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5   A Positive Theory of Fiscal Policy in Open Economies

David Backus, Michael Devereux,
and Douglas Purvis

5.1   Introduction

One of the principal effects of government policy is redistribution of the social product. To some extent this is accidental, the result of policies designed to achieve other goals. But there are also systematic attempts in most developed countries to influence the distribution of income. In this paper we present a model that uses the government's penchant for redistribution to explain the intertemporal behavior of government deficits, trade deficits, and capital formation. The argument is couched in terms of an overlapping-generations economy in which the endowments of generations differ and fiscal policy consists of intergenerational transfers. The emphasis on redistribution distinguishes the analysis from the efficiency-based theories of Barro (1979) and Kydland and Prescott (1980), who postulate that tax policy is designed to minimize the welfare losses associated with distortionary taxation. To emphasize this difference, we assume instead that taxes are lump sum and explain their configuration entirely in terms of redistributive goals.

Taken at face value, the goal of government policy in our model is to maximize a welfare function which depends on generational utilities. Interpreted more broadly, the theory suggests that when capital markets are incomplete, the government can increase aggregate welfare by using

its own borrowing and lending opportunities to expand consumers' opportunity sets. The overlapping-generations framework is simply a metaphor for these capital market imperfections. the result is essentially a theory of "income-smoothing": the government, in an attempt to moderate differences in utility between generations, taxes the rich and gives to the poor.

Within this framework we show the following: First, the government in a small, open, pure-exchange economy can exploit its access to long-term capital markets to smooth fluctuations in private agents' income streams. In this case government deficits coincide exactly with deficits in the balance of trade. Second, when goods are storable, they provide an alternative method of smoothing income. In an open economy, however, consumption and investment decisions are separable; the exact identity between government deficits and trade deficits is broken, although they remain correlated. Third, in a world composed of many economies there are no policy conflicts if all countries are small in the sense of being price-takers. The equilibrium resulting from each country's smoothing its own income stream is efficient from a global viewpoint. Finally, the theory implies that tests of the Ricardian equivalence theorem based on aggregate time series have no power: if the government redistributes income optimally, aggregate consumption behaves exactly as if it were chosen by a single, infinitely-lived household.

These points are developed in sections 5.3–5.6. Section 5.2 is devoted to a brief look at the data. In the final section we comment on the strengths and weaknesses of the model and suggest extensions that seem particularly useful.

5.2   Some Stylized Facts

We start with the fact that government tax revenues in most developed countries are strongly procyclical. The top panels of figures 5.1–5.5 illustrate this for the United States, Canada, the United Kingdom, Germany, and Japan. Recent work by Sahasakul (1983) on U.S. personal income tax reveals that both average and marginal tax *rates* are procyclical as well, probably reflecting the automatic response of a progressive income tax. We plan further work to examine this contention more closely.

Since government spending on goods and services varies little over the business cycle, consumers' consumption of the public good exhibits almost no cyclical tendency despite large variations in payment for these services. The implication is that government deficits are countercyclical. This is easily verified using the bottom panels of the figures, where government deficits (excluding interest payments) for the same
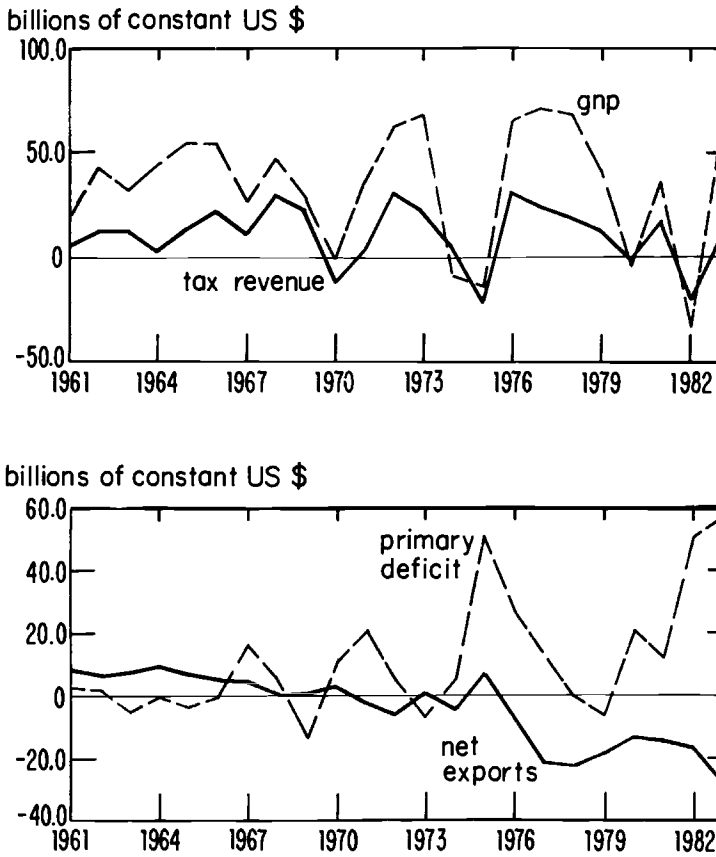
billions of constant US $

billions of constant US $

Fig. 5.1 United States real GNP and tax revenue (first difference)(*top*), United States primary deficit and net exports (*bottom*)

five countries are shown. The bottom panels also show the behavior of net exports. The strong but imperfect negative correlation between the two predicted above is apparent in most of the countries. For example, the sharp fiscal expansions in the United Kingdom in the early 1970s and in Canada in 1974–75 both were accompanied by sharp declines in net exports. The behavior of the two deficits during the last couple of years in the charts is of particular interest. The U.S. data show clearly the inverse correlation between the government deficit and the trade surplus, while for some of the other countries net exports have grown over the past few years, regardless of the behavior of their own government deficits. The suggestion is that their net exports are influenced significantly by U.S. policy. Similar remarks can be made
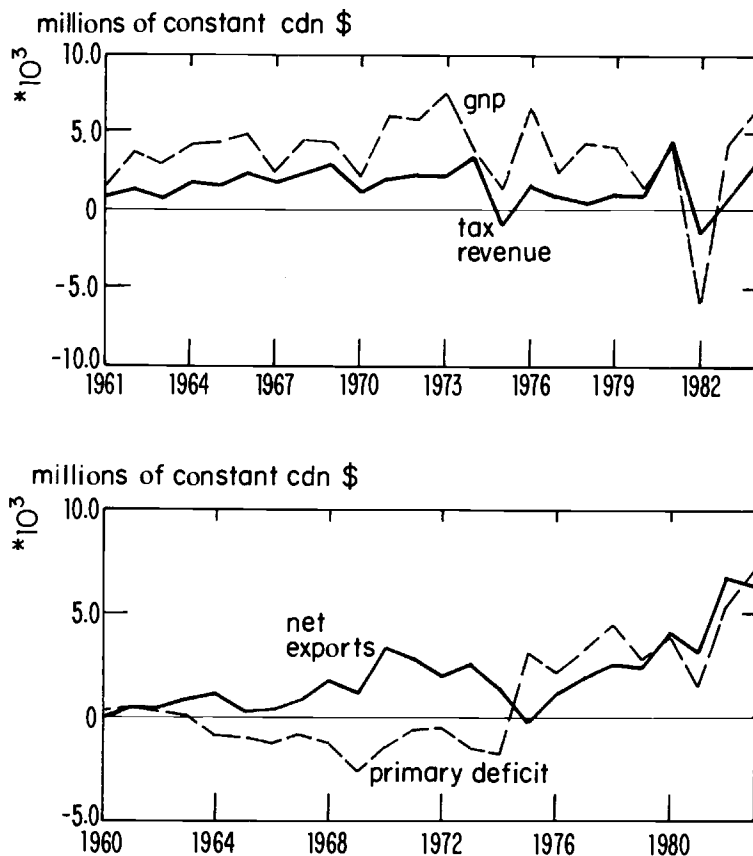
millions of constant cdn $

millions of constant cdn $

Fig. 5.2   Canada real GNP and tax revenue (first differences) (*top*),
Canada primary deficit and net exports (*bottom*)

about other episodes where the two series are positively correlated in various countries, including the United States. This underscores the need for a multicountry framework like that begun in section 5.4.

5.3   Optimal Fiscal Policy in a Pure Exchange Economy

We make the case for income-smoothing in an overlapping-generations economy with identical two-period consumers who have log-linear preferences and make no bequests. As in Levine (1983), population is constant and there is a single commodity available each period. The absence of bequest motives is clearly important in providing an incentive for public income-smoothing (Barro, 1974). None of the other elements is necessary, but they make the analysis simpler.
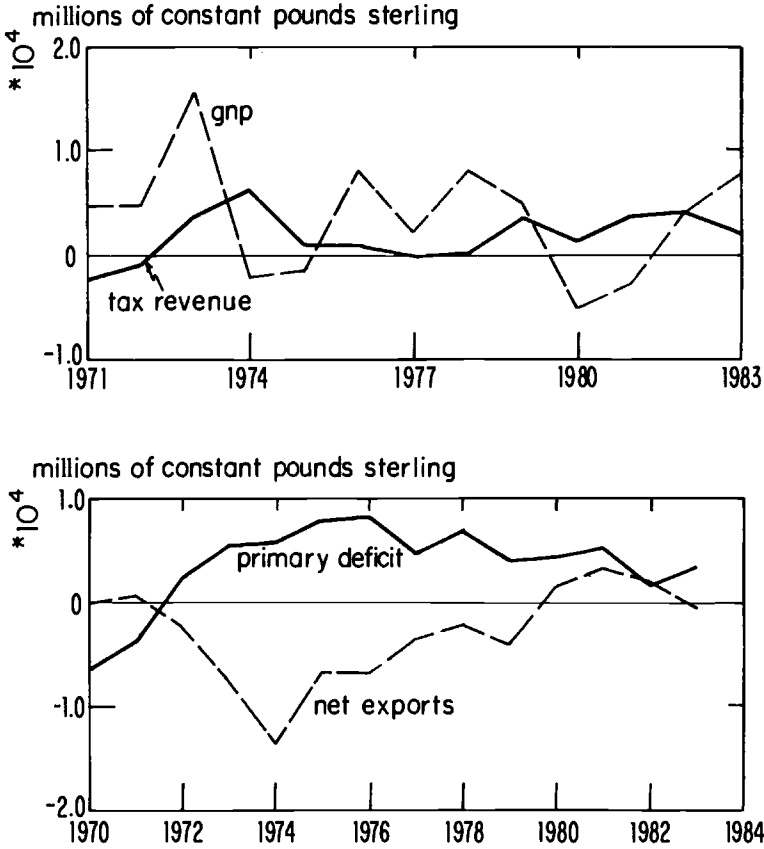
millions of constant pounds sterling

millions of constant pounds sterling

Fig. 5.3   United Kingdom real GNP and tax revenue (first differences)
                       (*top*),
                       United Kingdom primary deficit and net exports (*bottom*)

The object is to compare two types of equilibria: a competitive equi-
librium with no government and a welfare optimum supported by lump-
sum taxes and transfers. Each is examined in both a closed economy,
in which prices clear markets, and in an open economy facing prices
fixed in world markets. We view the welfare optimization as an ap-
proximation to actual government behavior and as the basis for a pos-
itive theory of fiscal policy.

The fundamental building blocks of the model are the consumers.
The representative of generation t is alive in periods t and $t + 1$ and
is endowed with amounts (a_t, b_{t+1}) of the commodity in each of these
two periods. The aggregate endowment of commodity t is therefore

(1) $e_t = a_t + b_t.$
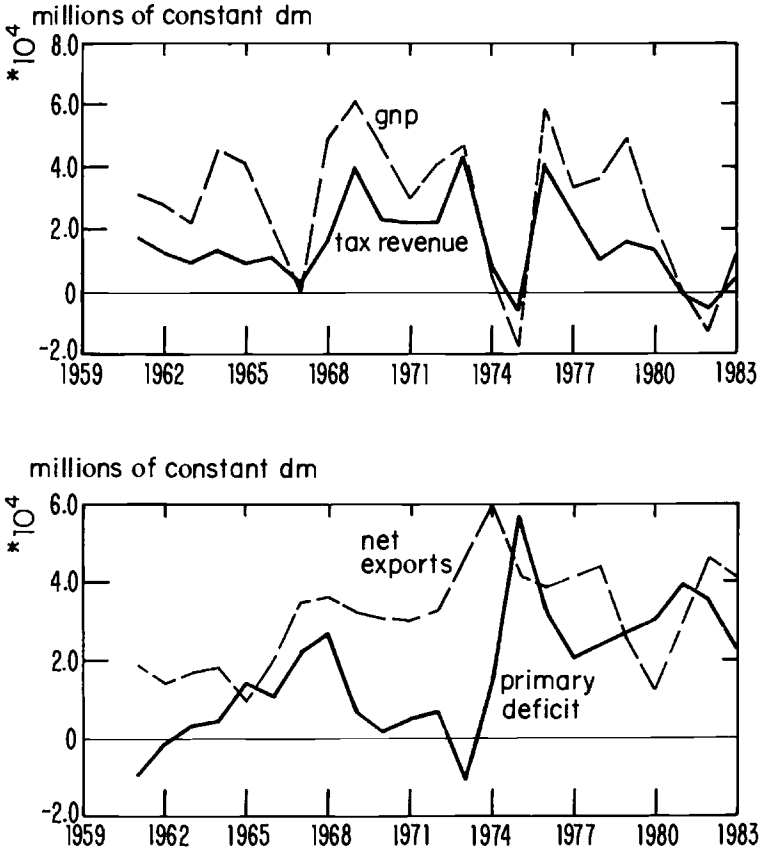
Fig. 5.4   Germany real GNP and tax revenue (first differences) (*top*),
                Germany primary deficit and net exports (*bottom*)

Preferences over consumption in the two periods, denoted c_t and d_{t+1}, are characterized by the utility function

(2) $u(c_t, d_{t+1}) = \log c_t + \alpha \log d_{t+1}.$

If the price of commodity t is p_t, then consumers choose c_t and d_{t+1} to maximize utility, subject to the budget constraint

(3) $p_t c_t + p_{t+1} d_{t+1} \leq p_t a_t + p_{t+1} b_{t+1},$

where p_{t+1} is the perfectly anticipated price in the second period of generation t's life. The demand functions are

(4) $c_t = (1 + \alpha)^{-1}(p_t a_t + p_{t+1} b_{t+1})/p_t$

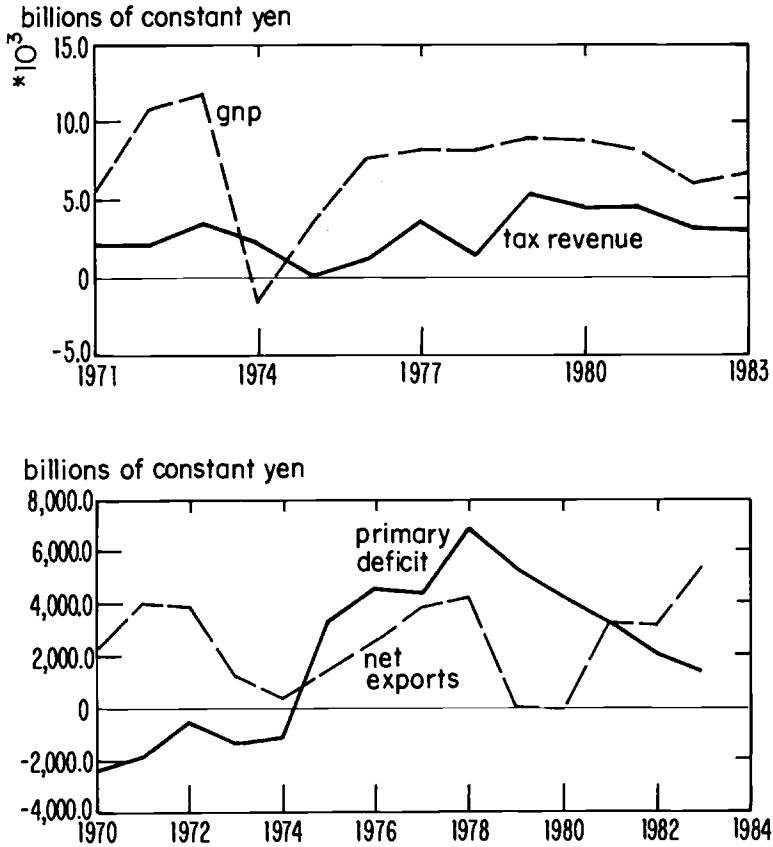$d_{t+1} = \alpha(1 + \alpha)^{-1}(p_t a_t + p_{t+1} b_{t+1})/p_{t+1}.$

Fig. 5.5   Japan real GNP and tax revenue (first differences) (*top*),
Japan primary deficit and net exports (*bottom*)

In the closed economy a competitive equilibrium is characterized by a sequence of prices, $\{p_1, p_2, \ldots\}$, or one-period rates of interest, $r_t = p_t/p_{t+1} - 1$, satisfying the equilibrium conditions

$$(5) \qquad c_t + d_t = e_t, \ t = 1, 2, \ldots .$$

In period 2 and after this implies that prices satisfy the difference equation

$$(6) \qquad b_{t+1} p_{t+1} - (\alpha a_t + b_t) p_t + \alpha a_{t-1} p_{t-1} = 0.$$

But in period 1 generation 0 has, in addition to its endowment, some savings from the previous period, which it spends in period 1. With only one good per period this expenditure cannot depend on relative prices. We introduce some price sensitivity with a now familiar device

by representing generation 0's savings by a fixed, arbitrary quantity denominated in period 0 prices, denoted M, and referred to as "money." The old generation now has a trivial choice problem, whose solution involves consuming its endowment plus whatever its holdings of money will buy:

(7) $$d_1 = b_1 + M/p_1.$$

A competitive equilibrium is therefore a solution to the difference equation satisfying the initial condition,

(8) $$\alpha a_1 p_1 + b_2 p_2 + (1 + \alpha)M = 0.$$

In fact there is a continuum of equilibria of this sort, indexed by p_1 and differing in the level of consumption of generation 0. This indeterminacy does not appear in the welfare-maximizing solution so we disregard it for the moment.

The model is a special case of the overlapping-generations economies studied by Balasko and Shell (1980; 1981a, b). They prove under more general conditions than those used here that a competitive equilibrium exists and that the competitive allocation is weakly Pareto-optimal (there are no Pareto-improving redistributions involving a finite number of consumers). The equilibrium allocation is Pareto-optimal if prices shrink at least as fast as the aggregate endowment (the interest rate is greater than or equal to the rate of growth of the economy). To see what this implies for our model, consider the case where each generation has the same endowment (a,b). Then the difference equation for prices is

(9) $$bp_{t+1} - (\alpha a + b)p_t + \alpha a p_{t-1} = 0.$$

Its characteristic equation has two roots, 1 and $\alpha a/b$. The first stems from the homogeneity of demand functions; the second tells us that the rate of interest approaches $(\alpha a/b) - 1$. If this is positive, as it will be if young consumers save, then the equilibrium is Pareto-efficient. In fact this condition suffices even if the endowment is bounded but varies over time.

Even if the equilibrium is Pareto-optimal, the government may prefer transfer schemes that help some generations at the expense of others. Another theorem from Balasko and Shell (1980) assures us that any efficient allocation can be supported as a competitive equilibrium by a system of lump-sum transfers. The question is which allocations the government is likely to prefer. One useful welfare function treats generations similarly, but places greater weight on those closest to the present:

(10) $$W = \Sigma\beta^t u_t,$$

where $0 < \beta < 1$ is a discount factor, u_t is the utility of generation t, and the sum is over current and future generations. The welfare function is utilitarian with the exception of the discount factor, which is needed to ensure a solution to the infinite-horizon programming problem. In the present case W is given by

$$(11) \qquad W = \sum_{t=0}^{\infty} \beta^t [\log c_t + \alpha \log d_{t+1}].$$

Because utility is additively separable, the value of c_0 does not affect the optimal plan.

In a closed economy the welfare optimum is obtained by maximizing W subject to the aggregate resource constraints,

$$(12) \qquad c_t + d_t \le e_t, \qquad t = 1,2, \ldots \ .$$

The solution to the problem involves

$$(13) \qquad \begin{aligned} c_t &= \theta \, e_t \\ d_t &= (1 - \theta)e_t \qquad t = 1,2, \ldots \ , \end{aligned}$$

where $\theta = \beta/(\alpha + \beta)$. Note in particular that the allocation to generation 0, d_1, is determined by the condition that its marginal utility equal the discounted marginal utility of c_1. The shadow prices associated with the constraints are

$$(14) \qquad p_t = (\alpha + \beta)\beta^{t-1}/e_t.$$

With a constant endowment stream this implies an interest rate of $(1 - \beta)/\beta > 0$. More generally the rate of interest is determined by the ratio of next period's endowment to this period's:

$$(15) \qquad 1 + r_t = e_{t+1}/\beta e_t.$$

Supporting this allocation as a competitive equilibrium requires the government to redistribute income, and there are a number of ways to do this. Basically the government must shift the budget constraints of consumers so that their after-tax incomes equal the values of their expenditures:

$$(16) \qquad y_t = p_t c_t + p_{t+1}d_{t+1}.$$

Clearly there is no unique way to accomplish this. The government can, with the same effect, transfer purchasing power to a generation when its members are young or when its members are old. For simplicity, we adopt the convention that the government transfers credits to each generation equal to the difference between its current endowment and its consumption at the welfare optimum. This involves real transfers of, say, g_t to the young and h_t to the old given by

(17)
$$g_t = \theta e_t - a_t$$
$$h_t = (1 - \theta)e_t - b_t.$$

It should be clear from the resource constraint that the government's budget is always balanced:

(18)
$$g_t + h_t = 0.$$

As a result, only limited smoothing is possible: the only feasible transfer schemes in this economy involve redistribution of the endowment between generations in the same period.

Let us turn now to an open economy facing fixed world prices. The possibility of trading with the rest of the world means that aggregate consumption need no longer equal the economy's endowment every period. In an economy with no government, the competitive allocation is given by the demand functions of the various consumers evaluated at world prices. The trade balance, tb_t, is defined by

(19)
$$t\,b_t = e_t - (c_t + d_t)$$
$$= (a_t - c_t) + (b_t - d_t).$$

Since the budget of any generation is balanced, a trade deficit is simply the result of less saving by the young than dissaving by the old.

The open economy also gives rise to additional possibilities for policy. The government can effectively transfer purchasing power from one generation to another by borrowing and lending in world capital markets. If prices converge to zero and the aggregate endowment is bounded, then the government's constraint can be expressed as a present value:

(20)
$$\sum_{t=1}^{\infty} p_t(c_t + d_t) \le \sum_{t=1}^{\infty} p_t e_t + p_0 F_0,$$

where F_0 is the net foreign asset position of the economy, measured in units of commodity 0. The solution to this problem involves demands of

(21)
$$c_t = \beta^t \,[(1 - \beta)/(\alpha + \beta)]\,Y/p_t$$
$$d_t = \alpha\beta^{t-1}\,[(1 - \beta)/(\alpha + \beta)]\,Y/p_t,$$

where Y is the value of the economy's endowment:

(22)
$$Y = \sum_{t=1}^{\infty} p_t e_t + P_0 F_0.$$

If prices in the world economy decline at rate β, as they would if the world had a constant endowment and were managed as the closed

economy above was, then c and d would be constant. Otherwise the plan will respond to fluctuations in prices, which we can think of as arising from fluctuations in the world endowment. As with the allocation of risk, idiosyncratic variations can be eliminated by the market, but aggregate variations cannot.

The implied tax policy again has the ambiguity noted earlier. If we retain the convention that transfers are made when they are consumed, the government runs a deficit when its country's endowment is small, relative to the norm, and a surplus when its endowment is large. The fluctuations in the government deficit are matched exactly by the trade balance. In a sense consumers, taken as a group, use the government's ability to borrow and lend to expand their opportunity set. Since the constraints for the closed economy are more restrictive than those for the open economy, the latter always achieves at least as high a level of welfare; the gains from intertemporal trade are nonnegative.

The following examples illustrate the salient features of the open economy under laissez-faire and the optimal tax policy.

Example 5.3.1. Consider an economy with $\alpha = 1$, $\beta = 0.9$, and an endowment (a_t, b_{t+1}) that alternates between $(3,1)$ (t odd) and $(3,2)$ (t even). The aggregate endowment thus varies between 4 (t even) and 5 (t odd). With $p_t = \beta^t$ the competitive allocation alternates between $(c_t, d_t) = (1.95, 2.67)$ (t odd) and $(2.40, 2.17)$ (t even), the trade balance between 0.38 (t odd) and -0.43 (t even). If generation 0 is treated the same way (it consumes 2.40 and 2.67), the value of the welfare function is 16.60. The welfare optimum, on the other hand, involves constant levels of consumption: $c = 2.18$ and $d = 2.42$. The trade balance and government deficit alternate between 0.32 (t odd) and -0.60 (t even). The value of the welfare function is 16.70. (This uses the same net foreign asset position as the competitive equilibrium, namely, the difference between generation 0's first-period endowment, 3, and its first-period consumption, 2.4. Y is then 41.34.)

Example 5.3.2. Suppose that in example 5.3.1 the world endowment is perfectly correlated with the domestic endowment and that prices are given by $p_t = (1/5)\beta^t$ (t odd) and $p_t = (1/4)\beta^t$ (t even). Then there are no opportunities for improving on the competitive equilibrium. The competitive equilibrium and the welfare optimum are identical. The analogy with risk-sharing should be obvious. If we view this as a proposition in trade theory, we see that there are no gains from trade when countries have the same preferences and endowments.

Example 5.3.3. With $\alpha = 1$ and $\beta = 0.9$, let the endowment of generation t be $(2, 1 + \delta^{t+1})$, with $\delta = 0.7$. The aggregate endowment in

Table 5.1   Competitive Equilibrium for Example 5.3.3

t	c_t	d_t	u_t	e_t	tb_t	p_t
1	1.670	1.961	1.132	3.700	0.068	0.900
2	1.604	1.856	1.051	3.490	0.030	0.810
3	1.558	1.783	0.992	3.343	0.002	0.729
4	1.526	1.731	0.950	3.240	−0.017	0.656
5	1.503	1.695	0.920	3.168	−0.030	0.590
6	1.487	1.670	0.899	3.118	−0.039	0.531
7	1.476	1.652	0.884	3.082	−0.046	0.478
8	1.468	1.640	0.873	3.058	−0.050	0.430
9	1.463	1.631	0.866	3.040	−0.054	0.387
10	1.459	1.625	0.861	3.028	−0.056	0.349

period t is therefore $3 + \delta^t$. Assume again that world prices are given by $p_t = \beta^t$. Since the endowment is shrinking, the competitive equilibrium has consumption declining over time, as shown in table 5.1. Treating generation 0 the same way gives us an initial foreign asset position of 0.24 and a welfare value of 9.58.

The value of the economy's endowment, including $F_0 = 0.24$, is 28.94, which corresponds to a "permanent" aggregate consumption level of 3.21. Equating the marginal utilities of young and old allows us to divide this into $c = 1.52$ and $d = 1.69$. With the endowment shrinking, the trade balance is initially positive, declines gradually, and reaches a lower asymptote of -0.06. The value of the welfare function is 9.62.

5.4   Implications for International Policy Coordination

The world economy is a closed system, so we might expect the closed-economy theory of the previous section to describe the optimal world equilibrium. We show that decentralized policymaking replicates the efficient world allocation if individual countries are too small to affect world prices by their own actions. Large countries, however, may want to exploit their ability to influence prices to raise domestic welfare at the expense of the rest of the world. As in Frenkel and Razin (1984), the world economy has a fixed endowment, so policies designed to change consumption in one country must change consumption in the rest of the world by an equal and opposite amount. Our guess is that optimal fiscal policy by a large economy is "beggar thy neighbor," but developing this argument remains a task for the future.

We begin by deriving efficient worldwide tax policies. We say that an allocation is *policy-efficient* if (i) it is Pareto-efficient, in the sense that welfare in any particular country cannot be raised without lowering welfare in at least one other country, and (ii) the value of an economy's

consumption equals, at equilibrium prices, the value of its endowment. Note that condition (i) defines Pareto–optimality in terms of welfare functions of countries, rather than utilities of individual consumers. Condition (ii) guarantees that the allocation can be supported as a competitive equilibrium without net transfer payments between countries. The two suffice to determine a unique allocation, which can be supported as a competitive equilibrium with the appropriate choice of lump-sum taxes.

We derive the policy-efficient allocation by looking first at Pareto-efficient allocations. If there are n countries, indexed by i, then any efficient allocation is the solution to a problem of the form,

$$(23) \qquad \max W = \sum_i \pi_i W_i, \ \Sigma \pi_i = 1,$$

subject to the world resource constraints, for some choice of the welfare weights π_i. To make this tractable, assume that countries have identical preferences but different endowments. As in section 5.3, the welfare of an individual country is given by

$$(24) \qquad W_i = \sum_{t=0}^{\infty} \beta^t \, [\log c_{i,t} + \alpha \log d_{i,t+1}],$$

where we have introduced additional subscripts to distinguish countries. The world resource constraint is

$$(25) \qquad \sum_i (c_{i,t} + d_{i,t}) \le \sum_i e_{i,t}, \ t = 1,2, \ldots \ .$$

If the world endowment, e_t, is bounded, so that a solution to the global welfare problem exists, and if p_t are the shadow prices associated with the constraints, then the first-order conditions are

$$(26) \qquad \pi_i \beta^t / c_{i,t} = p_t$$

$$\pi_i \, \beta^{t-1} \alpha / d_{i,t} = p_t,$$

$$i = 1,2, \ldots ,n, \qquad t = 1,2, \ldots \ .$$

The shadow prices, which give the market prices of the competitive equilibrium that supports this allocation, are

$$(27) \qquad p_t = (\alpha + \beta) \beta^{t-1} / e_t.$$

(The fact that these are independent of the π_is is an artifact of the countries' having identical, homothetic preferences.)

Now let us compute the welfare weights. If we impose condition (ii), then for each country

$$(28) \qquad \sum_{t=1}^{\infty} p_t(c_{i,t} + d_{i,t}) = \sum_{t=1}^{\infty} p_t e_{i,t} + p_0 F_{i,0} = Y_i.$$

In the present case this implies that the welfare weight is

$$(29) \qquad \pi_i = Y_i/[(1 + \alpha/\beta)\Sigma\beta^t]$$

$$= (1 - \beta)\Sigma\beta^{t-1}(e_{i,t}/e_t) + p_0 F_{i,0}.$$

In short, the weight varies inversely with the country's wealth relative to the world as a whole.

The question is whether this policy-efficient allocation can be attained by decentralized policymaking. Will the Nash solution—in which each country chooses taxes to maximize its own welfare, given its budget constraint, the taxes of other countries, and the world equilibrium condition—be policy-efficient? The answer depends upon how governments view prices. At one extreme we might consider small economies, whose decisions have no influence on world prices. It should be clear by analogy with the second welfare theorem that the policy-efficient allocation is the best any such country can attain. Decentralized policymaking is efficient.

The question is whether this decentralization result extends to policy coordination between large countries. Our intuition is that it does not, but we have yet to specify a model in which policy conflicts lead to suboptimal allocations.

5.5   Fiscal Policy in a Model with Capital

We saw in section 5.2 that while government deficits and trade balances are positively correlated, the correlation is hardly as close as predicted by the pure-exchange model. One reason might be physical capital, which provides an alternative method of transferring goods between periods and which is, as an empirical matter, closely related to both national income and the balance of trade.

We examine the interplay of trade deficits, capital formation, and fiscal policy in a variant of the Diamond (1965) debt model, used recently in a similar context by Persson (1985). We add to the model of section 5.3 the possibility of using some or all of the current endowment, which we now refer to as "labor," to produce output next period. In the simplest model each unit of labor produces one unit of "output," which is divided between consumption and capital. Capital is converted into next-period output by the production process Ak^γ, with $0 < \gamma < 1$.

The representative of generation t therefore consumes c_t and invests k_{t+1} in period t. In period $t + 1$ it consumes d_{t+1}, financed by its endowment, production, and saving from period t. The overall constraint is

$$(30) \quad p_t(c_t + k_{t+1}) + p_{t+1}d_{t+1} \leq p_t a_t + p_{t+1}[b_{t+1} + A_{t+1}k_{t+1}^\gamma].$$

Utility maximization yields the demand functions

(31)
$$c_t = (1 + \alpha)^{-1} y_t/p_t$$

$$d_{t+1} = \alpha(1 + \alpha)^{-1} y_t/p_{t+1}$$

$$k_{t+1} = (\gamma A_{t+1} p_{t+1}/p_t)^\sigma,$$

where $\sigma = 1/(1 - \gamma)$ and

(32) $$y_t = p_t a_t + p_{t+1} b_{t+1} + (\gamma/p_t)^\sigma (A_{t+1} p_{t+1})^{1+\sigma}.$$

A competitive equilibrium in a closed economy is a sequence of prices satisfying the equilibrium conditions.

(33) $$c_t + d_t + k_{t+1} = e_t + A_t k_t^\gamma, \qquad t = 1,2, \ldots .$$

As before we can express this as a difference equation in prices, but unlike the pure-exchange model it is highly nonlinear. The welfare optimum is derived by maximizing W, given in section 5.3, subject to the resource constraints.

(34) $$c_t + d_t + k_{t+1} \leq e_t + A_t k_t^\gamma, \qquad t = 1,2, \ldots .$$

The optimal policy is essentially the solution to an optimal growth problem. One of its interesting features is that the steady-state rate of interest, $(1 - \beta)/\beta > 0$, does not depend on how individual agents discount the future (the parameter α). This characteristic and others are described by Samuelson (1967) and Calvo and Obstfeld (1985).

Our interest, however, lies in the small, open economy, which is considerably easier to study because prices are exogenous and demand decisions are completely separate from investment decisions. In the laissez-faire equilibrium, the competitive allocation is described fully by the demand functions stated earlier. The capital stock is determined solely by prices, and the returns to capital and labor are then consumed and saved as prescribed by the demand functions and the distribution of income. Generations with larger endowments and higher profits from capital consume more than others.

The welfare optimum is computed much as before. If prices converge to zero and the endowment is bounded, then we can again express the government's constraint as an infinite sum:

(35) $$\sum_{t=1}^{\infty} p_t(c_t + d_t + k_{t+1}) \leq \sum_{t=1}^{\infty} p_t(e_t + A_t k_t^\gamma) + p_0 F_0.$$

The problem is recursive: the capital stock is determined by

(36) $$k_{t+1} = (\gamma A_{t+1} p_{t+1}/p_t)^\sigma,$$

as before. From this we define the economy's wealth as

(37)
$$Y = \sum_{t=0}^{\infty} p_t(e_t + A_t k_t^\gamma - k_{t+1}) + p_0 F_0,$$

and consume

(38)
$$c_t = \beta^t[(1 - \beta)/(\alpha + \beta)] \, Y/p_t$$

$$d_t = \alpha\beta^{t-1}[(1 - \beta)/(\alpha + \beta)]Y/p_t.$$

The interest derives from the interaction between capital formation and trade. Consider, for example, an economy with constant endowment, e, and productivity, A. If the world rate of interest is constant at $(1 - \beta)/\beta$, then consumption is constant and the capital stock approaches its steady-state value,

(39)
$$k^* = (\gamma A\beta)^\sigma.$$

A positive shock to the endowment simply raises Y, which increases consumption in all periods. As in section 5.3, this raises the trade balance in the period of the shock and lowers it in other periods since domestic consumption is higher. Alternatively, consider a temporary rise in the productivity parameter, A. This raises the demand for capital that period and also raises the economy's wealth, which raises consumption slightly in every period. The trade balance, given by

(40)
$$tb_t = (e_t + A_t k_t^\gamma) - (c_t + d_t + k_{t+1}),$$

will fall when the capital is imported, rise the next period when the capital is used in production, and fall slightly in other periods because the economy now consumes more each period. Both of these features are illustrated in the following examples.

Example 5.5.1. Let $\alpha = 1$, $\beta = \gamma = .8$, $A = a = e = 1$, and $b = 0$, and consider the behavior of the economy when world prices oscillate, as they would if the world endowment were oscillating. To make this concrete, let $p_t = \beta^t$ when t is even, and $2\beta^t$ when t is odd. In both the competitive and optimal equilibria the capital stock, k_t, is 3.436 when t is even, 0.0034 when t is odd. These fluctuations in the capital stock, which make even generations much richer, lead to a competitive equilibrium in which the utilities of the two generations fluctuate along with prices. Consumption, production, and the trade balance are given by

c_t	d_t	tb_t	u_t	
2.684	1.251	− 6.361	1.281	t even
0.500	1.342	2.591	− 0.468	t odd

The value of the welfare function is 2.28.

The welfare optimum smooths these fluctuations somewhat, although the government's budget constraint ensures that even generations still

do better since they face a lower rate of interest. We start with $F_0 = -5.12$, the dissaving of generation 0 in its first period of life and compute the optimal allocation of total income, $Y = 15.18$. Quantities are

c_t	d_t	tb_t	u_t	
1.687	2.107	-6.220	0.575	t even
0.843	1.054	2.536	0.575	t odd

which imply a welfare value of 2.30.

Example 5.5.2. With the same parameter values and $p_t = \beta^t$, we examine an economy in which the productivity parameter, A_t, oscillates between 1 (t odd) and 2 (t even). The capital stock therefore oscillates between 0.107 and 3.436. The trade balance is driven by the need to import capital goods in odd periods, and the output from those capital goods in even periods, and alternates between -3.84 and 4.587. The discrepancy in utility between generations brought about by this variation in the productivity of capital is eliminated completely in the welfare solution, which raises W from -1.80 to -0.72.

5.6   On Testing the Ricardian Equivalence Theorem

One of the consequences of the government's income-smoothing is that the aggregate economy behaves like a single infinite-horizon consumer. If government policy is approximately as we have modeled it, then tests of debt neutrality based on aggregate time series data have very little power. The result is based on the following idea: the essential difference between an overlapping-generations economy and an economy with infinitely-lived agents is that the latter can redistribute purchasing power across time without restraint, but the former cannot. But suppose that the government performs this redistribution as we have described. Then there is no longer any need for further redistribution and the two models are observationally equivalent.

The argument is quite general, but a statement based on log-linear preferences should suffice to communicate its essential elements.

Proposition. Consider the model of section 5.3. The demand for aggregate consumption, $C_t = c_t + d_t$, associated with the welfare problem is identical to that of a single infinitely-lived consumer with endowment $\{e_1, e_2, \ldots\}$ and utility function

$$(41) \qquad\qquad U = \Sigma \beta^t \log C_t.$$

The proof is straightforward. We know that the welfare optimum involves equating the discounted marginal utilities of the young and old:

$$(42) \qquad\qquad \beta^t/c_t = \beta^{t-1}\alpha/d_t.$$

Since the utility functions are homothetic this implies that the ratio of c_t to d_t is a fixed number independent of t, in this case

$$(43) \qquad\qquad c_t/d_t = \beta/\alpha.$$

Now aggregate consumption can be expressed

$$(44) \qquad\qquad C_t = (1 + \alpha/\beta)c_t,$$

and the utility function, U, and welfare function, W, are equivalent.

Now consider tests of the neutrality proposition, of which Aschauer (1985) is a nice example (and a good source of other references). The standard approach is to assume that aggregate consumption is the outcome of an infinite-horizon optimization. The optimization has the property that the timing of taxes, and therefore the value of currently outstanding debt, is irrelevant—the Ricardian equivalence theorem. It also imposes testable restrictions on the behavior of aggregate consumption, taxes, and debt. Aschauer, for one, finds that the data cannot reject the restrictions and therefore support the theorem. Our proposition, however, says that if the government manipulates taxes to smooth income, then our model, in which the timing of taxes is central, cannot be distinguished empirically from his. His test has no power and provides as much support for our model as for his.

5.7   Final Remarks

We have argued that distributional objectives provide an incentive for fiscal authorities to smooth the incomes of private agents. The details were developed in a model with two-period agents, overlapping lives and log-linear preferences, but we think its main features are considerably more general. A quick look at some data suggests that the theory agrees, at least roughly, with observed variations in aggregate income, government deficits, and trade balances.

Despite this somewhat cursory empirical verification, there are a number of theoretical extensions that appear to us worth pursuing. First, we would like to extend the theory to scholastic environments, in which fluctuations in the endowment stream are to some degree unpredictable. In these environments income-smoothing amounts to risk-sharing. Gordon and Varian (1985) have taken this route in a model with a similar structure, and their insights would be useful here as well. Second, and perhaps more important to the open economy issues, we would like to introduce a nontraded good, so that some of the impact of changes in the intertemporal pattern of consumption opportunities can be taken in the form of changes in the domestic relative price. Third, the conditions on the decentralization result of section 5.4 might be examined more closely. We argued, in short, that there are costs of

uncoordinated policies only if some countries are large, in the sense of being able to influence world prices by their own actions. Kehoe (1987) presents a counterexample, in which the global costs of decentralized fiscal policy rise as the number of countries grows. Finally, the model could be made richer by allowing for generational heterogeneity, so that fiscal policy might involve redistribution both within and across generations. In fact, the procyclical nature of tax rates in developed countries may simply be the accidental consequence of progressive taxation within generations.

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Comment   Stanley Fischer

Backus, Devereux, and Purvis (BDP) present a very clean theoretical paper that explains its assumptions and conclusions and leaves little for the discussant to do except to provide an intuitive explanation of the results and to talk about their relevance to real world fiscal policy.

The facts that the positive theory is called upon to explain are that budget deficits are countercyclical and net exports are procyclical—sometimes. Thus there is a "strong but imperfect" negative correlation between them. Theory tells us the negative relationship should indeed be imperfect. The cyclical character of net exports depends on the disturbances moving the economy.

First consider aggregate demand policy disturbances. In the floating exchange rate Mundell-Fleming model, with a given level of government spending and fixed tax rates, monetary expansion causes both the budget deficit and net exports to decrease. The association will be positive in that case. Fiscal expansion causes the budget deficit to increase and net exports to decrease. There will be a negative correlation between the budget deficit and net exports, but the budget deficit will be procyclical and net exports countercyclical.

Neither of these cases corresponds to the BDP reading of their charts. Their case is rather one of aggregate supply or productivity disturbances. Their positive theory is that when output is high because of a productivity shock, countries both lend abroad and raise taxes on the current generation for the benefit of later poorer generations. Thus in the presence of a favorable shock, a country will run a current account surplus to effect the lending, and a budget surplus because taxation is high.

BDP's underlying consumers are finite-lived finite-horizon maximizers. The fiscal authority, however, takes the long view, maximizing a discounted weighted sum of generational utility levels. The fiscal authority's actions effectively make the economy behave like one in which individuals have infinite horizons. Hence the interesting BDP argument that the economy behaves as if Ricardian equivalence holds even though it is thoroughly non-Ricardian.

That result seems close to a general result that in cases where stabilization policy can achieve first best solutions, the reduced form fails to show any effects of the policy. The general result goes back at least to Kareken and Solow,[1] who gave the example of a situation in which

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1. Robert M. Solow and John Kareken, Lags in monetary policy, part 1 of Lags in fiscal and monetary policy, by Albert Ando et al., in *Commission on money and credit, stabilization policies* (Englewood Cliffs, NJ: Prentice-Hall, 1963), 14–96.

active anticipatory monetary policy succeeds in stabilizing output to the extent of reducing GNP to a white noise process. Then there will be no correlation between output and previous monetary policy. Of course, if policy is not absolutely perfect, it will be possible to detect some of its effects. In the BDP model, if the fiscal authority makes mistakes, it will be possible to see individuals adjusting their lifetime consumption patterns to the debt-tax mix.

Shocks in BDP are transitory. Consider a small country starting with a balanced budget and zero net exports that suffers a permanent favorable productivity shock that affects the endowment of the young. What will happen to net exports and the budget? The first reaction is that consumption and output should rise by the same amount so there is no effect on net exports or the budget deficit. The presence of old people makes a difference though. The social welfare function requires them to share the bonanza. It also requires the burden of their increased consumption to be shared with future generations. The government will issue some debt, appearing initially to run a procyclical budget deficit. The result for the balance of payments is not obvious.

BDP have isolated one particular type of disturbance—transitory productivity shocks—for which their analysis applies. Saudi Arabia in the first post-oil shock period fits such a case well. But there are many other types of disturbance for which other correlations would be expected. Printed on the side of their paper should be the following notice. Warning: Correlations among endogenous variables are not independent of the shocks that move them.

Comment   Kenneth Rogoff

There are any number of plausible reasons why Ricardian equivalence may not hold: finite lives, tax distortions, imperfect capital markets, uncertain fertility, etc. However, as Barro (1974) points out, although many different reasons will imply that the timing of taxes "matters," they do not all suggest the same positive or normative conclusions. Backus, Devereux, and Purvis (BDP) posit that deficits are important because individuals do not leave bequests,[1] and they obtain some interesting results. Ideally, however, one would eventually like to see how their main conclusions hold up in models where deficits matter

1. Frankel and Razin (1986) present an open-economy model of budget deficits based on individual utility maximization. The absence of bequests is also important in their framework.

because taxes are distorting, or because of capital market imperfections. The issue of robustness would be less important, of course, if one could amass empirical evidence showing that absence of bequests is by far the most important reason for the failure of Ricardian equivalence. (Barro [1979] argues that tax distortions are more important.)

The BDP model is closed by the assumption that governments smooth consumption across generations.[2] Interestingly, their paradigm suggests the possible importance of certain shocks that have not been conventionally recognized as major factors in the determination of government budget deficits. For example, suppose there is an unanticipated positive shock to the rate of technological progress. The BDP model would predict an increase in the budget deficit, as future generations are now expected to be better off. There are, of course, other ways for society to transfer income across generations besides government debt. The current generation can also transfer income to future generations by increasing expenditure on education or by reducing pollution. Clearly, the existence of these other margins of substitution does not imply that the deficits channel is insignificant.

It is superficially anomalous that voters are willing to elect governments that care about future generations and yet are not willing to leave bequests themselves. This is internally consistent, however, if the trend rate of growth of productivity is high and if there are legal restrictions on leaving private debt to one's heirs. Hence agents are at a corner solution in terms of private bequests and use government debt to achieve an interior maximum. Thus it is perfectly possible to observe symmetric responses of deficits to temporary positive and negative productivity shocks, as in the BDP model. (Symmetric, in terms of deviations from trend. It might require a very large positive shock to observe an actual surplus.)

The BDP model, interpreted literally, captures the effects of government consumption smoothing across generations. Can it be interpreted more broadly to explain what happens when the government smooths consumption on a very short-term basis? The answer to this question is not immediately obvious. If individuals can borrow and lend at the same rate as the government, there would be no need for the government to run deficits. Again, it would be interesting to ask what types of capital market imperfections yield the same conclusions as the BDP's no-bequests assumption.

In section 5.4, BDP show that the gains from policy cooperation among governments become small as the number of countries grows

2. BDP's analysis is related to some analyses found in the social security literature; see, for example, Samuelson (1975) or Feldstein (1985). Both of these papers employ an OG model with no bequests and examine how income should be distributed across generations to maximize social welfare.

large. With an infinite number of countries, decentralized decision making yields a Pareto-optimal allocation. This is a model-specific result. Chari and Kehoe (1987) provide a natural example (in a model with distorting taxes) in which the cooperative equilibrium remains significantly better than the noncooperative equilibrium, even as the number of countries grows large. Incidentally, there is no theoretical presumption that governments can always better attain their objectives by cooperating. Rogoff (1985) provides an example in which the inflation credibility problems of governments vis-à-vis their own citizens are exacerbated when sovereign governments coordinate their monetary policy decisions.

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