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Table of Contents

1. *Introduction*

After a period of intensive study of optimal indirect taxation, there has been a renewed interest in recent years in the problem of optimal direct taxation, with particular emphasis on capital income taxation. A number of authors and tax committees have made proposals to replace the current form of taxation by various forms of cash-flow taxation, and there is an ongoing debate on the problem of double taxation of dividends.

While the discussion has clarified many of the advantages and disadvantages of the various taxes, it has not paid much attention to the question of how sensitive the results are to the assumption of tax-rate stability: nearly the whole theoretical literature on tax reform assumes unforeseen sudden changes in tax rates and a constancy of these rates thereafter.

A typical example is the report of the MEADE COMMITTEE (1978) on the reform of direct taxation, one of the most careful and voluminous studies on direct taxation ever done. In his introductory remarks to this report, Dick Taverne, the Director of the Institute of Fiscal Studies, expressed the expectation "that the Committee would adopt a practical approach: to aim at those reforms which would be able to command the widest possible support in the hope that political argument might in future be concerned with rates of tax rather than the structure". Although this statement is clearly based on the assumption of continuing tax rate adjustments, no attempt is made in the report to address the problems that would arise if people anticipated such adjustments.

Exceptions to the general disinterest are some remarks by NICKEL (1977, pp. 57-58) and a note by SANDMO (1979). These authors showed that the Brown tax on the real cash flow of an investment project is non-neutral when the tax rate is subject to change and that the equivalence between the Brown tax and a tax on pure profit that was previously proved by SANDMO (1974) for the case of a constant tax rate does not hold for a variable rate.

There are at least four reasons why the analysis of non-constant capital income tax rates begun by Nickel and Sandmo merits further attention. First, government forecasts of tax revenues often prove wrong, and a revision of tax rates turns out to be necessary to balance the budget. Second, to mitigate redistributive losses, tax reforms are often phased in over an extended adjustment period. Third, and perhaps most important, there is no presumption that a time-consistent policy will be compatible with a constant tax rate, even if the government may wish to announce a constant tax rate for efficiency reasons.[1] A fourth reason is that a policy of gradual tax reform may be necessary in order to avoid bankrupting high-debt firms. This reason will be considered in more detail in Section 8 of this paper.

The basic tasks of this paper are to extend the Nickel-Sandmo type of partial analytic result to other taxes and to identify the economy's reactions to anticipated tax rate changes. This second part of the analysis will be carried out in a perfect foresight general equilibrium model of economic growth that allows for a welfare evaluation of the taxes to be considered.

2. *Idealized Capital Income Taxes*

We study three idealized forms of capital income taxation which share the property of tax neutrality with regard to the firm's real, and to a considerable extent also with regard to its financial decisions, when applied with a constant rate: the Brown tax analyzed by Nickel and Sandmo, a uniform Schanz-Haig-Simons (SHS) tax on all kinds of capital income, and a dividend tax. A fourth type of capital income tax that was proposed by the Meade Committee and has found much

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[1] See KYDLAND and PRESCOTT (1975).

attention recently will be considered in Section 5, where it will be shown that this type is equivalent to the dividend tax.

The tax rates corresponding to the first three types are labelled τ_i where i = b, s, d. Each tax rate will be assumed throughout the analysis to be non-negative and strictly less than unity. For each tax, let θ_i denote the tax factor: $1-\tau_i$. We consider the effects of these taxes on a firm that produces a homogeneous output using capital and labor according to the linearly homogeneous neoclassical production function f(K,L), where the true economic depreciation rate is a constant $\delta>0$. Let P and w denote the output price and real wage, each in terms of the numeraire, capital.

The tax on the real cash flow of the firm, first analyzed by BROWN (1948), has only recently been considered as a practical alternative to existing systems. The MEADE COMMITTEE (1978) discussed it under the name R-base tax, and KAY and KING (1978) recommended it as an alternative to the present U.K. capital income tax system. Under the Brown tax a firm's liability is:

(1) $$T_b = \tau_b[Pf(K,L) - \delta K - \dot{K} - wL] .$$

This tax does not apply to interest income of shareholder-households.

The traditional SHS form[2] of capital income taxation can be modeled by a uniform tax on the interest income earned by households and on profits earned by firms where true economic depreciation and debt interest is deductible. When no other taxes are levied, the taxable profit of a firm is:

$$Pf(K,L) - \delta K - wL - rB$$

where $r > 0$ is the market rate of interest and $B \gtrless 0$ the firm's level of debt.

When the Brown tax is also levied, the effective net revenue of the firm is $\theta_b Pf(K,L)$, and the net wage cost is $\theta_b wL$. The value of the firm's stock of

[2]See GOODE (1977) for the details of the historical development of this form of tax.

capital is $\theta_b K$ since, if the firm decided to sell this capital stock, it would have to pay a tax equal to $\tau_b K$. True economic depreciation is accordingly[3] $(\delta-\hat{\theta}_b)\theta_b K$. Thus the base of the SHS tax on the firm is

$$\Pi \equiv \theta_b[Pf(K,L) + (\hat{\theta}_b-\delta)K - wL] - rB .$$

Define the firm's equity capital as $E \equiv \theta_b K-B$. Then Π can be rewritten as:

$$(2) \qquad \Pi = \theta_b[Pf(K,L) + (\hat{\theta}_b-\delta-r)K - wL] + rE$$

which is economic profit plus the normal return on equity.

The SHS tax is the theoretical basis of the income tax systems presently existing in the OECD countries, but of course less than perfect integration between company and household taxation on the one hand and a failure to implement true economic depreciation allowances on the other mark substantial deviations from this theoretical concept.

The political debate on abolishing the double taxation of corporate dividends in the United States has directed a number of authors' attention towards the dividend tax, but it seems that the role of this tax both for the firm's financial and real investment decisions has not yet been fully clarified. Dividends, D, equal the firm's pre-tax real cash flow minus debt interest, minus Brown and SHS tax liabilities, plus new issues of debt $\dot{B}$ and shares Q:

$$(3) \qquad D = Pf(K,L) - wL - \delta K - \dot{K} - rB - T_b - \tau_s\Pi + \dot{B} + Q$$

Rather than using (3) it is convenient to use the following equation for dividends, which holds true by the definition of retained earnings, R:

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[3] The "^" denotes a proportional rate of change with respect to time; "dots" denote time derivatives.

$$D = \theta_s \Pi - R \tag{4}$$

The dividend, net of all taxes, paid out to the firm's shareholders is $\theta_d D$.

Let M denote the market value of the shares of a firm facing these three taxes, when the after-tax rate of interest received by households is $r\theta_s$. Then $M = mz$, where z is the number of shares and m is the price per share. Assume that new shares are sold at their market price, $m\dot{z} = Q$, and that market equilibrium is characterized by:

$$\dot{m}z + \theta_d D = r\theta_s M$$

where $\dot{m}z$ is the capital gain on existing shares, $\theta_d D$ the net dividend, and $r\theta_s M$ the opportunity cost of holding shares in terms of foregone net interest income. Then it follows that

$$\dot{M} = \dot{m}z + m\dot{z} = r\theta_s M - \theta_d D + Q \tag{5}$$

Together with the assumption that M = 0 if all future dividends equal zero, (5) yields the unique solution:

$$M(t) = \int_t^{\infty} \left[D(u)\theta_d(u) - Q(u)\right]\left[\exp\int_t^u -\theta_s(v)r(v)dv\right]du \; . \tag{6}$$

3. *Optimal Employment of Capital with Varying Tax Rates*

In line with Fisher's separation theorem the firm tries to maximize the market value of its shares knowing the characteristics of a capital market equilibrium and expecting time paths (P), (r), and (w) for the three market prices.

This decision problem can be formulated as an optimal control problem with the single state variable E. Because the only ways of increasing equity are through retentions and new issues, the firm is constrained by the differential equation:[4]

(7) $$\dot{E} = R + Q \ .$$

It is also subject to the initial condition: $E(0) = E^o \equiv \theta_b^o K^o - B^o$ predetermined. Assume that the firm starts with positive equity:

(8) $$E^o > 0 \ .$$

The firm's control variables are K, L, Q, and R. The firm is constrained to keep all its controls non-negative. We will assume that this constraint is never binding on the real controls K and L. But it will often be binding on one or both of the financial controls Q and R. The non- negativity constraint on Q prohibits the firm from buying back its own shares.[5] The non-negativity constraint on R

[4]Equation (7) can be derived as follows:

$$\begin{aligned}
R+Q &= \theta_s \Pi - D + Q && \text{[by (4)]} \\
&= \theta_b [Pf(K,L) + (\hat{\theta}_b - \delta - r)K - wL] + rE - \tau_s \Pi + Q - D && \text{[by (2)]} \\
&= \theta_b [Pf(K,L) - \delta K - \dot{K} - wL] - rB - \tau_s \Pi + Q - D + \dot{\theta}_b K + \theta_b \dot{K} && \text{[by def'n of E]} \\
&= Pf(K,L) - \delta K - \dot{K} - wL - T_b - rB - \tau_s \Pi + Q - D + \dot{\theta}_b K + \theta_b \dot{K} && \text{[by (1)]} \\
&= -\dot{B} + \dot{\theta}_b K + \theta_b \dot{K} && \text{[by (3)]} \\
&= \dot{E} && \text{[by def'n of E] .}
\end{aligned}$$

[5]See AUERBACH (1979) for a discussion of the legal aspects of this constraint.

prevents the firm from paying dividends in excess of its earnings.[6] We also assume that dividends cannot be negative.[7]

The current-value Hamiltonian for this problem is:

$$\mathcal{H} = (\theta_d+\mu_d)\left\{\theta_s\theta_b[Pf(K,L)-wL-(r+\delta-\hat{\theta}_b)K]+r\theta_s E-R\right\}-Q+q(R+Q)+\mu_r R+\mu_q Q$$

where the μ's are Kuhn-Tucker multipliers and q is the costate variable associated with equity ('Tobin's q'). By the maximum principle we have:

$$\text{(9)} \qquad Pf_K(K,L) - (r+\delta-\hat{\theta}_b) = 0 \qquad (K),$$

$$\text{(10)} \qquad Pf_L(K,L) - w = 0 \qquad (L),$$

$$\text{(11)} \qquad -1 + q + \mu_q = 0 \qquad (Q),$$

$$\text{(12)} \qquad q - \theta_d - \mu_d + \mu_r = 0 \qquad (R),$$

$$\text{(13)} \qquad r\theta_s(q-\theta_d-\mu_d) = \dot{q} ,$$

$$\text{(14)} \qquad Q \geq 0, \ \mu_q \geq 0, \quad \mu_q Q = 0 ,$$

$$\text{(15)} \qquad R \geq 0, \ \mu_r \geq 0 \quad \mu_r R = 0 ,$$

$$\text{(16)} \qquad D \geq 0, \ \mu_d \geq 0, \quad \mu_d D = 0 ,$$

$$\text{(17)} \qquad \lim_{t\to\infty}\left[q(t)E(t)\exp\int_0^t -\theta_s(\tau)r(\tau)d\tau\right] = 0 .$$

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[6] Similar constraints are common to all countries to ensure that the company's share capital is maintained. For an overview of the restrictions on the declaration of dividends that are in use in the United States see HAMILTON (1980, § 16.3 and § 16.4). It would perhaps be more accurate to represent these constraints with the stock restriction $E(t) \geq E^o$ rather than the flow restriction $R(t) \geq 0$. However this modification would require us to allow jumps in the state variable E when it was profitable for the firm to pay a measurable fraction of its equity out in dividends. The modified analysis can be conducted using the techniques discussed by KAMIEN and SCHWARTZ (1981, pp. 215-32) but it is formally cumbersome. It results in no change in the conditions (9) and (10) below governing the firm's real decisions, and minor changes in the firm's financial decisions, which are described in footnote 11 below.

[7] This constraint excludes the possibility that the dividend tax can be perverted into a subsidy.

It follows from (9) and (10) that the only direct effect of taxation on the firm's employment of labor and capital arises because any anticipated change in the Brown-tax-rate will impose capital gains or losses that will affect the cost of capital.

This allows us to formulate

Proposition 1: *While a rising Brown tax rate drives a wedge between the market rate of interest and the net-of-depreciation marginal product of capital, the dividend tax and the Schanz-Haig-Simons tax do not, even when the tax rates are subject to change.*

This proposition confirms the Nickel-Sandmo result of non-neutrality of a variable Brown tax rate. It generalizes the famous Johansson-Samuelson Theorem of neutrality of a constant SHS tax rate to the case of a variable rate. It also generalizes the result obtained by KING (1974b), AUERBACH (1979), and BRADFORD (1981) of neutrality of a constant dividend tax rate to the case of a variable rate. The last result is particularly interesting because, in conjunction with the Nickel-Sandmo result, it shows that the Brown tax and dividend tax are no longer equivalent when their rates are allowed to vary over time. A corollary is that the frequently blamed double taxation of corporate dividends will not distort the firm's real decisions even when the degree of double taxation is subject to change.

4. *The Underlying Financial Decisions*

The key to understanding the neutrality results of Proposition 1 is twofold. First, debt is always available as a marginal source of finance. At any given point in time the firm can raise or lower K and B together, holding E constant, without violating any financial non-negativity constraint. It can hold Q fixed, and if D or R is zero then [by (20) below] the other must be positive, so any resulting change in earnings can be accommodated by a variation in the other. Thus the marginal cost of capital is the cost of debt financing, regardless of whether the firm retains or distributes its profits and regardless of the portions of real net investment ($\dot{K}$) that, in the optimum, turn out to be debt ($\dot{B}$) and equity ($\dot{E}$) financed.

The second key is to note that for purposes of the SHS tax the interest cost of a debt-financed marginal unit of capital is fully deductible from, and the capital gain fully taxable with, the return; *a fortiori* for purposes of the dividend tax, which applies to the unretained portion of profits after the SHS tax. This implies that the marginal unit of capital that is just worth being employed when there is only a Brown tax and that earns a rate of return including capital gains equal to the market rate of interest would not add to the firm's liability under the SHS or dividend tax. This unit stays the marginal unit and continues to satisfy the first-order condition (9) when these two taxes are introduced. Neither the rates of SHS and dividend taxation nor the time derivatives of these rates impinge on the investment decision, and the Brown tax matters only because it affects the rate of capital gain before the SHS or dividend tax.[8]

Although debt can always be taken as the marginal source of finance the same is not true of the other two sources of finance: share-issues and retentions. The rest of this section gives a complete analysis of the firm's financial decisions.

First, note that from (7), (8), and the non-negativity constraint on

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[8]The neutrality of profit taxes in the case of debt financing has been demonstrated by OBERHAUSER (1963, pp. 67 n.) and STIGLITZ (1973) in different contexts.

retentions and new share-issues, the solution to the firm's problem has equity positive at all times:

$$E(t) \geq E^{o} > 0 \text{ all } t \geq 0. \tag{18}$$

Next, in order for an interior solution to exist for capital and labor our assumption of constant returns implies that w and $(r+\delta-\hat{\theta}_b)$ must lie on the firm's factor-price frontier, and economic profits must always equal zero. Hence, from (2) and (18):

$$\Pi(t) = rE(t) > 0 \qquad \text{all } t \geq 0 \tag{19}$$

So from (4) and (19), either dividends or retentions must be positive:

$$D(t) > 0 \text{ or } R(t) > 0, \qquad \text{all } t \geq 0. \tag{20}$$

Next note that (20) together with the Kuhn-Tucker conditions (15) and (16) imply that one of the two multipliers μ_d, μ_r must be zero. It then follows that the Euler equation (13) can be rewritten as:[9]

$$\dot{q} = r\theta_s \min(q-\theta_d, 0) \tag{21}$$

and (12) implies:

$$\begin{cases} \mu_d > 0,\ \mu_r = 0 & \text{if } q-\theta_d > 0, \\ \mu_d = 0,\ \mu_r = 0 & \text{if } q-\theta_d = 0, \\ \mu_d = 0,\ \mu_r > 0 & \text{if } q-\theta_d < 0. \end{cases} \tag{22}$$

[9]To derive (21) note that if $\mu_d = 0$ then by (12), (13), and (15) $\dot{q} = r\theta_s(q-\theta_d) = -r\theta_s\mu_r \leq 0$, whereas if $\mu_r = 0$ then by (12), (13), and (16) $\dot{q} = 0 \leq r\theta_s(q-\theta_d)$.

The firm's financial decisions are thus governed by the value of equity. Condition (11) implies that $q \leq 1$ and that new shares will be issued only if $q = 1$. Thus (21) implies that if ever the value of equity falls below unity no new shares will be issued from then on. Condition (22) says that the firm will pay the maximum allowable dividend and retain no earnings, or vice-versa, depending upon whether the value of equity is greater or less than the dividend-tax factor.

Assume now that there is some date t^* beyond which all tax rates remain constant at τ_i^*; $i = d,r,s$, with corresponding tax factors θ_i^*. It is easily versified[10] that for $t \geq t^*$:

$$q = \theta_d^*,\ \mu_q = \tau_d^*,\ \mu_r = \mu_d = 0\ . \tag{23}$$

Thus in the steady state the value of equity is the value of distributing the equity as a dividend θ_d^*, as long as there is a positive dividend tax this value will be less than one and no new shares will be issued, and whatever the tax rates the firm will be indifferent between dividends and retentions.

The time path of q on the interval $[0,t^*]$ is given by the unique solution

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[10]These equations, together with $Q = 0$, $D = r\theta_S E$, $R = 0$, and K, L chosen to satisfy (9), (10) satisfy the conditions (9) ~ (17) and the differential equation (7). Thus they constitute a solution starting at t^*. To see that every other solution must satisfy (23) suppose first that $q < \theta_d^*$ for some $t \geq t^*$. Then (21) and (18) imply a violation of the transversality condition (17). Next suppose that $q > \theta_d^*$ for some $t \geq t^*$. Then (21) implies that $q = q^* = \text{const.} > \theta_d^*$ for all $t \geq t^*$. Together with (12) and (15) this implies $\mu_d > 0$ for all $t \geq t^*$. Thus, from (16), $D = 0$ for $t \geq t^*$. So, from (4), (7), and (19) $\dot{E} = R+Q \geq R = r\theta_s E$, which also implies a violation of (17).

to (21) with $q(t^*) = \theta_d^*$. This solution is illustrated in Figure 1.

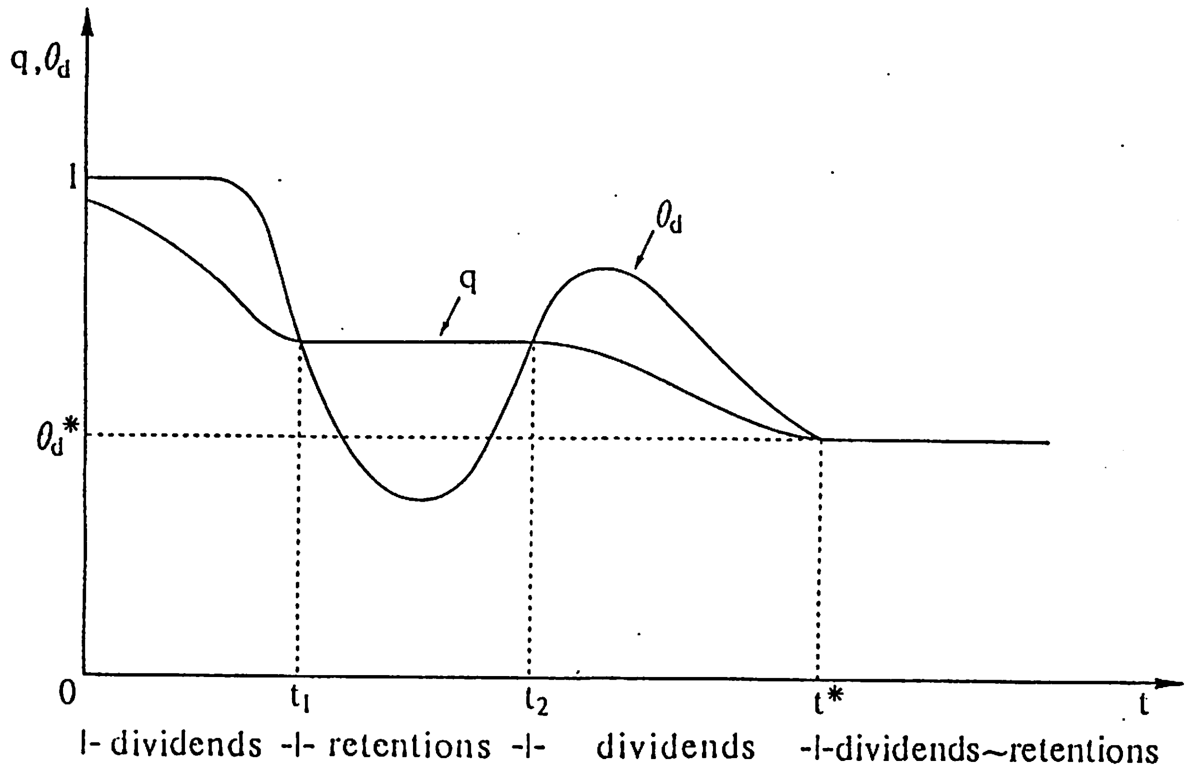

Figure 1

The Solution-Path to q when θ_d Varies

The economic interpretation of Figure 1 is straightforward. Once θ_d has permanently stopped varying, the shadow value of equity is θ_d. When θ_d is still varying, equity can be worth more than θ_d, if the dividend tax rate is eventually expected to fall below its current value. In these cases (between t_1 and t_2 in Figure 1), all equity should be retained [$\mu_d > 0$, by (22)] until the value of θ_d rises sufficiently to make dividends again worth paying. During this time q will remain unchanged, at the value of θ_d where dividend payments will recommence (t_2).

Likewise, q can be less than θ_d if the dividend tax rate is expected eventually to rise above its current value. In these cases (0 to t_1, t_2 to t^*) the firm will be paying dividends as fast as legally allowable [$\mu_r > 0$ by (22)] in order to beat the tax-increase. Meanwhile the value of equity will be falling, as the time left for beating tax-increase diminishes.

If $\theta_d^* < 1$ then it follows from (11) and (21) that $q < 1$ and $\mu_q > 0$ throughout. Thus, the threat of a dividend tax in the future suffices to deter the firm from issuing new shares in the present. On the other hand, if it was expected that the dividend tax would eventually be abolished ($\theta_d^* = 1$), then new issues would always be an attractive source of finance, because q would have to equal 1 (and hence $\mu_q = 0$) for all $t \geq 0$.

Consider now the case where θ_d is constant for all $t \geq 0$. Then, by (21), $q = \theta_d$ for all $t \geq 0$. In this case the firm will be indifferent between dividends and retentions or, equivalently, between retained earnings and debt as sources of finance. If the dividend tax rate is zero, the equivalence between these two sources of finance will even extend to new issues of shares. These financial neutrality results hold for arbitrary paths of the SHS and Brown tax rates; they have been derived by KING (1974a) and AUERBACH (1979) for the special case where τ_s and τ_b are constant.

As we have seen, the case in which all three tax rates follow arbitrary paths on $[0,t^*]$ will typically involve bang-bang points at which the firm switches between paying no dividends and retaining no earnings. The exact timing of these switches will depend upon the SHS tax rate, because the solution to (21) depends upon θ_s. But the Brown tax plays no role at all in the evolution of q and hence in the firm's financial decisions.

A simpler analysis is possible, with no switching, if we suppose that θ_d approaches θ_d^* monotonically on $[0,t^*]$. Under this assumption the SHS tax plays no role in the firm's financial decisions, which depend only upon the direction of change in the dividend tax rate. If there is a phasing-out of the dividend tax with $\dot{\theta}_d > 0$ on $[0,t^*)$, then q will equal θ_d^* for all $t \geq 0$. Thus $q > \theta_d$ and the firm pays no dividends before t^*. If there is a phasing-in, with $\dot{\theta}_d < 0$ on $[0,t^*)$, then, as in the interval $[t_2,t^*)$ in Figure 1, $q < \theta_d$ and the firm retains no earnings before t^*.

The results in this section[11] are summarized in

Proposition 2: *The Brown tax is neutral with regard to the firm's financial decisions even when all rates are subject to change. The SHS is also neutral with respect to the firm's financial decisions when the dividend tax rate is constant or monotonic. A dividend tax with a constant rate discriminates against new issues of shares but is neutral with regard to the firm's choice between dividends and retentions or, equivalently, between debt and retentions as sources of finance. A complete or partial phasing-in of the dividend tax favors debt over retentions and induces the firm to distribute its profits. A complete or partial phasing-out of the dividend tax favors retentions over debt and makes the firm abstain from paying dividends. In either case the firm will not issue new shares unless it believes the dividend tax will be completely abolished at some stage.*

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[11]If the analysis is modified to replace the flow-constraint $R \geq 0$ with the stock-constraint $E \geq E^o$ then the value of equity on $[0,t^*]$ will be $q'(t) = \max(\theta_d(\tilde{t}) \,|\, t \leq \tilde{t} \leq t^*)$ because the firm can always wait to pay out all its accumulated surplus capital at the most advantageous time. If $\theta_d(t)$ is monotonic on $[0,t^*]$ then the financial decisions are unchanged; a rising $\theta_d(t)$ will induce the firm in any case to pay no dividends until t^*, whereas a falling $\theta_d(t)$ will make the firm want to pay out a discrete dividend, but since it starts with no surplus capital it cannot - to keep $E(t)$ from falling below E^o it will have to set $R(t) = 0$ on $[0, t^*]$, as before. If $\theta_d(t)$ is not monotonic on $[0,t^*]$ there may be downward jumps in E at switch points, and the timing of these switch points will be somewhat different, but none of the results of Proposition 2 will be affected.

There are two noteworthy aspects about this result. First, it shows that, unlike many authors' contention, it is not the dividend tax *per se* that can make shareholders prefer to enjoy profits in the form of capital gains rather than dividends. Instead, it is the *decrease* in the dividend tax rate. Authors who contend that the double-taxation of dividends produces a lock-in effect must assume explicitly or implicitly that postponing dividend payments enables the shareholders to enjoy a more favorable taxation of corporate distributions in the future.[12]

The second aspect relates to the comparative performance of the Brown tax and the dividend tax. Although both taxes share the properties of investment neutrality and of neutrality with regard to the firm's debt-equity choice when tax rates are constant, they differ sharply when tax rates are subject to change: while the Brown tax distorts only the firm's real investment decision, the dividend tax distorts only the firm's financial decision.

From the viewpoint of Pareto efficiency this is a great advantage of the dividend tax. This tax allows the firm's financial decisions to act as a 'safety net' protecting the real economy from welfare-reducing distortions.

5. *Proposal of the Meade Committee*

One of the most radical proposals ever made by a tax reform committee is the proposal of the Meade Committee (1978) to abolish the presently existing capital income taxes, and to replace them with a so-called 'S-base tax' or 'flow-of-funds tax' to be levied on the firm sector. The Meade Committee favored

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[12] This confirms the analysis of FELDSTEIN and GREEN (1983) who assume that retained profits will eventually be distributed as share repurchases thus circumventing the dividend tax.

the S-base tax over the Brown tax (R-base tax) primarily because the latter would leave financial intermediaries untaxed. Although this is an important practical aspect, it is by no means the crucial aspect on which an allocative comparison should be based. A more important aspect is revealed by interpreting the above approach in the light of the Meade Committee's proposal. Although the S-base tax was not explicitly incorporated in this approach, its implications can be inferred from a comparison with the dividend tax. The S-base tax is very similar to this tax and deviates only insofar as new issues of shares are tax deductible from dividends.

It is not quite clear whether the committee wanted this deductibility to extend to the case where new issues exceed dividends, and hence where the government would be subsidizing the firm. Thus, we consider two alternative interpretations in that we distinguish between Q_1 as the tax deductible part of the cash inflow from new issues and Q_2 as the part that is not deductible.

To see the implications of this distinction for the objective of the firm, note that (5) becomes

$$\text{(24)} \qquad \dot{M} = r\theta_s M - (D-Q_1)\theta_d + Q_2,$$

and that, instead of (6), the market value of equity is

$$\text{(25)} \qquad M(t) = \int_t^{\infty}\left\{[D(u) - Q_1(u)]\theta_d(u) - Q_2(u)\right\}\left[\exp\int_t^u -\theta_s(\tau)r(\tau)d\tau\right] du \; .$$

Suppose first that there were a full 'loss offset' in the sense that $Q_2 = 0$, $Q_1 \geq 0$, and Q_1 were unconstrained above. Then this formulation would give rise to the same Hamiltonian as above with Q_1 replacing Q, except that instead of the term $-Q$ there would be a $-\theta_d Q_1$. Thus the necessary conditions would be the same as before but with (11) replaced by:

$$(11') \qquad -\theta_d + q + \mu_q = 0 \,.$$

But in general there will be no solution to this problem. The solution to q will still be governed by (21), but (11') requires $q \le \theta_d$ for all t, which is not generally satisfied by (21). In economic terms, whenever equity was worth more than θ_d because of the prospect of a reduced dividend tax rate the firm would want to issue an unlimited amount of shares, claiming deductibility at the current high rate of dividend tax, to yield future dividends taxable at a lower rate.

Assume therefore that the tax proposed by the Meade Committee is characterized by a limited loss-offset: $Q_1 \le D$; Q_1, $Q_2 \ge 0$. Then the Hamiltonian would be:

$$\mathcal{H}' = (\theta_d+\mu_d)\left\{\theta_s\theta_b[Pf(K,L)-wL-(r+\delta-\hat{\theta}_b)K]+r\theta_s E-R-Q_1\right\}$$
$$- Q_2 + q(R+Q_1+Q_2) + \mu_r R + \mu_1 Q_1 + \mu_2 Q_2 \,.$$

Inspection of $\mathcal{H}'$ reveals that Q_2 would play exactly the same role as Q does in $\mathcal{H}$, and that Q_1 would be a perfect substitute for retained earnings R. Because of this perfect substitutability the partial deductibility of new issues from dividends is quite meaningless. If the firm prefers to distribute its profits ($D = \theta_s \Pi$) it will not want to issue new shares but will deliberately set $Q_1 = 0$. If it prefers to retain its profits ($D = 0$) it cannot enjoy the deductibility and must set $Q_1 = 0$. Thus, an issuing of new shares will not be able to raise funds beyond the retainable level of profits, unless the firm is willing to increase Q_2 instead of Q_1 and forgo the advantage of tax deductibility.

This implies

Proposition 3: *If provided with a 'limited-loss' offset constraint the S-base tax proposed by the Meade Committee is economically equivalent to a dividend tax.*

Together with Proposition 1 this proposition clearly supports the decision of the Meade Committee to vote for the S-Base tax instead of the R-base tax, but it also shows that the committee was not, in fact, fully aware of the allocative implications an alternative decision might have had. The committee completely overlooked what may be the strongest advantage of the S-base over the R-base tax: investment neutrality despite a varying tax rate.

6. *The Decision Problem of the Household and the Conditions for an Intertemporal General Equilibrium*

We now attempt to close the model by constructing the market counterpart of the neoclassical one-sector model of optimal growth and allowing for a government sector.[13] The firm is assumed to be a representative firm, and there is a representative household who owns this firm, supplies loans and labor, and buys part of the firm's output for consumption. The government collects the tax revenue and redistributes it to the household sector in the form of lump-sum transfers. The government is allowed to hold debt, but Ricardian equivalence prevents this from affecting real economic behavior. All output is in the form of a single malleable capital-consumption good, so we set P = 1 for all t.

The household is concerned about his and his heirs' utility, whose present value is given by

$$\bar{U}(t) = \int_t^{\infty} e^{-\rho(\nu-t)} N(\nu)\, U[C(\nu)/N(\nu)]\, d\nu$$

where $\rho > 0$ is the rate of utility discount, N the population or family size and U

[13] For a similar procedure, see SINN (1981, 1985).

the period utility function that is assumed to be characterized by $U'(0) = \infty$, $U'(\infty) = 0$, $U'' < 0$, and a constant elasticity of marginal utility,

$$\eta \equiv -U''C/(U'N) = \text{const.} > 0 .$$

The household inelastically supplies the amount L of labor, in efficiency units, where $L = NG$ and the efficiency factor G grows at the exogenous rate g. It takes the time paths of N, r, w, and θ_s as given and chooses the path of C to maximize $\bar{U}(0)$ subject to the intertemporal budget constraint:

$$\int_0^\infty C(u)\left[\exp\int_0^u -\theta_s(v)r(v)dv\right] du = V(0)$$

where V(0) is the historically given (from the household's point of view) initial value of the household's net wealth, which consists of the sum of government debt, the firm's debt and shares, and the present value of government transfers and wage income discounted at the after-SHS-tax rate $r\theta_s$.

By standard arguments the solution to this problem must satisfy the equation

(26) $$\rho + \eta(\hat{C} - n) = r\,\theta_s$$

where n is the exogenous rate of growth of the population. Equation (26) shows the well-known result that the SHS tax drives a wedge between the market rate of interest and the consumers' rate of time preference [the LHS of (26)]. This wedge adds to the wedge that a rising Brown tax will drive between the market rate of interest and the marginal product of capital according to (9), and we will see that it produces similar intertemporal distortions. Note that the size of the wedge produced by the SHS tax depends only on the current *level* of the tax rate τ_s and, unlike the Brown tax, not on its *rate of change*.

In an intertemporal general equilibrium, the time paths of the market rate of interest {r} and the wage rate {w} are such that the plans of households and firms are compatible with one another under perfect foresight. To investigate the properties of equilibrium it is useful to redefine the aggregates relative to L. Thus $c \equiv C/L$, $k \equiv K/L$, $\varphi(k) \equiv f(k,1)$. Note that $\varphi'(k) = f_K(K,L)$ and $\hat{L} = n + g$. We can then reduce the definition of equilibrium to a pair of first-order differential equations. The first is the condition for market-clearing in the market for output:

(27) $$\dot{k} = \varphi(k) - (\delta+n+g)k - c\ .$$

This is the familiar equation of motion for the capital intensity in a growing economy with labor-augmenting technological progress.

The second equation combines (9) and (26) from the firm's and the household's decision problems:

(28) $$\dot{c} = \frac{c}{\eta}\left[\theta_s[\hat{\theta}_b + \varphi'(k) - \delta] - (\rho + \eta g)\right]\ .$$

Unlike (27), this differential equation is non-autonomous for $t \le t^*$, when the tax factors are approaching their long-run target levels.

The market equilibrium path implied by (27) and (28) can be studied by use of Figure 2 which shows the familiar (c,k) diagram known from the central planning literature. As usual, there is the ($\dot{k}$=0) line whose maximum indicates the Golden-Rule point where the marginal product of capital, $\varphi'-\delta$, equals the natural rate of growth, n + g. In addition, there is a ($\dot{c}$=0) line valid for $t \ge t^*$. Because of (28) and since $\theta_s = \theta_s^* =$ const. and $\hat{\theta}_b = 0$ for $t \ge t^*$, this line is vertical and satisfies the condition

(29) $$\varphi'(k^\infty) - \delta = \frac{\rho + \eta g}{\theta_s^*}\ ,$$

where k^∞ is the steady-state capital intensity. The intersection point between this line and the $(\dot{k}=0)$ line is the steady-state point. Accordingly, the steady state level c^∞ of the standardized consumption is:

$$c^\infty = \varphi(k^\infty) - (\delta + n + g)k^\infty .$$

The arrows in regions I through IV and those on the $(\dot{k}=0)$ and $(\dot{c}=0)$ lines indicate the movements compatible with the two differential equations when the tax rates are constant; that is, after t^*. The heavy line that connects the steady-state point with regions I and III indicates the *stable branch* among the possible paths. As in the central planning literature the equilibrium is unique given any initial k, and it coincides with the stable branch for $t \geq t^*$.[14]

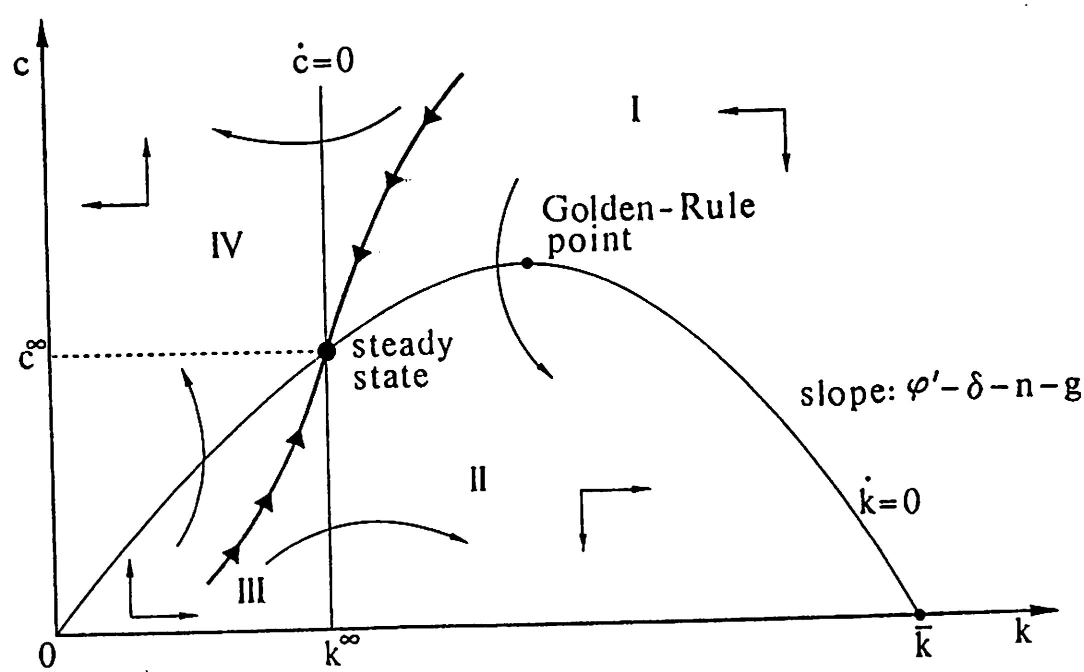

Figure 2

The Intertemporal General Equilibrium with Taxation (for $t \geq t^*$)

[14]Paths above the stable branch become infeasible in finite time, paths below it approach the point $(c=0, k=\bar{k})$ as time goes to infinity and violate condition (30).

To ensure that solutions to the planning problems of the agents exist on this branch it is necessary that

(30) $$\lim_{t\to\infty} \hat{X}(t) < \lim_{t\to\infty} [r(t)\theta_s(t)] \quad \text{for } X = C, K,$$

or, equivalently, that

(31) $$n + g < \rho + \eta g$$

where $\rho + \eta g$ is the steady-state rate of time preference. Condition (31) is a well-known existence condition for central planning models with the same technology and preferences as those assumed in this paper.[15] Remarkably, this condition is also required in the tax-distorted market economy considered here. It follows from (29) and (31) that $\Psi'(k^{\infty}) - \delta > (n+g)/\theta_s$. Thus, with or without taxation, only steady-state points to the left of the Golden-Rule point are compatible with a market equilibrium.

Before t^*, the non-autonomous part of (27) as represented by $\theta_s(t)$ and $\hat{\theta}_b(t)$ will affect the market equilibrium path, and in general this path will not coincide with the stable branch. The next section analyzes some of the more interesting possibilities.

7. *Tax Reforms and Economic Growth*

Unlike static taxation models, intertemporal taxation models often do not satisfy the two main theorems of welfare economics: even in the absence of a government activity the models generate a growth path that cannot in any meaningful

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[15] See ARROW/KURZ (1970, Ch. III).

way be considered as socially optimal. This is not so for the present model. If we maximize the representative household's utility function subject to the 'law of motion' (27) then we clearly get the equilibrium growth path for $\theta_r = \theta_s = \theta_b = 1$. The solution is well known from the work of ARROW and KURZ (1970).

The advantage of the coincidence between the social optimum and the laissez-faire solution is that the latter can serve as a benchmark for evaluating the tax distortions. Figure 3 depicts the laissez-faire path. It intersects the ($\dot{k}$=0) line at a point where (29) reduces to the Modified Golden Rule: $\varphi'(k_g^\infty)-\delta = \rho+\eta g$.

The steady state of an economy that has a SHS tax (and, possibly, other taxes) is on the ($\dot{k}$=0) curve to the left of the Modified-Golden-Rule point [because $\theta_s < 1$ in (28)]. For the following analysis we assume that the economy is initially in such a steady state. An optimal tax reform would be one that drops consumption suddenly and makes the economy move along the laissez-faire path.

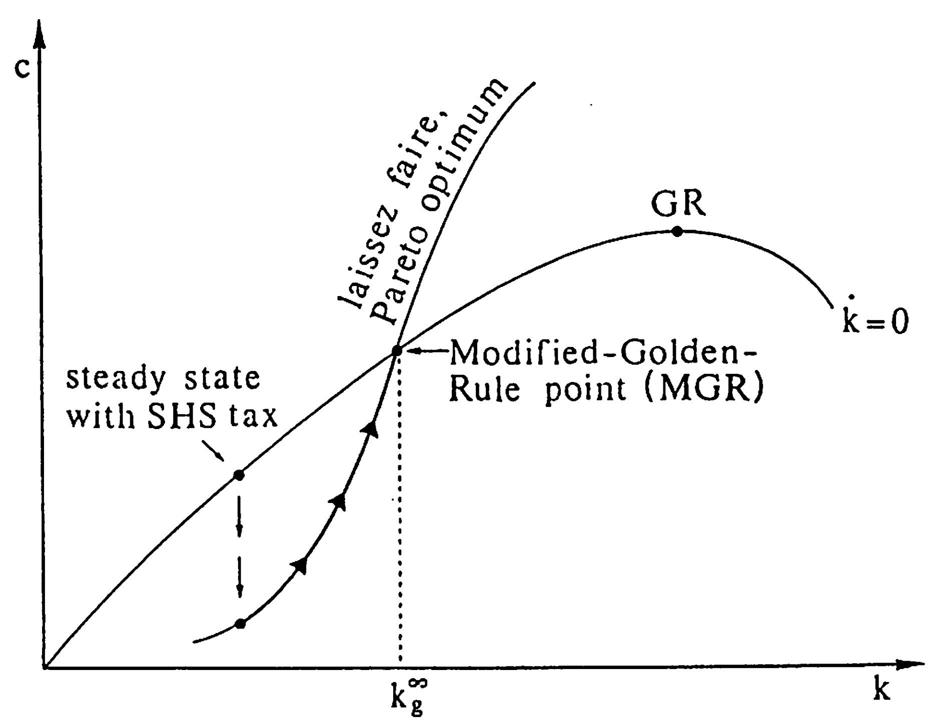

Figure 3

The 'Optimal' Tax Reform

In order to evaluate less than optimal reforms we make use of the following proposition, which is proved in the appendix. Specifically, suppose that $\{c(t),k(t)\}$ is the equilibrium path with respect to a given path of tax parameters such that $\hat{\theta}_b \leq 0$ and $k(t) \leq k_g^{\infty}$ (the Modified-Golden-Rule stock) for all $t \geq 0$. Then any other solution $\{c'(t),k'(t)\}$ to (27) that starts with the same capital and never has more:

$$k'(t) \leq k(t) \text{ for all } t \geq 0 \text{ with equality for } t = 0$$

yields strictly lower lifetime utility to the household. Because the proof involves a revealed preference argument involving a surrogate decision problem characterizing the equilibrium path we shall refer to this proposition as our revealed-preference proposition.

7.1. *The Dividend Tax and the Schanz-Haig-Simons Tax*

Phasing out the dividend tax and increasing the Schanz-Haig-Simons tax rate approximates what generations of economic advisors have had in mind when arguing for an integration of corporate and personal income taxation that would reduce the degree of double taxation of dividends. West Germany, for example, one of numerous countries that has followed this advice, has completely removed the corporate tax burden on dividends paid to domestic residents and raised the corporate and (maximum) personal tax rates in exchange. The United States may be among the next candidates for a similar reform.

It is clear from (28) that the removal of the dividend tax in itself produces no substitution effects that affect economic growth. Instead, all model reactions are driven through the change in the SHS tax factor. Assume that $\hat{\theta}_s < 0$ for $t < t^*$. Because of the decrease of θ_s to θ_s^*, the $(\dot{c}=0)$ locus defined by (29) will move to the left of the initial steady state in the (c,k) plane, and accordingly, when $t \geq t^*$, the equilibrium point must move along the stable branch leading through the intersection point between this locus and the $(\dot{k}=0)$ locus. If θ_s were lowered in a one-step reform, the equilibrium point would immediately jump upward to the stable branch and would then follow it, gradually drifting south-west towards the new steady state. However, since θ_s is falling gradually, there is a less rapid decline in c in the period before t^*. As shown by the leftward motion in Figure 4, the equilibrium point will move along a flatter path below the stable branch which, because of the continuity in $\theta_s(t)$, is tangent to the stable branch at $t = t^*$. Paths that start at or above the stable branch and paths that start at or below the $(\dot{k}=0)$ line will never lead to the stable branch and can thus be excluded.

Note that this reaction is the opposite to that of an optimal tax reform. Instead of steering the economy closer to the socially optimal growth path, it makes it drift even further away, exacerbating the distortion of capital-income taxes. This is in striking contrast to the efficiency gains claimed by proponents of integrating corporate and personal taxes.

Not only does this reform steer k away from its optimal growth path, it also reduces welfare. By our revealed preference proposition the post-reform equilibrium path will be inferior to the pre-reform steady state, because it involves less capital at each date, because the initial steady state is at or below k_g^{∞}, and because $\theta_b = 0$ in the initial steady-state equilibrium.

The following proposition summarizes the economy's reactions.

Proposition 4: *In comparison to the growth path that would have prevailed without a reform, a substitution of the Schanz-Haig-Simons tax for the dividend tax causes an initial rise in consumption at the expense of a long-run decline in the levels of both consumption and capital; it also reduces social welfare. The qualitative aspects of this result are independent of whether the reform is sudden or gradual, but when it is gradual, the initial rise in consumption is less extreme and so the capital intensity does not decline as quickly.*

Instead of the reform described, a more useful reform would be to phase out the SHS tax, substituting in its place an increased dividend tax; that is, to carry out the reform recommended by the MEADE COMMITTEE (1978). Deriving the implications of such a reform is analogous to the previous argument, and we leave it to the reader to verify the result depicted in Figure 4 for the case of a gradual reform. Clearly this reform approximates the optimal reform shown in Figure 2. The reform increases social welfare, whether it is carried out gradually or implemented immediately. This is because along the post-reform equilibrium path, where $\hat{\theta}_b = 0$, k is less than or equal to k_g^∞, and k is always greater than or equal to the initial steady state value k_1^∞. Therefore, the pre-reform steady state yields less social welfare than the post-reform equilibrium.

Figure 4 reveals that the less gradual the reform the more closely will it approximate the optimal tax reform. Immediate implementation would make it exactly optimal. This result stands a traditional public finance doctrine on its head: quick and courageous revolutions rather than slow and timid evolutions minimize the dynamic welfare loss of tax reform.

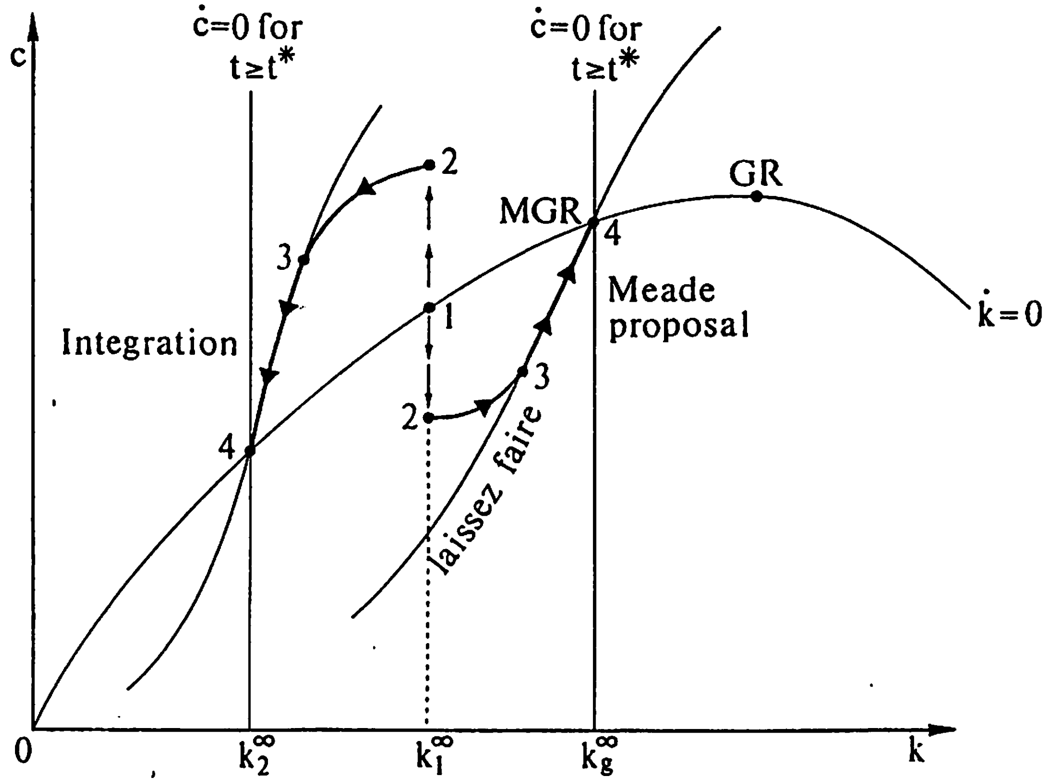

Figure 4

A Revenue-Neutral Integration of Corporate and Personal Income Taxation vs. Proposal of Meade Committee

7.2. *The Dividend Tax and the Brown Tax*

Suppose that double-taxation of dividends were eliminated by substituting the Brown tax rather than by increasing the SHS tax. If this were done immediately, with a surprise reform and a credible commitment not to alter rates in the future, then the equivalence of the Brown tax and the dividend tax for the case of constant rates would imply no change in the growth path. If the economy was initially at the steady state k^{∞} in Figure 5 it would remain there because equation (28) would remain unchanged.

If, however, the replacement of the dividend tax with the Brown tax were phased in gradually, then over the period before t^*, the term $\hat{\theta}_b$ in (28) would be negative, and growth would be affected. Figure 5 shows what would happen in the case where $\hat{\theta}_b$ was constant over the interval $[0, t^*)$. The $(\dot{c}=0)$ locus would temporarily shift leftward to $\tilde{k}$ defined by:

$$\varphi'(\tilde{k}) - \delta = \frac{\rho+\eta g}{\theta_s} - \hat{\theta}_b > \frac{\rho+\eta g}{\theta_s} = \varphi'(k^\infty) - \delta$$

but at t^* this locus would shift back to its initial position.

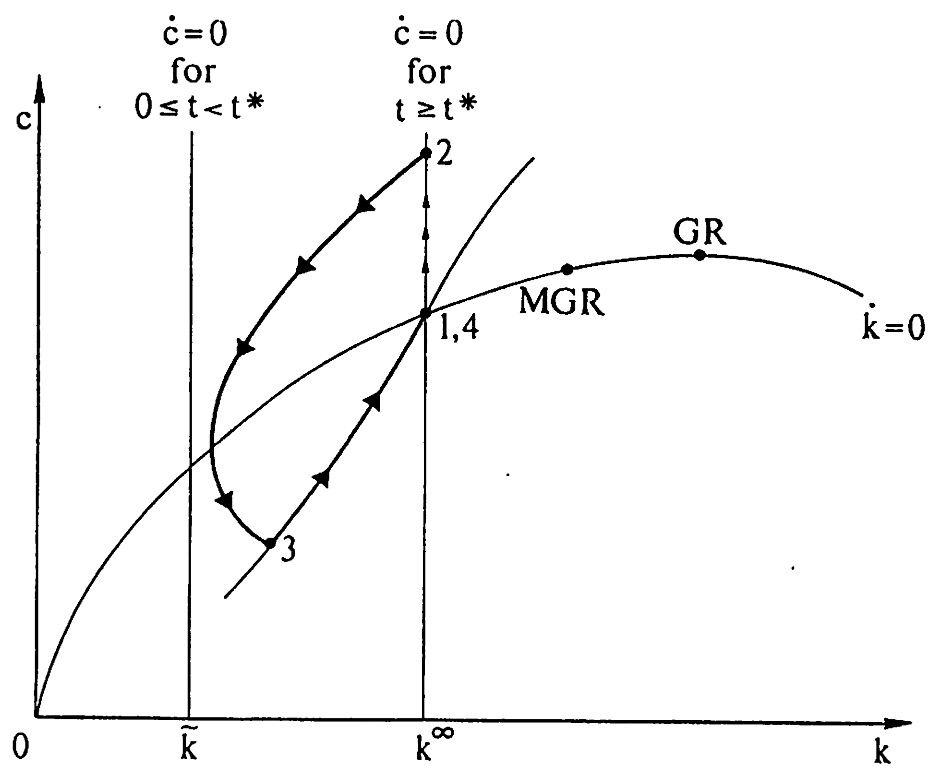

Figure 5

Replacing the Dividend Tax with the Brown Tax

Consumption would jump up immediately after the reform is announced, and the equilibrium point would drift away, first to the south-west then, after crossing the $(\dot{k}=0)$ locus, to the south-east until meeting the stable branch at t^*.

Note that c could not initially stay the same or fall because the equilibrium point would then begin immediately drifting south-east and could then never meet the stable branch. Our revealed preference proposition immediately implies that the post-reform welfare is lower than in the initial steady state.

Proposition 5: *A revenue-neutral gradual replacement of the dividend tax (S-base tax, double taxation) with the Brown tax (R-base tax) causes a cyclical movement of consumption, beginning with an upswing, around the path it otherwise would have followed. Capital accumulation undergoes a period of deceleration followed by a period of acceleration, with a recouping of the initial growth path in the long run. The reform reduces welfare.*

The economic reason for the perverse effects of this reform is the asymmetry noted above between the Brown tax and the dividend tax when rates are changing. The former affects only real and the latter only financial decisions. The prospect of a rising Brown tax imposes capital losses on the firm and discourages investment. Again we see that a quick and courageous reform rather than a gradual one would minimize the damage; in the extreme case a sudden once-over switch to the Brown tax with no phase-in period would give firms no time in which to avoid capital losses by reducing investment.

7.3. *The Schanz-Haig-Simons Tax and the Brown Tax*

Consider now a substitution of a Brown tax for a SHS tax, the reform which - albeit as a one-step move - KAY and KING (1978) recommended for Britain. This substitution will gradually remove the wedge which the SHS tax drives between the market rate of interest and the consumer rate of time preference. But, with a gradually rising Brown tax rate, it will also create a new wedge between the market rate of interest and the marginal product of capital. The combined effect of these two wedges makes it difficult to give a general assessment of the kind of reactions the substitution will provoke.

Equation (29) reveals that eventually the ($\dot{c}=0$) line and the stable branch will lead through the Modified-Golden-Rule point (when $t \geq t^*$ and $\theta_s = \theta_s^* = 1$, $\hat{\theta}_b = 0$). Thus, the economy must eventually converge to the optimal growth path. But there is a rich menu of possible adjustment paths that connect the initial steady state with the stable branch. We confine attention to the two cases where the 'sum' of the two wedges is constant at or above the wedge that existed before the reform was initiated or, in other words, where during the transition phase $[0,t^*)$ the ($\dot{c}=0$) locus is constant, either (a) at its pre-reform position, or (b) to the left of it. From (28) it follows that during the transition phase:

$$\frac{\rho + \eta g}{\theta_s(t)} - \hat{\theta}_b(t) = \frac{\rho + \eta g}{\theta_s^0} + \sigma \tag{32}$$

where σ is a constant, equal to zero in case (a) and positive in case (b). Integration of (32) reveals that for all $t \in [0,t^*]$:

$$\theta_b(t) = \theta_b(0)\ \exp\int_0^t \left[(\rho+\eta g)\left(\frac{1}{\theta_s(u)} - \frac{1}{\theta_s^0}\right) - \sigma\right]du\ . \tag{33}$$

Note that for any given value of $\sigma \geq 0$, (33) is well-defined and remains between zero and one no matter how large t^* is, and that, while θ_s is increasing, θ_b is decreasing on $[0,t^*)$.

Consider first case (a). (This case is similar to a pre-announced abolition of the SHS tax at $t = t^*$.) As indicated in Figure 6 by the solution 1 ~ 4, the adjustment path is characterized by a downward jump in c and a subsequent south-east motion towards the stable branch. An initial upward jump in c can be excluded since the equilibrium point would then gradually drift to the north-east and would never meet the stable branch.

While the adjustment path in case (a) more or less resembles the one that was derived above for the substitution of the SHS tax with the dividend tax, it may look completely different in case (b). Here it is still possible that there is an initial downward jump in c. However, with a sufficiently large value of t^*, there will be an initial upward jump in consumption followed by a gradual movement along a path that passes near the transitional steady state (c_2^∞, k_2^∞) and eventually joins with the ultimate stable branch below the $(\dot{k}=0)$ locus.[16]

Consider the specific example in which $\theta_s(t) = 1+(1-t/t^*)(\theta_s^o-1)$ during the transition. Then, as $t^* \to \infty$, the differential equation (28) on any finite interval will approximate the equation:

$$\dot{c}/c = (1/\eta)\left\{\theta_s^o[\varphi'(k)-\sigma] - [\rho+\theta_s^o\sigma+\eta g]\right\}$$

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[16]More specifically, it is clear from Figure 6 that if c did not increase initially then k would stay forever above k_1^∞. But then for all $t \in [0,t^*]$:

$$\begin{aligned}
(\dot{c}/c) &= (1/\eta)\left\{\theta_s[\hat{\theta}_b+\varphi'(k)-\delta] - (\rho+\eta g)\right\} \\
&= (\theta_s/\eta)\left\{\varphi'(k) - \delta - \frac{\rho + \eta g}{\theta_s^o} - \sigma\right\} && \text{[by (32)]} \\
&\le (\theta_s/\eta)\left\{\varphi'(k_1^\infty) - \delta - \frac{\rho + \eta g}{\theta_s^o} - \sigma\right\} && \text{(because } \varphi'' < 0) \\
&= -\theta_s\sigma/\eta \\
&\le -\theta_s^o\sigma/\eta && \text{(because } \theta_s \text{ is increasing on } [0,t^*])
\end{aligned}$$

Therefore $\ln c(t^*)-\ln c(0) \le -t^*\theta_s^o\sigma/\eta$. Furthermore Figure 5 makes it clear that $c(0)$ would have to be no greater than c_1^∞ and $c(t^*)$ no less than $\underline{c}$. Therefore $t^* \le (\ln c_1^\infty-\ln\underline{c})\eta/\sigma\theta_s^o$. For any larger t^*, c would therefore have to increase initially.

that would apply if the only tax were a constant SHS tax and if the rate of utility discount were $\rho+\theta_s^0\sigma$ instead of ρ. Thus, over any finite interval the equilibrium path will converge upon the stable branch defined by this artificial problem, which converges on the transitional steady state.

Our revealed preference proposition shows that the pre-reform steady state yields higher social welfare than this limiting path, which has $k \le k_1^\infty$. But as $t^* \to \infty$ the social welfare on the post-reform equilibrium path will converge on that of the limiting path. Therefore the substitution of the Brown tax for the SHS tax can actually reduce welfare if it is implemented too slowly. This results in an even more dramatic reversal of the usual 'gradualist' presumption of public finance than in the earlier examples. Too slow a reform will discourage investment for so long that the reform is welfare-reducing, whereas immediate implementation would yield the optimal tax reform.

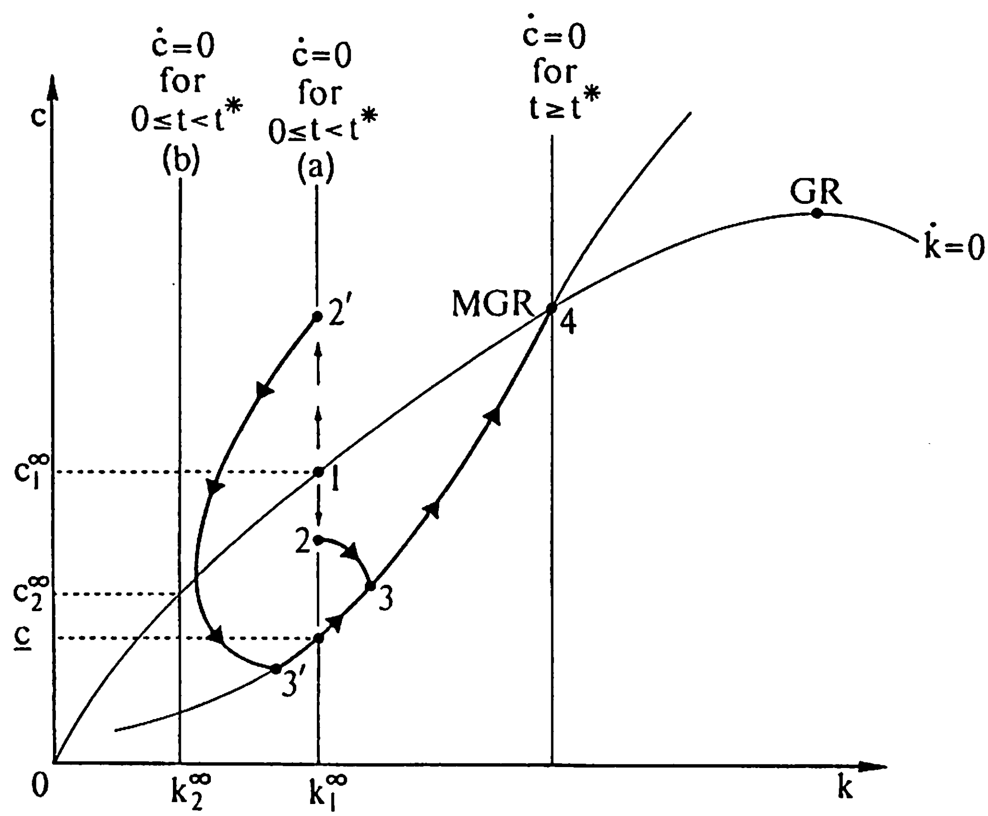

Figure 6

Substituting the Brown Tax for the SHS Tax: The Proposal of Kay and King

Thus, the following result emerges:

Proposition 6: *A gradual substitution of the SHS tax with the Brown tax will in the long run, when the tax rates have reached their target levels, induce an acceleration of economic growth and a movement towards the Modified-Golden-Rule point. However, since during the reform period the overall wedge between the marginal product of capital and the consumer rate of time preference may well be above its pre-reform level, an initial period of decline in the levels of consumption and capital per efficiency unit of labor cannot be excluded. The reform may lower social welfare.*

8. *The Market Value of Equity and the Bankruptcy Problem*

So far we have shown that the distortions produced by gradual tax reforms may differ between taxes. In this section we attempt to show that the need for gradual reforms may also differ between taxes.

The argument is based on the determinants of the firm's market value of equity. Since the firm is a price taker and operates under constant returns to scale, the market value of its shares is a linearly homogeneous function of the state variable E. Because of Euler's theorem and the general definition of the current-value costate variable:

$$(34) \qquad M(t) = q(t)\,E(t) = q(t)[\theta_b(t)\,K(t) - B(t)] \qquad \text{for all } t.$$ [17]

Equation (34) reveals that the SHS tax, the Brown tax, and the dividend tax affect the market value of equity in very different ways.

Because it reduces both the rate of return on equity and the rate of

[17] For the constant-tax-rate counterpart of this formula, see SINN (1985, Ch. VI).

return on all other assets the SHS tax does not affect the market value when the dividend tax rate is constant; under these circumstances, as we have seen, $q = \theta_d$. Hence

$$(35) \qquad M(t) = \theta_d[\theta_b(t)\,K(t) - B(t)] \qquad \text{for all } t \text{ and for } \theta_d = \text{const.}$$

This result is similar, but not identical, to the Johansson-Samuelson theorem. The latter says that $\partial M/\partial \tau_s = 0$ when the time paths of the firm's control variables and of the market prices are given and when τ_s is time-invariant. Our result instead is an implication of market equilibrium; it holds for nearly arbitrary future time paths of τ_s and despite the change in factor prices that the SHS tax can be expected to induce.

In the present context, the most important aspect of equation (34) is the difference between the Brown tax and the dividend tax. Obviously, the Brown tax resembles a tax on the existing *capital stock* whose rate equals that of the *initial* Brown tax rate $\tau_b(0)$. The dividend tax, on the other hand, resembles a tax that is levied on the stock of *equity capital*, and the rate of this tax is not just the initial dividend tax rate. Instead, it follows from our analysis in section 4 that the effective rate of this equivalent 'equity tax' is *below* the initial dividend tax rate $\tau_d(0)$ if τ_d is falling over time and *above* it if τ_d is rising.

Consider an economy where a SHS tax is in operation and where there are different firms with different debt-equity ratios. If, in this economy, the SHS tax is supplemented or replaced by a dividend tax, all firms will immediately experience the same percentage decline in the market values of their equities. Given that the initial market values were strictly positive and the dividend tax rate is below unity, no firm will go bankrupt as a result of the increased tax burden.

Suppose, however, the Brown tax is to be introduced instead of the dividend tax. In this case, the immediate imposition of a tax rate below unity is not sufficient to preserve the sign of the market value of equity. Instead, it follows from (34) that

$$M(0) \begin{Bmatrix} > \\ = \\ < \end{Bmatrix} 0 \Leftrightarrow \tau_b(0) \begin{Bmatrix} < \\ = \\ > \end{Bmatrix} \frac{K(0) - B(0)}{K(0)} . \tag{36}$$

This expression shows that the market value of the firm will become negative if the initial value of the Brown tax rate exceeds the historically given share of equity capital in the total capital stock. Unless we allow for firm-specific tax rates, this implies a severe limitation to the scope of possible tax reforms: in order to avoid causing firms to go bankrupt through the reform, the initial value of the Brown tax rate must be below the lowest equity/capital ratio among all the firms in the economy!

This suggests the necessity of a gradual phasing-in of the Brown tax even when there are no expectational mistakes on the part of the government and when binding policy commitments are possible.[18] Provided it is perfectly foreseen, such a gradual phasing-in will ensure that the market value of equity always stays strictly positive if, as we assumed in (8), the initial value of equity is positive. This is because, as was shown in (18), equity never falls below its initial value, whereas q(t) > 0.

Again, we summarize our results in a proposition.

Proposition 7: *While the SHS tax does not affect the market value of the firm, the*

[18]Bankruptcy problems could be avoided entirely by applying the tax immediately to all new capital but exempting the return to existing capital. However, under the assumptions of this paper, the tax would then yield no revenue. This is because the Brown tax is equivalent to a capital levy and a tax on pure profits; exempting existing assets would eliminate the capital levy, and there are no pure profits to be taxed.

imposition of a dividend tax or a Brown tax implies an immediate capital loss on the part of shareholders. However, while the dividend tax reduces the market value of equity in proportion to its own pre-tax value, the Brown tax reduces the value of equity in proportion to the firm's total capital stock and will cause bankruptcy if the initial tax rate is at or above the pre-tax share of equity in the firm's total capital stock. The problem can be avoided with an initial tax rate below the equity share and a subsequent gradual and correctly foreseen increase in this rate: even if the target level of the tax rate is above the initial equity share, adjustments in the market rate of interest will ensure that the market value of equity stays strictly positive and that the bankruptcy problem is avoided.

The last part of this proposition may seem puzzling to the reader. Why should it make a substantial difference to the equity value whether the firm is suddenly hit with an unexpected and discontinuous increase in the Brown-tax rate or whether there is a continuous and foreseen increase that takes place in a very short period of time? The answer has to do with the endogeneity of the market rate of interest. If θ_b is reduced quickly but in a pre-announced fashion the rate of interest will become very small during the transition period, because $r-\hat{\theta}_b$ is determined by k. As $t^* \to 0$ the minimal rate of interest during the transition goes to negative infinity. This fall in the rate of interest is what keeps the firm solvent despite the large capital loss resulting from the fall in θ_b. If the tax had come unexpectedly the rate of interest would not have time to fall.

This points out the importance for our analysis of having no long-term debt, whose capital value would be increased by this fall in the rate of interest, thus possibly pushing the firm into bankruptcy even if the change were pre-announced. It seems that an explicit analysis of the case of long-term debt would strengthen the case for the dividend tax even further.

9. *Conclusion: An Attempt to Evaluate the Taxes*

The present paper can be interpreted as a theoretical amendment to the report of the Meade Committee (1978), focussing on basically the same taxes as the committee did. It lends support to the committee's recommendation to replace the present capital income tax system by a dividend tax rather than by a Brown tax. However, it does so for reasons that have little in common with those put forward by the committee.

Our basic point is implicit in the first two rows of the following table that summarizes some of the implications of our investigation by giving a 'consumer report' on tax systems. While both the Brown tax and the dividend tax dominate the Schanz-Haig-Simons tax with regard to growth distortions when the tax rates are constant, only the dividend tax maintains its 'growth neutrality' with variable tax rates. This result seems particularly important in the light of the bankruptcy problem of the Brown tax: with a large dispersion in firms' debt-equity ratios it seems that a Brown tax would have to be phased in gradually, and hence that the resulting distortions would have to be suffered.

The analysis of this paper concentrated on distortions in the path of capital accumulation. Note, however, that the two basic marginal conditions (9) and (26) that were derived from the decision problems of the firm and the household have a number of further obvious efficiency implications for the international and intersectoral structure of capital and of debt contracts.

If there is a unique market rate of interest for all firms, a condition that in an international context requires the residence principle to be in operation, then the available capital stock will be allocated to the firms competing for it in such a way that an equation like (9) is satisfied for all firms. Clearly, therefore, firms whose owners are experiencing the phasing-in of a

Brown tax will be reluctant to express a high capital demand, and there will be an equilibrium where their marginal product of capital is beyond that of other firms. From the point of view of structural efficiency, too low a share of the existing capital stock will be employed by them, and Harberger-type welfare losses are unavoidable. On the other hand, all three taxes share the advantage that non-uniform tax rates are harmless when the rates do not change with time, and the SHS tax and the dividend tax are even neutral when they do: neither distortions in the capital structure nor the resulting welfare losses must be feared. The third row of the table represents these results.

A Tax Evaluation

	SHS Tax		Brown Tax (R-base tax)		Dividend Tax (S-base tax)	
	Constant tax rate	Variable tax rate	Constant tax rate	Variable tax rate	Constant tax rate	Variable tax rate
Growth	-	-	+	-	+	+
Bankruptcy	+	+	-	+	+	+
Capital Structure	+	+	+	-	+	+
Credit Contracts	-	-	+	+	+	+
Finance: Retentions~ Debt	+	+	+	+	+	-
Finance: New Issues~ Debt	+	+	+	+	-	-

For the sake of completeness the next row of the table reports an evaluation with regard to potential distortions in the credit contracts between households; that is, distortions that result from 'wedges' between different households' rates of time preference. It follows from (26), and is well known, that different SHS tax rates applied to different households will create such wedges.

Moreover, given that the Brown tax and the dividend tax exclude the taxation of interest income on the part of households, it is quite trivial that these taxes are neutral in this regard.

Obviously, these additional considerations contribute to the favorable evaluation of the dividend tax. There is, however, a 'price' for this tax, and this is reflected through the last two rows of the table, that follow from the discussion of Section 4. While the SHS tax and the Brown tax are neutral with respect to all financial decisions regardless of whether or not they are applied with a constant rate, the dividend tax creates significant financial distortions. Only when this tax is applied with a constant rate will it be neutral with regard to the firm's debt-equity choice, and this neutrality is even confined to the case where equity is formed through retention of profits.

Opinions will differ on how important these financial distortions are. From the point of view of the ordinary neoclassical equilibrium framework, financial distortions do not seem important; it is a great advantage of the dividend tax over its rivals that it replaces their real distortions with purely financial distortions. On the other hand, financial distortions may be important in other frameworks of analysis. The tax on equity imposed by a dividend tax is a disincentive to the formation of new firms, an activity not considered in our analysis. Excessive debt financing that results from a rising dividend tax rate may also weaken the firm's ability to withstand economic crises, and may therefore have a destabilizing effect on the economy that is more harmful than the Paretian welfare losses that the other taxes cause in a situation of market equilibrium. Whether these factors should outweigh the ones we have analyzed remains to be seen. One can only hope that further research will provide more conclusive answers to these questions before a major reform of the U.S. corporate tax system results from the current political discussion of, and the growing resistance against, the double taxation of dividends.

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Appendix

This appendix proves the revealed preference proposition stated in section 7 of the text.

First, note that $\{c(t),k(t)\}$ solve the surrogate decision problem of choosing $\{\tilde{c}(t),\tilde{k}(t)\}$ to maximize $\bar{U}(0)$ subject to the distorted law of motion:

$$\dot{\tilde{k}} \le \varphi(\tilde{k}) - (\delta+n+g)\tilde{k} - \tilde{c} + (\theta_s\hat{\theta}_b+\delta\tau_s)(\tilde{k}-k) - \tau_s[\varphi(\tilde{k})-\varphi(k)] \quad (27')$$

and the initial condition: $\tilde{k}(0) = k(0)$. (The solution to this problem is the unique convergent solution to (27') and (28) starting at $k(0)$. Because $\{c(t),k(t)\}$ satisfies (27) and (28), converges, and starts at $k(0)$, it is that solution.)

Next, because $\{c'(t),k'(t)\}$ satisfies (27) it must also satisfy (27') if $(\theta_s\hat{\theta}_b+\delta\tau_s)(k'-k)-\tau_s[\varphi(k')-\varphi(k)] \ge 0$. This condition is indeed satisfied because:

$(\theta_s\hat{\theta}_b+\delta\tau_s)(k'-k)-\tau_s[\varphi(k')-\varphi(k)]$

$\ge \{\theta_s\hat{\theta}_b+\tau_s(\delta-\varphi'(k)]\}(k'-k)$ (because $\varphi'' < 0$)

$\ge [\theta_s\hat{\theta}_b-\tau_s(\rho+\eta g)](k'-k)$ (because $\varphi'(k)-\delta \ge \rho+\eta g$ and $k' \le k$)

$\ge 0.$ (because $\hat{\theta}_b \le 0$ and $k' \le k$).

Since $\{c'(t),k'(t)\}$ also satisfies the initial condition $k'(t) = k(0)$ it satisfies all the constraints of the surrogate decision problem, and hence yields strictly less welfare than the unique solution $\{c(t),k(t)\}$ to that problem.