Redistribution and Efficiency Effects of Capital Tax Changes in a Dynamic Model*

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I. Introduction

The appropriate mix of taxation between labor and capital income has been intensively debated for many decades. Economists have studied the impact of taxation in dynamic economies, but have largely focussed on representative agent models. In this paper, we will focus on the distributional effects of factor income taxation.

One of the more provocative claims made by tax cut advocates is that cutting income taxation and increasing investment incentives through more generous depreciation allowances and investment tax credits will result in *increased* tax revenues due to the great increase in capital stock and output which would result. Even among many who reject this notion, there is a feeling that the efficiency cost of capital taxation is high. Another claim of some conservative policymakers is that the workers gain due to the increase in wages which will accompany capital accumulation. In this paper we examine these issues jointly in a simple equilibrium growth model.

This paper is similar in spirit to several other contributions to the literature on capital income taxation, but differs in substance and methodology. We adopt an intertemporal maximization approach for asset accumulation versus the ad hoc savings rate approach of Feldstein (1974) and Bernheim (1981). We adopt a continuous-time, infinite-horizon model as opposed to the two-period overlapping generations model of Diamond (1970) to avoid the intertemporal aggregation of such an approach. We adopt an infinitely-lived agent approach instead of the much less tractable model with finite-lived agents in Auerbach and Kotlikoff (1983). In a methodological vein, we adopt a local linearization approach, as in Judd(1985).

To keep the model simple, yet present a logically consistent treatment of the issues, we assume that labor is inelastically supplied. This results in a much more transparent analysis of the issues since we can interpret our model as an aggregated model. This also allows us to concentrate on physical capital accumulation and its effect on factor incomes. It is unclear that the results would be much different. In Judd(1987) the labor supply effects of tax cuts were small for almost all reasonable parameterizations because the price and income effects of tax changes usually pushed labor supply in contrary directions. We also examine a deterministic model since the basic arguments concerning long-run growth and output have little to do with risk, and risk is generally (perhaps mistakenly) ignored in this literature.

Distributional impacts of tax cuts have not been extensively studied. Auerbach and Kotlikoff focussed on the intergenerational differences between income and consumption taxation. ?? examined these issues but in an ad hoc dynamic model; we stay with the Arrow-Debreu general equilibrium approach, also known as perfect foresight, to dynamic modelling.

While the model is quite simple, it makes some important points. When we evaluate the model for reasonable parameters of taxes, tastes and technology, we can make several interesting conclusions, some obvious and general, but some dependent on those parameter values. First, an equal cut in both capital and labor taxation will almost surely cause a decline in revenue. Second, if only the tax on capital is cut, the capital tax revenues will decline with much of that revenue loss being offset by increased labor tax revenues due to the induced wage increases. However, if capital and labor are somewhat more substitutable of if effective taxation of capital is greater than commonly thought, total revenue would rise. Third, if the investment tax credit is increased, the direct revenue loss is possibly covered by increased labor and capital tax revenues. Fourth, whereas capitalists always gain from a cut in the capital income tax, they may either lose or gain from an investment tax credit increase, with the result remaining ambiguous when we assume reasonable parameter values. Fifth, for moderate levels of capital taxation, the marginal revenues of a capital income tax increase are less than the decline in wages, indicating that workers may gain from capital income tax cuts even if the revenue losses were covered by increase labor taxation.

II. The Model

Since the model is fully described in several other papers, e.g., Brock and Turnovsky (1981) and Judd (1985), we shall only review its essential elements here.

Assume that we have an economy of a large fixed number of infinitely-lived individuals with a common utility function. The common utility functional is assumed to be additively separable in time with a constant pure rate of time preference, ρ:

$$U = \int_0^\infty e^{-\rho t} u(C(t))\, dt$$

where $C(t)$ is consumption of the single good at time t and $u(\cdot) = c^{1+\gamma}/(1+\gamma)$ is the instantaneous utility function, where $\gamma < 0$ is the inverse of the intertemporal elasticity of substitution in consumption. Each agent supplies some labor inelastically at all times t, for which he receives a wage of $w(t)$ per unit. This assumption is made so that we may focus on aspects of capital taxation, the case of elastic labor supply deserving a separate study.

Let $F(k)$ be a standard neoclassical CRTS production function giving output per capital in terms of the capital-labor ration, k. We assume that the total amount of labor inelastically supplied is unity. At $t = 0$, k_0 is the total endowment of capital. Capital depreciates at a constant rate of $\delta > 0$. $f(k)$ shall denote the net national product, with σ being the elasticity of substitution between capital and labor, and θ_K and θ_L denoting the capital and labor share, respectively, of et output. Capital pays a rental rate of $r(t)$ unit at t, gross of taxes, credits, and depreciation.

To focus on the efficiency issues of taxation, we assume that the government plays no constructive role: at time t, it taxes capital income net of depreciation at a proportional rate $\tau_K(t)$, taxes labor income at a proportional rate of $\tau_L(t)$, gives an investment tax credit on gross investment of $\theta(t)$ units of consumption per unit of investment, and returns the net receipts to agents in a lump-sum transfer of $\ell(t)$ per person.

The representative agent supplying ℓ units of labor will choose his consumption path, $C(t)$, and asset accumulation, $\dot{A}(t)$ subject to the instantaneous budget constraint, taking the wage, rental, and tax rates and the lump-sum transfer, ℓ, as given:

$$\begin{aligned} &\max_{C(t)} \int_0^\infty e^{-\rho t}\, u(C(t))\, dt \\ &\quad \dot{A} = w\ell(1-\tau_L) + (r-\delta)A(1-\tau_K) + \ell + \theta(\delta A + \dot{A}) \qquad (1) \\ &A(0) = A_0 \end{aligned}$$

Time arguments are suppressed when no ambiguity results. Define

$$q(t) = \int_t^\infty e^{\rho(t-s)}((r-\delta)\ (1-\tau_K) + \delta\theta)\ u'(c)\ ds \qquad (2)$$

to be is the current marginal utility value of an extra unit of capital at time t. The basic arbitrage relation is

$$(1-\theta(t))u'(C(t)) = (1-\theta(t))C(t)^{\gamma} = q(t) \tag{3}$$

stating that along an optimum path, each individual is indifferent between an extra $1-\theta(t)$ units of consumption and the extra future consumption that would result from an extra unit of investment in capital. We assume that the transversality condition at infinity holds:

$$(TVC_{\infty})\ \lim_{t\to\infty} q(t)k(t)\ e^{-\rho t} = 0. \tag{4}$$

This condition is needed to insure that q and k remain bounded as $t \to \infty$. It is a necessary condition for the agent's problem if $u(\cdot)$ is bounded, which is a harmless assumption here since the net production function is bounded (see Benveniste and Scheinkman (1982)).

To describe equilibrium, impose the equilibrium conditions

$$r = F'(k) \tag{5a}$$

$$w = f(k) - kf'(k) \tag{5b}$$

on (2) and the budget constraint. Differentiation of the result yields the equilibrium equations

$$\dot{q} = q\Big(\rho - \frac{(1-\tau_K)f'(k) + \delta\theta}{1-\theta}\Big) \tag{6a}$$

$$\dot{k} = f(k) - c(q/(1-\theta)) \tag{6b}$$

for each individual. If we let c be aggregate consumption and k be aggregate capital (that is, net assets) then the aggregate system is

$$\dot{c} = -\frac{c}{\gamma}\ (\rho - \frac{(1-\tau_K)f'(k) - \delta\theta}{1-\theta}) \tag{19a}$$

$$\dot{k} = f(k) - c \tag{19b}$$

$$\dot{q} = q\Big(\rho - \frac{(1-\tau_K)f'(k) + \delta\theta}{1-\theta}\Big) \tag{6a}$$

$$\dot{k} = f(k) - c(q/(1-\theta)) \tag{6b}$$

where $u'(c(p)) = p$ defines $c(\cdot)$. The transversality condition insures that c and k remain bounded. The economy will therefore (see Brock and Turnovsky) converge montonically to the steady state capital stock, k^*, determined by

$$f'(k^*) = \frac{\rho(1-\theta) - \delta\theta}{1-\tau_K} \tag{7}$$

$$\dot{c} = c??\Big(\rho - \frac{(1-\tau_K)f'(k) + \delta\theta}{1-\theta}\Big) \tag{6a}$$

$$\dot{A} = Af'(k) + \ell(f(k) - kf'(k)) - c \tag{6b}$$

These equations aggregate to the system

$$\dot{C} = C??\Big(\rho - \frac{(1-\tau_K)f'(k) + \delta\theta}{1-\theta}\Big) \tag{6a}$$

$$\dot{k} = f(k) - C \tag{6b}$$

This aggregation is due to the Gorman aggregation property of the power utility function and the inelastic labor supply. It drastically simplifies our analysis. If we had heterogeneous tastes or elastic labor supply then we would have to track the individual wealth of each type of agent where by type we would distinguish by wealth as well as by utility function.

To examine revenue and efficiency impacts of capital taxation, we analyze a simple perturbation of a steady state, though the analysis remains valid as long as the linear approximation to (6) is acceptable (see Judd (1985) for a rigorous development of our analysis). For any permanent change in the tax parameters, there will be a new steady-state capital stock. From the steady-state equation, we see that

$$dk^* = -\frac{\sigma}{\theta_L}\Big(\frac{d\tau_K}{1-\tau_K} - \frac{\rho+\delta}{\rho(1-\theta)-\delta\theta}\, d\theta\Big). \tag{8}$$

The economy will converge to the new steady state according to

$$\dot{k} = \lambda(k - k^*) \tag{9}$$

where λ is the negative eigenvalue of the linearization of (6) and equals

$$\lambda = \frac{f'(k^*)}{2}\Big(1 - \sqrt{1 + \frac{4(1-\tau_K)\theta_L}{\gamma(1-\theta)\sigma\theta_K}}\Big) \tag{10}$$

λ is greater in magnitude as the steady-state capital stock is less, as τ_K, σ, and θ_K are greater, and as the utility function is less concave.

III. Revenue Changes

We next examine the impact of a decrease in the capital income tax rate and an increase in the investment tax credit on the discounted value of the government revenue stream.

a) Reduce τ_K

Using (8) and (9), if the capital income tax rate drops immediately and permanently by $d\tau_K$, then

$$dR = -[\{\tau_K(1-\frac{\theta_L}{\sigma}) + \tau_L\frac{\theta_L}{\sigma} - \theta\ \frac{\rho+\delta}{f'}\}\ \frac{\lambda}{\lambda-\rho}\ \frac{\sigma}{\theta_L}\frac{1}{1-\tau_K}\ -1]\ \frac{\theta_K f}{\rho}\ d\tau_K \tag{11}$$

expresses the value of the change in revenue as a fraction of capital's before tax share of the present value of output, $\theta_K f/\rho$. dR has the property that if discounted revenue increases by dR, then the government could increase transferes to individuals by a constant ρdR per period.

The formula for the discounted change in revenue can be decomposed intuitively into its separate components. First, if there were no change in capital stock, then a 1% increase in the tax rate would increase discounted revenues by 1% of $\theta_K f/\rho$, capital's share of the net product.

However the capital stock is affected, causing a change in capital income tax revenues, in wages and wage tax revenues, and in investment tax credit outlays. A change in the capital stock of dk will cause the capital income tax base, kf', to change by $d(kf') = f'(1-\theta_L/\sigma)dk$, resulting in revneues from existing capital changing by $\tau_K f'(1-\theta_L/\sigma)dk$. Similarly, wages increase by $(\theta_L/\sigma)f'dk$ and wage taxes increase by $\tau_L\theta_L f'dk$. An increase in the capital stock by dk will increase the present value of investment tax credit outlays in two ways: replacement investment will increase by δdk, causing the flow of investment tax credit outlays to increase by $\theta\delta dk$, and there will also be investment tax credits paid on the extra capital, the present value of that outflow being θdk. Therefore, the value of the net change in revenues at some time due to the induced changes in the capital stock is

$$[f'\{(1-\frac{\theta_L}{\sigma})\tau_K + \frac{\theta_L}{\sigma}\tau_L\} - \theta(\rho+\delta)]\ \frac{dk}{\rho} \tag{20}$$

Since τ_K and τ_L are substantially larger than θ and θ_L/σ is not large (almost surely less than 2.0) and $(\rho+\delta)/f'$ is also not much different than unity for reasonable values of τ_K and θ, it is most likely that capital accumulation will raise revenues.

If the change in capital stock were instantaneous, then (20) and (8) would determine the impact of the induced capital formation on income tax revenues and investment tax credit outlays. However, the capital stock converges to the new steady state according to the linear stock adjustment process indicated in (9). Since the steady-state rate of discount is ρ, the discounted change in income tax revenues[1] and investment tax credits is $\lambda/(\lambda-\rho)$ times that which would be the case if adjustment were instantaneous, i.e., if $\lambda = -\infty$. The sum of these effects is (11).

Comparative static exercises for the change in revenue are cumbersome due to the complex dependence of λ on σ, θ_L, τ_L, and θ. The primary concern here is the sign of dR and, more generally, a feeling as to how much of the revenue change which would occur if there were no change in capital stock is countered by the extra revenue which results from the capital accumulation. Therefore, we have tabulated the results of some calculations in Tables 1 and 2. In Table 1 we assume that $\tau_K = .5$, $\theta = .05$, and $\theta_K = .25$, values fairly representative of the U.S. economy. The .5 capital tax rate is a compromise between the higher effective nonfinancial corporate tax rate (see Feldstein and Summers) and the lower noncorporate rate. Note that we are ignoring the intersectoral distortions due to unequal treatment caused by the corporate tax and the structure of depreciation allowances, concentrating solely on intertemporal issues. The .25 capital share implicitly means that we are ignoring consumer durables. The relatively low capital share is chosen for close examination because it biases the results against the main points of this paper. Fullerton (1983) has argued for substantially lower rates, so in Table 2 we assume $\tau_K = .3$.

The elasticity of substitution, σ, has been estimated often with mixed results. We allow σ to range between .4 and 1.3. This range includes some of the low estimates from time-series analysis, the higher cross-sectional estimates, and the reconciled estimates of Berndt (1976). (See Berndt (1976) for a general discussion and also Nerlove (1967), Lucas (1969),

[1] From Brock and Turnovsky (1982) and Judd (1985), we know that the appropriate rate of discount in computing tax revenue changes is the ret rate of return.

and Berndt and Christensen (1973)). One should note that our σ is factor substitutability in f, whereas most of these studies estimate substitutability in gross output, a number which, given our assumptions on δ and θ_K is about one-third greater.

The other major parameter is the elasticity of marginal utility, γ. There are two types of empirical analysis which can be used to guide us in choosing an appropriate range. First, the macroeconometric literature argues for γ between .5 and 10 (see Weber (1970, 1975), Hansen and Singleton (1982, 1983), Grossman and Shiller (1981), and Hall (1981)). Second, the more disaggregated estimation of demand by Phlips (1978) (ignoring the nonsensical result for "other services") implies a range of γ from .5 to 6. We allow γ to range between .5 and 10.0.

The first column of Tables 1 and 2 gives the change in capital tax revenue, net of investment tax credits, as a portion of the steady-state present value of capital income, i.e., $(dR/d\tau_K)/(\theta_K f/\rho)$ for various plausible values for σ, γ, and τ_K. Note that if there were no induced capital accumulation, this number would be unity. In comparing column 1 with column 2, which expresses the discounted change in wage income also as a multiple of discounted capital income, we see that with even just moderate labor taxation much of the direct loss of revenue due to the cut in τ_K is offset by the increased revenue due to either higher capital or labor income,[2] however, only for unrealistically high rates of labor taxation would a decrease in τ_K actually lead to greater revenue in present value terms. The extent to which increased labor tax revenues offset capital tax losses is increased as γ decreases because a small γ indicates a small desire for a constant rate of consumption, implying that agents are more willing to save today in order to raise lifetime consumption and leading to a more rapid adjustment, causing the accumulation effects on revenue to be more important. The same is true as σ increases since the adjustment is greater and the net capital tax loss is less.

For higher rates of taxation and capital-labor substitutability, it is increasingly likely that a capital tax cut would result in higher total revenues. Fore xample, if τ_K were .6, τ_L

[2] When $\sigma < \theta_L$ capital accumulation results in a lower rate of return for capital and depresses revenues per unit of capital, explaining why many entries in column 1 exceeds unity, i.e., the loss of revenue due to a tax cut is accentuated by the induced capital formation.

were .4, the production function were Cobb-Douglas, and utility were logarithmic, then a capital income tax cut would leave total tax revenues unchanged. If τ_K were .7, this would hold if σ were only .8. For $\tau_K = 8$, we find that capital income tax revenues alone may increase with a tax cut. While these parameters are on the fringe of what is considered reasonable, it does point out how close we may be to this perverse possibility, especially if we were to add other realistic elements such as the nonuniform taxation of capital.

In comparing these results with Fullerton (1982) we find that this intertemporal maximizing growth model is more likely to yield the perverse revenue movements compared to his ad hoc savings specification. Fullerton finds that revenues go up with the tax rate even when τ_K is over .8, something which would not happen in this model for reasonable values of γ and σ. This reflects the incentive effects of future tax cuts on savings today which exist in our model, whereas in Fullerton individuals are not allowed to save currently in response to high future returns.

b) Increase θ

We next examine the impact of an increase in the investment tax credit on discounted revenue. Using the same arguments as above, we find that

$$dR = \{[\tau_K(1 - \theta_L/\sigma) + \tau_L\theta_L/\sigma - \theta \, \frac{\rho + \delta}{f'}] \, \frac{\sigma}{\theta_L} \, \frac{1}{1 - \tau_K} \, \frac{\lambda}{\lambda - \rho} \, \frac{\rho + \delta}{\delta} \, - 1\} \, \frac{\delta k}{\rho} \, d\theta \tag{15}$$

when θ is increased immediately and permanently. Here we express the change in revenue as a fraction of the present value of economic depreciation. The direct cost of greater tax credits on replacement investment is substantially offset by the greater income tax revenues due to the capital accumulation. We immediately note that an increase in the investment tax credit is more liekly to result in greater revenues than a cut in capital income tax for reasonable parameter values, since comparing (11) and (15) shows that the revenue change due to capital formation induced per dollar in subsidy to replace existing captial is $(\rho + \delta)/\delta$ times the revenue change induced by a one dollar cut in taxation of existing capital.

Column 4 in Tables 1 and 2 displays the net revenue loss as a fraction of discounted capital income, i.e., $(dR/d\theta)/(\theta_K f/\rho)$. In comparing column 4 with column 5, which expresses the present value of the increase in the wages also as a fraction of $\theta_K f/\rho$, we see that an increase in θ would lead to only small revenue losses even for moderate rates of wage taxation, and revenue could possibly increase. Moderately higher tax rates would make perverse revenue movements even more likely.

In summary, reductions in τ_K have a small likelihood of raising revenues unless τ_K and τ_L are very high, whereas increases in θ are much more likely to increase total revenues. On the other hand, an equal cut in both τ_K and τ_L will surely lead to a reduction in revenue. Since $\theta_K = .25$, the loss of revenue flow due to a cut in τ_L of $d\tau_L$ will be $3\theta_K f d\tau_L$. Adding this loss to column 2 yields the total revenue change. It is straightforward to see that when $d\tau_K = d\tau_L$, tax cuts will increase revenues only for unrealistically high values of τ_K and σ; for example, if $\sigma = 1$ and adjustment were instantaneous, τ_K would have to exceed .75.[3]

IV. Distributional Effects

Another nickname attached to policies promoted by concervatives is trickel-down economics because of the claim that the tax cuts will so stimulate capital formation that the increase in wages will leave workers better off even if they are taxed to finance the program, either directly, or indirectly through lower provision of public goods. Neoclassical growth models, such as in Grieson (1975) and Boadway (1979), have been used to argue that this is unlikely. In this section we examine a disaggregtated interpretation of our model and examine distributional impacts of a cut in τ_K and an increase in θ. We assume that all agents inelastically supply one unit of labor per unit of time but own varying amounts of capitals. If we assume that the elasticity of marginal utility of consumption, $-u''(c)c/u'(c)$, is equal to a constant, γ, then it is straightforward to show that the individual optimality equations aggregate and that the general equilibrium movement of per capita consumption, c, and aggregate capital per worker, k, are given by the solutions to

$$\dot{c} = -\frac{c}{\gamma}\,(\rho - \frac{(1-\tau_K)f'(k) - \delta\theta}{1-\theta}) \tag{19a}$$

$$\dot{k} = f(k) - c \tag{19b}$$

The change of variable

$$q = u'(c)(1-\theta) \tag{20}$$

[3] The effect of an elastic labor supply on all of these calculations would be ambiguous since a capital income tax cut would raise both wage and nonwage income and price and income effects shift labor supply in opposite directions.

converts (19) into our equations (6), showing that (6) can be given a disaggregated interpretation. For the purposes of this exercise, we assume that all revenues are redistributed lump-sum to all in a uniform fashion, hence, equal to $\tau_K f(k) - \theta\dot{k} - \theta\delta k$ per person. Since the wage tax is effectively a uniform lump-sum tax, we set it to zero.

a) Cut τ_K

First assume that the capital income tax is decreased instantly and permanently. The discounted value of the change in wages, dW, is:

$$dW = \frac{\lambda}{\rho - \lambda} \frac{1}{1 - \tau_K} \frac{\theta_K f}{\rho} \, d\tau_K \tag{21}$$

which is always positive for a tax cut, being greater as λ, τ_K, and θ_K are greater in magnitude, and as σ and γ are smaller. Column 2 in Tables 1 and 2 gives values of the discounted wage change as a fraction of capital income, i.e., $(dW/d\tau_K)/(\theta_K f/\rho)$, for an unanticipated permanent cut in τ_K. We see that the wage gain may or may not exceed the revenue loss. In Table 1, the wage gain is greater, whereas in Table 2 the revenue gain is greater. Hence τ_K is the crucial parameter, being .3 in Table 1 and .5 in Table 2.

The impact on an investor holding one unit of capital is $d\Pi$, the discounted value of the change in the net-of-tax return on the exisiting capital stock, and is expressed in:

$$d\Pi = \frac{f'}{\lambda - \rho} \, d\tau_K \tag{22}$$

We immediately see that the holder of capital always gains from the tax cut since λ, the rate of adjustment, is negative. The induced capital accumulation reduces the gain, which is smaller as adjustment is faster.

To focus on the trickle-down aspects of capital tax cuts, separate from the benefits of less taxation, we add wage and rebate changes to measure the net impact on an individual holding no capital. This net change in worker welfare is

$$dy^w = \frac{\theta_K f}{\rho} \, [[(\tau_K(1 - \frac{\theta_L}{\sigma} - \theta \, \frac{\rho + \delta}{f'}) \, \frac{\sigma}{\theta_L} \, + 1] \, \frac{1}{1 - \tau_K} \, \frac{\lambda}{\lambda - \rho} \, - 1] \, d\tau_K. \tag{23}$$

Since this disaggregated model is equivalent to the representative agent model we examined earlier, we may use Tables 1 and 2 in assessing these impacts. In Table 2, where $\tau_K = .5$ and $\theta = 0$, that the increase in wages substantially exceed the loss in revenue from a cut in τ_K for most reasonable values of σ and γ. An interesting question is how high τ_K can be before the revenue gains from increases in τ_K are offset by the loss in wages. In Table 3, we show the tax rate τ_K such that $dy^w = 0$ when $\theta = 0$ for various values of σ and γ. If τ_K exceeds this value, then *all* agents will benefit from a permanent unanticiapted decrease in τ_K. Note that these rates are relatively low unless the utility function is very concave, demonstrating the weakness of even unanticiapted permanent capital taxation as an instrument of redistribution.

b) Increase θ

Next we consider the welfare impact of increasing the investment tax credit. When θ is changed, the change in discounted value of wages is

$$dW = \frac{\rho + \delta}{\delta} \frac{\lambda}{\lambda - \rho} \frac{1}{1 - \tau_K} \frac{\delta k}{\rho}\, d\theta \tag{24}$$

which is positive whenever the tax credit is increased.

When θ is increased, the change in investor welfare per unit of capital is the discounted value of the change in net income on one unit of capital:

$$d\Pi = \frac{\delta}{\rho - \lambda}\, d\theta \tag{25}$$

The changes in investor welfare due to increased profits needs to be distinguished from the change in the present value of his investment. The value of the captial stock at any time is expressed in terms of the commodity good at that time. In our model with no adjustment costs, the capital and the good are perfect substitutes and hence the value of k units of capital in place will be k as long as $\theta = 0$. However, when $\theta > 0$, then new investment is subsidized and one is indifferent between one unit of consumption and $1 - \theta$ units of capital in place, so the value of k units of capital is $k(1 - \theta)$. Therefore changes in τ_K leave value unchanged but changes in θ affect the value of the capital stock. These values do not reflect the welfare changes of a tax change because the induced capital formation changes the relative prices of goods across time. Our formulas (22) and (25) give the true welfare impact.

When we add the increase in wages to the loss in rebate income, the change in a worker's utility is

$$dy^w = \frac{\delta k}{\rho}\ [[\tau_K(1-\frac{\theta_L}{\sigma}) - \theta\frac{\rho+\delta}{f\prime})\ \frac{\sigma}{\theta_L}\ +1]\ \frac{\rho+\delta}{\delta}\ \frac{1}{1-\tau_K}\ \frac{\lambda}{\lambda-\rho}\ -1]\ d\tau_K \tag{26}$$

In comparing (23) to (26) we see that a worker is more likely to gain from increasing θ than from decreasing τ_K, reflecting again the fact that an investment tax credit subsidizes only investment whereas a tax cut is partially an investment incentive but also a lump-sum tax cut to holders of the current capital stock. Column 5 of Tables 1 and 2 expresses the change in wages due to an unanticipated permanent increase in wages due to an unanticiapted permanent increase in θ as a fraction of depreciation, i.e., $(dW/d\theta)/(\theta_K f/\rho)$. Note that the increased tax credit expense due to a larger θ is always much less than the wage gain in Table 1. In particular, for the log utility cases, the wage gain is two to three time the revenue loss. Only when γ is unrealistically large does the revenue loss come close to the wage gain. Therefore, investment incentives are substantially superior to tax cuts on both revenue and distributional grounds. Auerbach and Kotlikoff (1983b) make a similar point but claim that it rests on intergenerational differences in savings responses. Here we show that this result is independent of such considerations.

In this section, we have examined a disaggregated version of this model. We have seen that for reasonable values of the parameters, wage gains may exceed revenue losses when τ_K is cut and γ is small or when θ is increased. This is a relevant calculation when the lost revenues are balanced by either increased labor taxation or reduced provision of public goods which are substitutes for private consumption. This model indicates that there may be some validity to the "trickle-down" claims of current policy, especially if the investment tax credit is cut.

VI. Conclusions

In this paper we have analyzed the impacts of capital income tax cuts and increases in an investment tax credit on both revenue and the welfare of both investors and workers in a perfect foresight representative agent model of equilibrium growth. We have seen that when there is a moderate labor income tax rate, and moderately high capital income tax rate, a cut in the capital income tax rate would probably not increase the discounted value of government revenue. However, this is much more likely if instead the investment tax credit is increased. Both possibilities are plausible, however, when we assume tax, taste and technology parameters on the fringe of what is considered representative of the U.S. economy. These revenue calculations are sensitive to the parameterizations used, and we cannot make any robust claim concerning them.

On the other hand, our welfare analysis indicates that for moderately high rates of capital income taxation, a permanent and unanticipated cut in the capital income tax rate can be a Pareto improvement even when the revenues are distributed uniformly. We also found that permanent investment tax credits financed by capital income tax increases could yield substantial increases in welfare, at the margin, the net benefit being between 50¢ to $3.50 per dollar of new investment tax credits. The performance of such a substitution is substantially better if both were temporary increases. This argues for a much greater reliance on investment incentives on tax reform as opposed to tax cuts.

Table 1

		Decrease τ_K			Increase θ			
σ	β	$-dR$	dW	MDWL	$-dR$	dW	MDWL	λ
.4	.5	1.16	1.14	.16	-.67	1.35	.32	-.16
	1.0	1.14	1.04	.14	-.65	1.22	.30	-.11
	2.0	1.13	.90	.13	-.63	1.06	.27	-.07
	4.0	1.10	.74	.11	-.60	.87	.23	-.04
	6.0	1.09	.64	.09	-.58	.75	.21	-.03
	10.0	1.07	.50	.08	-.56	.59	.17	-.02
.7	.5	1.02	1.06	.29	-.50	1.25	.69	-.11
	1.0	1.02	.93	.26	-.50	1.10	.61	-.07
	2.0	1.02	.77	.21	-.50	.91	.51	-.05
	4.0	1.01	.60	.16	-.49	.70	.40	-.03
	6.0	1.01	.49	.14	-.49	.58	.33	-.02
	10.0	1.01	.37	.10	-.49	.43	.25	-.01
1.0	.5	.90	1.00	.44	-.36	1.17	1.30	-.09
	1.0	.91	.85	.37	-.38	1.00	1.06	-.06
	2.0	.93	.68	.29	-.40	.81	.81	-.04
	4.0	.95	.50	.21	-.42	.59	.56	-.02
	6.0	.96	.40	.17	-.43	.47	.44	-.02
	10.0	.97	.29	.12	-.45	.34	.31	-.01
1.3	.5	.79	.94	.62	-.23	1.11	2.47	-.08
	1.0	.83	.79	.50	-.27	.93	1.76	-.05
	2.0	.86	.61	.37	-.32	.73	1.18	-.03
	4.0	.90	.44	.25	-.37	.52	.73	-.02
	6.0	.92	.34	.19	-.39	.40	.54	-.01
	10.0	.95	.24	.13	-.42	.28	.35	-.01

$\theta_K = .25,\ \tau_K = .3,\ \theta = .05,\ \tau_L = 0,\ \delta k/f = .12,\ \rho = .04.$

Table 2

		Decrease τ_K			Increase θ			
σ	β	$-dR$	dW	MDWL	$-dR$	dW	MDWL	λ
.4	.5	1.38	1.64	.32	-.86	1.61	.50	-.18
	1.0	1.35	1.50	.30	-.82	1.47	.48	-.12
	2.0	1.31	1.31	.27	-.78	1.29	.44	-.08
	4.0	1.25	1.08	.23	-.73	1.06	.39	-.05
	6.0	1.22	.93	.20	-.69	.91	.35	-.03
	10.0	1.17	.74	.17	-.65	.72	.30	-.02
.7	.5	1.05	1.53	.68	-.53	1.50	.132	-.13
	1.0	1.05	1.35	.60	-.52	1.33	1.18	-.08
	2.0	1.04	1.13	.51	-.52	1.11	1.00	-.05
	4.0	1.03	.87	.40	-.51	.85	.78	-.03
	6.0	1.02	.72	.33	-.50	.70	.65	-.02
	10.0	1.02	.53	.24	-.50	.52	.49	-.01
1.0	.5	.76	1.45	1.27	-.24	1.42	3.87	-.10
	1.0	.79	1.24	1.05	-.28	1.22	2.94	-.07
	2.0	.83	1.00	.80	-.32	.98	2.06	-.04
	4.0	.88	.74	.56	-.36	.72	1.33	-.02
	6.0	.90	.59	.43	-.38	.57	1.00	-.02
	10.0	.93	.42	.30	-.41	.41	.66	-.01
1.3	.5	.50	1.37	2.40	.01	1.35	83.51	-.09
	1.0	.58	1.16	1.74	-.06	1.13	15.20	-.05
	2.0	.67	.90	1.16	-.16	.88	4.89	-.03
	4.0	.77	.64	.72	-.25	.62	2.16	-.02
	6.0	.82	.50	.53	-.30	.49	1.40	-.01
	10.0	.87	.35	.34	-.36	.34	-.83	-.01

$\theta_K = .25$, $\tau_K = .5$, $\theta = .05$, $\tau_L = 0$, $\delta k/f = .12$

Table 3

β \ σ	.3	.5	.8	1.0
.5	.34	.30	.27	.25
1.0	.42	.38	.35	.33
1.5	.48	.44	.41	.39
3.0	.57	.54	.52	.51
10.0	.75	.74	.73	.73

Table 4

		Reduce τ_K			Increase θ		
σ	β	$-dR$ (1)	dW (2)	MDWL (3)	$-dR$ (4)	dW (5)	MDWL (6)
.5	.5	1.31	1.58	.37	1.68	3.39	.65
	1.0	1.28	1.42	.34	1.61	3.05	.60
	2.0	1.25	1.20	.30	1.52	2.62	.54
.7	.5	1.12	1.51	.60	1.26	3.24	1.22
	1.0	1.11	1.33	.53	1.23	2.85	1.09
	2.0	1.10	1.11	.44	1.15	2.38	.92
1.0	.5	.86	1.42	1.10	.70	3.05	3.71
	1.0	.88	1.21	91	.74	2.61	2.76
	2.0	.89	.96	.69	.83	2.06	1.91
1.3	.5	.64	1.35	2.07	.17	2.86	36.8
	1.0	.68	1.14	1.49	.33	2.44	16.7
	2.0	.76	.87	1.00	.50	1.87	4.65

$\theta_K = .25$, $\tau_K = .5$, $\theta = .05$, $\delta k/f = .12$

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