factors could, of course, have affected shifts in output. The main lesson in this exercise, however, is that the magnitude of changes predicted by the model do not, in general, lie outside of historical experience. This exercise does, however, suggest that the exponential distribution of entrepreneurs abilities may produce too elastic a supply, at least in some industries, and that the actual efficiency gains may be closer to the fixed entrepreneurs model.

IV. Summary of Findings

The model presented in this paper allows mutual production of goods by corporate and noncorporate firms in a multi-sector, dynamic economy. When applied to the U.S. economy prior to the Tax Reform Act of 1986, the model predicts a very substantial excess burden arising primarily out of misallocation of capital between corporate and noncorporate firms within an industry -- a distortion not captured by the traditional Harberger model.

Moreover, the analysis suggests that the Tax Reform Act of 1986 made substantial progress in reducing this excess burden at no sacrifice of revenue. The magnitude of these efficiency gains are much larger than previously estimated. These gains from the Tax Reform Act occur in part because the Tax Reform Act reduces corporate tax wedges significantly in industries which have a substantial amount of noncorporate production, even though these wedges increased in other industries. These gains also arise in part because of the repeal of the investment tax credit. Although the investment credit reduces effective tax rates, it does little to reduce the corporate tax wedge because it is allowed in the form of a credit rather than a deduction. By using revenue gained from repeal of the credit to lower tax rates, substantial reductions in tax wedges were possible. Such observations have implications for the design of efficient marginal tax incentives.

While the results of the model for the Tax Reform Act and for the removal of corporate tax wedges are striking, they must be viewed in perspective. Neither debt/equity ratios nor dividend payout ratios are endogenous; different theories of equilibria in these markets could alter the results.6/ In addition, while the model has been expanded from the original two sector model to an eleven sector model, these sectors still represent a relatively high degree of aggregation.

It is also possible that corporate and noncorporate products in some cases are imperfect substitutes. This differentiation may be particularly important in the case of rental housing where corporations are much more concentrated in large multifamily units. Moreover, many of these large multifamily units are owned in the form of limited partnerships (popularly known as tax shelters) which are non-corporate but have the size attributes of the corporate form. Such aggregation may explain some of the difficulties in modeling shifts in ownership of rental housing in the fifties, since the rules relaxing the characterization of these firms as partnerships were promulgated in the sixties. Gravelle and Kotlikoff (1988) suggest, however, that altering the perfect substitute assumption to goods which are still very close substitutes would not change the conclusion of much larger efficiency effects from the corporate tax distortion than those predicted by the Harberger model.

Table 1: Equilibrium Equations

$$(9)\ \sum_{i=1}^{8} \int_{\underline{A}_i}^{\infty} (1+l_{ni})L\,\Gamma_i^{-\Gamma_i A_i} \prod_{i\neq j} \int_0^{A_i A_j/\underline{A}_j} \Gamma_j e^{-\Gamma_j A_j}\, dA_j \quad dA_i \ + M_{ci}(1+l_{ci}) = L$$

$$(10)\ Q_i = C_i + \sum_{j=1}^{11} v_{ij}Q_j + nx_iK_i \qquad i= 1,4;\ 6,8;\ 10,11$$

$$(11)\ Q_5 = C_5 + \sum_{j=1}^{11} v_{5j}Q_j + nx_5K_5 + \sum_{j=1}^{11} y_j(n+\delta_{5j})K_j$$

$$(12)\ Q_9 = C_9 + \sum_{j=1}^{11} v_{9j}Q_j + nx_iK_i + \sum_{j=1}^{11} (1-x_j-y_j)(n+\delta_{9j})K_j$$

$$(13)\ (k_{ci}/q_{ci}) = (\mu_i\beta_{ci}/R_{ci}) \left[(1-\beta_{ci})(WR_{ci}{*}/R_{ci})^{(1-\sigma_i)} + \beta_{ci} \right]^{(\sigma_i/(1-\sigma_i)}$$

$$(14)\ k_{ci} = (\beta_{ci}/(1-\alpha_i-\beta_{ci})\ (W/R_{ci})^{\sigma_i}\ R_{ci}{*}^{(\sigma_i-1)}$$

$$(15)\ l_{ci} = \alpha_{ci}/(1-\alpha_i-\beta_{ci})$$

$$(16)\ k_{ni}(A)/q_{ni}(A) = (\mu_i\beta_{ci}/R_{ci}) \left[(1-\beta_{ci})(WR_{ci}{*}/R_{ci})^{(1-\sigma_i)} + \beta_{ci}(R_{ci}/R_{ni})^{(1-\sigma_i)} \right]^{(\sigma_i/(1-\sigma_i)}$$

$$(17)\ \underline{A}_i = \left[1-(\beta_{ci}/(1-\alpha_i-\beta_{ci}))\ ((R_{ci}/R_{ci}{*}W)^{(1-\sigma_i)} - (R_{ni}/R_{ci}{*}W)^{(1-\sigma_i)}\ ) \right]^{-1/(1-\sigma_i)}$$

$$(18)\ k_{ni}(A) = A(\beta_{ci}/(R_{ci}{*}(1-\alpha_i-\beta_{ci})))\ \ (R_{ci}{*}W/R_{ci})^{(1-\sigma_i)} + (\beta_{ci}/(1-\alpha_i-\beta_{ci}))\ (R_{ci}/R_{ni})^{(1-\sigma_i)}\ {}^{\sigma_i/(1-\sigma_i)}$$

$$(19)\ l_{ni}(A) = k_{ni}(A)\ (\alpha_i/\beta_{ci})\ R_{ci}{*}^{(1-\sigma_i)}\ (R_{ni}/W)^{\sigma_i}$$

$$(20)\ P_i = \sum_{i=1}^{11} v_{ji}\,Pj + \mu_i \left[(1-\beta_{ci})(WR_{ci}{*}/R_{ci})^{(1-\sigma_i)} + \beta_{ci}(R_{ci}/R_{ci}{*})^{(1-\sigma_i)} \right]^{(1/(1-\sigma_i)}$$

$$(21)\ C_i = g_i^{\phi}P_i^{\phi} \ /\ \left(\sum_{i=1}^{11} g_i^{\phi}P_i^{(1-\phi)} \right)$$

Table 2: Simulation of Tax Reform Act of 1986

	Observed	REDISTRIBUTION Variable	REDISTRIBUTION Fixed	NO REDISTRIBUTION Variable	NO REDISTRIBUTION Fixed
r	1.00	.98	1.00	.98	.99
W	1.00	1.01	1.01	1.01	1.01
P1	1.00	.92	.93	.91	.93
P2	1.00	.95	.96	.94	.95
P3	1.00	.98	1.00	.98	.98
P4	1.00	1.00	1.01	1.00	1.01
P5	1.00	1.00	1.00	1.00	1.00
P6	1.00	1.00	1.01	1.00	1.01
P7	1.00	.97	.98	.97	.98
P8	1.00	1.00	1.01	1.00	1.01
P9	1.00	.98	.99	.98	.99
P10	1.00	1.00	1.01	1.00	1.01
P11	1.00	.98	.99	.98	.99
Price Index	1.00	.98	.99	.98	.99
Compensating Variation (%)		2.00	.85	2.02	1.09
Kc1	6.1	68.2	34.2	68.2	34.4
Kc2	7.0	16.6	8.8	16.6	8.9
Kc3	24.1	29.1	25.8	29.1	25.9
Kc4	3.9	2.7	3.7	2.7	3.7
Kc5	9.8	10.1	9.7	10.1	9.8
Kc6	13.5	13.1	13.1	13.1	13.2
Kc7	81.5	97.4	88.8	97.4	89.5
Kc8	44.0	43.3	43.3	43.3	43.6
Kc9	80.1	85.7	83.6	85.8	84.5
Kc10	48.4	48.9	48.0	48.9	48.3
Kn1	79.4	.7	43.0	.7	43.4
Kn2	23.6	12.6	21.9	12.6	22.1
Kn3	5.1	.1	3.4	.1	3.4
Kn4	.8	2.2	.9	2.2	.9
Kn5	4.2	3.7	3.9	3.7	3.9
Kn6	1.3	1.6	1.3	1.6	1.3
Kn7	22.3	12.7	20.5	12.7	20.6
Kn8	25.3	27.5	25.9	27.5	26.1
K11	194.5	198.9	195.2	199.0	196.4
K	674.8	675.0	675.0	675.3	680.1
Kn	161.9	61.0	120.8	61.1	121.8

Table 3: Efficiency Gain (Compensating Variation)

σ_n	σ_c	ϕ	Tax Reform Act of 1986	Uniform Taxes	Setting Corporate Rate To Noncorporate Rate
Variable Entrepreneurs					
1.00	1.00	1.00	2.00	2.98	2.86
1.00	1.00	0.50	1.99	2.78	2.70
0.75	1.24	1.00	2.12	3.15	3.01
1.25	0.75	1.00	1.86	2.76	2.69
Fixed Entrepreneurs					
1.00	1.00	1.00	0.85	1.97	1.88
1.00	1.00	0.50	0.82	1.77	1.73
0.75	1.25	1.00	0.86	2.10	1.95
1.25	0.75	1.00	0.87	1.85	1.71

σ_n = Factor substitution elasticity for rental housing and agriculture

σ_c = Factor substitution elasticity for remaining sectors

Appendix

Part 1 of the Appendix provides a simple illustration of the compensation scheme necessary to reach an equilibrium where asset values are fixed. Part 2 provides sources of data and an explanation of the computation of marginal tax rate.

Part 1: The Compensation Scheme

To simplify the illustration of the compensation scheme, a simple two period, two good model is used. The results generalize to a multi-period, multi-good model. In addition to taxing (or subsidizing) capital income so as to restore the old after-tax rate of return, there is a set of additional lump sum taxes and payments where an amount N is given to the old and taken from the young. Goods are subscripted by a and b, initial prices in the old equilibrium are one, prices in the new equilibrium are designated P. Quantities in the old equilibrium are designated by an asterisk. Subscripts y and o refer to young and old, subscripts a and b refer to commodities. Output is designated by a Q, consumption is designated by a C, and capital goods by a K; capital goods refer to the industry where produced. The term s is the old generation's share of consumption in the old equilibrium. R is the pre-tax rate of return, r is the net rate of return, and W is labor income.

In the new equilibrium, the budget constraint of the old is:

(A1.1) $P_a C_{ao} + P_b C_{bo} = (1+R)(P_a K_a + P_b K_b) + N$

The budget constraint of the young is:

(A1.2) $P_a C_{ay} + P_b C_{by} = -(1+n)(P_a K_a + P_b K_b) + W - N$

(A1.3) $N = P_a C_{ao}{}^* + P_b C_{bo}{}^* - (P_a K_a{}^* + P_b K_b{}^*) - R(P_a K_a + P_b K_b) + s(P_a(Q_a - Q_a{}^*) + P_b(Q_b - Q_b{}^*))$

Thus, we can rewrite (1) as:

$$(A1.3)\ P_aC_{ao} + P_bC_{bo} = P_aC_{ao}^* + P_bC_{bo}^* - (P_aK_a^*+P_bK_b^*-P_aK_a-P_bK_b)$$
$$+ s(P_a(Q_a-Q_a^*)+P_y(Q_b-Q_b^*))$$

Note that in the initial equilibrium when each type of capital is fixed, the old generation consumption is the old quantities times new prices plus a share of the change in output.

By taking advantage of the fact that:

$$(A1.4)\quad P_a(Q_a-Q_a^*) + P_b(Q_b-Q_b^*) = W + R(P_aK_a + P_bK_b) - P_aC_a^* - P_bC_b^* - n(P_aK_a^*+P_bK_b^*)$$

we can re-write (2) as:

$$(A1.5)\ P_aC_{ay}+P_bC_{by} = P_aC_{ay}^* + P_bC_{by}^* + (1-s)(P_a(Q_a-Q_a^*) + P_b(Q_b-Q_b^*))$$
$$+(1+n)(P_aK_a^*+P_bK_b^*-P_aK_a-P_bK_b)$$

In the next period, all of the values are (1+n) times the initial values. By multiplying equation (A1.3) by (1+n) and dividing by (1+r), the net rate of return we can add this revised equation to equation (A1.5) to obtain the budget constraint of the young individual. To solve this budget constraint, note that for an individual (in both equilibria), consumption when old is equal to consumption when new times $((1+r)^{\Omega})/(1+p)$, the discrete time analog to equation (6). In addition, the number of young consumers is (1+n) times the number of old consumers in any time period. By using these relationships and noting that for each product in each equilibrium, Q is the sum of C and nK, all of consumption terms cancel, leaving:

$$(A1.6)\quad P_aK_a^* + P_bK_b^* = P_aK_a + P_bK_b$$

which is the constraint used in (8). For a multi-generation model, the shares of total consumption of each age cohort are fixed as well as the value of assets.

If the capital stock could adjust immediately, each generation would receive an equal compensating variation. The economy, however, cannot produce immediately at its new equilibrium because the mix of capital must be changed. And, in practice, there is likely to be a period of adjustment in the reallocation of all factors, so that the economy would move slowly to its long run equilibrium and long run efficiency gain.

Part 2. Sources of Data

Table A1 lists the data used to calibrate the model, except the input output coefficients. Data sources are from slightly different years in the early 1980's reflecting differences in availability of data at the level of detail needed. The share of corporate output is from Gravelle and Kotlikoff (1989). Shares of value added, and capital income shares, were taken from data in the national income accounts for 1982. Capital income shares are the sum of depreciation, profits, interest, and property taxes. Rosenberg's (1969) data were used to make certain allocations for which information was not available (property taxes and the allocation of proprietorship income between capital and labor). Input output data are from the latest input output accounts, 1981. Labor income shares are estimated from data on payments to labor from sole proprietorship tax returns, 1980, the last year in which such data were reported for agriculture.

The use of marginal tax rates requires some further elaboration. In earlier studies, such as Shoven (1976), the level of tax burden was typically judged by cash flow taxes, which were based on taxes paid divided by some measure of income. These cash flow tax rates did not explicitly account for the advantage of the timing of benefits, and reflected the tax paid in the current period on both the existing stock of capital and on new investments.

The pattern of cash flow tax burdens could deviate substantially from the pattern of tax rates on a new investment, and it is the latter which governs the allocational effects of tax policies.

A marginal effective tax rate is determined by a discounted cash flow analysis, where the internal rate of return with and without taxes is compared. This type of measure can take into account all of the timing effects which are the crucial features of certain tax preferences, including accelerated depreciation and deferral of taxes on capital gains until realization. Most current studies, such as Fullerton, Henderson, and Mackie (1987) and Gravelle (1982) employ these marginal tax rates.

In the case of a depreciating asset, the relationship between pre-tax return and after tax return in the corporate sector is determined by the rental price formula of Hall and Hall and Jorgenson (1967):

(A2.1) $$R^* = ((r^c+\delta)(1-uz(1-mk)-k))/(1-u) - \delta$$

where R^* is the pre-tax real return, r^c is the after tax discount rate of the firm, δ is the economic depreciation rate, u is the statutory tax rate of the firm, z is the present value of depreciation deductions for tax purposes, k is the investment tax credit rate, and m is the fraction of k that reduces the basis for depreciation purposes. The value of depreciation is discounted at the nominal discount rate, $r^c + \pi$, where π is the rate of inflation. This formula applies to investments in equipment and structures which are subject to depreciation.

In the case of an appreciating asset, assuming that returns are not indexed:

(A2.2) $$r^c = (\ln (e^{(R^*+\pi)T}(1-u) + u))/T - \pi$$

where T is the holding period and u is the tax rate. This type of calculation applies to inventories at the level of the firm, when FIFO (first-in, first- out) accounting is used. When LIFO (last-in, first-out) accounting is used, π is set to zero in equation (A2).

In these formulas, the discount rate is the rate of the firm when considering depreciating assets and inventories. For a noncorporate firm, the same formulas would apply but the discount rate is the overall after tax discount rate, r. In the case of the corporate sector, however, there is another layer of tax imposed, so that r^c is different from than r. Corporations are allowed to deduct interest at their statutory tax rate, including the inflation premium and this interest is subject to individual tax at the personal level. In addition, the equity return to capital is subject to tax as dividends and capital gains. To measure total tax rates in the corporate sector, a calculation of the after tax return to the final recipients of income -- holders of corporate bonds and corporate equities -- is needed.

The discount rate of the corporate firm is equal to a weighted average of debt and equity:

(A2.3) $r^c = f(i(1-u)-\pi) + (1-f)E$

where f is the fraction financed by debt, i is the nominal interest rate, and E is the real return to corporate equity holders after corporate tax but before individual tax. The after personal tax discount rate, r is:

(A2.4) $r = f(i(1-t)-\pi) + (1-f)E(1-v)$

where t is individual tax rate and v is the effective tax rate on corporate equity at the personal level. The value of v is determined by (E-E*)/E, where E* is the after tax real return to equity and is determined by the formula:

(A2.5) $E^* = xE(1-t) + (\ln (e^{(E(1-x)+\pi)T}(1-t^*)+t^*) - \pi)/T$

where x is the share of the real return paid out as dividends, T is the capital gains holding period and t^* is the capital gains tax rate.

In equations (A2.1) and (A2.2), the corporate tax rate u and the corporate after tax discount rate r^c are used when calculating corporate values of R^*. When measuring taxes on non-corporate firms, the personal tax rate t and the after tax discount rate r are used in equations (A2.1) and (A2.2).

The tax rate on owner occupied housing and other consumer durables is calculated by determining a cost of capital which is:

(A2.6) $R^* = f(i(1-nt)-\pi) + (1-f)E^* - ntg$

where n is the fraction of interest and property taxes deducted by homeowners and g is property taxes as a percent of asset value. The effective tax rate is raised by the inability to deduct interest payments in full and lowered by the ability to deduct property taxes in part. Effective tax rates are measured as $(R^*-r)/R^*$.

The depreciation rates for equipment and structures used to construct tax rates and elsewhere in the model are taken from Hulten and Wykoff (1981); rates for rental housing and owner occupied housing are set at one percent. The inflation rate is set at .0456, the nominal interest rate at .0804, and the real return to corporate equities before personal tax are set at .0883 based on data and techniques used by Hendershott and Hu (1981). The holding period for inventories is set at four months, based the ratio of inventories to sales, and half of inventories are assumed to be FIFO. The holding period for capital gains, following Bailey (1969), is set at 40 years. Based on data from tax returns, about half of property taxes and interest on owner-occupied housing are deducted; property taxes are estimated to be 1.4 percent of asset value. Following Fullerton, Gillette, and Mackie (1987), the share deducted falls to 40 percent after the Tax Reform Act.

There are a number of unsettled issues in the economics literature, especially as to how corporations choose debt/equity ratios and dividend pay-out ratios. The conventions adopted in this study use an averaging approach; alternative conventions could alter tax rates. The value of f is set at one third (see Fullerton and Henderson, 1987). Based on historical averages, two thirds of the real return on corporate equities is paid out as dividends.

When aggregating capital to construct tax rates, capital stock shares are weighted by pre-tax returns. Capital stock shares used to construct tax rates and directly in the model as reported in Table A1 are based on cumulating historical investment over time and applying depreciation weights to obtain capital stocks for 28 different business assets. These assets are allocated to industry using the capital flows tables. For further detail on the construction of assets as well as the measurement of tax lives and investments credits see Gravelle (1982, 1983). The stock of land and allocations of land among industries are taken from Eisner (1980). Allocations of inventories are taken from tax return data.

The corporate tax rate is 46 percent under prior law and 34 percent under the new tax law. The average marginal tax rates under prior and new law vary by type of income sources. In this analysis, a composite tax rate is used and is set at 30 percent under prior law and 23 percent under the new tax law, based on data from the Office of Tax Analysis, U. S. Treasury.

The inter-temporal substitution elasticity, Ω, is .25 (see Auerbach and Kotlikoff, 1987).

Table A1: Data Used to Calibrate the Model

	Qci/Qi	β_c	s	α	t_c^*	t_n^*	δ
Rental Housing	.097	.770	.05	.135	.47	.23	.14
Agriculture	.293	.580	.03	.100	.52	.28	.32
Oil and Gas	.848	.776	.03	.185	.34	.11	1.17
Mining	.844	.435	.01	.425	.37	.20	1.54
Construction	.731	.321	.05	.410	.38	.09	2.31
Transportation	.923	.351	.04	.467	.34	.11	1.64
Trade	.829	.421	.20	.386	.52	.28	.73
Services	.666	.296	.22	.315	.41	.22	1.54
Manufacturing	1.000	.301	.24	.369	.49		1.00
Utilities	1.000	.621	.06	.220	.37		.94
Owner Occupied Housing	.000	1.000	.07	.000		.04	.14

Shares of Assets

	x	y		δ_9	t_c	t_n
Rental Housing	.00	.00	1.00		.40	.20
Agriculture	.10	.11	.79	2.39	.44	.23
Oil and Gas	.05	.09	.86	2.87	.33	.13
Mining	.03	.37	.60	2.93	.42	.20
Construction	.05	.68	.27	3.30	.44	.23
Transportation	.02	.43	.53	2.41	.41	.19
Trade	.36	.14	.45	3.87	.47	.26
Services	.03	.42	.55	3.17	.44	.23
Manufacturing	.30	.31	.39	2.64	.46	
Utilities	.04	.24	.72	2.28	.40	
Owner Occupied Housing	.00	.00	1.00			.04

Notes

1/ The model used in this study treats corporate and noncorporate products of the same type as homogeneous, and thus the demand elasticity between the two is infinite. Equilibrium is obtained through substitution in production due to the rising cost function for noncorporate production. Gravelle and Kotlikoff (1988a) present an alternative model where all production is constant returns to scale but corporate and noncorporate products are close but not perfect substitutes. This model also produces very large excess burdens from differential taxation of corporate capital.

2/ Estimates presented here are over four times as large, even using the conservative assumption of fixed entrepreneurs, as those in Fullerton, Henderson, and Mackie (1987) for the traditional view of dividends which corresponds to the marginal tax rates in this study. Fullerton, Henderson and Mackie, (and Fullerton and Henderson (1986)), unlike earlier models, do allow some within sector substitution of corporate and noncorporate capital by allowing aggregate production in an industry to be a function of both corporate and noncorporate capital as well as labor. They do not allow corporate/noncorporate substitution in production of rental housing, where important shifts in capital took place in our estimates, and the elasticities they assume are quite low compared to those which emerge from the model used in this study. Their measures of changes in corporate tax wedges appear to be of similar magnitude; thus, the much larger estimates of efficiency gains reported here are due to the different treatment of corporate/noncorporate within industry substitution.

3/ The models of Harberger (1966), Shoven (1976), Fullerton, Shoven and Whalley (1978, 1983), and Ballard, Fullerton, Shoven, and Whalley (1985) do not allow for corporate/noncorporate substitution within an industry or the production, pricing, and depreciation of capital. They also rely on average rather than marginal tax rates. Fullerton and Henderson (1986) do allow a mechanism for substitution between corporate and noncorporate capital in different industries. They incorporate depreciation to the extent of using it to calculate marginal effective tax rates. Their production functions are, however, production functions for output net of depreciation and there are no asset prices or asset markets. Many of these models, on the other hand, are designed to capture a wider range of tax distortions than those on capital misallocations arising from differential taxation of capital by type. Fullerton and Henderson also allow for within firm substitution between different types of capital. If these effects were allowed in the model presented in this paper the efficiency gains would be slightly larger.

4/ Treating land as a produced capital good is perhaps not ideal; to treat it as in fixed supply, however, would not allow constant returns to scale production functions. By and large, this treatment is not important to the empirical results which derive largely from within industry substitution of corporate and noncorporate production. Another simplifying assumption, that industries used a fixed mix of capital goods, causes efficiency gains to be somewhat understated. Based on estimates in Gravelle (1982, 1983), the efficiency gains from changing the mix of assets used within a firm would be quite modest, however.

5/ These tax rates are marginal tax rates on new investment. Arguments have been made that the Tax Reform Act, by trading a reduction in rates which apply to income from the existing capital stock for marginal incentives restricted to new investment, provide a windfall to existing capital and thus would lose revenue in present value terms if marginal rates are constant. This view of the Act ignores the substantial range of lump sum tax increases, such as the inventory capitalization rules.

6/ There are certain "trapped equity" theories of these financial decisions which would substantially reduce the corporate tax wedges. For example, if marginal corporate investment is financed by debt, no corporate tax would be paid other than on the existing stock of equity. Since historical debt/equity ratios have not risen continually, as such a theory would predict, the bankruptcy risk theories, such as those of Gordon and Malkiel (1981) may be more plausible and are reasonably consistent with the corporate tax wedges. Indeed, under such a theory the reduction of corporate tax rate would lead to more efficient financial decisions and benefit corporations further. There is also a "trapped equity" or "new view" of dividends. In this case, the dividend tax does not matter and corporate tax wedges are much smaller. Results would be quite sensitive to changing this assumption. In that case, that the total welfare gains from removing all taxes would be 1.36 percent under the variable entrepreneurs assumption and .79 percent under the fixed entrepreneurs assumption; the corresponding gains from the Tax Reform Act would be .6 percent and .19 percent respectively. The difficulty with the new view is that it relies on the assumption that firms cannot get out of their trap by repurchasing shares. Such an option has always been legally available in the United States; moreover, Shoven (1986) presents evidence of considerable repurchase activity. Thus, the new view appears to be counter-factual. For a more detailed discussion of this issue see Poterba and Summers (1985).

References

Auerbach, Alan and Laurence J. Kotlikoff. Dynamic Fiscal Policy. Cambridge: Cambridge University Press, 1987.

Bailey, Martin J. "Capital Gains and Income Taxation." In The Taxation of Income from Capital. Edited by Arnold C. Harberger and Martin J. Bailey. Washington, D.C. The Brookings Institution, 1969.

Ballard, Charles L., Don Fullerton, John B. Shoven, and John Whalley. A General Equilibrium Model for Tax Policy Evaluation. Chicago: University of Chicago Press, 1985.

Eisner, Robert. "Capital Gains and Income: Real Changes in the Value of Capital in the United States, 1946-77." In The Measurement of Capital, ed. by Dan Usher, Chicago, University of Chicago Press, 1980.

Fullerton, Don, and Yolanda K. Henderson. "A Disaggregate General Equilibrium Model of the Tax Distortions Among Assets, Sectors, and Industries." National Bureau of Economic Research Working Paper 1905, 1986.

Fullerton, Don, Yolanda K. Henderson, and James Mackie. "Investment Allocation and Growth Under the Tax Reform Act of 1986." In Compendium of Tax Research 1987, Office of Tax Analysis, Washington, D.C., U.S. Government Printing Office, 1987.

Fullerton, Don, John B. Shoven, and John Whalley. "General Equilibrium Analysis of U.S. Tax Policy." In 1978 Compendium of Tax Research, Office of Tax Analysis,Washington, D.C., U.S. Government Printing Office, 1978

__________"Replacing the U.S. Income Tax with a Progressive Consumption Tax." Journal of Public Economics 20 (1983)pp. 3-23.

Gordon, Roger H., and Burton G. Malkiel. "Corporation Finance." In How Taxes Affect Economic Behavior, ed. By Henry J. Aaron and Joseph A. Pechman, Washington D.C., The Brookings Institution, 1981.

Gravelle, Jane G. "Capital Income Taxation and Efficiency in the Allocation of Investment." National Tax Journal 36 (September, 1983): 297-306.

__________ "Effects of the 1981 Depreciation Revisions on the Taxation of Income from Business Capital." National Tax Journal 35 (March, 1982): 1-20.

Gravelle, Jane G. and Laurence J. Kotlikoff. (1988a). "Does the Harberger Model Greatly Understate the Excess Burden of the Corporate Tax? -- Another Model Says Yes." National Bureau of Economic Research Working Paper 2742, 1988.

__________. "The Incidence and Efficiency Costs of Corporate Taxation when Corporate and Noncorporate Firms Produce the Same Good," forthcoming, Journal of Political Economy, 1989.

__________.(1988b). "A Multi-Good Steady State Mutual Production Model of Corporate Taxation," Manuscript. November 1988.

Hall, Robert and Dale W. Jorgenson. "Tax Policy and Investment Behavior." American Economic Review 57 (1967): 391-414.

Harberger, Arnold. "Efficiency Effects of Taxes on Income from Capital," in Effects of the Corporation Income Tax, ed. by Marianne Krzyzniak. Detroit: Wayne State University Press, 1966.

__________. "The Incidence of the Corporation Income Tax." Journal of Political Economy 70 (3), June, 1962.

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

Hendershott, Patric and Sheng Cheng Hu. "Investment in Producer's Durable Equipment." In How Taxes Affect Economic Behavior, ed. by Henry J. Aaron and Joseph A. Pechman; Brookings Institution, 1981.

Hulten, Charles R. and Wykoff, Frank C. "The Measurement of Economic Depreciation." In Depreciation, Inflation and the Taxation of Income from Capital, ed. by Charles R. Hulten; Washington, D.C., The Urban Institute, 1981.

Poterba, James M. and Lawrence H. Summers. "The Economic Effects of Dividend Taxes." In Edward I. Altman and Marti G. Subrahmanyam (Eds.), Recent Advances in Corporate Finance. Homewood, Il.: Richard D. Irwin, 1985.

Rosenberg, Leon G. "Taxation of Income from Capital by Industry Group," in The Taxation of Income from Capital, ed. by Arnold C. Harberger and Martin J. Bailey, Washington, D.C.: Brookings Institution, 1969.

Shoven, John B. "The Incidence and Efficiency Effects of Taxes on Income from Capital," Journal of Political Economy, 84 6, December, 1976.

__________. "New Developments in Corporate Finance and Tax Avoidance." In Tax Policy and the Economy 1986, ed. by Lawrence Summers, National Bureau of Economic Research, 1986.

U.S. Department of Commerce. "Input-Output Accounts of the U.S. Economy, 1981. Survey of Current Business, January 1987, pp. 42-57.

U. S. Department of Treasury. Internal Revenue Service. Statistics of Income.