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NOTES ON THE PUBLIC DEBT AND SOCIAL INSURANCE

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Introduction

Due perhaps to its very size, the public debt has long ben the subject of economic analysis and debate.[1] Yet despite this history, its economic effects are still not fully understood on either theoretical or empirical grounds. Presently, the areas of persistent doubt, or disagreement, have been thrust further to the fore for several reasons. First, economic events of the early 1970's left traditional Keynesian macroeconomic theories in an uneasy position. Challenged by the monetarist position,[2] the central and differing roles of the public debt in the two theories formed a focal point for the analyses.[3] Second, recent awareness of the acute state of the social security system[4] which is in the position of owing a huge unfunded debt to the current working population and faces a further adverse swing in the ratio of retirees to workers due to demographic factors, has highlighted the need to reevaluate the role of the public debt and social insurance policy in our economy. Intergenerational aspects of income redistribution and risk-bearing more generally[5] have also been raised in this context. Finally, the question of the choice of the discount rate for public investment[6] in the context of a growing economy without lump-sum taxation, has led to the study of the relationship between bond-financing and tax-financing, and their implications for project selection.

In the wake of these, further open questions have been generated: What are the implications of having government bonds with interest and principle denominated in money units, rather than being indexed to prices, wages, or something else?[7] What are the effects of public debt issuance on the distribution of income?

In these notes I hope to touch on a variety of these issues and to suggest ways in which they might be approached. It is to be viewed

as a research proposal, or an outline of open problems rather than as a statement of results.

The notes are divided into two sections. In the first, problems of intertemporal reallocation of resources through the public debt and social security are treated in the context of complete certainty about future events. Both positive and normative aspects of the problem are investigated, but principle emphasis is given to the latter. In the second section, the set of issues related to uncertainty and the role of intergenerational social insurance in its mitigation are explored.

The remainder of this introduction consists of a brief summary of these two sections; details follow in the body of the notes.

A. Intergenerational Aspects of Public Debt: certainty.

Public debt as a method of financing public investment has recently been given a rigorous treatment by Arrow and Kurz. Their pathbreaking book deals with the case in which the investment is to be made by a government which does not directly control the private savings behavior of its citizens. When faced with a particular tax structure and planned sequence of public investment levels, the private sector determines its savings behavior through competitive markets for capital and the factors of production. Because private and public capital may be complementary inputs in the aggregate production process, and public capital is not producible by the private sector, the financing and investment decisions are intertwined.

Arrow and Kurz treat the case in which the government's objective is to maximize its citizen's welfare. Because the private sector is modelled as a single, infinitely long-lived, household, this amounts to

the assumption that the public and private sectors have the same objective function.

In the context of a simple life-cycle model, there is an obvious direction to pursue: If the government maximizes a utilitarian objective function over all generations, the coincidence of goals assumed by Arrow and Kurz no longer exists.

One of their theorems sheds light on this case: It states that the coincidence of goals condition is necessary and sufficient for a system with income taxation and public debt to be able to achieve any arbitrary feasible path. By virtue of this result we know that the life-cycle problem is a second-best one.

How can we characterize the second-best policy? In particular, what is the second-best optimal relationship between the rate of return on public investment, that on private investment and the social rate of time preference?

B. Intergenerational Aspects of the Public Debt: uncertainty

One of the interesting features of the public debt other than its roles in aggregate demand determination and as a means of financing investment, is its ability to provide mutual intergenerational insurance against risks common to members of an age cohort. Modelling this in the overlapping generations framework as in section A, some of the same questions arise as in the certainty case.

When, given a feasible contingent intergenerational consumption plan, is it possible to decentralize this system by means of a tax system and a social security/ government debt policy, with rates changing with respect to the observed events. What other instruments are part of this

scheme? Is it necessary to distinguish individuals by age in the implementation of various taxes?

If we are in a model where complete decentralizability fails to obtain, what types of contingent consumption arrangements are possible in the steady state, and how are they implemented given the available policy tools? In such a second-best world, do the precepts of productive efficiency under constant returns still hold as in the certainty case?

A. Intergenerational Aspects of the Public Debt: certainty

1. The Diamond Model Reviewed

There are two main issues that come under the broad heading of intergenerational aspects of the public debt. The first is whether using debt as a policy instrument can increase the efficiency of the economy, both dynamically and in the steady-state. The second is the relationship between the required rate of return on public investment, that on private investment and the social rate of time preference when debt finance is available. As we will see, these are closely connected. They differ only in so far as the second problem requires us to model public investment as a different type of capital. It may not be perfectly substitutable with private capital in the production process; and it is not available as an investment to the private sector. In the first type of model, the two are indistinguishable and the government has direct access to the private capital market. We will begin there, because of its greater simplicity.

Much of the recent literature uses the basic model of Diamond (1965) to capture both the growth and the intergenerational aspects of capital accumulation. In this model, a generation born at time t consists of identical individuals whose lifetime is two periods, t and $t+1$. There are two goods in the system, labor services and a single consumption-capital good. Every individual is endowed with one unit of labor services when young and none, when old.

Thus, at date t, the economy consists of an old generation owning K_t units of capital in the aggregate and a young generation owning L_t units of labor services in the aggregate.

Production takes place within the period according to the stationary neoclassical production

(1) $$Y_t = F(K_t, L_t)$$

Since the stocks of the two factors are supplied inelastically, the real factor prices w_t and y_t are determined by competitive forces as the respective marginal products. By homogeneity of the production function, we have

(2) $$w_t = f(k_t) - k_t f'(k_t)$$

(3) $$r_f = f'(k_t)$$

where $k_t = K_t/L_t$ and $f(k_t) = \frac{1}{L_t} F(K_t, L_t)$. Eliminating k_t one can write

(4) $$w_t = \phi(r_t)$$

which is the factor-price frontier.

The linkage between adjacent periods in this system depends on two factors, which together determine the movement of k_t to k_{t+1}.

K_{t+1} is just the savings of generation t. Assuming no uncertainty about the rate of return on their savings, r_{t+1}, K_{t+1} is determined by solving

$$\max u(c_t, c_{t+1})$$

subject to

$$w_t \geq c_t + \frac{1}{(1+r_{t+1})} c_{t+1}$$

which is the problem faced by the typical economic agent, and multiplying his savings, $(w_t - c_t)$, by the population size.

To determine k_{t+1}, the percapita savings, $w_t - c_t$ is divided by the ratio of the population sizes at the two dates. Thus, assuming a constant growth rate n,

$$(5) \qquad k_{t+1} = \frac{w_t - c_t}{1+n} .$$

We have observed above that w_t depends on k_t and c_t depends on both k_t (through w_t) and r_{t+1}. Therefore (5) can be reexpressed as

$$(6) \qquad k_{t+1} = \frac{f(k_t) - k_t\, f'(k_t) - c_t(k_t, r_{t+1})}{1+n} .$$

In order for the perfect foresight assumption to be justified, $r_{t+1} = f'(k_{t+1})$ is required. Thus applying f'(.) (a one-to-one function) to both sides of (6) we have

$$(7) \qquad r_{t+1} = f'\left(\frac{f(k_t) - k\, f'(k_t) - c_t(k_t, r_{t+1})}{1+n}\right)$$

as an equation to be solved for r_{t+1}. The solution in turn determines k_{t+1} as a function of k_t.

An alternative interpretation of (7) which Diamond used to analyze the stability of this system, can be obtained by writing it directly in terms of w_t and r_{t+1}.

$$(8) \qquad r_{t+1} = f'\left(\frac{w_t - c_t(w_t, r_{t+1})}{1+n}\right) .$$

One can look for steady states as solutions to (6) and (8) in w and r, or one can look for values of k such that the solution to (7) is precisely f'(k).

To introduce government debt into the model, we suppose that the government offers to borrow from generation t, when they are young, inelastically with respect to the rate of interest. Since in this system the government debt must yield the same return as private capital, the government debt is held as an asset by the generation t in place of private capital. At date t+1, the government must refund the debt, plus interest, and can borrow again from the new, larger, generation. Nevertheless, as long as r>n, this new borrowing will not finance the principle plus interest, and taxes will have to be levied to make up the difference. For these reasons, when r > n, borrowing is going to be unambiguously harmful: It causes extra taxes to be collected, and it lowers total income by displacing private investment. Since the growth path is efficient when r > n, there is no way to improve the welfare of all generations by means of this type of policy. In the inefficient case, r < n, public borrowing will serve to reduce capital intensity and thereby promote efficiency.

One might think, on the basis of this analysis, that if the government were to <u>demand</u> bonds inelastically, it could improve welfare in the steady-state. Although the validity of this proposition for the steady state is easy to demonstrate, the policy cannot be executed without confiscatory taxation of the older generation in the initial period. When the bonds are bought by the government in the initial period, the young generation must be paid out of tax revenues. If it is

they who are taxed, their welfare must decrease. The older generation, not anticipating taxation, cannot be taxed unless the government is willing to forego their welfare for the sake of future generations. Thus, the problem must be treated explicitly on the basis of inter-generational equity vs. efficiency, and a dominance criterion cannot be applied.

2. Intergenerational Considerations: extensions of the Diamond Model

Because of the results mentioned above, it is necessary to consider objective functions which aggregates the welfare of agents living in different generations. This is the approach taken in Arrow and Kurz (1969) and Pestieau (1974). A set of instruments is specified that is typically more complex than Diamond's assumption of lump-sum labor income taxation. One asks whether the optimal path for the economy, describing the maximal feasible value of this objective function, can be attained through the use of these instruments in a decentralized economy.

If the answer to this question is in the negative, we are then in the framework of second-best theory. In these cases one wants to describe the optimizing levels of the control variables and contrast them with their first-best values.

The common objective function is

$$(9) \qquad \sum_{t=0}^{\infty} (1+\delta)^{-t} u_t$$

where u_t is the lifetime utility attained by generation t. Pestieau deals with the same overlapping generations framework as Diamond, above; Arrow-Kurz takes the view that there is a single, infinitely long lived household, which discounts its own utility at the rate δ.

We begin with Pestieau, since it is closest to Diamond. He considers the household utility function

$$(10) \qquad u(c_t, c_{t+1}, L_t)$$

and the production function

$$(11) \qquad Y = F(K_t, G_t, L_t)$$

where G_t is government capital. The available instruments are a wage tax, an interest tax, public debt and public investment. There are several important additional complexities built into this system, beyond those in Diamond's model. The first is that labor is no longer supplied inelastically so that lump-sum taxation of the younger generation can no longer be interpreted as wage taxation. The second is that government capital is physically distinguished from private capital. Implicitly this means that the government is forbidden to invest in the latter and the private sector cannot buy the former. This feature is comparable to the Arrow-Kurz formulation, but their labor supply function is inelastic. The elasticity of factor supplies, both of labor and of capital indirectly through savings, are the crucial forces shaping the optimal policy in these models.

A third complexity, and in my view an artificial one, arises from the specification of the government's budget constraint. The government's net revenue at date t consists of taxes less interest on debt, plus rent on government capital. This is written as,

$$(12) \qquad \theta_{w,t} L_t + \theta_{r,t} k_t + F_2^t g_t - r_{t-1} B_{t-1}$$

where

$\theta_{w,t}$ and $\theta_{r,t}$ are the tax rates on wages and profits

F_2^t is the marginal product of government capital, g_t

and

B_{t-1} is the past debt issue.

This net revenue, plus any new borrowing, constitutes the level of government investment up to the next date.[8]

The assumption about the revenue from renting government capital is particularly odd in this context. Since the government is the only owner of government capital, it is not entirely clear why it should be restricted to rent it out at the competitive price. One possible argument is that, having selected the quantity, it must accept the marginal product as the price of government capital services, or else some of the stock will be unemployed. However this does not preclude the government from charging a price below the private marginal product, and holding the utilization down to the available stock by other means. Perhaps more realistically, it may be difficult, if not impossible, to collect any rentals at all on government owned capital, because it may enter into the production process in non-appropriable ways. This difficulty is hidden in the aggregative structure of the mathematical model. Arrow-Kurz take the more flexible position that the rental is itself a policy variable between these limits. For the most part, however, they work with the assumption that government capital services are provided free of charge. It would be of interest to see if Pestieau's conclusions about optimal taxation and government investment in this framework are robust to changing his specification of the budget constraint in this way.

Under these conditions, Pestieau derives the first-order conditions for optimization with respect to θ_w, θ_r and B in the steady state. These imply that

$$(13) \qquad F_1 = F_2 = (1+\delta)$$

Rates of return on the two types of capital are equal and are equated to the social rate of time preference. A first-best is not achieved, however, since these rates may not be the same as the private, net of tax, rate of return on investment.

3. Open Problems in the Theory of the Public Debt under Certainty

These models are in need of generalization in several respects, most of which center crucially on the introduction of multiple periods for individuals' lifetimes. Apart from an increase in realism, longer lifetimes raise issues of both a theoretical nature in the theory of optimal taxation, and of a conceptual nature in the modeling of individuals' beliefs about future rates of taxation.

With three or more periods of life, the individual could, in principle, be faced with different rates of labor and capital income taxation as a function of his age. These might be useful for the purpose of overcoming imperfections in the capital market, dynamic inefficiencies of the Diamond type (see above), or the absence of suitable instruments of lump-sum taxation as in the Pestieau model (see above). For practical reasons, however, age-specific taxation may not be feasible. In such cases, further problems of a second-best nature will arise, and it would be interesting to investigate, for example, the way in which the rate of return on government borrowing would be biased.

In a recent paper Auerbach (1977) has investigated a model in which there are two types of capital with different degrees of substitutability with labor. Employing a two-period lifetime structure has shown that it is valuable to distort the returns to the two types of capital differently, as an indirect way of taxing labor and financing a public debt intended to reduce the dynamic inefficiency inherent in private life-cycle accumulation programs. However, although consumers' prices should be made to differ in this second-best environment. producers prices should not be distorted. Just as in the Diamond-Mirrlees (1971) static constant returns to scale model, producer effieiency should not be disturbed.

It is apparent from the analogy between the Auerbach and Diamond-Mirrlees models that this result persists in the presence of age-specific taxation. But with multi-period lifetimes and no age-specific taxation possible, the potential advantage of placing part of the distortive burden on production inefficiency may be relevant. This remains one of the important open theoretical questions at the present stage of research.

Perceptions about future rates of taxation[9] are another type of problem which becomes much more serious in the multi-period literature context. The arguments raised by Barro (1974) are directed towards establishing the proposition that government bonds are not part of the net wealth of the community because the economic agents perceive their future tax liabilities to be increased in order to cover interest payments on the debt.

Barro counters the usual rebuttal that the debt bears on future generations, whose consumption plans are not part of the instantaneous macroeconomic equilibrium, by an appeal to the bequest motive. If there is a margin on which bequest decisions are made, then when debt is increased more bequests will be necessary to offset the higher level of interest costs, and this extra savings, he asserts, will reduce current consumption to precisely that level consistent with the original wealth and real income.

A second line of attack on this neutrality hypothesis is that the government's debt is viewed as a safer asset than the privately issued claims that it displaces. Private consumption will thus increase because of the change in the characteristics of individuals' portfolios, rather

than an increase in the net level of wealth per se. Barro rejects this on the theory that the goverment does not have any risk pooling opportunities not also available to the market via private, mutual-fund type arrangements. No fundamentally new security can be issued.

The first of Barro's counter-arguments is rejected by Feldstein (1976) and Buchanan (1976) on the grounds that it requires a "no-growth" hypothesis. Feldstein therefore argues, in defense of his 1974 article, that social security is a source of net wealth and thereby depresses private savings.

Although correct as far as it goes, Feldstein's point is not entirely complete. One characteristic of social security which distinguishes it from both public debt and private financial assets is its lack of inheritability. Although limited provisions exist in the United States for widows and dependent children, the value of the social insurance benefits decreases upon the death of the principle beneficiary. Therefore social security wealth is not perfectly substitutable with private asset accumulation, and a full offset is not to be expected. On the other hand, the aspects of social security that are relevant to insurance against privately risky events (health, disability, death) make it more valuable than a purely nominal claim. Thus, to the extent that there is a precautionary motive for saving, the offset of private wealth may be more than one for one. It certainly seems necessary to model both of these forces explicitly in a life cycle model with population growth before a definitive answer to the Barro-Feldstein controversy can be discussed.

Barro's second argument, concerning aggregate risk-pooling possibilities on the private and social levels requires treating uncertainty of a different type than that mentioned above. Here the emphasis is on risky events that affect the welfare of members of a cohort similarly, rather than independently. By setting up a debt/social insurance program that's variable contingent upon these aggregate risk events, the government may be able to create new securities. This requires a new type of intergenerational model which we turn to in the following section.

B. Intergenerational Aspects of the Public Debt: uncertainty

A further, and perhaps equally important, use of intergenerational intervention is to mitigate uncertainties which might affect all members of an age cohort similarly, and which therefore cannot be efficiently insured by contracts among these agents alone. By adopting a debt/tax policy that is flexible with respect to the outcome of aggregate risks, the investment and intertemporal allocation policies of individuals can be arranged so as to provide some mutual insurance across generations.

Because of the greater complexity of this stochastic system, it is easiest to begin by simplifying the role of capital as a factor of production. It is assumed that labor is paid a fixed wage, which can thus be regarded as the endowment of the younger age group. This can be either consumed or invested, investment constituting a one period storage activity. As above, in the case of two-period lifetimes, the results of the investment activity constitute consumption in the second period of life.

Uncertainty takes the form of a randomized return, r, per unit of investment. Returns are perfectly correlated for agents within the same generation, but are independent and identically distributed across generations. Stokey (1977) has examined this system and obtained the following results.

Any feasible steady-state policy in which the capital stock is non-stochastic can be decentralized if the following four instruments are available:

a) a consumption tax

b) lump-sum, generation-specific, subsidies

c) an interest income tax

d) public debt (whose yield is set equal to that on private capital)

Several things must be noted about these instruments:

The level of debt and the rates of taxation or subsidization must be allowed to depend on the current realization of r, but they are independent of past values. Public debt is defined to be an asset which duplicates the return on private investment. This restriction could have been generalized to any pattern of returns with the property that the desired, fixed, level of private capital would be held in everyone's portfolio. It is of interest to note that such types of public debt are unnecessary to administer the decentralization of any plan with fixed capital stock, as long as the other state-contingent policies are available.

Finally, note that the only parts of the policy in which the government is required to distinguish between agents of differeng ages is in the administration of the lump-sum, age-specific subsidies. Because of the nature of capital and labor in this simplified overlapping generations model, this amount to state-contingent wage taxation and social security.

Corresponding to these observations there are several conjectures that should be investigated. The answers will shed light on the role of public debt and social security in more general models, and on the possibility of decentralizing efficient patterns of intergenerational risk-bearing with these instruments.

Most of these extensions are related to models with multi period lifetimes, instead of only two. Apart from the added realism, this ex-

tension is important for several reasons of analytic interest, with potential relevance for social insurance policies.

The capital stock at any date will depend on the sequence of events that has taken place within the lifetimes of the oldest generation then alive. Their savings/consumption patterns will depend on realizations during their lives. Thus, policies that are restricted to vary with only the current realization may not be able to sustain growth paths with a constant capital stock. This suggests two possibilities--either treat stochastic steady states explicitly, and find out which of these can be decentralized by policies of the type considered, or generalize the policy to be conditional on either the aggregate capital stock, or, more generally, on its distribution of ownership by age group.

Another aspect of multiperiod lifetimes, relevant to a second best world in which some feasible steady states cannot be decentralized by the available instruments, is that age-specific social insurance schemes can serve as a partial substitute for the absence of age-specific interest income taxation. Further, a policy of issuing public debt whose returns differ from that on private capital, but which will be held together with private capital in portfolios, may be useful in these models, whereas we had argued that it was redundant in the simpler, two-period lifetime system.

Even within the two-period context, it may be a valuable type of policy when the full set of instruments is not available. In particular it would be of interest to see whether the decentralizability results hold up if state-contingent consumption taxes are removed, but debt/social insurance policies can incorporate the issuance of such assets.

Footnotes

1. The literature on the burden of public debt goes back quite far. The interested reader might begin with Modigliani (1961) which gives one of the first analytic treatments of the subject, and Ferguson (1964), in which an excellent survey of the early literature is given.

2. Some of the principal critics of Keynesian macro policy, led by Friedman (see, for example Friedman (1968) and Barro (1976), Sargent (1976), (1973), and Sargent and Wallace (1976).

3. See Barro (1974), and the subsequent comments by Feldstein (1976) and Buchanan (1976).

4. See Munnell (1974), Feldstein (1974).

5. See Fleming (1976), Stokey (1977).

6. See Arrow (1966), Marglin (1963), Arrow-Kurz (1969), Dreze-Sandmo (1971). A more general treatment of the local welfare calculus is given in Bradford (1975).

7. See Fischer (1975). Sheshinski (1977) explores the possibility of linking wage contracts to nominal GNP, rather than to a price index, which may have superior properties as an automatic stabilization device.

8. Pestieau also assumes that both debt and capital have a maturity of one period, rather than being consoles and indestructible, respectively. This point is, however, inconsequential for the economics of his analysis.

9. See Kochin (1974) and Bomberger (1977).

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