

The Dynamic Impact of Fundamental Tax Reform

Part 2: Extensions

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Our results suggest that if tax reform is to be successful in stimulating investment and raising long-run living standards, then it is important that ways be found to keep the consumption tax rate at or below the current rate of labor-income taxation.

In Part 1 of “The Dynamic Impact of Fundamental Tax Reform,” we described a few of the proposals for moving to a consumption-based taxation system. Advocates of this type of tax reform cite two advantages. First, it would simplify the tax code by imposing a single consumption tax rate and eliminating many of the deductions and exemptions that exist in the current tax scheme. This simplification, in turn, would reduce compliance and enforcement costs and thereby make the tax collection system more efficient. Second, by shifting from an income-based to a consumption-based tax, this reform would increase the incentive to save and invest, as opposed to consume. These incentive effects could lead to a subsequent increase in growth. Our emphasis is more on the second of these claimed advantages, as we focus on the aggregate economic effects of tax reform.

The economic models presented here differ from the model described in Part 1 in that they allow for variable work effort—not just a variable capital stock. This change adds substantial realism to our analysis and brings it into closer conformity with the efforts of others.¹ We ignore international capital flows, earnings uncertainty, and investment in training and education—each of which may be quantitatively important.

Our results suggest that if tax reform is to be successful in stimulating investment and raising long-run living standards, then it is important that ways be found to keep the consumption tax rate at or below the current rate of labor-income taxation. Like labor-income taxes, consumption taxes distort labor-market decisions. Consequently, a consumption tax imposed at a high rate may be worse than a low-rate income tax; the additional labor-market distortion caused by the consumption tax may undo the positive economic effects of the cut in the rate of capital-income taxation.

In this article we first describe the nature of preferences and technology in our economy. We then show how eliminating the existing labor and capital taxes and replacing them with a consumption tax would affect such variables as capital, employment, and interest rates. These results generally hold true for a wide range of economies. We also illustrate how various configurations of tax rates, preferences, and technology could alter the economy’s response to tax reform. For example, we demonstrate that the economy’s immediate response to tax reform is muted—and the overall adjustment process is substantially prolonged—if firms find it expensive to add quickly to

their stocks of plant and equipment. The reader interested primarily in these illustrations may wish to focus on the section entitled “Some Specific Examples,” which contains these results. Also, in the box entitled “Growth Effects” we describe circumstances under which tax reform might have a permanent impact on the economy’s growth rate.

DESCRIPTION OF THE ECONOMY

It is useful to consider and analyze tax reforms within a concrete economic model. In particular, we describe a few variants of neo-classical growth models used to analyze issues in dynamic economies, such as growth or business cycles. For the most part, we abstract from issues related to sustained growth by assuming that the trend growth rate is determined exogenously. In this case, all quantitative results should be interpreted as deviations from some trend growth rate. For convenience we also abstract from any uncertainty.

It is useful, but by no means necessary, to assume that the total tax bill is paid by households. We show in the box entitled “The Equivalence of Tax Regimes” that this assumption is actually not inconsistent with a world in which the firms pay corporate profits taxes. Effectively, the household tax bill in our model includes what in reality is a corporate tax. This is a useful simplification.

The Consumer’s Problem

We consider an environment in which all households are identical so that we may abstract from the distributional consequences of tax reform. This assumption allows us to carry out our analysis in per-capita terms. To facilitate the study of the different tax regimes, we first present an analysis of the economy in the presence of capital and labor taxation. We then show how the introduction of a consumption tax changes the decisions of households and firms.

We assume that households have identical preferences characterized by the following utility function:

$$\sum_{t=1}^{\infty} \left(\frac{1}{1+\rho} \right)^t U(c_t, 1-n_t).$$

Here c_t and n_t represent the amount of consumption and employment in period t . Additionally, ρ represents the households’ pure rate of time preference. We assume that each household has one unit of time that can be used for either work or leisure and that the household cares about acquiring more of the con-

sumption good (c_t) and leisure ($1-n_t$). Moreover, we assume that there is a capital tax rate of τ_p and a labor tax rate of τ_w .² At date t , the typical household has k_t units of capital, which is rented to the typical firm. The households have budget constraints that are written as

$$(1) \quad c_t + \Delta k_t \leq (1 - \tau_w)w_t n_t + (1 - \tau_p)r'_t k_t + \eta_t.$$

The right side of this equation represents after-tax income. The left side represents consumption plus saving in the form of investment in new capital. Here r'_t is the pretax return to capital, net of depreciation, that is paid to households for the capital rented by the firm.³ The household pays tax on this capital income and consequently receives $(1 - \tau_p)r'_t$ units of after-tax income per unit of capital. Similarly, w_t is the pretax wage paid by firms, and $(1 - \tau_w)w_t$ is the after-tax wage paid to workers. It is assumed that capital used by the firm depreciates at the rate δ per period. The term Δk_t refers to the change in the capital stock that results from period- t investment. Lastly, η_t represents a lump-sum transfer payment from the government, which includes all revenue derived from government taxation.⁴

In each period, households must make decisions concerning how much to work and invest. Having made these decisions, the level of consumption is determined by default from Equation 1. The employment decision by consumers must satisfy the following equation:

$$(2) \quad (1 - \tau_w)w_t U_1(c_t, 1 - n_t) = U_2(c_t, 1 - n_t),$$

where $U_i(\cdot)$ denotes the marginal utility with respect to the i ’th argument. Equation 2 states that the marginal return from working an extra hour, calculated in units of utility and taking taxes into account, must equal the marginal disutility from doing so.

The optimality condition that characterizes the investment decision takes the form

$$(3) \quad U_1(c_t, 1 - n_t) = \left(\frac{1}{1+\rho} \right) U_1(c_{t+1}, 1 - n_{t+1}) \left[1 + (1 - \tau_p)r'_{t+1} \right].$$

This condition states that the marginal after-tax return to investing another unit, calculated in terms of utility, must just equal the marginal cost of giving up one unit of consumption.

The Firm’s Problem

We assume there are many identical firms. Each firm has access to a technology for producing the consumption good, written as

Growth Effects

Supporters of the move to a consumption-based taxation system argue that one of the benefits of such a system is that it would increase the economy's growth rate. There are legitimate reasons for this view. A consumption tax would deter individuals from consuming and eliminate the present distortion in the capital-income tax, which discourages saving or investment. In other words, this investment would increase the capital stock, which would, in turn, increase the future level of output. Furthermore, the removal of taxation on capital income makes it even more rewarding to invest in capital, because the return would be higher.¹

The welfare consequences of these growth effects could be substantial. That is, economic agents would be willing to pay a lot to receive the benefits from a relatively small increase in the growth rate.

Before quantifying this effect, it is also important to acknowledge factors that may mitigate it. First, some forms of capital investment are already subject to (relatively) favorable tax treatment. Investment in housing is already encouraged through interest deductibility and reduced capital-gains taxation. Additionally, some forms of investment in human capital are already treated favorably.

To give some content to this analysis, it is useful to consider a model of endogenous growth in which the equilibrium growth rate is determined by the economic decisions of agents. To illustrate the potential growth benefits from eliminating the capital-income tax, consider the simple economy below in which employment is held fixed. Suppose that all agents have preferences given as

$$(B.1) \quad \sum_{t=1}^{\infty} \left(\frac{1}{1+\rho} \right)^t \left(\frac{c_t^{1-\sigma}}{1-\sigma} \right),$$

where $(1/\sigma) > 0$ is the intertemporal elasticity of substitution and is assumed to be a fixed parameter. Here c_t represents consumption in period t . Labor does not enter either the utility or production functions.

The technology for the economy can be written as

$$c_t + k_{t+1} = Z_t k_t^\theta,$$

where k_t is the capital stock in period t and Z_t the technology shock in period t . Implicitly, we assume a 100 percent depreciation rate and that Z_t is a function of the average capital stock in the economy. In particular, if K_t is the average capital stock, then $Z_t = AK_t^{1-\theta}$. The logic behind this specification is that an agent's productivity is positively influenced by the capital or investment undertaken by other agents in the economy. This specification can be justified in that some firms or individuals are more productive if there are other firms or individuals with high levels of human or physical capital. For example, manufacturers of automobiles or televisions can make a better product if they also have access to better electronic or microchip technology. Similarly, research scientists as well as various organizations or coalitions of agents (football players, for example) are more productive if they can work alongside other productive individuals.

An analysis of this economy shows that the growth rate g is

$$g = (1/\sigma) \log \left(\frac{\theta A (1 - \tau_p)}{1 + \rho} \right).$$

This equation illustrates that the growth rate is related to parameters ρ , θ , and A . In particular, the smaller ρ is, the larger the level of saving or investment will be and, consequently, the higher the growth rate will be. Similarly, the higher θ or A is, the greater the incentive to save or invest will be, and the higher the growth rate will be. However, the higher the tax rate, the lower the return to investment, and therefore the lower the growth rate will be. Table 1 gives some examples of the growth rates for output that result for various parameter values.

In this economy, we can show that the return to a unit of extra investment is $A\theta(1 - \tau_p)$. Hence, a higher tax rate reduces the after-tax return to investment. In this model, the rate of return to investment is pinned down by these parameters.

When the capital-income tax is replaced by a consumption tax, the growth rate formula given above reduces to

$$g = (1/\sigma) \log \left(\frac{\theta A}{1 + \rho} \right).$$

The rate of return to investment is then written as θA . Hence both the growth rate and the rate of return are higher with the consumption tax than with the capital tax.

Generally, in any model in which agents have the preferences as given by Equation B.1, the net after-tax rate of return on investment (r) and the growth rate are linked by the following: $g = (1/\sigma) \log[r/(1 + \rho)]$. Thus, any policy that raises the growth rate g of the economy is also likely to raise the after-tax rate of return to investment. That is, it is incompatible to simultaneously have high growth rates and low rates of return. Of course, this relationship also implies that if σ is small, then there are potentially large growth effects that can be derived from policies that raise the rate of return to investment.

This example and the results presented in Table 1 suggest that eliminating capital-income taxation would have a substantial impact on the economy's growth rate. In fact, the results contained in the table almost certainly exaggerate the potential impact of tax reform. Moreover, it should be noted that this framework abstracts from some other features that can be of substantial import. For example, there is no human capital in the model, and it could be argued that reducing the rate of taxation on human capital is at least as important as that of physical capital. Stokey and Rebelo (1995) and Lucas (1990) study a model that has human and physical capital and analyze the impact that reductions in the capital-income tax rate can have on the economy.² Given some reasonable parameterizations for their model economy, they find that there is little reason to think that this type of tax reform would significantly increase the growth rate of aggregate output. The reasoning appears to be that although physical capital is an important ingredient in the production process, human capital is even more important. The impact of policies that could facilitate or encourage capital accumulation is always important in promoting growth. However, it is perhaps more important to promote the accumulation of human capital if the goal is to increase the growth rate of aggregate output. Nevertheless, these models imply that the impact on welfare of reducing the rate of capital-income taxation can be fairly substantial, even if the impact on growth is small.

NOTES

¹ There are also other models, sometimes referred to as the neoclassical growth models, in which the asymptotic growth rates are independent of the tax rate on capital. However, the framework specified in this box is not a model of this type.

² Cassou and Lansing (1996) conduct a related experiment. Within the context of a model that includes both human and physical capital, they analyze how moving from a progressive income tax regime to one with a flat tax rate on income would affect the equilibrium growth rate. Their quantitative results hinge on the values of a few of the parameters of the model.

Table 1
Growth Rates

	$\sigma = .5$ (percent)	$\sigma = 1$ (percent)	$\sigma = 10$ (percent)
$\tau_p = .50$	-2.2	-1.1	-10.9
$\tau_p = .25$	9.3	4.6	-5
$\tau_p = 0$	30.3	15.2	1.5

NOTE: All growth rates are calculated for $\theta = .35$, $\left(\frac{1}{1+\rho} \right) = .95$, $A = 3.5$.

$f(k_t, n_t)$, using capital and employment. The typical firm maximizes profits, which are given as

$$f(k_t, n_t) - w_t n_t - (r'_t + \delta)k_t.$$

Written in this manner, profits are calculated in units of the consumption good. This formulation allows the firm's problem to be written without any tax parameters. Profit maximization dictates that the firm must equate the marginal product of labor to the real wage rate:

$$(4) \quad f_2(k_t, n_t) = w_t.$$

The optimization condition for the choice of capital requires that the marginal product of capital equal the marginal cost of capital. This condition is formally written as

$$(5) \quad f_1(k_t, n_t) - \delta = r'_t.$$

A Consumption Tax

Now consider the elimination of the capital and labor taxes and the replacement of them with a consumption tax. The beauty of the formulation presented above is that the firm's problem is not changed by this tax reform. However, the budget constraint for the individual consumers is changed from Equation 1 to

$$(6) \quad c_t \leq [r'_t k_t + w_t n_t - \Delta k_t + \eta_t](1 - \tau).$$

Here τ is the consumption tax rate, calculated so that tax revenue is divided by the consumption base *inclusive* of the amount of the tax.⁵ Clearly, Equation 6 says that consumption will equal the after-tax value of income, less investment or saving.

The optimization condition for employment is then determined as

$$(1 - \tau)w_t U_1(c_t, 1 - n_t) = U_2(c_t, 1 - n_t).$$

Working an extra unit produces w_t units of income (measured in real units). However, this extra revenue purchases only $(1 - \tau)w_t$ units of extra consumption since the consumption tax must be paid on such purchases. It should be noted that a comparison of this last equation with Equation 2 reveals that the effects of the labor and consumption taxes on the optimality condition for employment are identical. Both of these taxes work to discourage work effort and consumption and instead encourage the agents to take more leisure. The optimization condition for capital accumulation is written as

$$U_1(c_t, 1 - n_t) = \left(\frac{1}{1 + \rho} \right) U_1(c_{t+1}, 1 - n_{t+1})(1 + r'_{t+1}).$$

Compare this equation with Equation 3,

which is the counterpart with the tax on capital. As can be seen, there is now no tax on the return to capital.

We now focus on the analytical or qualitative details of the tax reform. We show how various variables respond—in both the short and long run—to the change in tax rates. This analysis is inherently detailed because of the complex nature of the equilibrium responses of so many variables. The reader interested primarily in the quantitative illustrations of this experiment may skip the following sections and go directly to “Some Specific Examples.”

TAX REFORM IN AN ECONOMY WITH ENDOGENOUS LABOR SUPPLY: THE GENERAL CASE

In Part 1, in which we assumed the labor supply to be exogenously fixed, we found that we could trace paths of consumption and the capital stock through time using a simple phase diagram. Here we discuss how the results presented in Part 1 must be modified if households can choose the number of hours they work.

Labor Market Equilibrium

Equation 2 can be rearranged to give the supply price of labor as a function of the tax rate on labor income and the *marginal rate of substitution* between leisure and consumption:

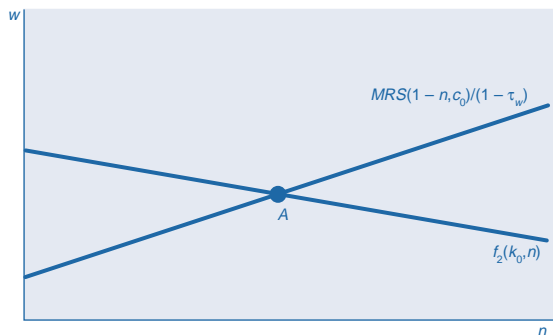
$$(7) \quad w = MRS(1 - n, c)/(1 - \tau_w),$$

where $MRS(1 - n, c) \equiv U_2(c, 1 - n)/U_1(c, 1 - n)$. It is standard to assume that leisure and consumption are both normal goods or, equivalently, that the marginal rate of substitution is decreasing in its first argument and increasing in its second.⁶ Equation 7 then implicitly defines a labor-supply function. The supply price of labor is increasing in the quantity of labor supplied, in consumption, and in the tax rate on labor income. In Figure 1, the labor-supply schedule is upward sloping for given values of c and τ_w .

We assume that the production function $f(\cdot, \cdot)$ exhibits constant returns to scale and is increasing in both capital and labor. Then Equation 4 implies that the demand price of labor is a decreasing function of the number of hours per worker and an increasing function of the amount of capital per worker. In Figure 1, the labor-demand curve is negatively sloped for any given capital stock k .

Equilibrium in the labor market must occur at a point like A , where the labor-supply and labor-demand curves intersect. Of course, point A represents only a partial equilibrium in the labor market, since the level of consumption

Figure 1
Partial Labor Market Equilibrium



(which was held constant when we drew the labor-supply schedule) is not predetermined in our economy. As the level of consumption increases, the labor-supply schedule shifts upward, moving point *A* to the northwest along the labor-demand curve. Intuitively, households want more leisure to accompany their increased consumption. Increases in τ_w also shift the labor-supply schedule upward, moving point *A* back along the labor-demand curve. In this instance the higher tax penalizes work effort, which results in a fall in labor supply. By contrast, increases in the capital stock shift the labor-demand schedule proportionately to the right, moving point *A* to the northeast, along the labor-supply schedule.

In summary, equilibrium hours are increasing in the capital stock and decreasing in both consumption and the tax rate:

$$(8) \quad n = \phi(k, c, \tau_w),$$

with $\phi_1 > 0$ and $\phi_2, \phi_3 < 0$. Because the labor-supply schedule is upward sloping, equilibrium employment varies less than in proportion to the capital stock. Formally, $\phi_1/(n/k) < 1$. By using Equation 8 to eliminate hours of work from our model, we can construct a diagram helpful for analyzing how consumption and the capital stock vary through time in response to tax reform.

The Dynamics of Capital and Consumption

Capital. Output is either consumed by households or the government, or is channeled into capital investment: $f(k, n) = c + g + i$. It follows that net investment, Δk , will be positive if, and only if, $c < f(k, n) - g - \delta k$. The identical condition held in Part 1. There, hours of work were fixed. Here, we can substitute from Equation 8 to obtain

$$(9) \quad \Delta k > 0 \Leftrightarrow c < f[k, \phi(k, c, \tau_w)] - g - \delta k.$$

For given levels of government purchases and the labor-income tax rate, the equation $c = f[k, \phi(k, c, \tau_w)] - g - \delta k$ gives those combinations of capital and consumption that are sustainable in the sense that they are consistent with an unchanging capital stock. Much as in Part 1, an increase in the capital stock will increase sustainable consumption, provided that the net marginal product of capital, $f_1 - \delta$, is positive.⁷ In Figure 2, the schedule labeled “ $\Delta k = 0$ ” is upward sloping over the relevant range. However, whereas in Part 1 the sustainable level of consumption was independent of tax policy, now an increase in the labor-income tax rate reduces the representative household’s willingness to work, shifting the $\Delta k = 0$ schedule downward.

Consumption. If we assume that the household utility function is additively separable between consumption and leisure, then the marginal rate of substitution between consumption today and consumption tomorrow will depend only upon the levels of consumption today and tomorrow. If we further assume that current and future consumption are normal goods, Equation 3 says that consumption will be rising over time if, and only if, the after-tax return on capital exceeds the rate of time preference:

$$\Delta c > 0 \Leftrightarrow (1 - \tau_p)r' > \rho.$$

Using Equation 5 to eliminate the return on capital:

$$(10) \quad \Delta c > 0 \Leftrightarrow (1 - \tau_p)[f_1(k, n) - \delta] > \rho.$$

The same condition held in Part 1. However, now that hours are endogenous rather than fixed, we must substitute from Equation 8 to eliminate employment from Equation 10. This substitution yields

$$(11) \quad \Delta c > 0 \Leftrightarrow (1 - \tau_p)[f_1(k, \phi(k, c, \tau_w)) - \delta] > \rho.$$

Figure 2
Dynamics of the Capital Stock

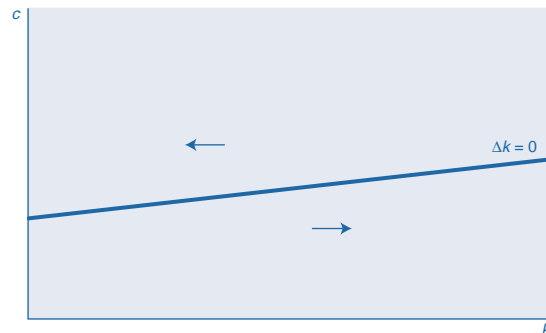
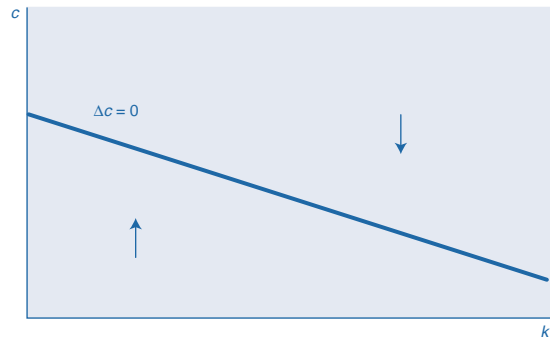


Figure 3
Dynamics of Consumption



For given tax rates, the equation $(1 - \tau_p)[f_1(k, \phi(k, c, \tau_w)) - \delta] = \rho$ gives those combinations of capital and consumption that are consistent with an unchanging level of consumption. As noted above, although equilibrium hours are increasing in the capital stock, hours rise less than in proportion to capital ($\phi_1/(n/k) < 1$). It follows that k/ϕ is increasing in the capital stock and, hence, $f_1(k, \phi(k, c, \tau_w))$ is decreasing in the capital stock. We also know that households like to accompany a higher level of consumption with additional leisure ($\phi_2 < 0$). Therefore, k/ϕ is increasing in consumption, and $f_1(k, \phi(k, c, \tau_w))$ is decreasing in consumption. Since the marginal product of capital is decreasing in both k and c , the equation $(1 - \tau_p)[f_1(k, \phi(k, c, \tau_w)) - \delta] = \rho$ traces out a downward-sloping schedule in $k \times c$ space. In Figure 3, this schedule is labeled “ $\Delta c = 0$.” To the right (above) the schedule, the after-tax rate of return on capital is less than the rate of time preference, and consumption falls through time. To the left of (below) this curve, the after-tax rate of return on capital is high enough that households are willing to defer consumption. Hence consumption rises over time.

Just as in the case in which hours of work are exogenously fixed, a cut in the capital-income tax rate shifts the $\Delta c = 0$ curve to the right. However, changes in the labor-income tax rate also shift the $\Delta c = 0$ curve. In particular, a cut in the labor-income tax rate increases the supply of labor, which tends to increase the marginal product of capital. To offset this increase, the capital stock (or consumption) must rise. In other words, the $\Delta c = 0$ curve now shifts to the right (upward) in response to a cut in τ_w , much as it shifts to the right in response to a cut in τ_p .

Capital and Consumption, Combined. Figure 4 combines the information in Figures 2 and 3. Arrows show the direction of movement for the different combinations of consumption and cap-

ital. The economy has a unique steady state—point E —at which consumption and capital are both constant. Point E is a saddle-path equilibrium: for each initial capital stock there is a unique optimal level of consumption. In the diagram, if the economy starts at capital stock $k_A < k_E$, then households choose consumption level $c_A < c_E$ and, over time, the economy follows the dotted path from point A toward point E . Similarly, if the economy starts at capital stock $k_B > k_E$, then households choose consumption level $c_B > c_E$ and the economy follows the dotted path from point B toward point E .

The Effects of Tax Reform

We can use our phase diagram developed above to analyze the effects of fundamental tax reform on the time paths of consumption and the capital stock. First, capital-income taxes are eliminated, with no change in the labor-income tax rate.⁸ Then, we briefly consider how the analysis would change if it were possible to lower the labor-income tax rate or necessary to raise it.

A Constant Labor-Income Tax Rate. We assume that the economy begins in a steady-state equilibrium in which both labor income and capital income are taxed. In Figure 5, this steady state is point E . Suddenly, the tax on capital income is eliminated. Suppose that the labor-income tax rate is unchanged. (As a practical matter, most reform proposals call for the elimination of enough tax loopholes so that the labor-income tax rate would, in fact, remain roughly constant.) In this case, the $\Delta k = 0$ curve remains fixed, while the $\Delta c = 0$ schedule shifts unambiguously to the right. It follows that the economy’s steady state must shift to the northeast: in our diagram, the new steady state is at point E' . Just as in an economy with exogenously fixed labor hours, the long-run effect of

Figure 4
Combined Dynamics of Consumption and Capital

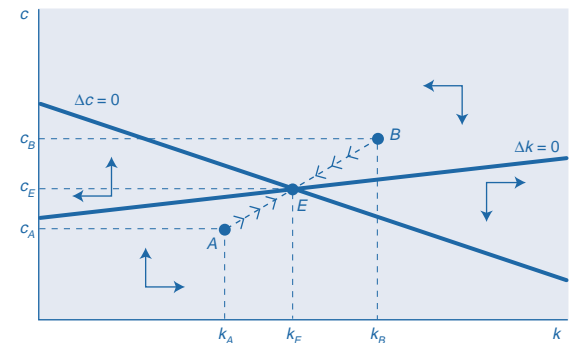
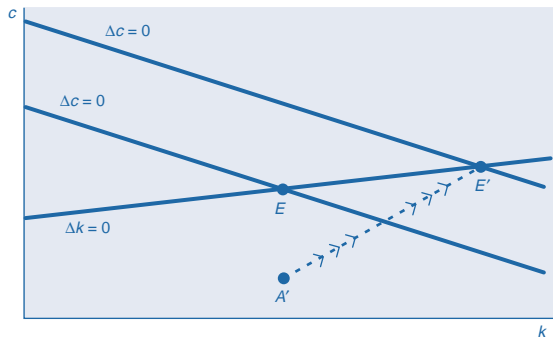


Figure 5
Consumption Drops in Response to Tax Reform, then Consumption and Capital Increase



fundamental tax reform is to raise both consumption and the capital stock.

In the short run, the aggregate capital stock is fixed and the interest rate adjusts to eliminate any excess demand for capital. Consumption, by contrast, is free to jump when tax reform goes into effect. As shown in Figure 5, consumption must jump downward to put the economy on the saddle path leading to E' : the immediate effect of tax reform is to move the economy from point E to point A' . Thus, here—as in an economy with exogenously fixed labor hours—the immediate effect of fundamental tax reform is a decrease in consumption. Then, as capital gradually accumulates, the economy follows the saddle path from A to E' .

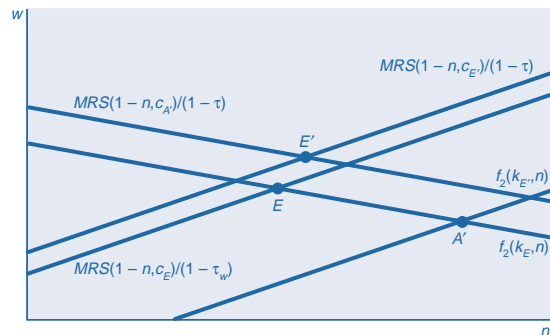
Figure 6 illustrates the labor market's response to tax reform. The initial equilibrium is at point E . When tax reform first goes into effect, we know that consumption falls (from c_E to $c_{A'}$) while the capital stock remains unchanged. The fall in consumption implies a rightward shift in the labor-supply schedule. Intuitively, by working harder, households can prevent consumption from falling by as much as would otherwise be necessary. The fact that the capital stock is initially unchanged means that the labor-demand curve is also initially unchanged. In Figure 6, therefore, the economy moves from point E to point A' : work effort increases and the real wage falls. Through time, as consumption and the capital stock gradually increase, the labor-supply schedule shifts to the left and the labor-demand schedule shifts to the right. Indeed, since consumption eventually rises above its initial steady-state level, the labor-supply schedule ends up to the left of its original position. In the new steady state, the real wage is clearly higher than it was originally. Whether work effort rises or falls relative to the

initial steady state is ambiguous. In Figure 6, the new steady state is at point E' .

In Part 1, we showed that replacing the current income tax system with a consumption tax causes the after-tax return on capital to jump upward in the short run. Indeed, it is this jump—the result of the elimination of the corporate income tax—that induces households to defer consumption. Gradually, as the capital stock increases, the after-tax return on capital falls back to its original level. This pattern of movement in the after-tax return on capital also holds in an economy with endogenous work effort. Indeed, the initial upward jump in the after-tax return is even greater than in an economy with fixed work effort. The after-tax return on capital rises not only because of the elimination of the corporate income tax, but also because people initially respond to tax reform by working harder, thereby raising the marginal product of capital. As capital accumulates, the marginal product of capital falls, and the after-tax return on capital approaches its original level. Whether the new steady-state capital stock is above or below what it would have been with a fixed labor supply is ambiguous, since it depends upon whether work effort rises or falls in steady state.

Tax Reform When the Labor-Income Tax Rate Changes. Until now, we have assumed that the labor-income tax rate is unchanged following tax reform. If this assumption is invalid, the economy's response to tax reform may be markedly different from that described above. If, for example, eliminating the capital-income tax requires that the tax rate applicable to labor income be increased, then the $\Delta c = 0$ schedule in Figure 5 will not shift quite so far to the right following tax reform and, in extreme cases, might actually shift to the left. Moreover, the

Figure 6
Effects of Tax Reform on the Labor Market



$\Delta k = 0$ schedule shifts downward. Consequently, it is quite possible for the postreform steady-state level of consumption to be lower than the prereform level of consumption. Whether the steady-state level of capital rises or falls is also ambiguous.

If the labor-income tax rate is *lower* postreform than it is prereform, then the $\Delta c = 0$ schedule in Figure 5 will shift strongly to the right, and the $\Delta k = 0$ schedule will shift up. For some parameterizations, the latter effect is so strong that consumption itself actually jumps upward rather than downward immediately following tax reform. Additional, more gradual increases in consumption follow as the economy moves along the saddle path leading to the new steady state. The steady-state capital stock necessarily increases.⁹

Review and Outlook. We have seen that the qualitative effects of tax reform in an economy with endogenous work effort differ little from those in an economy in which labor effort is fixed—*provided that the tax rate on labor income is unchanged*. The most important difference between the fixed-effort and the variable-effort cases is that with fixed effort, households must cut back on consumption if they wish to increase their saving, whereas with variable effort, households have the option of increasing their saving by cutting back on leisure. Typically, households will choose to cut both leisure *and* consumption immediately following tax reform.

If tax reform is to be successful in stimulating investment and raising long-run living standards, then it is critical that ways be found to avoid increasing the rate of labor-income taxation. Increases in the labor-income tax rate can negate the positive economic effects of cuts in the capital-income tax rate. Conversely, cuts in the labor-income tax rate reinforce savings incentives and contribute to higher steady-state levels of consumption.

Specific illustrations of the effects of tax reform are provided below for a variety of assumptions about the new labor-income tax rate. We also simulate the effects of tax reform on an economy in which each firm finds it expensive to make rapid changes to its capital stock, and in one in which each firm finds that the larger the capital stocks held by others, the more productive its capital becomes.

SOME SPECIFIC EXAMPLES

To obtain quantitative estimates of the short- and long-run consequences of tax reform,

it is necessary that we adopt some precise specifications for preferences and technology. Accordingly, consider an economy in which agents' preferences are determined by the utility function

$$(12) \quad U(c_t, 1 - n_t) = \log(c_t) + \log(1 - n_t),$$

and in which aggregate output is determined according to the following technology:

$$(13) \quad f(k_t, n_t) = k_t^\theta n_t^{1-\theta}.$$

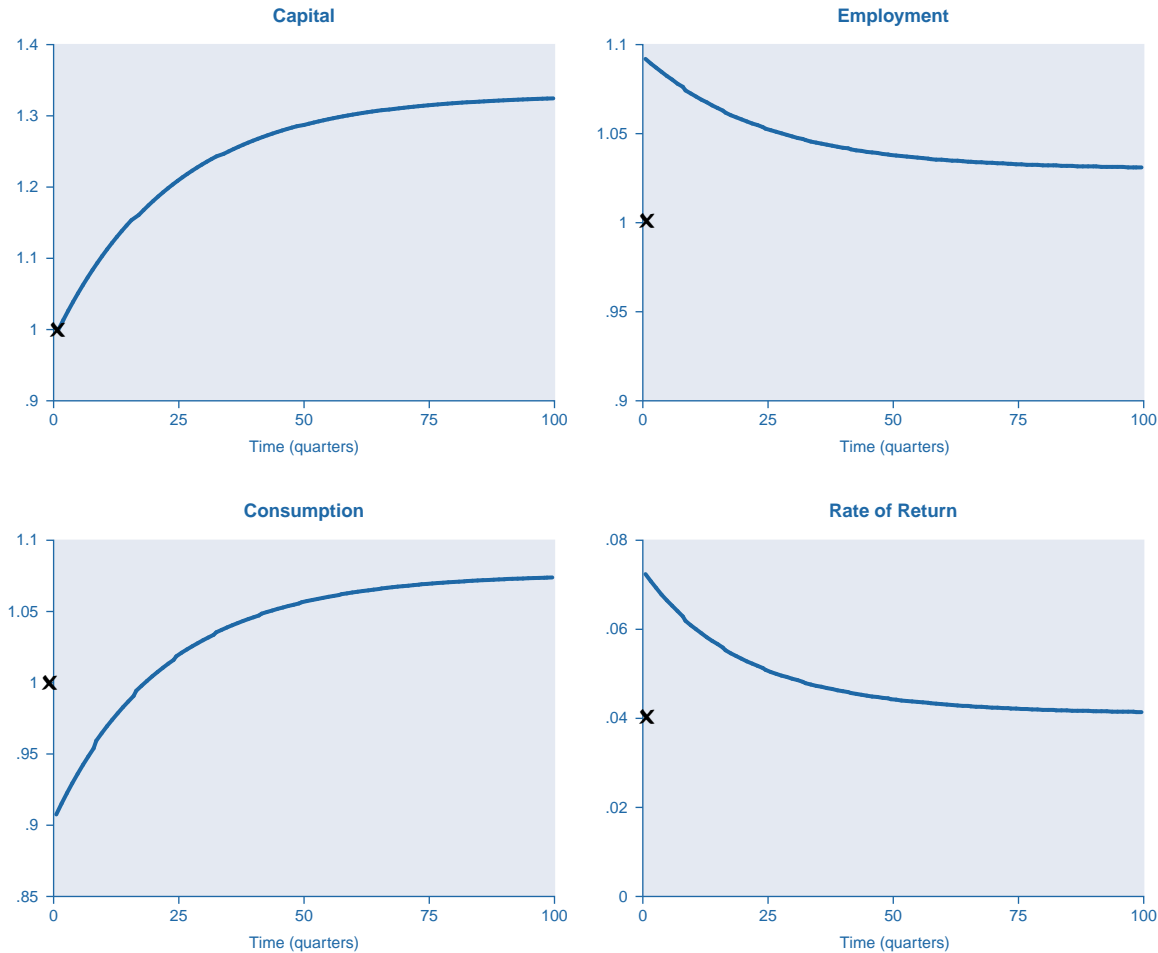
The parameter δ will continue to denote the depreciation rate of capital. It is useful to consider an economy in which a period is a quarter and the parameter values are $\rho = 0.01$, $\theta = 0.35$, and $\delta = 0.02$. These specifications imply that the annual average real interest rate is about 4 percent and that the annual depreciation rate is approximately 8 percent. They also imply that capital's share of aggregate income is 35 percent, which is approximately what it is in the data. Lastly, they imply that in the model with the current levels of taxation imposed, individuals spend approximately one-third of their available time working, which would appear to be an acceptable prediction.

It is useful to look at a few experiments in which the labor and capital tax rates are eliminated and replaced with a consumption tax. Consider first an economy that initially has an effective capital tax rate of 35 percent and a labor tax rate of 35 percent. Assume that this economy is in its steady state. We arbitrarily assume that the tax reform is implemented in period 1. That is, during this period, the capital and labor taxes are eliminated and the consumption tax is implemented at a 35 percent rate.¹⁰

Figure 7 illustrates the impact of the reform on the capital stock, employment, consumption, and the after-tax interest rate (rate of return to capital). In these figures the \times denotes the initial level of the variable. As can be seen, the tax reform leads to an increase in investment, which produces a subsequent increase in the capital stock. This increase raises the wage rate in the economy, which leads to a substantial increase in the employment level. The increased investment is partially financed by a decrease in consumption that occurs concurrently with the tax reform. Although consumption falls, it subsequently grows to its new steady-state level, surpassing its previous level after four and one-half years.¹¹ Additionally, the after-tax return to capital rises because of the reform, but subsequently falls.

It is of interest to compare the initial pre-

Figure 7
Effects of Imposing a 35 Percent Consumption Tax



reform levels of some variables with their resulting values after they have converged to the new steady state, even though this convergence takes a long time. After the reform, employment increases 3 percent. Moreover, since both the capital stock and employment have risen, aggregate output rises 12.6 percent. Wages, or the marginal product of labor, rise by 9.4 percent.¹²

Some concern exists that eliminating the existing income and payroll taxes may require a tax rate higher than 35 percent on consumption. Figure 8 shows the responses of variables to a tax reform requiring a consumption tax rate of 45 percent.¹³ As can be seen, the responses are more pronounced than those in Figure 7. Consumption falls substantially more in the short run and never recovers its original level. Similarly, employment initially rises but then falls below the original level. As a result of the reform, the capital stock grows—although not as much as it does in Figure 7 because of the comparatively high tax rate. An unfortunate by-product of this type of reform is that aggregate

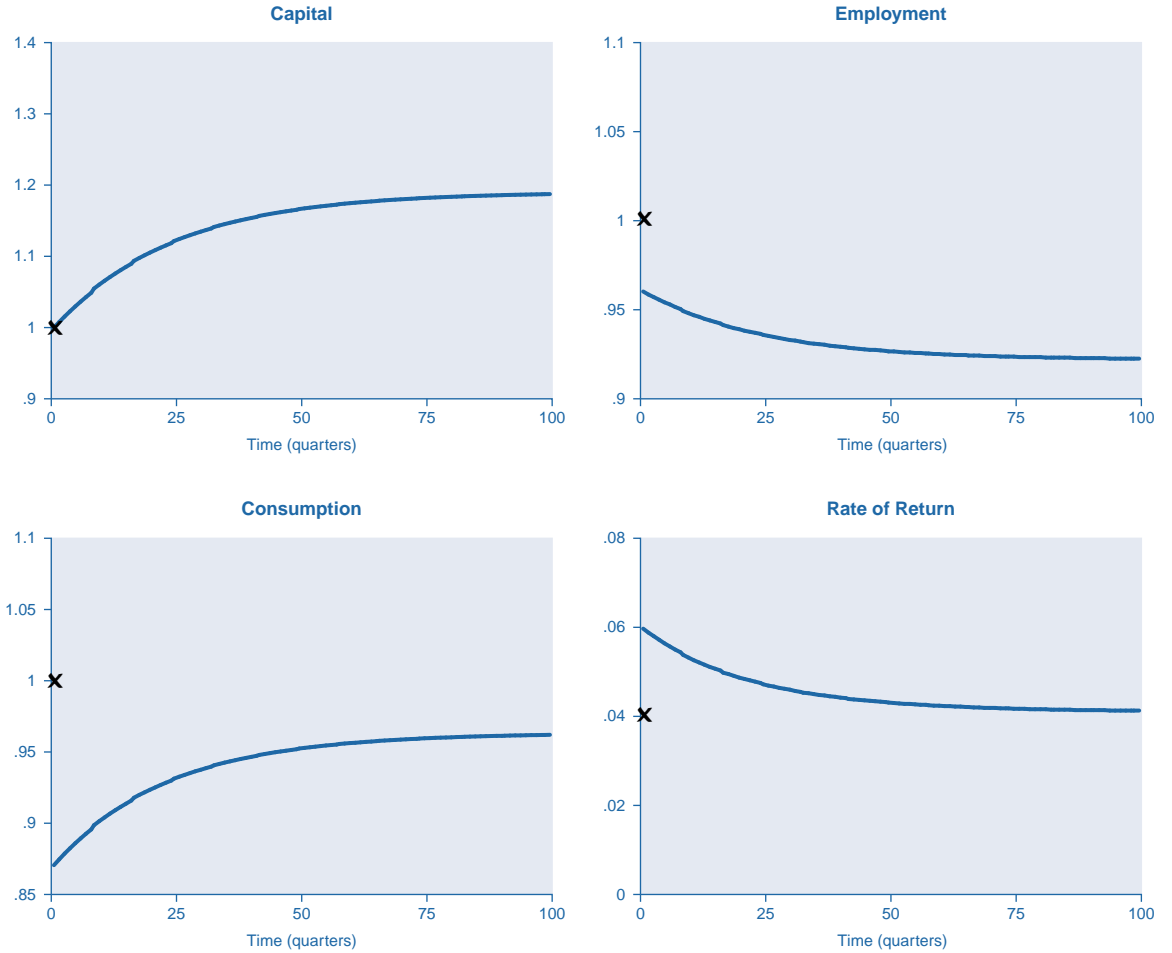
output exhibits a substantial fall of about 2.6 percent at the time of the reform and only recovers to surpass its prereform level after eight years. Therefore, one should not assume that all tax reforms that entail a movement to a consumption-based tax system must immediately increase aggregate output.

It is interesting to compare the resulting values of some important aggregates for prereform and postreform tax regimes with this higher consumption tax. After the reform, employment *decreases* 7.8 percent. Since the capital stock rises and employment falls, aggregate output rises only 0.8 percent. Wages rise 9.4 percent.

As evident in each of these examples, the economy converges to a new steady state, but this convergence does not take place overnight. It is relatively complete after 50 periods, or about 12 years.

It is also useful to consider one last experiment. Suppose that the technology is such that there are adjustment costs to accumulating

Figure 8
Effects of Imposing a 45 Percent Consumption Tax



capital—that is, costs that inhibit the accumulation of capital too quickly. These costs are captured by altering the production technology as follows:

$$(14) \quad f(k_t, n_t) = k_t^\theta n_t^{1-\theta} - (k_{t+1} - k_t)^2.$$

The quadratic term in this constraint reflects a penalty for accumulating capital too quickly.¹⁴ Assume that the preferences are given by Equation 12. Again, we consider eliminating the labor and capital tax rates and replacing them with a consumption tax of 35 percent. Compare these results in Figure 9 with those in Figure 7. Because of the adjustment costs, the accumulation of capital and the growth in consumption are much slower. As a result of the slow responses of investment and capital, employment also does not respond as dramatically to the tax reform.

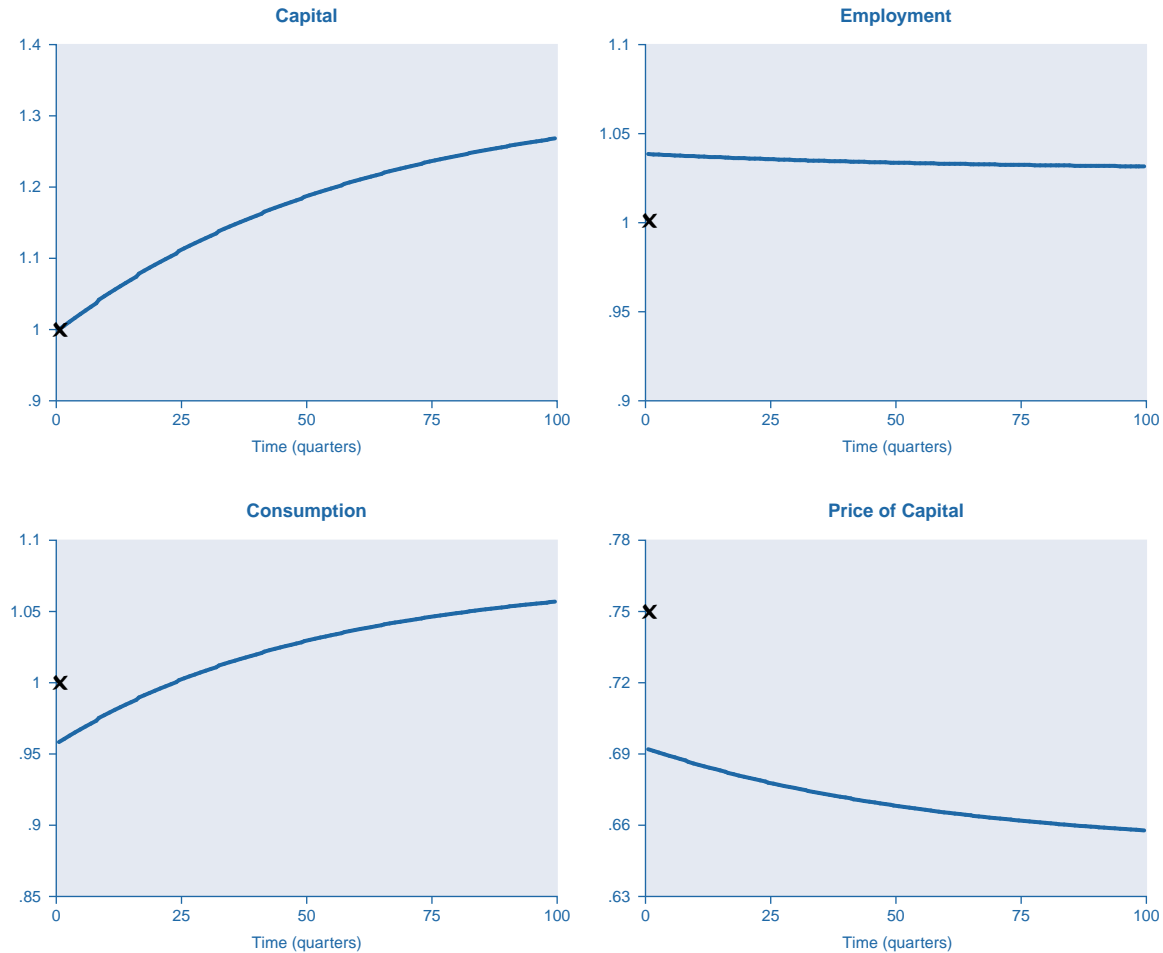
The *real* price of capital, measured in units of the consumption good, is¹⁵

$$(15) \quad P_t = [1 + 2(k_{t+1} - k_t)](1 - \tau).$$

Along a path where the capital stock is growing (that is, $(k_{t+1} - k_t) > 0$) the price of capital will be greater than $(1 - \tau)$, because the adjustment costs impede the accumulation of capital by making it more costly, relative to consuming. Conversely, along a path where the capital stock is declining, the price of capital will be below $(1 - \tau)$.

Figure 9 also shows the path of the price of capital. This path reflects the value or price of a unit of capital, measured in units of the consumption good. This price is 0.75 in the equilibrium with the old tax system, assuming a dividend tax rate of 25 percent.¹⁶ With no adjustment costs, the price would immediately fall to 0.65 after the tax reform. This reflects the fact that a unit of capital is worth only this fraction of a unit of the consumption good since the consumption tax must be paid out of the proceeds. With adjustment costs, the imposition

Figure 9
Imposing a 35 Percent Consumption Tax with Capital Adjustment Costs



of the consumption tax would cause the price of capital to fall, but not as dramatically. The need to augment the capital stock, in the presence of the adjustment costs, leads to a price for the capital stock that is higher than it would be otherwise. Nevertheless, because of the accumulation of capital, this price falls slowly as the economy converges to its new steady state. It is possible to increase the price of capital by multiplying the squared term in Equation 14 by a coefficient that is greater than unity. If capital adjustment costs are sufficiently high, it is possible that the tax reform would temporarily increase the price of capital because the adjustment costs have this effect. However, this increase is only temporary and the price of capital must subsequently fall.

FINAL REMARKS

We have presented a fairly standard dynamic framework within which the effects of

tax reform can be studied. This framework allows for variable work effort as well as a variable capital stock. Using it, we show that moving from an income-based tax system to a consumption-based tax system can be expected to stimulate savings, investment, and work effort in the short run and lead to an increased capital stock and, ultimately, a higher standard of living in the long run. A key assumption is that the postreform rate of consumption taxation does not exceed the current rate of labor-income taxation. Since consumption spending is less than income, keeping the consumption tax rate at or below the current rate of labor-income taxation will generally require either that existing tax loopholes be eliminated or that existing government programs be cut. If the tax rate assumption is violated, the disincentive to work may be strengthened as a result of tax reform—potentially strengthened to the extent that consumption never recovers its prereform level. In extreme cases, the capital stock may actually

The Equivalence of Tax Regimes

As stated in the article, no generality is lost by assuming that all taxes are paid by the household. Consider a regime in which the firm pays corporate profits taxes. We show that this regime is equivalent to another in which the household pays the taxes.

Under a profits tax, the after-tax cash flow of a firm can be written as

$$\pi_t = (1 - \tau_p) [f(k_t, n_t) - w_t n_t - \delta k_t] - \Delta k_t,$$

assuming that all investment is financed out of retained earnings. Here τ_p is the tax rate on profits, and Δk_t is investment financed out of retained earnings of the firm. The optimization condition for profit maximization implied by choosing the optimal employment level is

$$f_2(k_t, n_t) = w_t.$$

The optimization condition for profit maximization implied by optimal capital accumulation is that the firm equate the after-tax return to investment with the rate of return. This can be written as

$$(A.1) \quad (1 - \tau_p) f_1(k_t, n_t) = r_t,$$

where r_t is the after-tax rate of return. That is, the consumer will still have to pay a dividend tax if these earnings are distributed to him as dividends. The profit function above can be equivalently written as¹

$$(A.2) \quad \pi_t = (1 - \tau_p) [f_1(k_t, n_t) - \delta] k_t - \Delta k_t.$$

The budget constraint for the agent can be written as

$$(A.3) \quad c_t \leq (1 - \tau_w) w_t n_t + (1 - \tau_d) \pi_t + \eta_t.$$

This equation means that the wealth or income for the individual to consume consists of labor income plus the value of the dividends paid by the firm. These dividends consist of the profit from the current period, net of taxes paid and investment undertaken by the firm. Combining Equations A.1 and A.2 with A.3 produces

$$(A.4) \quad c_t + \Delta k_t (1 - \tau_d) \leq (1 - \tau_w) w_t n_t + r_t k_t (1 - \tau_d) + \eta_t$$

or

$$(A.5) \quad c_t + \Delta k_t' \leq (1 - \tau_w) w_t n_t + (1 - \tau_d) r_t' k_t' + \eta_t,$$

where $k_t' = k_t (1 - \tau_d)$ and $r_t' = r_t / (1 - \tau_d)$. Here r_t' is the pretax return. Equation A.4 is now identical to Equation 1, with k_t' replacing k_t . The only difference is that under this scheme, in which investment is financed through retained earnings and there is a dividend tax, one unit of capital equals $(1 - \tau_d)$ units of consumption. The transformation in going from Equation A.4 to Equation A.5 reflects this notion.

NOTES

¹ The assumption that the production function $f(k_t, n_t)$ is constant return to scale implies that

$$f(k_t, n_t) = \left[\frac{\partial f(k_t, n_t)}{\partial k_t} \right] k_t + \left[\frac{\partial f(k_t, n_t)}{\partial n_t} \right] n_t.$$

decline over time rather than increase following the adoption of a consumption tax.

For reasonable assumptions about tax rates, the real price of capital falls as a result of tax reform. When individual firms are able to costlessly adjust their capital stocks, the entire price decline is immediate. Otherwise, some fraction of the decline occurs gradually as the economy approaches its new steady state. The after-tax return to capital is likely to shoot up

even more in an economy with variable-labor effort than in an economy with fixed-labor effort.

NOTES

We are grateful to Carlos Zarazaga for his comments and suggestions.

- ¹ See Becsi (1993), Wynne (1997), and, especially, Cooley and Hansen (1992). Like these authors, we use a representative agent, infinite-horizon model. For alternative approaches, see Engen, Gravelle, and Smetters (1997) or Joint Committee on Taxation (1997).
- ² This notation is consistent with that in Part 1, where τ_w and τ_p are the income tax rates applicable to wages and corporate profits, respectively. Interest and dividend income was taxed at the rate τ_d in our earlier article. But changes in τ_d have no effect on the behavior of agents, so we drop it from the model presented here. The price of capital is affected by τ_d , however, and when we discuss the price of capital, we assume that $\tau_d = 0.25$ under the current income tax. See the box entitled "The Equivalence of Tax Regimes."
- ³ The after-tax interest rate, r , in Part 1 is related to r' by the formula $r = (1 - \tau_p) r'$.
- ⁴ It could alternatively be assumed that the government revenue is thrown away. However, changing the tax rate would then mean that the government is changing the amount of its consumption. The approach adopted here permits us to focus exclusively on the substitution effects produced by the presence of the taxes.
- ⁵ This approach makes it easy to compare the consumption tax rate with current income tax rates, since the latter are defined as tax revenue divided by the tax-inclusive income. An alternative way to write this budget constraint is $(1 + \tau^*) c_t + \Delta k_t \leq r_t' k_t + w_t n_t + \eta_t$. It is easily shown that $\tau = [\tau^* / (1 + \tau^*)]$, so that $\tau \leq \tau^*$.
- ⁶ For example, for the preferences given below by Equation 12, it is easy to show that $MRS(1 - n, c) = c / (1 - n)$. A good is said to be "normal" if a relaxation of the household budget constraint, with no change in relative prices, leads to an increased demand for the good.
- ⁷ Formally, $\partial c / \partial k = (f_1 - \delta + f_2 \phi_1) / (1 - f_2 \phi_2)$. For $\partial c / \partial k > 0$, it is sufficient that $f_1 - \delta > 0$.
- ⁸ A consumption tax can be implemented by combining a wage tax with a tax on a firm's cash flow. (This approach is advocated by Hall and Rabushka 1995.) The cash flow tax is nondistortional, so we can ignore it when tracing the economy's response to tax reform. For our purposes, the adoption of a consumption tax is equivalent to eliminating taxes on capital income while continuing to tax wage income.
- ⁹ Consider the effects of a cut in the labor-income tax rate, holding the capital-income tax rate constant. (We already know how changes in τ_p affect the capital

stock.) Equation 11 says that the steady-state capital–labor ratio is unaffected by a cut in τ_w . But if steady-state consumption is to increase (as our phase diagram says it must), then the steady-state levels of capital and labor cannot both fall. Hence, both must increase.

¹⁰ As discussed in Part 1, current average marginal rates of profit and wage taxation are approximately 35 percent. A 35 percent Hall–Rabushka-style consumption tax would be sufficient to replace the revenues raised by the current income and payroll taxes, provided most existing tax deductions and tax credits are eliminated.

¹¹ It should be noted that the convergence in this economy is faster in this case than if there were no labor entering the production technology. (See the example in Koenig and Huffman 1998). In the present case, the level of output can be augmented by increasing employment, which enables the capital stock to move more quickly to its new steady-state level. Because households seek to smooth the path of consumption, they are willing to work especially hard in the years immediately following tax reform.

¹² This framework does not allow the tax rate to influence the long-term rate of growth, which is assumed to be exogenously determined. For a simple model in which the growth rate is influenced by the tax rate, see the box entitled “Growth Effects.”

¹³ Such a high marginal tax rate might be required if the consumption tax were accompanied by a demogrant — a lump-sum transfer payment from the government — or if certain categories of consumption were excluded from the tax base.

¹⁴ Unfortunately, while there is a general consensus among economists that capital adjustment costs are important, there is no consensus on just how big they are. Since we have made no serious effort to calibrate our adjustment-cost equation to real-world data, our simulations are useful solely for what they have to say about the *qualitative* impact of capital adjustment costs on the economy’s response to tax reform.

¹⁵ Roughly speaking, with appropriate substitutions Equation 6 can be written as $c_t = (1 - \tau)[k_t^\theta n_t^{1-\theta} + (1 - \delta)k_t - (k_{t+1} - k_t)^2 - k_{t+1}]$. Taking the total derivative of this expression to calculate the price as $-dc_t/dk_{t+1}$ yields Equation 15.

¹⁶ See note 2.

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