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Tax Policy, the Macroeconomy, and Intergenerational Distribution

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The paper studies the dynamic macroeconomic and welfare effects of tax policy in the context of an overlapping-generations model of the Yaari-Blanchard type for a closed economy. The model is extended to allow for endogenous labor supply and three tax instruments—namely, a capital tax, labor income tax, and consumption tax. It is shown that labor taxes increase welfare of old generations whereas capital and consumption taxes reduce their welfare. [JEL D60, H23, H63]

Taxation has an immediate impact on resource allocation—via its effect on labor supply and goods consumption—as well as an intertemporal effect through, among others, its effect on investment decisions of firms and savings decisions of households. Given the cumulative character of physical and knowledge capital formation, current decisions on taxes made by short-lived individuals may have long-lasting effects, affecting current and future generations' welfare. The present paper addresses both the macroeconomic and intergenerational welfare aspects of tax policy in a Yaari (1965)-Blanchard (1985) model of overlapping generations. Three tax instruments are considered—namely, a capital tax, labor income tax, and consumption tax.

A large body of literature on the dynamic macroeconomic effects of tax policy has developed during the past two decades. Early studies on this topic (e.g., Feldstein, 1974; and Bernheim, 1981) were based on neoclassical growth models, featuring arbitrarily specified savings behavior, and thus are not well suited to

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analyzing the long-run growth effects of economic policies. Contributions in the 1980s addressed this shortcoming by modeling an infinitely lived representative household, which, endowed with perfect foresight, determines its optimal savings rate as the outcome of an intertemporal optimization procedure.[1] This literature argued that capital taxes reduce private savings and output in the steady state. Typically, labor supply was taken to be exogenous, so that the employment effects of policy-induced changes in capital formation could not be studied.

Recently, various authors have employed overlapping-generations models, as developed by Diamond (1965) and Yaari-Blanchard, to study the intergenerational effects of fiscal policy. The classic Yaari-Blanchard approach models a continuum of households that face an exogenous probability of death. In this setup, current generations are unconnected to previous and future generations—due to the absence of a bequest motive—and differ in the amount of accumulated financial wealth. Most studies have primarily employed the analytically more tractable Diamond[2] model (e.g., Auerbach and Kotlikoff, 1987, 1995; and Ihori, 1996), but recently, a few authors have studied tax policy issues employing the Yaari-Blanchard framework. Notably, Bovenberg (1993), who analyzes the distributional effects of capital taxation in a small open economy, and Bovenberg and Heijdra (1998), who look at capital taxes in a closed economy setting. Both studies show that old generations lose out in terms of welfare when capital taxes are introduced, while generations born at the time of the policy change gain. Recently, Heijdra and Ligthart (2000) have extended the Yaari-Blanchard model for a closed economy to include endogenous (intertemporal) labor supply and various instruments of tax policy.

The analysis in the present paper builds on the analytical model of Heijdra and Ligthart (2000), which is employed for two purposes. The first is to develop a versatile graphical apparatus, facilitating a qualitative analysis of the main macroeconomic linkages and tax effects.[3] As such, it can serve as a useful tool to policymakers trying to come to grips with the intertemporal effects of taxes. The graphical framework—and, more generally, the underlying model—encompasses a variety of special cases with respect to household characteristics and behavior. In particular, life spans of households and elasticities of (intertemporal) labor supply can be varied. In this way, the framework is a helpful tool in the study of key results from influential models—namely, the prototypical Barro (1974)-Ramsey (1928) model and Blanchard's (1985) model—as well as in providing new insights. It is shown that the equivalence of labor taxes and consumption taxes, a well-known result in dynamic general equilibrium models with infinitely lived households, no longer holds in a world of overlapping generations. Indeed, consumption taxes may increase savings and output if the investment effect associated with intergenerational turnover exceeds the labor supply effect, whereas labor taxes unambiguously reduce savings.

[1]See Brock and Turnovsky (1981), Turnovsky (1982, 1990), Abel and Blanchard (1983), and Judd (1985, 1987a, 1987b).

[2]Diamond (1965) assumes that individuals live for two discrete time periods, according to a life cycle in which they work and save during the first period and consume out of their savings in the second period.

[3]Rather than working with a linearized version of the model, the main schedules are depicted in nonlinear form.

The second purpose of this paper is to compute the intergenerational welfare effects for a plausibly calibrated version of the extended Yaari-Blanchard model. A number of studies (e.g., Auerbach and Kotlikoff, 1987; and Fullerton and Rogers, 1996) have addressed intergenerational tax matters in life cycle models, featuring a detailed general equilibrium structure calibrated for the U.S. economy. Compared to the present model, these frameworks are less able to provide clear insights in the key transmission mechanisms of policy shocks. To date, however, few studies have employed Yaari-Blanchard models to study welfare effects. Notable exceptions are the earlier mentioned papers of Bovenberg (1993) and Bovenberg and Heijdra (1998).

The present paper extends this literature to a menu of tax instruments. It shows that the political attractiveness of tax instruments differs due to their disparate effect on the intergenerational distribution of welfare. Capital and consumption taxes are shown to reduce welfare of existing generations, more so for the older generations, whereas generations born at the time of policy implementation gain in terms of welfare. Old generations experience a bigger welfare loss under consumption taxation. The simulation results for labor taxes indicate that old generations enjoy welfare gains, but future generations and generations born in the new steady state lose out. Therefore, from a political economy point of view, the introduction of labor taxes is likely to get more support in a popular vote. It may provide one of the reasons why labor taxes are so prevalent in developed countries.

I. The Model of Overlapping Generations

Model Structure

The perpetual youth approach of Blanchard (1985) is employed and extended to include endogenous labor supply and various tax instruments. The economy consists of a household sector, firm sector, and a government. Households are assumed to maximize lifetime utility—featuring a log-linear felicity function with private consumption and leisure as arguments—subject to their dynamic budget constraint. The latter says that the return on the household's financial wealth, plus its net labor income, is either consumed or saved. The production sector is characterized by a large number of firms that produce an identical good under perfect competition. The representative firm maximizes its net present value subject to the capital accumulation and production constraint. Households own the firms, which is their only way to accumulate financial wealth. The government provides lump-sum transfers to households, which are financed by capital, labor, and consumption taxes. It does not issue bonds.[4]

The model equations, variables, and parameter definitions are presented in Table 1.[5] The first two equations describe the dynamic part of the model. Aggregate consumption growth evolves according to equation (T.1) and differs from consumption growth for individual cohorts (i.e., the first term on the right)

[4]Issues of tax smoothing are thus abstracted from.

[5]A technical description of the model can be found in Heijdra and Ligthart (2000).

Table 1. The Model Equations

$$\dot{C}(t)=\left[r(t)-\alpha-\frac{\dot{t}_C(t)}{1+t_C(t)}\right]C(t)-\varepsilon_C\beta(\alpha+\beta)\left(\frac{K(t)}{1+t_C(t)}\right), \tag{T.1}$$

$$\dot{K}(t)=Y(t)-C(t), \tag{T.2}$$

$$W(t)[1-L(t)]=\left(\frac{1-\varepsilon_C}{\varepsilon_C}\right)\left(\frac{1+t_C(t)}{1-t_L(t)}\right)C(t), \tag{T.3}$$

$$W(t)=\varepsilon_L\left(\frac{Y(t)}{L(t)}\right), \tag{T.4}$$

$$\frac{r(t)}{1-t_K(t)}=(1-\varepsilon_L)\left(\frac{Y(t)}{K(t)}\right), \tag{T.5}$$

$$Y(t)=\gamma_0 L(t)^{\varepsilon_L}K(t)^{1-\varepsilon_L}, \tag{T.6}$$

$$T(t)=t_K(t)[Y(t)-W(t)L(t)]+t_L(t)W(t)L(t)+t_C(t)C(t). \tag{T.7}$$

Variables:

$L(t)$	Employment
$K(t)$	Capital stock
$C(t)$	Aggregate consumption
$Y(t)$	Aggregate net output
$W(t)$	Real wage rate
$r(t)$	Real interest rate
$T(t)$	Lump-sum transfers
$t_K(t)$	Capital tax
$t_L(t)$	Labor income tax
$t_C(t)$	Consumption tax

Parameters:

α	Pure rate of time preference
β	Death (=birth) rate ($\beta \geq 0$)
ε_L	Production share of labor ($0 < \varepsilon_L < 1$)
ε_C	Utility share of consumption
γ_0	Productivity parameter ($\gamma_0 > 0$)

Notation:

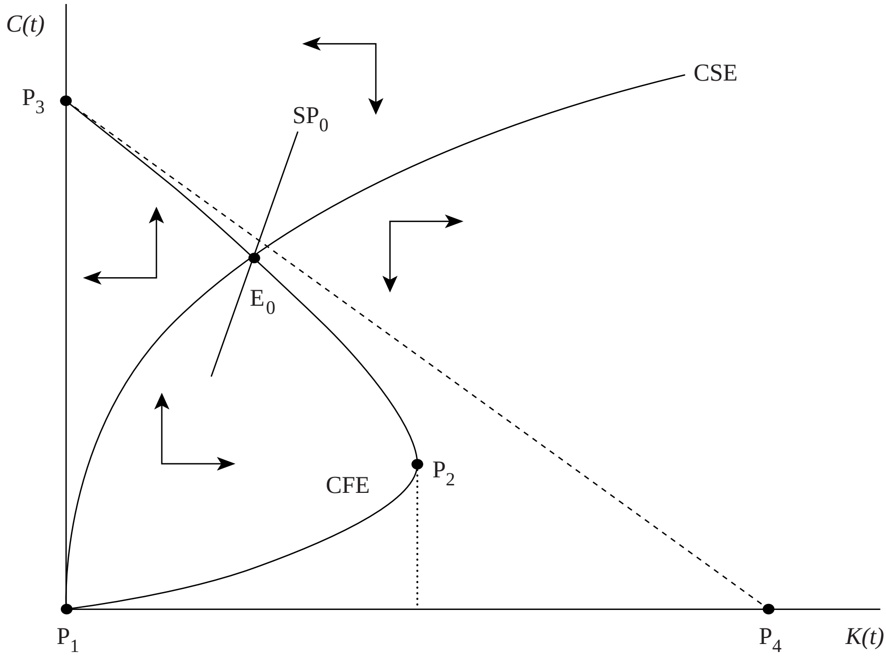
$\dot{x}(t) \equiv \mathrm{d}x(t)/\mathrm{d}t$

$\dot{t}_C(t) \equiv \mathrm{d}t_C(t)/\mathrm{d}t$

because of the turnover of generations (i.e., the second term on the right).[6] Note that individual consumption growth is a positive function of the wedge between the rate of interest and pure rate of time preference. Equation (T.2) describes the net accumulation of physical capital, which equals net output minus consumption. The static part of the model is represented by equations (T.3)–(T.7). The household's leisure-consumption decision rule is described by equation (T.3), which relates the value of leisure to consumption and the tax wedge, consisting of labor taxes, t_L, and consumption taxes, t_C. Equations (T.4) and (T.5) represent the firm's

[6]At each instant a cross section of the existing population dies and is replaced by a new generation. Since average consumption exceeds consumption by newly born agents (that are born without any financial wealth), the generational turnover effect drags down aggregate consumption growth.

Figure 1. Phase Diagram for the Overlapping Generations Model



marginal conditions for, respectively, labor and capital. Since capital is taxed at the firm level, the capital tax, t_K, appears in equation (T.5). The production function and the government budget constraint are given by equations (T.6) and (T.7).

Graphical Apparatus

The dynamic part of the model consists of the aggregate capital stock (a predetermined variable) and aggregate consumption (a forward-looking or jump variable). It can be summarized graphically by means of a phase diagram (Figure 1), featuring two schedules, the constant capital stock equilibrium (CSE) curve and the consumption flow equilibrium (CFE) locus. Steady-state (or long-run) equilibrium is attained at the intersection of the CSE and CFE curves in point E_0.[7] Although the figure is drawn in such a way that the equilibrium occurs on the upper branch of the CFE curve, it is quite possible that the structural parameters generate an outcome on the upward sloping section of the CFE curve (see also the discussion on the CFE curve below). Given the configuration of arrows, indicating the direction of motion, it is clear that this equilibrium is saddle-point stable, and that the saddle path, SP_0, is upward sloping.[8]

[7]The mathematical proofs are presented in the Appendix.

[8]Being the set of points from which the dynamic system converges to the steady state.

The CSE curve is upward sloping and represents (C, K) combinations for which net investment is zero. Points above the CSE curve are associated with a falling capital stock over time because goods consumption is too high and labor supply (and hence production) is too low. The opposite is the case for points below the CSE curve.

The second schedule, the CFE curve, depicts the aggregate consumption growth equation augmented for the turnover of generations. The position and slope of the CFE curve is determined by two effects, which work in opposite directions: (i) the "generational turnover" effect (see footnote 6); and (ii) the labor supply effect. The CFE curve is nearly horizontal close to the origin, where labor supply is approaching full exogeneity (as assumed in the standard Blanchard model) and upward sloping on the section P_1P_2. In contrast, on the section P_2P_3 labor supply is fairly elastic, yielding a CFE curve that is downward sloping and steeper than the respective CFE curve for an infinitely lived representative agent (given by the dashed line connecting points P_3 and P_4). When the elasticity of intertemporal labor supply approaches infinity the two CFE curves coincide.[9] The labor supply effect and short-run factor market dynamics can be illustrated with the help of some simple supply and demand diagrams (Box 1).

The dynamic forces operating on aggregate consumption along the two branches of the CFE curve can now be studied. Consider a point on the lower branch of the curve, where the labor supply effect is dominated by the generational turnover effect. Holding the capital stock constant, an increase in aggregate consumption leads to a small decrease in labor supply—as the relatively steep labor supply curve in Figure 2 shifts only a little—and, consequently, depresses the interest rate by a small amount. At the same time, the capital-consumption ratio falls, reducing the drag on aggregate consumption growth due to population turnover. The net effect of both forces is a rising aggregate consumption growth profile for points above the lower branch of the CFE curve. Points above the upper branch of the curve feature a falling consumption growth profile, reflecting a fall in the interest rate, which exceeds the growth-reducing effect operating through the capital-consumption ratio.

II. The Dynamic Macroeconomic Effects of Tax Policy: A Graphical Analysis

In this section the short- and long-run effects of the three tax instruments on the macroeconomy are analyzed with the aid of the graphical apparatus developed in the previous section. To keep matters simple, attention is restricted to an unanticipated and permanent change to a new tax policy. The government is assumed to maintain a balanced budget at each point in time; revenues raised by taxes are rebated to households in a lump-sum fashion. Further, it is assumed that the labor

[9]Note that in a representative agent (or Barro-Ramsey) model, aggregate and individual consumption coincide so that the CFE curve represents the locus of points where the rate of interest equals the rate of pure time preference.

Box 1. The Labor Supply Effect and Short-Run Factor Market Dynamics

Figure 2 depicts the rental market for the capital and labor markets, which can be used to analyze short-run factor market dynamics. In the left-hand panel, the demand for capital (K^D) is a standard downward sloping schedule due to diminishing returns to capital. An increase in employment[1] or a decrease in the capital tax rate shifts K^D up. The intersection of K^D and the vertical schedule K_0—representing a given capital stock—yields the short-run real interest rate that clears the rental market for capital at point E_0. The right-hand side panel features a downward sloping labor demand schedule (L^D) for a given capital stock. Labor supply (L^S) is an upward sloping schedule, reflecting the (positive) pure substitution effect of a wage change, which is isolated by incorporating the (negative) income effect in consumption. As a result, a rise (fall) in consumption shifts the labor supply curve to the left (right).

The figures can now be used to show that the rate of interest depends positively on consumption and negatively on the capital stock. An increase in consumption (say from C_0 to C_1) moves the labor supply curve to the left (from $L^S(W,C_0)$ to $L^S(W,C_1)$), and for a given capital stock, employment falls from L_0 to L_1 and the wage rate rises (represented by the move from E_0 to A). As a result, the capital demand schedule shifts to the left (from $K^D(r,L_0)$ to $K^D(r,L_1)$) in the left-hand panel of Figure 2, inducing a fall in the rate of interest. It can be demonstrated easily that a rise in the labor tax or consumption tax has qualitatively similar effects on the labor and capital markets in the short run. Intuitively, labor and consumption taxes reduce households' real after-tax wage, inducing them to substitute leisure for consumption.

An increase in the capital stock, from K_0 to K_1, has two effects on the rate of interest: a *direct* effect, which depresses the rental price of capital from E_0 to B′ in the left-hand panel of Figure 2, represented by a downward movement along the initial capital demand schedule, and, an *induced* effect, operating through the labor market. An increase in the capital stock boosts labor demand, leading to an increase in wages and employment, which, in turn, increases the demand for capital (from $K^D(r,L_0)$ to $K^D(r,L_2)$) and pushes up the interest rate—represented by the move from B′ to B. In sum, the net effect of a larger capital stock is depicted by the fall in the interest rate from point E_0 to B.[2]

[1]Note that labor and capital are cooperative factors given the assumed Cobb-Douglas production structure.

[2]It can be demonstrated easily that the direct effect always dominates the induced effect.

supply effect is relatively strong, implying that the initial equilibrium is located on the downward sloping section of the CFE curve (see Figure 1). Notably, the qualitative allocation effects of the capital and labor taxes are not affected by the slope of the CFE curve. However, it is demonstrated below that, for the qualitative effects of a consumption tax change, the size of the generational turnover effect does matter.

Capital Tax

The effects of the capital tax are illustrated with the aid of Figures 2 and 3. An increase in the capital tax rate shifts the CFE locus to the left in Figure 3. On impact, this leads to a fall in the demand for capital, which depresses the rate of interest for a given initial stock of capital. As a result, consumption today is made more attractive than future consumption, as represented by the vertical jump from point E_0 to A, which is located on the new saddle path, SP_1. The increase in consumption shifts the labor supply schedule to the left (see Figure 2) so that

Figure 2. The Capital and Labor Markets

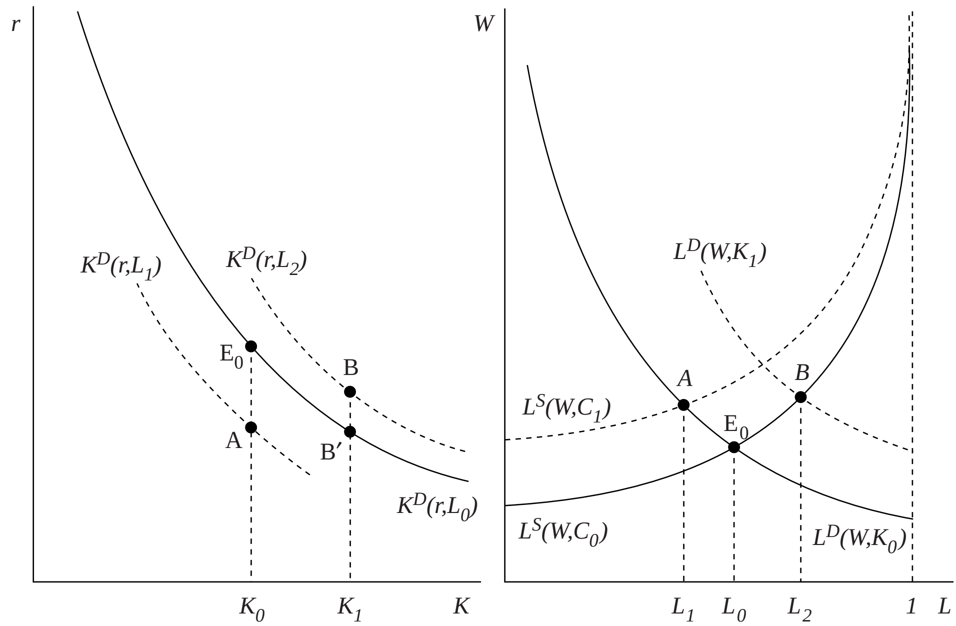
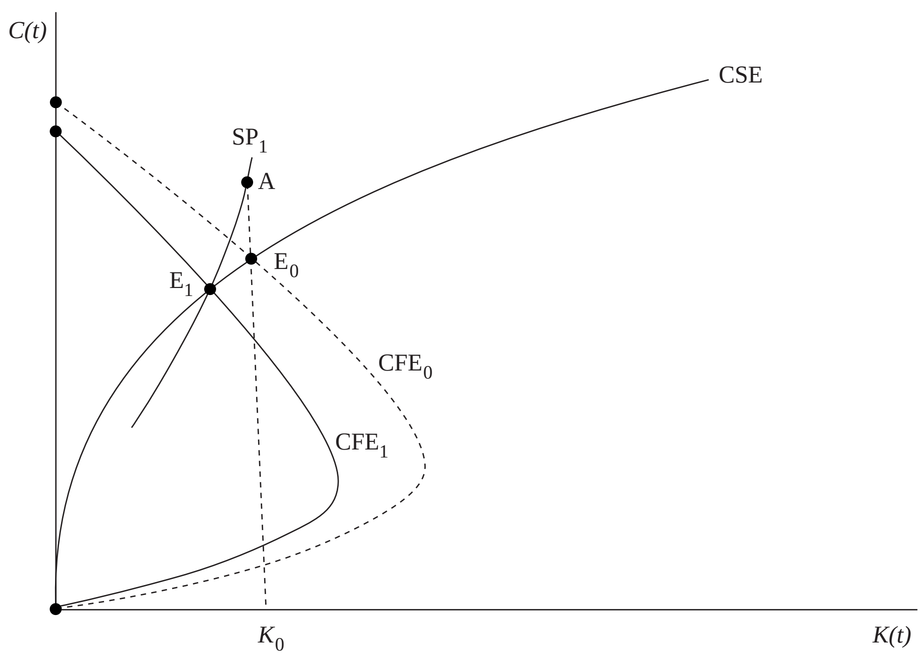


Figure 3. Effects of the Capital Tax



employment and output fall, while the wage rate rises in the short run. The reduction in employment prompts a further decline in capital demand, depressing the rate of interest even more.

The simultaneous increase in consumption and decrease in production crowds out net investment, causing the capital stock to fall over time. In the medium term, the optimal time profile of consumption is downward sloping, so that consumption also starts to decline after its initial increase—depicted by the move from point A to E_1 along the SP_1 curve in Figure 3. In the long run, output and consumption decline proportionally, but steady-state employment is unaffected. Intuitively, the reduction in the capital stock depresses the firm's labor demand, but the fall in consumption boosts labor supply, depressing long-run wages and causing employment to move back to its old level (see Figure 2). Note that the after-tax interest rate recovers somewhat during transition, but remains below its old equilibrium level. Part of the burden of capital taxes is thus borne by capital owners, a result which is impossible in a dynamic representative agent model. The latter features an exogenous steady-state rate of interest that equals the pure rate of time preference. Table 2 compares the short- and long-run results for both classes of models.

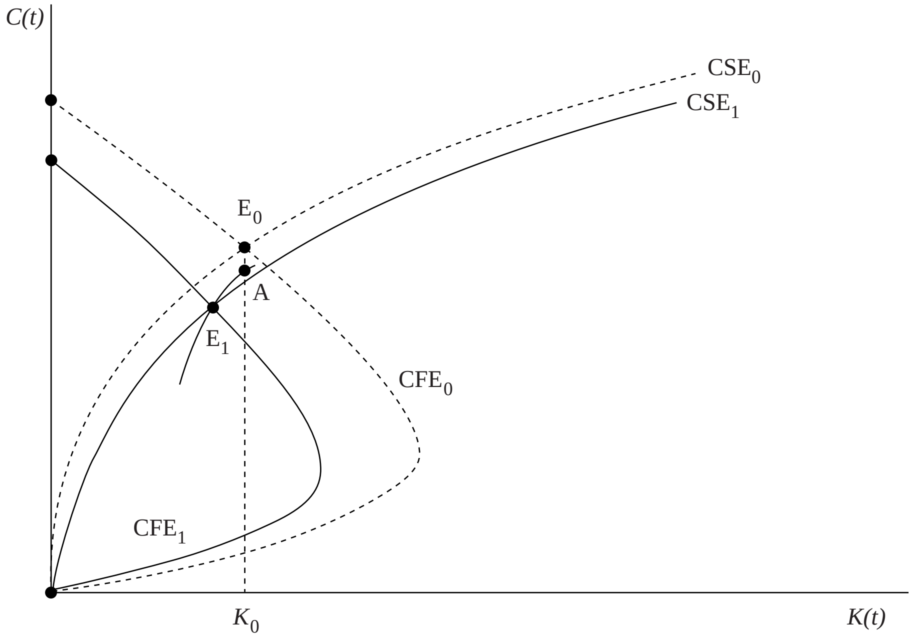
Labor Income Tax

The effects of the labor income tax can be studied with the aid of Figures 2 and 4. In Figure 4, the CSE curve shifts down and the CFE curve shifts to the left, reducing consumption from point E_0 to A. An increase in the labor tax shifts both the capital demand and labor supply schedules to the left (see Figure 2). On impact, the reduced capital demand causes a fall in the rate of interest and consumption, which, subsequently, shifts the labor supply curve to the right. The net effect on the labor market is a reduction in employment, which causes a fall in short-run output. Both gross and after-tax wages rise, whereas the rate of interest declines, reflecting that capital bears part of the short-run incidence of labor taxes.[10]

In the medium term, consumption, physical capital, and output decline when the economy moves from point A to E_1 in Figure 4. In terms of Figure 2, the fall in the capital stock gradually shifts the labor demand curve further to the left, giving rise to additional reductions in employment, which are partially offset by increased labor supply (induced by the negative income effect of a fall in consumption). In the long run, both employment and the capital stock fall. The optimal capital-labor ratio is unaffected, however, which explains why gross wages and interest rates (and hence the C/K ratio) do not change in the long run. After-tax wages decline if intertemporal labor supply is elastic, implying that workers fully bear the long-run incidence of labor taxes. This is in line with results derived in a representative agent framework (Table 2).

[10]Tax incidence is defined as the after-tax wage (including transfers) for labor and the after-tax rate of interest for capital.

Figure 4. Effects of the Labor Income Tax



Consumption Tax

From the tax policy literature it is well known that in a representative agent model, a consumption tax is equivalent to a labor tax with respect to its effects on the macroeconomy.[11] In such a model, the steady-state rate of interest is given, so that the consumption tax, or equivalent labor tax, does not affect the household's intertemporal tradeoff between present and future consumption. Indeed, taxation affects savings only through its impact on a household's level of wealth. In the presence of overlapping generations, this familiar equivalence result no longer holds because the generational turnover effect now works in the opposite direction of the labor supply effect.

For a marginal increase in the consumption tax, the CSE schedule shifts down, whereas the CFE line shifts to the right (left) for points below (above) the auxiliary line P_1P_2 (see Figure 5). Consumption jumps down on impact from point E_0 to A. The graphical framework set out in Box 1 can be used to explain this effect. An increase in the consumption tax shifts the labor supply curve to the left and the capital demand curve down, causing a reduction in the interest rate and a fall in consumption, which, on its turn, shifts the labor supply locus partially back. The net effect on the labor market is a fall in employment that

[11]The change in the consumption tax must also be unanticipated and permanent to obtain equivalence. See Summers (1981), and Atkinson and Stiglitz (1980).

Table 2. Summary of Qualitative Effects of Tax Policy[1]

	model[2]	period	Y	K	L	C	W	r
Capital tax	OLG	0[3]	–	0	–	+	+	–
		∞[4]	–	–	0	–	–	–
	RA	0	–	0	–	+	+	–
		∞	–	–	0	–	–	0
Labor tax	OLG	0	–	0	–	–	+	–
		∞	–	–	–	–	0	0
	RA	0	–	0	–	–	+	–
		∞	–	–	–	–	0	0
Consumption tax	OLG	0	–	0	–	–	+	–
		∞	–	–	–	–	+	–
	RA	0	–	0	–	–	+	–
		∞	–	–	–	–	0	0

[1]It is assumed that the generational turnover effect is dominated by the labor supply effect.

[2]Two variants are considered: an overlapping generations (OLG) model and an infinitely lived representative agent (RA) model.

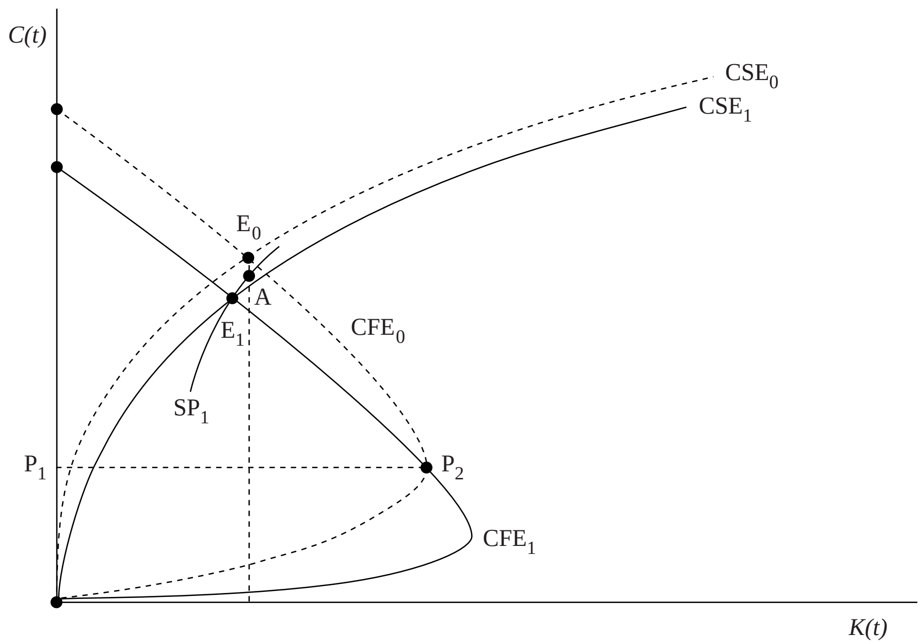
[3]The impact effect is denoted by $t = 0$.

[4]The long-run effect is denoted by $t \to \infty$.

increases the capital intensity of production. Consequently, the after-tax return on capital declines and the aggregate consumption growth profile becomes downward sloping. In the impact period, the reduction in consumption is dominated by the fall in output, thus having a negative effect on net investment. Over time, the capital stock and output fall, which is represented by the movement from point A to E_1 in Figure 5. In the new steady state, employment and capital are both lower than their pre-reform values, but the fall in employment is larger, yielding an increase in the equilibrium capital-labor ratio. As a result, the steady state rate of interest is below its initial value; part of the burden of the consumption tax is thus borne by capital owners, who do not bear any incidence in a representative agent setting (Table 2).

Matters are quite different if the generational turnover effect dominates the labor supply effect; savings may increase. This can be explained as follows. An increase in the consumption tax causes a redistribution of income from old to young generations. Old agents have more wealth accumulated and consume more than recently born agents and thus face a larger tax bill. Since the additional tax revenue is recycled to all generations in an age-independent manner, old generations are hit harder by the consumption tax than young generations. On impact, the proportional consumption difference between old and young agents falls, giving rise to an increase in aggregate consumption growth. However, the level of aggregate consumption falls, but outweighs the fall in production, so as to yield an increase in net investment. In the new steady state, the capital stock and the capital-labor ratio are higher so that the rate of interest is below its old equilibrium value.

Figure 5. Effects of the Consumption Tax



III. Intergenerational Welfare Effects: Simulation Experiments

Tax policy affects the intergenerational distribution of welfare. This section attempts to quantify the intergenerational welfare effects of various tax policy instruments by presenting numerical simulations of the model set out in Section I.

Methodology

To explain the intuition behind the welfare effects, instantaneous utility (or felicity) of generation v at time t, $\Lambda(v,t)$ is decomposed in a "quantity" component (represented by full consumption of generation v at time t, $C_F(v,t)$, which is defined as the value of goods consumption plus the opportunity cost of leisure) and a "price" component (that is, the cost-of-living index, $p_\Lambda(t)$), which affects all generations equally:

$$\Lambda(v,t) = \frac{C_F(v,t)}{p_\Lambda(t)}, \quad p_\Lambda(t) \equiv \left(\frac{1+t_C(t)}{\varepsilon_C}\right)^{\varepsilon_C}\left(\frac{W(t)(1-t_L(t))}{1-\varepsilon_C}\right)^{1-\varepsilon_C}. \tag{1}$$

Welfare of generation v at time t is defined as:

$$U(v,t) \equiv \int_t^\infty \ln[\Lambda(v,\tau)]\exp[(\alpha+\beta)(t-\tau)]d\tau, \tag{2}$$

where α denotes the pure rate of time preference, β is the probability of death (that is equal to the birth rate so as to keep the population size constant), and ε_C is the utility share of consumption. Utility rises if full consumption increases or the cost-of-living index decreases. A fall in gross wages or a rise in labor taxes decreases the cost-of-living index because the opportunity cost of leisure is reduced. Raising consumption taxes increases the cost-of-living index. Note that changes in the rate of interest affect welfare indirectly through its effect on full consumption.

The model is calibrated for a more or less plausible set of parameters.[12] The instantaneous probability of death, β, is set equal to 4 percent a year, implying that agents have a planning horizon of 25 years. The pure rate of time preference is assumed to be 0.04. A Cobb-Douglas function is considered with a (before-tax) wage share in net output of $\varepsilon_L = 0.8$. The benchmark model employs a moderate value of the intertemporal elasticity of labor supply (that is, $\omega_{LL} = 2$), which, taken together with a low value of β, implies that the labor supply effect dominates the generational turnover effect. In addition, it is assumed that initial tax rates are zero. Given the values of the basic parameters (that is α, β, ω_{LL}, and ε_L) and initial taxes, the implied estimates are derived for the equilibrium output-capital ratio, interest rate, and other relevant variables. The calibrated model is employed to explore how the various taxes affect the path of intergenerational welfare. In addition, it is studied in what way this path is affected by initial tax rates, the intertemporal elasticity of labor supply, and the birth rate.

Simulation Results

Table 3 presents the simulation results for three representative generations: extremely old existing generations (denoted by $dU(-\infty, 0)$), generations born at the time of the policy shock (denoted by $dU(0, 0)$) and future steady-state generations (denoted by $dU(\infty, \infty)$). Introducing a capital tax benefits generations born at the time of the policy shock, while welfare of old existing generations and generations born far in the future declines. Old generations experience a bigger welfare loss than future generations. The shape of the welfare profile induced by a capital tax can be explained as follows. The capital tax depresses the rate of return on financial capital, causing consumption of old generations—who predominantly consume out of financial capital—to fall. Generations born at the time of the policy change benefit from the jump in wages on impact, which raises their full consumption. Future generations—who mainly consume out of human wealth[13]—experience a welfare loss due to the fall in human wealth associated with a reduction in after-tax wage income,[14] which is only partially offset by an improvement in the cost-of-living index. Similar

[12]By substituting equation (1) in (2) and applying the Laplace transform method (see Judd, 1985, 1987a) to the loglinearized model as set out in Heijdra and Ligthart (2000), analytical expressions for the welfare profiles of existing generations (with a generation index $v \leq 0$) and future generations (with $v = t \geq 0$) can be derived. These equations are employed in deriving the numerical results.

[13]Human wealth is defined as the present discounted value of maximum after-tax wage income.

[14]Gross wages fall as a result of the introduction of the capital tax. However, receipts of age-independent lump-sum transfer income—that is, the recycled revenues from the capital tax—attenuate the fall in gross wage income somewhat.

Table 3. Intergenerational Welfare Effects of Taxation for Various Values of the Labor Supply Elasticity

Shock	Tax Rate	$dU(v,v)$	$\omega_{LL} = 1$	$\omega_{LL} = 3$	$\omega_{LL} = 6$
Δt_K	$t_K = 0$	$dU(-\infty,0)$	–3.796	–3.225	–2.941
		$dU(0,0)$	0.706	0.358	0.209
		$dU(\infty,\infty)$	–0.024	–0.088	–0.073
		ρ	59.78	62.79	65.38
	$t_K = 0.10$	$dU(-\infty,0)$	–3.612	–3.021	–2.722
		$dU(0,0)$	0.513	0.253	0.145
		$dU(\infty,\infty)$	–0.199	–0.172	–0.120
		ρ	54.05	56.48	58.83
Δt_L	$t_L = 0$	$dU(-\infty,0)$	3.710	5.778	6.710
		$dU(0,0)$	–0.357	–0.259	–0.164
		$dU(\infty,\infty)$	–0.694	–0.551	–0.369
		ρ	61.23	66.25	68.90
	$t_L = 0.10$	$dU(-\infty,0)$	3.402	5.521	6.535
		$dU(0,0)$	–0.699	–0.560	–0.375
		$dU(\infty,\infty)$	–1.017	–0.831	–0.564
		ρ	38.31	42.75	45.18
Δt_C	$t_C = 0$	$dU(-\infty,0)$	–9.361	–7.077	–6.016
		$dU(0,0)$	1.241	0.530	0.284
		$dU(\infty,\infty)$	1.018	0.280	0.096
		ρ	48.57	49.29	50.98
	$t_C = 0.10$	$dU(-\infty,0)$	–9.606	–7.296	–6.170
		$dU(0,0)$	0.906	0.293	0.126
		$dU(\infty,\infty)$	0.642	0.009	–0.085
		ρ	39.63	31.61	27.14

Key: Parameter values are: $\alpha = 0.04$, $\beta = 0.04$, and $\varepsilon_L = 0.8$. The parameter ρ measures the proportion of the existing population benefiting from a welfare improvement due to an increase in the respective tax, and ω_{LL} represents the intertemporal labor supply elasticity.

results for capital taxes are obtained by Auerbach and Kotlikoff (1987), who simulate a multi-generation calibrated Diamond (1965) model for the U.S. economy.

The introduction of a labor tax yields a welfare gain to old and young existing generations at the expense of future generations and generations born close to the time of the policy change. Intuitively, the labor tax induces a fall in the after-tax wage in the new steady state, which reduces human wealth and thus decreases consumption of future generations. This deleterious effect is partly offset by the fall in the cost-of-living index caused by the reduction in net wages. Old generations gain substantially due to the beneficial effect of the reduction in the cost-of-living index that exceeds the welfare loss prompted by the fall in the short-run rate of interest. The pattern of welfare change is preserved for various values of the intertemporal elasticity of labor supply and initial taxes. Higher intertemporal elasticities of labor supply increase the welfare gain of old existing generations and reduce the welfare losses of future generations. It more or less pushes upward the profile of welfare change. In contrast, higher initial taxes drag down the profile of welfare change. This qualitative pattern also applies to initial taxes larger than those presented in the table, but these results are not shown for the sake of brevity.

The final tax policy experiment concerns the introduction of a consumption tax, which benefits generations born at the time of the policy change and generations yet to be born at the expense of welfare of old existing generations. Intuitively, an increase in the consumption tax raises the steady-state capital-labor ratio,[15] thereby pushing up the wage-rental ratio. As a result, human wealth increases and thus full consumption of future generations rises in the new steady state. However, old generations bear the full burden of the consumption tax rise. Due to the fall in the rate of interest their consumption is reduced, more so the older they are (in which case they consume a larger share out of financial capital).

Table 3 also shows the percentage of the population alive that does not suffer a welfare loss from a policy change.[16] This proportion, represented by ρ, can be interpreted as the degree of political support in a popular vote on introducing (or raising) the tax under consideration. If decisions are made by a majority rule, both capital and labor taxes are viable policy instruments even when (intertemporal) labor supply is relatively inelastic. Labor taxes get the most political support, which is not surprising given that they yield a welfare gain to old generations. Political support for capital and labor taxes increases for higher values of the labor supply elasticity. However, introducing consumption taxes can count on the least political support given that old generations lose out the most.[17] Political support for further tax increases declines in all three cases, but the fall in support is much larger for labor taxes than for capital taxes. Table 4 shows that political support for consumption and capital taxes is strong for low birth rates (represented by a low β), but declines as the expected lifetime of individuals decreases and thus the generations become more disconnected. Conversely, labor taxes get more political support if birth rates rise, reflecting the smaller welfare loss experienced by young generations and generations born at the time of the policy change.

IV. Policy Discussion

The present section tries to link the analytical results from the previous sections to the recent tax policy debate on consumption taxes in OECD countries. To this end, some of the rather stylized assumptions of the model are relaxed; policy issues are discussed in a broader context, which includes aspects of reality such as unemployment, inflation, and income differences within generations.

[15]The consumption tax decreases both the long-run capital stock and the long-run level of employment, but the fall in the latter is bigger so that the capital-labor ratio rises.

[16]These values are computed for a 1 percent rise in the respective tax rate. Alternatively, one could look at the degree of political support for tax increases that raise an equivalent amount of revenue, in which case tax base effects would matter.

[17]Note that the government can, if it wants to, issue bonds to compensate old generations for the welfare loss so as to make the introduction of consumption or capital taxes less painful. Future generations are taxed when the public debt is redeemed.

Table 4. Intergenerational Welfare Effects of Taxation for Various Values of the Birth Rate

Shock	Tax Rate	$dU(v,v)$	$\beta = 1$	$\beta = 3$	$\beta = 6$
Δt_K	$t_K = 0$	$dU(-\infty,0)$	–5.690	–4.682	–2.683
		$dU(0,0)$	0.587	0.553	0.400
		$dU(\infty,\infty)$	–0.220	–0.155	–0.042
		ρ	64.85	63.98	58.97
	$t_K = 0.10$	$dU(-\infty,0)$	–5.372	–4.418	–2.529
		$dU(0,0)$	0.362	0.367	0.297
		$dU(\infty,\infty)$	–0.402	–0.308	–0.131
		ρ	53.69	55.35	54.06
Δt_L	$t_L = 0$	$dU(-\infty,0)$	7.763	6.586	4.130
		$dU(0,0)$	–0.585	–0.457	–0.232
		$dU(\infty,\infty)$	–1.023	–0.855	–0.513
		ρ	46.14	54.15	70.38
	$t_L = 0.10$	$dU(-\infty,0)$	7.288	6.192	3.895
		$dU(0,0)$	–1.114	–0.902	–0.506
		$dU(\infty,\infty)$	–1.530	–1.275	–0.765
		ρ	24.10	31.04	47.56
Δt_C	$t_C = 0$	$dU(-\infty,0)$	–12.482	–10.445	–6.297
		$dU(0,0)$	1.099	0.954	0.603
		$dU(\infty,\infty)$	0.678	0.593	0.406
		ρ	59.28	55.00	44.39
	$t_C = 0.10$	$dU(-\infty,0)$	–12.901	–10.786	–6.489
		$dU(0,0)$	0.633	0.571	0.382
		$dU(\infty,\infty)$	0.156	0.161	0.155
		ρ	41.10	38.66	31.54

Key: Parameter values are: $\alpha = 0.04$, $\omega_{LL} = 2$, and $\varepsilon_L = 0.8$. The parameter ρ measures the proportion of the existing population benefiting from a welfare improvement due to an increase in the respective tax, and ω_{LL} represents the intertemporal labor supply elasticity.

The previous sections showed that capital taxes reduce savings and, given the closed economy setting, concomitantly reduce investment and the physical capital stock. Higher labor taxes also reduce capital formation and employment provided that *inter*temporal labor supply is sufficiently flexible. The capital-labor ratio and wage-rental ratio are unaffected by labor taxes, however, a result that crucially depends on the assumption of a unit *intra*temporal elasticity of substitution between consumption and leisure. But, if households can easily substitute leisure for consumption at a given point in time, labor taxes typically increase the capital intensity of production. This may be an undesirable implication for economies that suffer from high rates of unemployment and feature capital-intensive production structures.

Allocation results for consumption taxes are quite different. Increases in consumption taxes increase the steady-state capital stock if the positive investment effect associated with generational turnover dominates the intertemporal labor supply effect. If this condition is not met, investment and savings decline, and consequently the long-run capital stock and output fall, but by less than that for labor taxes. Results from a plausibly calibrated version of the model indicate that the labor supply effect is likely to dominate even for quite high values of the death rate. Without overlapping generations—and thus a zero death/birth rate—consumption and labor taxes have an equivalent (negative) effect on aggregate savings and output. However, the reduction in the capital stock is larger than with finitely lived households because the positive investment effect of generational turnover is absent.

During the past two decades, in view of their relatively high labor tax burden, various OECD countries implemented tax reforms aimed at switching the burden of taxation away from labor to broad-based consumption taxes (via increases in value-added tax (VAT) rates and extension of the VAT base).[18] The extended Yaari-Blanchard model can be employed to show why such a strategy is appealing to countries with low savings rates. Take the case of a one-for-one substitution of consumption for labor taxes. This type of reform leaves the CSE curve unaffected, but shifts the CFE curve to the right, boosting household savings, consumption, and capital accumulation in the new long-run equilibrium. Employment is unaffected; the higher capital stock increases labor demand but this is exactly offset by a reduction in labor supply induced by a rise in consumption.

Alternatively, countries may contemplate revenue-neutral swaps of consumption taxes for labor taxes.[19] In this case, the consumption tax has to rise less than one for one, owing to the fact that a tax on consumption is more efficient than a tax on labor income.[20] Intuitively, both instruments tax labor income,[21] but consumption taxes have a broader base because they also tax the returns from the initial holdings of financial assets and transfer income. This basically amounts to a lump-sum tax on initial wealth. The policy literature (e.g., OECD (1995)) has suggested that this type of reform may have a beneficial effect on employment, but is not specific about under what circumstances this is likely to materialize. In general, one could say that the following conditions need to be met: (i) the base of the consumption tax is relatively broad; and (ii) the difference in marginal efficiency costs in the initial tax system is large. In particular, the marginal excess burden of the initial labor tax should be high and the consumption tax burden should primarily fall on the production factor with low marginal efficiency costs (that is, capital). Relative efficiency costs of labor and capital taxes, on their turn, depend on the level of initial taxes, the wage elasticity of labor supply (determining the size of the distortion along the labor-leisure margin), and the intertemporal elasticity of substitution (determining the distortion along the intertemporal dimension).[22]

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[18]See OECD (1995) for an overview of the policy discussion on coordinated labor-consumption tax reforms.

[19]A full analysis of this reform—using numerical simulations—is beyond the scope of the present paper. Instead, an intuitive account of the effects is provided.

[20]Note that the labor income tax will vary over time reflecting changes in the labor and consumption tax bases during transition.

[21]As is well known, taxes on consumption are *implicit taxes* on labor that produce both labor and commodity market distortions.

[22]Specifically, distortions are larger, the higher the initial tax rates and the larger the elasticities of labor supply and intertemporal substitution.

Besides the aforementioned beneficial effects, the literature has also indicated some concerns with consumption taxes due to their distributional impact. First, they are generally considered to be regressive *intra*generationally; that is, the income distribution is shifted in favor of high-income taxpayers who consume a lower proportion of their income. In addition, higher consumption taxes are likely to increase the general price level shifting part of the burden to those households whose income is not indexed against inflation. In practice, low-income households are often somewhat protected against this effect by preferential tax rates charged on basic food items and well-targeted subsidy programs. Second, consumption and labor taxes have disparate effects on the *inter*generational distribution of welfare. The present model shows that consumption taxes are progressive across generations; households that consume out of the return on their financial assets—that is, wealthy, old generations—are hit harder by a consumption tax than young working households.

V. Concluding Remarks

The paper has extended the Yaari-Blanchard model of overlapping generations to study the intertemporal macroeconomic and welfare effects of tax policy. The graphical analysis shows that capital taxes reduce savings and discourage capital formation in the steady state, whereas labor taxes reduce the capital stock provided intertemporal labor supply is endogenous. In addition, the short- and long-run effects of tax changes differ. For example, the capital tax increases the capital-labor ratio in the short run, but ultimately the new steady-state capital-labor ratio is below its initial value.

Results are less definite for consumption taxes because the labor supply and generational turnover effects work in opposite directions. If the generational turnover effect dominates, an increase in consumption taxes leads to a rise in the long-run capital stock. The equivalence between consumption and labor taxes, which applies in a representative agent model, thus fails to hold in an overlapping-generations context. Results from a plausibly calibrated version of the model indicate, however, that the labor supply effect is likely to be dominant even for quite high values of the death rate. As a result, consumption taxes depress the capital stock, but by a smaller amount than in a representative agent model, reflecting the positive investment effect of generational turnover.

Simulation experiments demonstrate that capital and consumption taxes reduce welfare of existing generations, more so the older the generations are, reflecting the higher share of interest-bearing assets in their portfolios. Intuitively, both consumption and capital taxes depress the long-run rate of interest and thus reduce the household's capital income. Generations born at the time of the introduction of these taxes enjoy a welfare gain, however, because their full consumption increases. The welfare effects of labor taxes are drastically different. Old generations gain in terms of welfare, but future generations born in the new steady state lose out. Consequently, from a political point of view, the introduction of labor taxes is likely to get the largest support in a popular vote on the three taxes.

APPENDIX

In this appendix the schedules underlying the phase diagram (see Figure 1)—that is, the capital stock equilibrium (CSE) and consumption flow equilibrium (CFE) locus—are derived.

Equilibrium Employment

By using labor demand (equation (T.4)) and labor supply (that can be derived from equation (T.3)), and the production function (equation (T.6)), an expression is obtained relating equilibrium employment to the variables C and K:

$$\Omega(L) \equiv (1-L)L^{\varepsilon_L - 1} = \frac{(1-\varepsilon_C)(1+t)}{\gamma_0 \varepsilon_L \varepsilon_C} C K^{-(1-\varepsilon_L)}, \tag{A.1}$$

where $t \equiv (t_C + t_L)/(1 - t_L)$ denotes the tax wedge faced by the household and $\Omega(L)$ is a decreasing function in the economically meaningful interval $L \in [0,1]$. Equilibrium employment depends negatively on consumption and the tax wedge and positively on the capital stock.

The Capital Stock Equilibrium Schedule

The capital stock equilibrium (CSE) locus represents the collection of points in the (C,K) space for which net investment is zero and thus $Y = C$. We note from equations (T.3) and (T.4) that:

$$\omega_{LL} \equiv \frac{1-L}{L} = \left(\frac{(1-\varepsilon_C)(1+t)}{\varepsilon_C \varepsilon_L}\right)\left(\frac{C}{Y}\right), \tag{A.2}$$

where ω_{LL} denotes the leisure-labor ratio. Since $Y = C$ along the CSE curve, it follows that employment L_{CSE} along that line is given by:

$$L_{CSE} \equiv \frac{\varepsilon_C \varepsilon_L}{\varepsilon_C \varepsilon_L + (1+t)(1-\varepsilon_C)}, \quad 0 < L_{CSE} < 1. \tag{A.3}$$

Note that if labor supply is exogenous (i.e., $\varepsilon_C = 1$, so that $L_{CSE} = 1$), then consumption and labor taxes do not affect steady-state employment. In the case of endogenous labor supply, represented by $0 < \varepsilon_C < 1$, a rise in the tax wedge reduces employment along the CSE curve. Using equation (A.3) in the production function (equation (T.6)) and using equation (T.2) in steady-state format, an expression for the CSE curve can be derived:

$$C = \gamma_0 L_{CSE}^{\varepsilon_L} K^{1-\varepsilon_L}, \tag{A.4}$$

which is a concave upward sloping function through the origin—see Figure 1.

The Consumption Flow Equilibrium Schedule

The consumption flow locus represents all points in the (C,K) space for which aggregate consumption is in equilibrium. By using equation (T.1) in steady state and equations (T.5) and (T.6), the CFE locus in the (K,L) space is obtained:

$$\xi_0 \equiv \frac{\beta(\alpha+\beta)(1-\varepsilon_C)}{\varepsilon_L(1-\varepsilon_L)(1-t_L)(1-t_K)} = \omega_{LL} y[y - \bar{y}], \quad \bar{y} = \frac{\alpha}{(1-\varepsilon_L)(1-t_K)}, \tag{A.5}$$

$$y=\gamma_0\left(\frac{L}{K}\right)^{\varepsilon_L}, \tag{A.6}$$

where $y\equiv Y/K$ is the output-capital ratio. The CFE line can be described by parametrically varying L in the feasible interval [0,1]. Solving equation (A.5) for the economically meaningful root yields the output-capital ratio as a function of employment, initial taxes, and the various preference and technology parameters:

$$y=\bar{y}\left(\frac{1}{2}+\sqrt{\frac{1}{4}+\frac{\xi_0}{\bar{y}^2\omega_{LL}}}\right). \tag{A.7}$$

By using this result in equation (A.6) an expression for the capital-labor ratio is obtained:

$$\frac{K}{L}=\left(\frac{y}{\gamma_0}\right)^{-1/\varepsilon_L}=\left(\frac{\bar{y}}{\gamma_0}\right)^{-1/\varepsilon_L}\left(\frac{1}{2}+\sqrt{\frac{1}{4}+\frac{\xi_0}{\bar{y}^2\omega_{LL}}}\right)^{-1/\varepsilon_L}, \tag{A.8}$$

from which the following limiting results can be derived:

$$\lim_{L\to 0}\left(\frac{K}{L}\right)=\left(\frac{\bar{y}}{\gamma_0}\right)^{-1/\varepsilon_L},\quad \lim_{L\to 1}\left(\frac{K}{L}\right)=0. \tag{A.9}$$

The labor market equilibrium condition (equation (A.1)) can be rewritten to arrive at an expression for consumption:

$$C=\left(\frac{\gamma_0\varepsilon_C\varepsilon_L}{(1-\varepsilon_C)(1+t)}\right)\left(\frac{K}{L}\right)^{1-\varepsilon_L}(1-L), \tag{A.10}$$

from which the following limiting results can be derived:

$$\lim_{L\to 0} C=\left(\frac{\gamma_0\varepsilon_C\varepsilon_L}{(1-\varepsilon_C)(1+t)}\right)\lim_{L\to 0}\left(\frac{K}{L}\right)^{1-\varepsilon_L}, \tag{A.11}$$

$$=\left(\frac{\gamma_0\varepsilon_C\varepsilon_L}{(1-\varepsilon_C)(1+t)}\right)\left(\frac{\bar{y}}{\gamma_0}\right)^{(\varepsilon_L-1)/\varepsilon_L},$$

$$\lim_{L\to 1} C=0. \tag{A.12}$$

This implies that the CFE line has the same vertical intercept as the CFE line for a representative agent model—represented by the dashed downward sloping line—if laborers decide not to supply any labor (i.e., $L\to 0$). If laborers work all of their available time (i.e., $L\to 1$), however, then the CFE line goes through the origin.

In the representative agent model, with $\beta = 0$, the CFE locus can be represented by $y=\bar{y}$. Using this result in equation (A.10) yields, after a few steps, the following expression for consumption:

$$C=\left(\frac{\gamma_0\varepsilon_C\varepsilon_L}{(1-\varepsilon_C)(1+t)}\right)\left(\frac{\bar{y}}{\gamma_0}\right)^{(\varepsilon_L-1)/\varepsilon_L}\left[1-\left(\frac{\bar{y}}{\gamma_0}\right)^{1/\varepsilon_L}K\right] \tag{A.13}$$

$$=\left(\frac{\alpha\varepsilon_C\varepsilon_L}{(1-\varepsilon_C)(1-t_K)(1-\varepsilon_L)(1+t)}\right)\left[\left(\frac{\bar{y}}{\gamma_0}\right)^{-1/\varepsilon_L}-K\right],$$

showing that the CSE curve is linear and downward sloping. It can be shown—though it is somewhat tedious to do so—that the CFE line for the overlapping-generations model is downward sloping and steeper than the CFE curve for a representative agent model.

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