Ricardian non-equivalence The old saying that "in life only death and tax are certain" fits the Ricardian non-equivalence view well. Many economists dissociate themselves from representative agent models because of their problematic description of the household sector. Instead attention is drawn to overlapping generations models which emphasize finite lifetime and life-cycle behavior of human beings and lead to a refutation of Ricardian equivalence. The essential point is that those individuals who benefit from lower taxes today will only be a fraction of those who bear the higher tax burden in the future. As taxes levied at different times are thereby levied at partly different sets of agents, the timing of taxes generally matters. The current tax cut makes current tax payers feel wealthier and so they increase their consumption and decrease their saving. The present generations benefit and future tax payers (partly future generations) bear the cost in the form of access to less national wealth than otherwise. With another formulation: under full capacity utilization government deficits have a crowding-out effect because they compete with private investment for the allocation of saving.

The next subsection provides an example showing in detail how a change in the timing of taxes affects aggregate private consumption in an overlapping generations life-cycle framework.

6.7.1 A small open OLG economy with a temporary budget deficit

We consider a Diamond-style overlapping generations (OLG) model of a small open economy (henceforth named SOE) with a government sector. The relationship between SOE and international markets is described by the same four assumptions as in Chapter 5.3:

(a) Perfect mobility of goods and financial capital across borders.

(b) No uncertainty and domestic and foreign financial claims are perfect substitutes.

(c) No need for means of payment, hence no need for a foreign exchange market.

(d) No labor mobility across borders.

The assumptions (a) and (b) imply *real interest rate equality.* That is, in equilibrium the real interest rate in SOE must equal the real interest rate, r, in the world financial market. By saying that SOE is "small" we mean it is small enough to not affect the world market interest rate as well as other world market factors. We imagine that all countries trade one and the same homogeneous good. International trade will then be only *intertemporal* trade, i.e., international borrowing and lending of this good.

We assume that r is constant over time and that $r > n \geq 0$. We let L_t denote the size of the young generation and assume $L_t = L_{-1}(1+n)^{t+1}$, $t = 0, 1, 2, \ldots$. Each young supplies one unit of labor inelastically, hence L_t is aggregate labor supply. Assuming full employment and ignoring technical progress, gross domestic product, GDP, is $Y_t = F(K_t, L_t)$.

Firms' behavior and the equilibrium real wage

GDP is produced by an aggregate neoclassical production function with CRS:

$$Y_t = F(K_t, L_t) = L_t F(k_t, 1) \equiv L_t f(k_t),$$

where K_t and L_t are input of capital and labor, respectively, and $k_t \equiv K_t/L_t$. Technological change is ignored. Imposing perfect competition, profit maximization gives $\partial Y_t/\partial K_t = f'(k_t) = r+\delta$, where δ is a constant capital depreciation rate, $0 \leq \delta \leq 1$. When f satisfies the condition $\lim_{k\to 0} f'(k) > r + \delta > \lim_{k\to\infty} f'(k)$, there is always a solution for k_t in this equation and it is unique (since $f'' < 0$) and constant over time (as long as r and δ are constant). Thus,

$$k_t = f'^{-1}(r + \delta) \equiv k, \text{ for all } t \geq 0, \tag{6.29}$$

where k is the desired capital-labor ratio, given r. The endogenous stock of capital, K_t, is determined by the equation $K_t = kL_t$, where, in view of clearing in the labor market, L_t can be interpreted as both employment and labor supply (exogenous).

The desired capital-labor ratio, k, also determines the equilibrium real wage before tax:

$$w_t = \frac{\partial Y_t}{\partial L_t} = f(k_t) - f'(k_t)k_t = f(k) - f'(k)k \equiv w, \tag{6.30}$$

a constant. GDP will evolve over time according to

$$Y_t = f(k)L_t = f(k)L_0(1 + n)^t = Y_0(1 + n)^t.$$

The growth rate of Y thus equals the growth rate of the labor force, i.e., $g_Y = n$.

Some national accounting for an open economy with a public sector

Since we ignore labor mobility across borders, gross national product (= gross national income) in SOE is

$$GNP_t = GDP_t + r \cdot NFA_t = Y_t + r \cdot NFA_t,$$

where NFA_t is net foreign assets at the beginning of period t. If $NFA_t > 0$, SOE has positive net claims on resources in the rest of the world, it may be in the form of direct ownership of production assets or in the form of net financial claims. If $NFA_t < 0$, the reason may be that part of the capital stock, K_t, in SOE is directly owned by foreigners or these have on net financial claims on the citizens of SOE (in practice usually a combination of the two).

Gross national saving is

$$S_t = Y_t + rNFA_t - C_t - G_t = Y_t + rNFA_t - (c_{1t}L_t + c_{2t}L_{t-1}) - G_t, \quad (6.31)$$

where G_t is government consumption in period t, and c_{1t} and c_{2t} are consumption by a young and an old in period t, respectively. In the open economy, generally, gross investment, I_t, differs from gross saving.

National wealth, V_t, of SOE at the beginning of period t is, by definition, national assets minus national liabilities,

$$V_t \equiv K_t + NFA_t.$$

National wealth is also, by definition, the sum of private financial (net) wealth, A_t, and government financial (net) wealth, $-B_t$. We assume the government has no physical assets and B_t is government (net) debt. Thus,

$$V_t \equiv A_t + (-B_t). \quad (6.32)$$

We may also view *national* wealth from the perspective of national *saving. First*, when the young save, they accumulate *private* financial wealth. The private financial wealth at the start of period $t+1$ must in our Diamond framework equal the (net) saving by the young in the previous period, S_{1t}^N, and the latter must equal *minus* the (net) saving by the old in the next period, S_{2t+1}^N :

$$A_{t+1} = s_t L_t \equiv S_{1t}^N = -S_{2t+1}^N. \quad (6.33)$$

The notation in this section of the chapter follows the standard notation for the Diamond model, and so s_t stands for the saving by the young individual in period t, not the primary budget surplus as in the previous sections.

Second, the increase in *national* wealth equals by definition net *national* saving, S_t^N, which in turn equals the sum of net saving by the private sector, $S_{1t}^N + S_{2t}^N$, and the net saving by the public sector, S_{gt}^N. So

$$\begin{aligned} V_{t+1} - V_t &= S_t - \delta K_t = S_t^N \equiv S_{1t}^N + S_{2t}^N + S_{gt}^N = A_{t+1} + (-A_t) + (-GBD_t) \\ &= A_{t+1} - A_t - (B_{t+1} - B_t), \end{aligned}$$

where the second to last equality comes from (6.33) and the identity $S_{gt}^N \equiv -GBD_t$, while the last equality reflects the maintained assumption that budget deficits are fully financed by debt issue.

Government and household behavior

We assume that the role of the government sector is to deliver public goods and services in the amount G_t in period t. Think of non-rival goods like "rule of law", TV-transmitted theatre, and other public services free of charge. Suppose G_t grows at the same rate as Y_t :

$$G_t = G_0(1+n)^t,$$

where G_0 is given, $0 < G_0 < F(K_0, L_0)$. We may think of G_t as being produced by the same technology as the other components of GDP, thus involving the same unit production costs. We ignore that the public good may affect productivity in the private sector (otherwise G should in principle appear as a third argument in the production function F).

To get explicit solutions, we specify the period utility function to be CRRA: $u(c) = (c^{1-\theta} - 1)/(1-\theta)$, where $\theta > 0$. To keep things simple, the utility of the public good enters individuals' life-time utility additively. Thereby it does not affect marginal utilities of private consumption. There is a tax on the young as well as the old in period t, τ_1 and τ_2, respectively. These taxes are *lump sum* (levied on individuals irrespective of their economic behavior). Until further notice, the taxes are time-independent. Possibly, τ_1 or τ_2 is negative, in which case there is a transfer to either the young or the old.

The consumption-saving decision of the young will be the solution to the following problem:

$$\begin{aligned}
\max U(c_{1t}, c_{2t+1}) &= \frac{c_{1t}^{1-\theta} - 1}{1-\theta} + v(G_t) + (1+\rho)^{-1}\left[\frac{c_{2t+1}^{1-\theta} - 1}{1-\theta} + v(G_{t+1})\right] \text{ s.t.} \\
c_{1t} + s_t &= w - \tau_1, \\
c_{2t+1} &= (1+r)s_t - \tau_2, \\
c_{1t} &\geq 0, c_{1t+1} \geq 0,
\end{aligned}$$

where the function v represents the utility contribution of the public good. The implied Euler equation can be written

$$\frac{c_{2t+1}}{c_{1t}} = \left(\frac{1+r}{1+\rho}\right)^{1/\theta}.$$

Inserting the two budget constraints and solving for s_t, we get

$$s_t = \frac{w - \tau_1 + \left(\frac{1+\rho}{1+r}\right)^{1/\theta}\tau_2}{1 + (1+\rho)\left(\frac{1+r}{1+\rho}\right)^{(\theta-1)/\theta}} \equiv s_0 = s(w, r, \tau_1, \tau_2), \qquad t = 0, 1, 2, \ldots,$$

This shows how saving by the young depends on the preference parameters θ and ρ and on labor income and the interest rate. Further, saving by the young is constant over time.

Before considering the solution for c_{1t} and c_{2t+1}, it is convenient to introduce the *intertemporal* budget constraint of an individual belonging to generation t and consider the value of the individual's after-tax *human wealth*, h_t, evaluated at the end of period t. This is the present (discounted) value, as seen from the end of period t, of *disposable lifetime income* (the "endowment").obtainable by a member of generation t. In the present case we get

$$c_{1t} + \frac{c_{2t+1}}{1+r} = w_t - \tau_1 - \frac{\tau_2}{1+r} \equiv h, \tag{6.34}$$

where h on the right-hand side is the time independent value of h_t under the given circumstances.[26] To ensure that $h > 0$, we must assume that τ_1 and τ_2 in combination are of "moderate" size.

The solutions for consumption in the first and the second period, respectively, can then be written

$$c_{1t} = w - \tau_1 - s_t = \hat{c}_1(r)h \tag{6.35}$$

and

$$c_{2t+1} = \hat{c}_2(r)h, \tag{6.36}$$

where

$$\hat{c}_1(r) \equiv \frac{1+\rho}{1+\rho+\left(\frac{1+r}{1+\rho}\right)^{(1-\theta)/\theta}} \in (0,1) \text{ and} \tag{6.37}$$

$$\hat{c}_2(r) \equiv \left(\frac{1+r}{1+\rho}\right)^{1/\theta} \hat{c}_1(r) = \frac{1+r}{1+(1+\rho)\left(\frac{1+r}{1+\rho}\right)^{(\theta-1)/\theta}} \tag{6.38}$$

are the marginal (= average) propensities to consume out of wealth.[27]

Given r, both in the first and the second period of life is individual consumption proportional to individual human wealth. This is as expected in view of the homothetic lifetime utility function. If $\rho = r$, then $\hat{c}_1(r) = \hat{c}_2(r) = (1+r)/(2+r)$, that is, there is complete consumption smoothing.

The tax revenue in period t is $T_t = \tau_1 L_t + \tau_2 L_{t-1} = (\tau_1 + \tau_2/(1+n))L_t$. Let $B_0 = 0$ and let the "benchmark path" be a path along which the budget is and remains *balanced* for all t, i.e.,

$$T_t = (\tau_1 + \frac{\tau_2}{1+n})L_0(1+n)^t = G_t = G_0(1+n)^t.$$

[26] With technical progress, the real wage would be rising over time and so would h_t.

[27] By calculating backwards from (6.38) to (6.37) to (**??**), the reader will be able to confirm that the calculated s, c_{1t} and c_{2t+1} are consistent.

In this "benchmark policy regime" the tax code (τ_1, τ_2) thus satisfies $(\tau_1+\tau_2/(1+n))L_0 = G_0$. Given L_0, consistency with $h > 0$ in (6.34) requires a "not too large" G_0.

Along the benchmark path, aggregate private consumption grows at the same constant rate as GDP and public consumption, the rate n. Indeed,

$$C_t = c_{1t}L_t + \frac{c_{2t}}{1+n}L_t = (c_{1t} + \frac{c_{2t}}{1+n})L_0(1+n)^t = C_0(1+n)^t.$$

In view of (6.33) and the absence of government debt, also *national wealth* grows at the rate n :

$$V_t = A_t-B_t = A_t-0 = s_{t-1}L_{t-1} = s_0L_{t-1} = s_0L_{-1}(1+n)^t = V_0(1+n)^t, \qquad t = 0, 1, \ldots. \tag{6.39}$$

Consequently, national wealth per old, V_t/L_{t-1}, is constant over time (recall, we have ignored technical progress).

6.7.2 A one-off tax cut

As an alternative to the benchmark path, consider the case where an unexpected one-off cut in taxation by z units of account takes place in period 0 for every individual, whether young or old. What are the consequences of this? The tax cut amounts to creating a budget deficit in period 0 equal to

$$GBD_0 = rB_0 + G_0 - T_0' = G_0 - T_0' = T_0 - T_0' = (L_0 + L_{-1})z,$$

where the value taken by a variable along this *alternative path* is marked with a prime. At the start of period 1, there is now a government debt $B_1' = (L_0+L_{-1})z$. In the benchmark path we had $B_1 = 0$. Since we assume $r > n = g_Y$, government solvency requires that the present value of future taxes, as seen from the beginning of period 1, rises by $(L_0 + L_{-1})z$, cf. (6.28). Suppose this is accomplished by raising the tax on all individuals from period 1 onward by m. Then

$$\Delta T_t = (L_t + L_{t-1})m = (L_0 + L_{-1})(1+n)^t, \qquad t = 1, 2, \ldots.$$

Suppose the government in period 0 credibly announces that the way it will tackle the arisen debt is by his policy. So also the young in period 0 are aware of the future tax rise.

As solvency requires that the present value of future taxes, as seen from the beginning of period 1, rises by $(L_0 + L_{-1})z$, the required value of m will satisfy

$$\sum_{t=1}^{\infty} \Delta T_t(1+r)^{-t} = \sum_{t=1}^{\infty}(L_0 + L_{-1})(1+n)^t m(1+r)^{-t} = (L_0 + L_{-1})z.$$

This gives

$$m\sum_{t=1}^{\infty}\left(\frac{1+n}{1+r}\right)^{t}=z.$$

As $r>n$, from the rule for the sum of an infinite geometric series follows that

$$m=\frac{r-n}{1+n}z\equiv\bar{m}. \tag{6.40}$$

As an example, let $r=0,02$ and $n=0.005$ per year. Then $\bar{m}\simeq 0.015\cdot z$.

The needed rise in future taxes is thus higher the higher is the interest rate r. This is because the interest burden of the debt will be higher. On the other hand, a higher population growth rate, n, reduces the needed rise in future taxes. This is because the interest burden per capita is mitigated by population growth. Finally, a greater tax cut, z, in the first period implies greater tax rises in future periods. (It is assumed throughout that z is of "moderate" size in the sense of not causing $\bar{m}$ to violate the condition $h_t'>0$. The requirement is $0<z<(1+r)(1+n)h/\left[(2+r)(r-n)\right]$.)

Effect on the consumption path

In period 0 the tax cut unambiguously benefits the old. Their increase in consumption equals the saved tax:

$$c_{20}'-c_{20}=z>0. \tag{6.41}$$

The young in period 0 know that per capita taxes next period will be increased by $\bar{m}$. In view of the tax cut in period 0, the young nevertheless experience an increase in after-tax human wealth equal to

$$\begin{aligned}
h_0'-h_0 &= \left(w-\tau_1+z-\frac{\tau_2+\bar{m}}{1+r}\right)-\left(w-\tau_1-\frac{\tau_2}{1+r}\right)\\
&= \left(1-\frac{r-n}{(1+r)(1+n)}\right)z \qquad \text{(by (6.40))}\\
&= \frac{1+(2+r)n}{(1+r)(1+n)}z>0. && (6.42)
\end{aligned}$$

Consequently, through the *wealth effect* this generation enjoys increases in consumption through life equal to

$$\begin{aligned}
c_{10}'-c_{10} &= \hat{c}_1(r)(h_0'-h_0)>0, \qquad \text{and} && (6.43)\\
c_{21}'-c_{21} &= \hat{c}_2(r)(h_0'-h_0)>0, && (6.44)
\end{aligned}$$

by (6.35) and (6.36), respectively. The two generations alive in period 0 thus gain from the temporary budget deficit.

All *future* generations are worse off, however. These generations do not benefit from the tax relief in period 0, but they have to bear the future cost of the tax relief by a *reduction* in individual after-tax human wealth. Indeed, for $t = 1, 2, \ldots,$

$$\begin{aligned} h_t' - h_t &= h_1' - h = w - \tau_1 - \bar{m} - \frac{\tau_2 + \bar{m}}{1+r} - \left(w - \tau_1 - \frac{\tau_2}{1+r}\right) \\ &= -\left(\bar{m} + \frac{\bar{m}}{1+r}\right) = -\frac{2+r}{1+r}\bar{m} < 0. \end{aligned} \tag{6.45}$$

All things considered, since both the young and the old in period 0 increase their consumption, aggregate consumption in period 0 rises. Ricardian equivalence thus *fails*.

Effect on wealth accumulation*

How does aggregate *private* saving in period 0 respond to the temporary tax cut? Consider first the old in period 0. Along both the benchmark path and the alternative path the old entered period 0 with the financial wealth A_0 and they leave the period with zero financial wealth. So their aggregate net saving is $S_{20}^N = -A_0$ in both fiscal regimes. The young in period 0 increase their consumption in response to the temporary tax cut. At the same time they *increase* their period-0 saving. Indeed, from (6.44) and the period budget constraint as old follows

$$\begin{aligned} 0 &< c_{21}' - c_{21} = (1+r)s_0' - (\tau_2 + \bar{m}) - ((1+r)s_0 - \tau_2) \\ &= (1+r)(s_0' - s_0) - \bar{m} < (1+r)(s_0' - s_0), \end{aligned}$$

thus implying $s_0' - s_0 > 0$. The explanation is that the individuals have a preference for consumption smoothing in that $\theta > 0$. So the young in period 0 want to smooth out the increased consumption possibilities resulting from the increase in their human wealth. To be able to increase consumption as old, their extra saving, with interest, must exceed what is needed to pay the extra tax $\bar{m}$ in period 1. It is the tax cut that makes it possible for the young to increase both consumption and saving in period 0.

The impact on national wealth in period 1 The higher saving by the young in period 0 implies higher aggregate *private* financial wealth per old at the beginning of period 1, since $A_1'/L_0 = s_0' > s_0 = A_1/L_0$. Nevertheless, gross *national* saving, cf. (6.31), is clearly lower than in the benchmark case. Indeed, $C_0' > C_0$ implies

$$S_0' = F(K_0, L_0) + r \cdot NFA_0 - C_0' - G_0 < F(K_0, L_0) + r \cdot NFA_0 - C_0 - G_0 = S_0.$$

That gross national saving is lower is not inconsistent with the just mentioned rise in *private* saving in period 0 compared to the benchmark path. A counterpart of the increased *private* saving is the *public dissaving*, reflecting that the tax cut in period 0 creates a budget deficit one-to-one. Since the increased disposable income implied by the tax cut is used partly to increase private saving *and* partly to increase private consumption, the rise in private saving is *smaller* than the public dissaving. So *total* or *national* saving in period 0 is reduced.

Consequently, we have:

(i) *National wealth* at the start of period 1 is lower in the debt regime than in the no-debt regime.

By how much? In the benchmark regime the national wealth at the start of period 1 is $V_1 = V_0 + S_0^N = V_0 + S_0 - \delta K_0$. This exceeds national wealth in the debt regime by

$$\begin{aligned} V_1 - V_1' &= S_0 - S_0' = C_0' - C_0 = c_{10}' L_0 + c_{20}' L_{-1} - (c_{10} L_0 + c_{20} L_{-1}) \\ &= (c_{10}' - c_{10}) L_0 + (c_{20}' - c_{20}) L_{-1} \\ &= \hat{c}_1(r)(h_0' - h_0) L_0 + z L_{-1} \qquad \text{(by (6.43) and (6.41))} \\ &= \left(\hat{c}_1(r) \frac{1 + (2+r)n}{1+r} + 1 \right) \frac{1}{1+n} L_0 z > 0. \qquad \text{(by (6.42))} \qquad (6.46) \end{aligned}$$

Later consequences As revealed by (6.45), all future generations (those born in period $1, 2, \ldots$) are worse off along the alternative path. This gives rise to two further claims:

(ii) *National wealth per old* along the alternative path, V_t'/L_{t-1}, will remain constant from period 2 onward at a level below that along the path without government debt.

(iii) The constant level along the alternative path from period 2 onward will even be below the level in period 1.

To substantiate these two claims, consider $V_t' \equiv A_t' - B_t'$. In Appendix A it is shown that *government debt* per old will from period 1 onward satisfy

$$\frac{B_t'}{L_{t-1}} = \frac{B_1'}{L_0} = \frac{(L_0 + L_{-1})z}{L_0} = \frac{2+n}{1+n} z, \qquad t = 1, 2, \ldots,$$

and thus be constant. So government debt grows at the rate of population growth. In addition, Appendix A shows that *private* financial wealth per old is constant from period 2 onward and satisfies

$$\frac{A_t'}{L_{t-1}} = s_{t-1}' = s_0 - \left(1 - \hat{c}_1(r)\frac{2+r}{1+r}\right)\frac{r-n}{1+n}z, \qquad t = 2, 3, \ldots.$$

It follows that *national* wealth per old from period 2 onward will be

$$\begin{aligned}\frac{V_t'}{L_{t-1}} &\equiv \frac{A_t'}{L_{t-1}} - \frac{B_t'}{L_{t-1}} = s_{t-1}' - \frac{2+n}{1+n}z = s_0 - \left(1 - \hat{c}_1(r)\frac{2+r}{1+r}\right)\frac{r-n}{1+n}z - \frac{2+n}{1+n}z \\ &= s_0 - \left(1 - \hat{c}_1(r)\frac{r-n}{1+r}\right)\frac{2+r}{1+n}z = \frac{V_2'}{L_1} < s_0 = \frac{V_2}{L_1} = \frac{V_1}{L_0} \qquad t = 2, 3, \ldots \end{aligned} \tag{6.47}$$

where the last two equalities follow from (6.39). This proves our claim (ii).

National wealth per old in period 1 of the debt path is, by (6.46),

$$\begin{aligned}\frac{V_1'}{L_0} &= \frac{V_1}{L_0} - \left(\hat{c}_1(r)\frac{1+(2+r)n}{1+r} + 1\right)\frac{z}{1+n} \\ &= s_0 - \left(\hat{c}_1(r)\frac{1+(2+r)n}{1+r} + 1\right)\frac{z}{1+n} > \frac{V_2'}{L_1},\end{aligned}$$

where the inequality follows by comparison with (6.47). This proves our claim (iii).

Period 1 is special compared to the subsequent periods. While there is a per capita tax increase by $\bar{m}$ like in the subsequent periods, period 1's old generation still benefits from the higher disposable income in period 0. Hence, in period 2 national wealth per old is even lower than in period 1 but remains constant henceforth.

A closed economy Also in a closed economy would a temporary lump-sum tax cut make the future generations worse off. Indeed, in view of reduced national saving in period 0, national wealth (which in the closed economy equals K) would from period 1 onward be smaller than along the no-debt path. The precise calculations are more complicated because the rate of interest will no longer be a constant.

6.7.3 Widening the perspective

The fundamental point underlined by OLG models is that there is a difference between the public sector's future tax base, including the resources of individuals yet to be born, and the future tax base emanating from individuals alive today.

This may be called the *composition-of-tax-base argument* for a tendency to non-neutrality of shifting the timing of (lump-sum) taxation.[28]

The conclusion that under full capacity utilization budget deficits imply a burden for future generations may be seen in a somewhat different light if persistent technological progress is included in the model. In that case, everything else equal, future generations will generally be better off than current generations. Then it might seem less unfair if the former carry some public debt forward to the latter. In particular this is so if a part of G_t represents spending on infrastructure, education, research, health, and environmental protection. As future generations directly benefit from such investment, it seems fair that they also contribute to the financing. This is the "benefits received principle" known from public finance theory.

A further concern is whether the economy is in a state of full capacity utilization or serious unemployment and idle capital. The above analysis assumes the first. What if the economy in period 0 is in economic depression with high unemployment due to insufficient aggregate demand? Some economists maintain that also in this situation is a cut in (lump-sum) taxes to stimulate aggregate demand futile because it has no real effect. The argument is again that foreseeing the higher taxes needed in the future, people will save more to prepare themselves (or their descendants through higher bequests) for paying the higher taxes in the future. The opposite view is, first, that the composition-of-tax-base argument speaks against this as usual. Second, there is in a depression an additional and quantitatively important factor. The "first-round" increase in consumption due to the temporary tax cut raises aggregate demand. Thereby production and income is stimulated and a further (but smaller) rise in consumption occurs in the "second round" and so on (the Keynesian multiplier process).

This Keynesian mechanism is important for the debate about effects of budget deficits because there are limits to how *large* deviations from Ricardian equivalence the composition-of-tax-base argument can deliver in the long-run life-cycle perspective of OLG models. Indeed, taking into account the sizeable life expectancy of the average citizen, Poterba and Summers (1987) point out that the composition-of-tax-base argument by itself delivers only modest deviations if the issue is timing of taxes over the business cycle. They find that to comply with the data on private saving responses to supposedly exogenous shifts in taxation should be combined with the hypothesis that households are "myopic" than what standard OLG models assume.

Another concern is that in the real world, taxes tend to be distortionary and

[28] In Exercise 6.?? the reader is asked how the burden of the public debt is distributed across generations if the debt should be completely wiped out through a tax increase in only periods 1 and 2.

not lump sum. On the one hand, this should not be seen as an argument against the possible *theoretical* validity of the Ricardian equivalence proposition. The reason is that Ricardian equivalence (in its strict meaning) claims absence of allocational effects of changes in the timing of *lump-sum* taxes.

On the other hand, in a wider perspective the interesting question is, of course, how changes in the timing of *distortionary* taxes is likely to affect resource allocation. Consider first *income taxes.* When taxes are proportional to income or progressive (average tax rate rising in income), they provide insurance through reducing the volatility of after-tax income. The fall in taxes in a recession thus helps stimulating consumption through *reduced precautionary saving* (the phenomenon that current saving tends to rise in response to increased uncertainty, cf. Chapter ??). In this way, replacing lump-sum taxation by income taxation underpins the positive wealth effect on consumption, arising from the composition-of-tax-base channel, of a debt-financed tax-cut in an economic recession.

What about *consumption taxes*? A debt-financed temporary cut in consumption taxes stimulates consumption through a positive wealth effect, arising from the composition-of-tax-base channel. On top of this comes a positive intertemporal substitution effect on current consumption caused by the changed consumer price time profile.

The question whether Ricardian non-equivalence is important from a quantitative and empirical point of view pops up in many contexts within macroeconomics. We shall therefore return to the issue several times later in this book.

6.8 Concluding remarks

(incomplete)

Point (iv) in Section 6.1 hints at the fact that when outcomes depend on forward-looking expectations in the private sector, governments may face a time-inconsistency problem. In this context *time inconsistency* refers to the possible temptation of the government to deviate from its previously announced course of action once the private sector has acted. An example: With the purpose of stimulating private saving, the government announces that it will not tax financial wealth. Nevertheless, when financial wealth has reached a certain level, it constitutes a tempting base for taxation and so a tax on wealth might be levied. To the extent the private sector anticipates this, the attempt to affect private saving in the first place fails. This raises issues of *commitment* and *credibility.* We return to this kind of problems in later chapters.

Finally, point (v) in Section 6.1 alludes to the fact that political processes, bureaucratic self-interest, rent seeking, and lobbying by powerful interest groups interferes with fiscal policy.[29] This is a theme in the branch of economics called *political economy* and is outside the focus of this chapter.

6.9 Literature notes

(incomplete)

Sargent and Wallace (1981) study consequences of − and limits to − a shift from debt financing to money financing of sustained government budget deficits in response to threatening increases in the government debt-income ratio.

How the condition $r > g_Y$, for prudent debt policy to be necessary, is modified when the assumption of no uncertainty is dropped is dealt with in Abel et al. (1989), Bohn (1995), Ball et al. (1998), and Blanchard and Weil (2001). On self-fulfilling sovereign debt crises, see, e.g., Cole and Kehoe (2000).

Readers wanting to go more into detail with the policy-oriented debate about the design of the EMU and the Stability and Growth Pact is referred to the discussions in for example Buiter (2003), Buiter and Grafe (2004), Fogel and Saxena (2004), Schuknecht (2005), and Wyplosz (2005). As to discussions of the actual functioning of monetary and fiscal policy in the Eurozone in response to the Great Recession, see for instance the opposing views by De Grauwe and Ji (2013) and Buti and Carnot (2013). Blanchard and Giavazzi (2004) discuss how proper accounting of public investment would modify the deficit and debt rules of the EMU. Beetsma and Giuliodori (2010) survey recent research of costs and benefits of the EMU.

On the theory of *optimal currency areas,* see Krugman, Obstfeld, and Melitz (2012).

In addition to the hampering of Keynesian stabilization policy discussed in Section 6.4.2, also demographic staggering (due to baby booms succeeded by baby busts) may make rigid deficit rules problematic. In Denmark for instance demographic staggering is prognosticated to generate considerable budget deficits during several decades after 2030 where younger and smaller generations will succeed older and larger ones in the labor market. This is prognosticated to take place, however, without challenging the long-run sustainability of current fiscal policy as assessed by the Danish Economic Council (see the English Summary in De Økonomiske Råd, 2014). This phenomenon is in Danish known as "hængekøjeproblemet" (the "hammock problem").

Sources for last part of Section 6.7 ....

[29] *Rent seeking* refers to attempts to gain by increasing one's share of existing wealth, instead of trying to *produce* wealth.

6.10 Appendix A

In Section 6.7.2 we asserted that along the alternative path the government debt will grow at the same rate as the population. The proof is as follows.

The law of motion of the debt is, for $t = 1, 2, \ldots,$

$$\begin{aligned} B'_{t+1} &= (1+r)B'_t + G_t - T'_t = (1+r)B'_t + G_t - \left(\tau_1 + \frac{\tau_2}{1+n} + \bar{m} + \frac{\bar{m}}{1+n}\right) L_t \\ &= (1+r)B'_t - \left(\bar{m} + \frac{\bar{m}}{1+n}\right) L_t = (1+r)B'_t - \frac{2+n}{1+n}\bar{m}L_t, \end{aligned}$$

where the second line follows from $G_t - (\tau_1 + \tau_2(1+n))L_t = 0$ in view of the balanced budget along the benchmark path. It is convenient to rewrite the law of motion in terms of $x_t \equiv B'_t/L_{t-1}$, i.e., government debt per old. We get

$$x_{t+1} \equiv \frac{B'_{t+1}}{L_t} = \left(\frac{1+r}{1+n}\right) x_t - \frac{2+n}{1+n}\bar{m}, \qquad t = 1, 2, \ldots,$$

where we have used that $L_t = (1+n)L_{t-1}$. The solution of this first-order difference equation with constant coefficients is

$$x_t = (x_1 - x^*)\left(\frac{1+r}{1+n}\right)^{t-1} + x^*,$$

with

$$\begin{aligned} x_1 &= \frac{B'_1}{L_0} = \frac{(L_0 + L_{-1})z}{L_0} = \frac{2+n}{1+n}z, \quad \text{and} \\ x^* &= -\frac{2+n}{1+n}\bar{m}\left(1 - \frac{1+r}{1+n}\right)^{-1} = \frac{2+n}{r-n}\bar{m} = \frac{2+n}{1+n}z, \end{aligned}$$

using the solution (6.40) for the tax rise $\bar{m}$. It follows that x_t is constant over time and equals x^*. Hence, from period 1 onward $B'_t/L_{t-1} = (2+n)z/(1+n)$ where z is the per capita tax cut in period 0. □

In Section 6.7.2 we also asserted that along the alternative path the private financial wealth per old will from period 2 onward be constant. The proof is as follows:

For $t = 2, 3, \ldots,$

$$\begin{aligned} \frac{A'_t}{L_{t-1}} &= s'_{t-1} = w - (\tau_1 + \bar{m}) - c'_{1t-1} = w - (\tau_1 + \bar{m}) - \hat{c}_1(r)\left(w - \tau_1 - \bar{m} - \frac{\tau_2 + \bar{m}}{1+r}\right) \\ &= w - \tau_1 - \hat{c}_1(r)(w - \tau_1 - \frac{\tau_2}{1+r}) - \bar{m} + \hat{c}_1(r)\bar{m} + \hat{c}_1(r)\frac{\bar{m}}{1+r} \\ &= s_0 - \left(1 - \hat{c}_1(r)\left(1 + \frac{1}{1+r}\right)\right)\bar{m} = s_0 - \left(1 - \hat{c}_1(r)\frac{2+r}{1+r}\right)\frac{r-n}{1+n}z, \end{aligned}$$

where we have used (6.33), the period budget constraint of the young along the alternative path, (6.35), (6.34), the period budget constraint of the young along the benchmark path, the constancy of saving by the young along the benchmark path, and finally the solution for the tax rise $\bar{m}$. We see that private financial wealth per old is constant from period 2 onward. □

6.11 Exercises

6.? Consider the OLG model of Section 6.7. a) Show that if the temporary per capita tax cut, z, is sufficiently small, the debt can be completely wiped out through a per capita tax increase in only periods 1 and 2. b) Investigate how in this case the burden of the debt is distributed across generations. Compare with the alternative debt policy described in the text.