TAXATION IN DYNAMIC ECONOMIES
SOME PROBLEMS & METHODS

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CPD Discussion Paper No. 1985-13
October 1983

CPD Discussion Papers report on work in progress and are circulated for Bank staff use to stimulate discussion and comment. The views and interpretations are those of the authors.
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ABSTRACT

This study has been prepared as part of the research on taxation and growth.

The paper surveys recent work on tax reforms in dynamic economies where the level of capital and the factor prices are endogenous. The presentation emphasizes methodological issues.

The framework for the evaluation of tax reforms is described, and the main results of the literature are presented for three types of capital accumulation: the neoclassical model with an ad hoc saving rate, the life-cycle model of overlapping generations, and the model with intertemporal optimization and bequest. The tax on cash balances, the public debt and the social security program are discussed in the context of these models. Other issues such as the flexibility in the mobilization of government revenues and the case of an open economy are also considered.

* Discussions with members of the CPD division have been very stimulating. The constant and close collaboration of Zmarak Shalizi has been essential in this work.

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I. INTRODUCTION

This paper is a selective survey of some of the current methods used in studies of taxation with a special regard to the accumulation of capital. It is not a survey for an encyclopedia, but more a technical note which could be used as a reference in the elaboration of specific research tasks.

The framework of this note is the theory of general equilibrium. Over the last decade, this framework has been used in a growing number of studies on dynamic taxation. The models of general equilibrium used in these studies can be classified in three categories according to their fundamental assumption on the saving function. This function has an ad hoc definition in so-called neoclassical growth models. It is determined by individual optimization in the life-cycle models and in the models with an operative bequest.

All the available studies can be considered as pedagogical exercises at this point. Each concentrates on some important point but for tractability's sake, simplifies the model by omitting important other aspects. Clearly there is no "good model" yet for any economy which is sufficiently realistic and consistent to be used directly for policy. However, since policy recommendations will have to be made on the (partial) evidence of these approaches, it is important to review them in detail. This is the subject of the next two sections.

The neoclassical approach is appealing because it provides a simple extension of static models of general equilibrium, and also
because it may be empirically relevant in economies without developed intertemporal markets (although this relevance is rarely tested). Its general implications are simple: the capital accumulation may not be efficient, future policy changes are in general not included in the structure of the model, as they should be if agents have some rationality. One advantage of the neoclassical approach is its tractability. Technically, it leads to a method for the evaluation of policy in a dynamic context which is very similar to the methods of social accounting of Little and Mirrlees.

The models of optimizing agents are treated in Section III. They allow for all the effects of anticipated policies. Their evaluations produce different results depending on the individual's horizon (life-cycle or infinite). These studies concentrate on the intergenerational distribution of welfare and assume away issues of intragenerational distribution.

Section IV is devoted to the inflation tax. The treatment of this problem is directly related to the various methodologies outlined in the previous two sections.

Section V deals with specific policy issues as the public debt, social security, increasing returns, which could be the subjects of further studies. A brief discussion of the interest elasticity of saving is also given (using some of the material presented in Sections II and III). This concept is often misused in dynamic taxation. The concluding section presents some methodological suggestions for policy applications.
II. "NEOCLASSICAL" GROWTH MODELS

II.A. Introduction

The label of "neoclassical growth models" is traditionally associated with a saving function which is an ad hoc function of endogenous variables (income and factor prices), and determines the level of investment.

In the simplest models the ratio between saving and income is constant. In more elaborate studies, different saving rates are imputed to different agents or to various types of incomes (for example, capital and labor income). Also these functions may depend at any instant on the contemporary values of the factor prices.

In public finance, neoclassical models have been very useful to highlight the difference between the short-run and the long-run impacts of taxation. For example, Feldstein (1974a), showed that in the long run, a substantial fraction of the burden of a general profits tax is borne by labor. This occurs because the tax has a negative impact on the level of the capital stock and on the productivity of labor.¹

Neoclassical models seem to have been especially popular in studies on the savings process in developing economies, for two reasons.

The first is related to the absence of capital markets. When there is no widespread market for the efficient allocation of savings, 

¹ In a similar study, Feldstein (1974b) noted that in the long run, labor may bear more than 100 percent of the net burden of a tax on labor income.
profits may be reinvested only in the sectors where they are generated. In simple models, à la Kaldor, all profits are re-invested and the workers save nothing. Since individuals have to survive in their retirement, one could presume that intra-family transfers occur between the young working generations and the old generations. Arrow and Kurz (1971), have also justified the assumption of a constant overall saving rate by the absence of capital markets. One could also invoke the imperfections of foresight.

These problems are important for all economies, and are possibly even more relevant for developing countries. It is not clear, however, that these imperfections are adequately represented by ad hoc functions for the saving rate. In particular, one would like to see more research work on the impact of market imperfections on the form of savings (housing, productive capital, and human capital). Too often, studies based on neoclassical models give a mechanistic view of individual agents.

This brings us to the second reason for the success of such models, i.e., their tractability. Since the level and the form of capital accumulation depend only on the current values of the endogenous variables, the solution of a dynamic neoclassical model is relatively easy and proceeds in two steps for each period. First, the static equilibrium within the period is computed. It depends on the initial

\[ \text{See, for example, Dervis et al. (1982), Chapter 5.} \]
stocks of various capital goods. This solution determines the flows of saving (i.e., investment). In the second step, these flows are allocated by an ad hoc method across the different sectors of the economy, and determine the levels of the capital stocks for the next period. The entire dynamic path is solved sequentially, period by period.

The standard application for these models is the simulation of the dynamic path for the endogenous variables with the fiscal policies under consideration. These policies are then evaluated by examination of the dynamic paths or by computing a social welfare function on the paths. Since the main difference between "neoclassical" models and the models of optimization discussed later is the saving function, it is important to highlight the main implications of this structural feature for the analysis of fiscal policy. Before turning to this subject, one should make a last remark.

The saving rate in a neoclassical model is a function solely on the current values of some endogenous variables (capital stock, etc.). This property is also satisfied in general equilibrium models with intertemporal optimization when the fiscal policy (tax rates, etc.) is fixed. However, the two approaches are very different.

In the second, the saving function is only the "reduced form" of an intertemporal optimization problem. It depends on all the anticipated values of policy instruments. In the first, this saving function is invariant to anticipated changes. The neoclassical models assume in general a myopic behavior. In general, the function which determines the saving rate is not compatible with intertemporal optimization, even
on the balanced growth path (see Section II.D, however). This implies that the capital accumulation is inefficient. It is also because future endogenous prices have no effect on "today's" decisions that the model can be solved sequentially.

II.B. Fiscal Policy in Neoclassical Growth Models

Most neoclassical growth models keep the framework of intratemporal optimization. The evaluation of fiscal policy is characterized by two main features.

Because of the ad hoc specification of saving, the level of investment is in general inefficient and appropriate policies can improve upon the no-intervention solution.

Future policies have no effect on contemporary variables. Changes in fiscal policies are evaluated by measuring the perturbation they create at the time they occur, and by computing the implications of this perturbation for the dynamic path in a sequence of static equilibria. Let us first consider the evaluation of investment in the situation of no government intervention.

II.B.1. The Value of Investment

As an illustration, consider the simple one-good model ("corn") with a constant savings rate, equal to $s$. Represent by $v_t$ the value of "corn" planted at time $t$ (for production at time $t+1$), in terms of consumption at time $t$ (consumption at time $t$ is the numeraire). The capital invested at time $t$ produces a rate of return $r_{t+1}$ at time $t+1$. A fraction $(1-s)$ of this income is consumed
in the same period. Each unit of consumption at time \( t+1 \) is worth 
\[
\frac{1}{1 + \rho_{t+1}}
\] units of consumption at time \( t \) (where \( \rho_{t+1} \) is the dis-
count rate between the two consecutive periods).

The value of investment at time \( t \) is determined by perturba-
tion analysis: if there is a marginal unit increase of capital at 
time \( t \), the level of income increases by \( r_{t+1} \) (for production at time 
t+2), is equal to \( 1 + sr_{t+1} \), and by definition, it has a value of \( v_{t+1} \) in 
terms of consumption at time \( t+1 \). This argument shows that there is a 
simple relation between \( v_t \) and \( v_{t+1} \):

\[
v_t = \frac{1}{1 + \rho_{t+1} + (sr_{t+1} + 1)v_{t+1}} \tag{1}
\]

A recurrent application of this formula determines the value 
of \( v_t \) which depends on the future path of the economy. If agents were 
optimizing, the value of \( v_t \) would always be equal to one. When the sav-
ing rate is equal to an ad hoc ratio, the value of \( v \) can significantly 
differ from one.

To simplify the computation, assume that the economy is in a 
steady state. All values are time invariant in the above formula, and 
\( v \) is equal to

\[
v = \frac{r(1-s)}{\rho - rs} = 1 + \frac{r - \rho}{\rho - rs} \tag{2}
\]

This value is greater than one when the level of private savings is "too 
low" and the rate of return exceeds the discount rate. With \( r = 15\% \),
\( \rho = 15\% , s = 20\% \), the social value of corn is six times larger than its private value!

One should keep in mind that the value of \( v \) obtained in this calculation, is very sensitive to the discount rate. It also depends on the assumption that the economy is in a steady state with a permanent inefficient value of the level of savings.

On the path toward a more efficient steady state, the values \( v_{t+k} \) used in the recursive application of formula (1), may tend to a lower value, closer to one, when \( k \) tends to infinity. The initial value \( v_t \) is then also closer to one.

The previous discussion only illustrates the principle of the method. It should be especially useful in more disaggregated models with various agents and capital goods. In this setting, one would place weights on the consumption levels of different agents. The social values of different capital goods depend on the distribution of capital, on the returns to capital goods across different agents and on their respective propensities to save in these capital goods. Such extensions are discussed briefly in Bradford (1975). Their application in specific context should not raise methodological difficulties.

II.B.2. Policy Evaluation

The perturbation method described above provides also the framework for the evaluation of policy. All the impacts of policy on the private sector should be taken into account for the relevant periods. The values of these effects are then added together to determine the overall value of the "project". The principle of the method is
very similar to the project evaluation of Little and Mirrlees (1974). Its implementation is simple in the dynamic context because saving decisions are made in a sequential process, and do not depend on a large number of future variables.

As an example, consider the previous model with a constant saving rate, and assume that the government has the same investment possibilities as the private sector (with the same rate of return). When the government expenditures are fixed, the revenues of this investment are used to reduce income taxes, and therefore accrue to private income. The perturbation analysis shows that the value of "social" investment, $\bar{v}_t$, is equal to

$$\bar{v}_t = \frac{1}{1+s}\cdot\left[(1-s+sv_{t+1})r_{t+1} + \bar{v}_{t+1}\right]$$

(3)

By comparing the relations (1) and (3), $\bar{v}_t$ is equal to $v_t$ if $\bar{v}_{t+1}$ is equal to $v_{t+1}$. An inductive argument shows that $\bar{v}_t$ is equal to $v_t$ for all periods. In the steady state, it is equal to $\frac{(1-s)r}{(p-sr)}$. If the social investment is financed by a tax on income, it reduces the levels of private consumption and investment in the first period by $1-s$ and $s$, respectively. Assume also that there is an efficiency cost of taxation equal to $\alpha$ per unit of net revenue (in the first period). This cost is the sum of the excess burden due to price distortions and of the administrative cost of collecting revenues. The total value of the project net of cost, is
\[ V = V - (1-s + sv) - \alpha \]
\[ = (1-s)(v-1) - \alpha \]

Other cases occur when the revenues of the project are re-invested entirely, or when the government uses different financing methods (by debt issue, or a consumption tax, etc.). They can be treated in the same manner.

Note also that the same method provides rules for the optimal level of social investment. Consider the previous example, and assume that the excess burden of taxation \( \alpha \), is equal to zero. The efficient level of investment is reached (in the steady state), when \( V \) is equal to one, i.e., when the rate of return \( r \) is equal to the discount rate \( \rho \) (Arrow & Kurz, 1971).

Other rules can be derived easily for the various cases of financing of the project and the distribution of its returns. Some of them are discussed by Boadway (1978). For example, if the investment is financed by debt, it crowds out an equal amount of private investment (under the assumption of a fixed saving rate). The government should not invest with debt financing when it does not have a technological advantage over the private sector.

The same perturbation method can be used to analyze tax reforms in various contexts (also with many agents or capital goods). A tax reform usually applies for a number of periods, and the perturbations have to be added up over all relevant periods. As an example, consider a permanent shift of one unit of revenue from an income tax to a consumption tax. The decrease of the income tax generates an increase
of consumption equal to a fraction $1-s$ of one unit, and an increase of investment equal to $s$, with a value equal to $sv$. The consumption tax reduces consumption by one unit. The effect for one period is equal to $(sv+1-s) - 1 = s(v-1)$. The total effect of the tax reform is equal to the discounted sum of the effects for all periods. If the economy is initially on a balanced growth path with a growth rate $n$, the welfare gain of tax reform, in terms of first period consumption, is equal to $s(v-1)/(\rho-n)$.

In the discussion of the previous examples, the saving rate was assumed to be constant for simplicity. One can also consider a saving rate which depends on endogenous variables without affecting the sequential dynamic property of the neoclassical method (for such an extension, see Boadway, 1978).

The perturbation method has been used in different examples by numerous authors (Marglin, 1963a, 1963b; Feldstein, 1972). Its more general exposition has been presented by Bradford (1975). Boadway (1978) gave a more formal presentation and noted that one should carefully take into account all the effects of government policy.

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3 The same result can also be determined by another method outlined below (Section II.B.5).

4 When public investment is financed by debt, the debt should be introduced as an additional stock variable in the analysis, because the taxes needed for the service of the debt may have an incidence on the savings rate (an example of this situation is given by a neoclassical model with a consumption tax).
The perturbation method is based on marginal changes and relies on the dynamic programming approach for the evaluation of stocks (see the above formula). It generates the same rules for optimal programs as the optimal control approach, since the optimality is characterized by marginal rules. If the policy issues go beyond relatively small tax reforms and involve the evaluation of large changes, the social values of capital goods are no longer exogenous to the policy changes. Policies can be evaluated by an explicit welfare function. The natural technique for the optimization of (large) tax reforms is the optimal control method (Arrow & Kurz, 1971).

II.C. Other Issues

II.C.1. Intratemporal and Intertemporal Inefficiencies

The numerical examples given in the previous section showed that saving functions which are not based on intertemporal optimization may lead to large intertemporal inefficiencies. In this context, the social values of capital goods could be multiples of their market values.

This occurs because the inefficiency is measured in the (inefficient) steady state. It is equal to the discounted sum of foregone opportunities. The discrepancy computed between the social and the private value \( v^{-1} \), is the discounted sum of all future "saving inefficiencies". A large value for this difference does not imply that intertemporal distortions are greater than the intratemporal distortions. The expression \( v^{-1} \) corresponds to a "stock" and should be compared to
the discounted sum of the intratemporal inefficiency flows (caused by
tax distortions, etc.) for all future periods.

In other terms, a large value of $v$ does not mean that the
problem of saving incentives is more important or "urgent" than the
problem of labor incentive for example. Also, if the reform towards
more efficient saving incentives is postponed for a few years, the
social costs will accrue only for those years and their sum will be sig-
nificantly smaller than the total sum $v-1$.

II.C.2. Operating Costs of Social Investments

The important benefits to social investment which were des-
cribed in the previous section may vanish when these projects imply user
charges which may be recovered only through taxation. The efficiency
cost of these taxes (price distortion or administrative cost reduce the
net benefits of the project).

Consider for example, an infinitely lived project with a rate
of return $r = 12\%$, which has an operating cost equal to a multiple $\theta$ of
the return in each period. Furthermore, each unit of operating cost
implies an inefficiency of $\mu$ (because of tax distortion, or other
causes). The value of $a$ is equal to $a = \theta \mu / \rho$. With the plausible
values $\rho = 4\%$, $\theta = 3$, $\mu = 0.5$, we find that the gross social value
of the project $v$ is equal to 3, but its nest social value is negative
and equal to -1.4.

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5 The "profits" are equal to one-quarter of gross output.

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II.C.3. The Rate of Convergence to the Steady State

It is sometimes argued that the rate of convergence towards the steady state is relatively low for an economy with a constant saving rate (Sato, 1963). This property is sensitive to the values of the parameters of the model. As an illustration, consider a one-good economy with a constant saving rate, s. Let $n$, $\mu$ and $\delta$ represent the rate of population growth, labor augmenting technological change and depreciation, respectively. The variation in the capital labor ratio $k$, is equal to

\[ k = sf(k) - (n + \mu + \delta) k. \] (5)

Near the steady state it is approximated by the linear function:

\[ k = -\lambda(k-k^*) , \] (6)

where $\lambda$ and $k^*$ represent the rate of convergence toward the steady state, and the value of the capital labor ratio in the steady state, respectively. The value of $\lambda$ is equal to:

\[ \lambda = n + \mu + \delta - sr, \] (7)

$r$ is the (steady state) rate of return.
If the growth rate is low and $s$ represents the net saving rate, the value of $\lambda$ may be small (for $n = 5\%$, $s = 15\%$ and $r = 12\%$, $\lambda = 3.2\%$). But the value of $\lambda$ increases with the growth rate (with a high growth rate most of the capita is relatively recent).

One could also assume that the level of gross saving is a constant fraction of gross income (with an identical value for the net saving rate in the steady state). To compare the effects of these two assumptions on $\lambda$, assume that $\lambda_1 = n + \mu - sr$ (constant net saving rate), with $s = s^* - \delta(K/Y)$ (identical saving in the steady state). Then

$$\lambda_2 = \lambda_1 + (1-a)\delta,$$

(8)

where $a$ is equal to the share of capital income. We have always:

$$\lambda_2 > \lambda_1.$$  

(9)

If $\delta = 6\%$ and $a = 1/4$ the value of $\lambda_2$ is equal to about 8%, which is more than twice the value of $\lambda_1$.

The value of the rate of convergence towards the balanced growth path also increases with the interest elasticity of saving.

II.C.4. **Myopic Expectations**

An important class of neoclassical growth models is given by the economies where private agents optimize the intertemporal allocation of their resources, but have myopic expectations about future prices:
at any instant, all anticipated values are equated to their currently observed levels. Such behavior is rational on the balanced growth path, but not during a transition period. Recently this framework has often been used in the evaluation of tax reform (see below). In this context, the saving rate can be expressed as a function of the contemporary values of endogenous variables.

As an example, consider a one-good economy with a single agent. Assume that his utility function is additively separable in the logarithms of the consumption levels in different periods. The optimal consumption level is equal to a fixed fraction (equal to the time preference rate \( \rho \)) of the total wealth (human and non-human capital). Under myopic expectations, the factor prices are expected to stay permanently at their current values. The level of consumption is determined by a straightforward computation.

\[
c = \rho(k + \frac{y}{r}).
\]  

The saving rate is equal to

\[
s = 1 - \frac{c}{y} = 1 - \frac{\rho}{r},
\]

where \( y \) represents income. It has a "neoclassical" form, and it increases with the rate of return.

The assumption of myopic expectations has a significant positive impact on the rate of convergence to the steady state. Consider
the case where the level of the capital stock is below its steady state value and increasing. Under myopic expectations individuals underestimatethe increase of future outputs due to capital accumulation, andtherefore the level of future wages and of the price of future consumption (they overestimate the rate of return). Since they are saving, thefirst effect dominates: myopic expectations generate a negative incomeeffect which depresses the level of consumption (of produced goods andleisure); it therefore increases the level of saving and of the labor supply, the same argument shows that the substitution effect operates inthesame direction as the income effect. This implies that the rate ofconvergence to the balanced growth path is greater under myopic expecta-
tions than under perfect foresight (Chamley, 1984b).

In the above example (with a fixed labor supply), when \( p \) andthe share of capital income are equal to 4% and 1/4, respectively, theseconvergence rates are equal to 12% and 3%, respectively. In a growingeconomy, the impact of myopia may be even stronger because of the largeincome effect which arises when the growing human capital is underestima-
ted.

The saving function derived from intertemporal optimizationunder myopic expectations is equivalent to perfect foresight only whenall factor prices are constant, i.e. on the balanced growth path. Thisimplies that in the long run, the level of capital accumulation is ef-
ficient (the social and private values of capital are equal).
II.C.5. **Comparisons Between the Short Run and the Long Run**

It is well known that a distinction should be made between the impacts of tax reform in the short run and in the long run. Some policies are beneficial in the short run and have adverse effects in the long run, or reciprocally. In some situations these impacts can be compared by a simple and useful rule.

Assume that a social planner has a utility function over the current state of the economy. Its arguments may include the level of private consumption, the distribution of income, etc. The intertemporal utility of the social planner is the sum of utility levels in all periods, measured on the dynamic path, discounted at the rate $\rho$. There is one type of capital good which may be allocated in different sectors of production. The level of investment depends at any instant only on the current values of endogenous variables, and other fixed factors. (This property is satisfied in neoclassical models.) Assume now that the tax structure is subjected to a small permanent change. The state of the economy changes immediately after the tax reform, and it evolves towards a new balanced growth path.\(^6\)

The social welfare measured on the dynamic path can be approximated by a very simple formula (Boadway, 1979). It is equal to the weighted sum of the utility of the state immediately after the tax reform $U_0$, and of the state in the steady state $U^*$.

\[^6\] For example, if the capital income tax is abolished, the saving level jumps to a new value.
where \( \rho \) in (12), is equal to the difference between the pure rate of time preference and the growth rate.

This formula has a simple interpretation: the weight of the short run increases with the discount rate, and the weight of the long run increases with the rate of convergence to the steady state (or the balanced growth path). It also highlights the importance of a model's bias about the value of the convergence rate \( \lambda \).

The above formula is useful only for small tax reforms. Large perturbations should be evaluated by complete numerical computations.

This approximation method has to be modified either when there is more than one type of capital as in an economy with irreversible investments in different sectors, or with agents endowed with different amounts of capital. Instead of a single rate of convergence there are as many "stable" eigenvalues to the system as types of capital. However, the eigenvalue with the largest modulus (smaller than one) dominates the others asymptotically (in a discrete model), and except for some initial interval of time, the previous method should still be applicable.

II.D. Disaggregated General Equilibrium Models

Harberger's study (1964) has been seminal for analyses of intratemporal tax distortions. Shoven, Whalley and their associates
expanded on this work by disaggregating the production sector and introducing agents with different levels of income. Such models have stylized parameters (various elasticities of substitution), which are calibrated with the available data from various sources. The disaggregation is necessary to measure the effects of the differences of tax rates which apply to various production sectors or individuals.

Such models are extended to a dynamic framework by introducing a unique future good in the utility function of individuals, which takes in any period, the form:

$$U = U(H(C_O, \ell), C_f),$$  \hspace{1cm} (13)

where $U$ and $H$ are CES functions, $C_O$ is a vector of current consumption of goods, and $\ell$ is the level of leisure (or labor supply). The variable $C_f$ represents an index of future consumption.

Two critiques can be raised about this approach. First, when there is more than one consumption good or when the labor supply is variable, the utility function presented above does not have a form which can be interpreted as the reduced form of a complete intertemporal utility function, even if prices are time invariant. This implies that the model is not compatible with utility maximization even when the economy is on the balanced growth path.
The second issue is that the choices which optimize the "reduced" utility function in any period, depend only on the contemporaneous values of the endogenous variables and are unaffected by anticipations about the dynamic path of the economy or the future policies. This is sometimes justified by a myopic assumption about these expectations. It follows that the saving function which is generated by DGE models has the same general properties as standard neoclassical functions.

The dynamic DGE models are simply sequences of static DGE models linked by an ad hoc saving function which depends on the current values of factor prices.

Also, because the saving function has some of the properties generated by myopic behavior, the short-run interest elasticity of saving and the rate of convergence toward the balanced growth path may be biased upwards, as we have seen in Section II.C.4. The reader of these studies can have some doubts about the validity of the numerical results generated with this type of model.

Consider, for example, the standard experiment of the abolition of the corporate tax which is then integrated in a general income tax (Fullerton et al., 1981). Myopic individuals underestimate the future decrease of the rate of return (induced by capital accumulation). They overestimate its value on the dynamic path. This reduces the negative impact of the income tax on the net rate of return, the distortions of the tax, and generates a more efficient dynamic path.
Another source of bias in DGE models is that the capital stock can be reallocated costlessly between production sectors immediately after the tax reform. If investment is irreversible, capital can be reduced in a sector only through depreciation. The postponement of an efficient reallocation of resources reduces the discounted value of the benefits of tax reform (Fullerton et al., 1982, analyzes the interaction of irreversibility and tax reform).

The current DGE models are not based on rational intertemporal optimization, and they cannot be used for welfare evaluation of policies. These tax policies are evaluated by inspection of the endogenous variables on the dynamic path. A convenient summary statistic is a Paasche or Laspeyres index, which can be computed at the aggregate level or by income class (Fullerton et al., 1981, 1983).

Since the DGE models have been developed to represent more accurately actual economies, one would like to see how their predictions compare with ex post data. This exercise seems relevant since the models are "calibrated" with a combination of data from a few periods and plausible values for stylized parameters (various elasticities of substitutions), which are interpolated from specific empirical studies. Contrary to standard econometric practice, the DGE models' performance has not been tested.

7 Since the structure of the model is not compatible with dynamic optimization in the steady state, its saving function is somewhat "more ad hoc" than the function derived under dynamic optimization and myopic expectations.

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Finally, DGE models have sometimes been used to generate nominal variables. However, the general equilibrium solution in each period is computed in real terms. The choice of the numeraire is left open. The standard method is to specify a path for the price level which is determined according to other information available to the model builder (quantity of money, etc.). As Bell and Srinivasan (1983) have pointed out, this is an irrelevant exercise.
III. MODELS WITH PRIVATE INTERTEMPORAL OPTIMIZATION

III.A. Introduction

Most recent studies on fiscal policy in a static framework (with a public finance approach), assume that private agents have an optimization behavior. It is remarkable that this fundamental principle is less widely used when dynamic aspects are considered.

One should first emphasize that the methods developed in the static theory of optimal taxation or tax reform, can be applied in the dynamic context with private optimization and perfect foresight. In this framework, all future actions are determined in the beginning of the "planning period". As time unfolds, the contracts become due and are realized.

However, the issues and problems raised in the dynamic context tend to be of a specific nature. These typically include comparisons between the short run and the long run, the intergenerational distribution of wealth, the level of the public debt, the level of saving, the formation of expectations, etc.

The analysis of dynamic taxation has been relatively recent. There is at the present time no study of dynamic taxation in a general equilibrium framework which has developed a reasonable stylized model applicable for a comprehensive evaluation of policy. The available studies are usually devoted to some aspects of the problem, but ignore others, which are potentially important.
An important feature of any theoretical or empirical dynamic model is the horizon of individuals. In some studies individuals are life-cyclers, in others, intra-family transfers generate a behavior which is equivalent to that of infinitely-lived individuals (Barro, 1974).

III.B. The Life-Cycle Models

The fundamental property of the life-cycle is that individuals save only for their own consumption (in their retirement period), and do not consider the benefits of capital accumulation which accrue to future generations. The level of aggregate savings, which is determined by the private sector is then obviously different from the level chosen by a social planner who takes into account the welfare of all generations, present and future. In this framework, there is an opportunity for a redistribution of wealth between generations by a social planner.

In a simple model with homogenous overlapping generations, Pestieau (1974), has shown that the optimal fiscal policy is to bring the total level of capital (private plus public) to a value such that the marginal return is equal to the discount rate. This criterion applies even if the policy requires transfers between the private sector and the government through distortionary taxes and subsidies.

One should make an important remark at this point. In some cases, restrictions may be placed on the government's opportunities for investment. However, if the government wants to supplement private savings by public savings, it does not need to own capital. This "public" capital can be put in private hands by a subsidy to young individuals.
and a tax to older generations. When a private agent is young, he receives capital which he returns to the government in later years. The capital is then transferred to younger individuals and so on. This scheme could be achieved by a subsidy on labor and a consumption tax, since the labor income streams precede, on average, the stream of consumption expenditures. One can see immediately that such a simple concept as the public debt has no meaning in this context since it can be manipulated arbitrarily by tax policies. This important point is analyzed carefully in a recent survey by Kotlikoff (1983).

The manipulation of the public debt (positive or negative), through the tax system is especially important when there are institutional restrictions on its level. In this case, because of the "transfer property", the optimal values of the tax rates are different from the efficient values obtained with the Ramsey rules (Atkinson and Sandmo, 1977). 8

This argument applies only if individuals have some foresight (as they do in a life-cycle model). If individuals are myopic, they may not perceive that the subsidy they receive when young is accompanied by a tax when old. The implications for aggregate savings are then clearly very different.

The effect of tax reform in a life-cycle framework of general equilibrium have been analyzed in synthetic stylized models by Summers

8 When there is no restriction on the level of the public debt, the Ramsey rules apply (Pestieau, 1974).
(1981), and by Auerbach et al. (1983). Instead of the usual two-period models frequently found in theoretical studies, they add some realism by considering a large number of generations (55 years). However, all generations are homogenous and there is only one good in the economy. The first study considers only the steady states, and the second analyzes the entire dynamic path.

Summers observed that if individuals' life-time utilities are the discounted sum of generalized CES functions for each period, the long-run aggregate supply of capital is very elastic with respect to the rate of return. This applies even if the elasticity of current marginal utilities is high, and there is little substitutability between the consumption levels as different dates. In other terms, the long-run interest elasticity of the supply of capital (a stock) is large even if the interest elasticity of saving (a flow) is relatively low. This fact is easily explained by noticing that when individuals are infinitely lived and have an additively separable isoelastic utility, the long-run supply of savings is infinitely elastic (with the rate of return equal to the discount rate). The life-cycle horizon (55 years), although not infinite, is sufficiently long to generate a high value for the interest elasticity of savings.

The implications for fiscal policy are obvious: a tax on capital income has a strong negative impact on the levels of capital accumulation, total output and welfare. Also the consumption and the labor income tax are not equivalent (see note 9).
Auerbach et al., extend the approach of Summers by including a labor-leisure choice, and analyze the effect of tax reform on the inter-generational distribution of welfare for the entire dynamic path. Generations are homogenous. Individuals have a life-time utility which is a generalized CES between consumption and leisure and additively separable between periods. The life-time wage profiles have a stylized shape derived from other empirical studies. Two policies are analyzed, a shift from a general income tax to a wage tax and a reform to a consumption tax. For computational convenience, it is assumed that the government budget is balanced in every period. All simulations are conducted under the assumption of perfect foresight about the future factor prices.

For the parametric values used in the study, a shift to a wage tax does not increase welfare in the steady state because of the increased distortion in the labor-leisure choice. (For low values of the elasticity of substitution between goods and leisure one would find, as in the study of Summers, that the shift to wage tax generates a welfare gain in the long term.) This policy generates a welfare gain only for the generations who are old at the time of the reform (with an economic age greater than 20). It is explained by the fact that their value of human capital is relatively small.

The shift to the consumption tax induces a welfare gain in the long run. Of course the consumption tax produces also a distortion between the price of leisure and consumption, as the wage tax. However it is superior to the wage tax in the long run because of two reasons.
First, the base of the consumption tax is higher than that of the wage tax,\textsuperscript{9} hence a smaller tax rate and a smaller distortion. Second, the level of savings is higher with a consumption tax than under a wage tax (individuals need to save to pay the tax when old, whereas with the wage tax they pay it when young). The long-run welfare gain must be generated by a temporary reduction of consumption. It is imposed mainly on the individuals who are relatively old at the time of the tax reform (with an economic age greater than 20).

Auerbach \textit{et al.} measure the order of magnitude of the effects involved and present numerical illustrations. They consider an initial position in the steady state with a 30\% general income tax. For plausible parametric values,\textsuperscript{10} the shift to a consumption tax generates a welfare gain in a new steady state which is equivalent to an increase of life-time wealth for each individual of about 6\%.

This gain arises because of two effects. First, aggregate savings are stimulated at a cost for "transitional" generations. The second effect is generated by the efficiency improvement of the tax

\textsuperscript{9} In the steady state, the level of consumption is the sum of wage income and profits net of investment to maintain the economy on the balanced growth path. This latter term is positive if the rate of return is greater than the growth rate. In other terms, the consumption tax is a tax on non-human and human capital, whereas the wage tax is only a tax on human capital.

\textsuperscript{10} The elasticity of substitution between capital and labor in the technology, leisure and consumption, consumption at different dates, are equal to 1, 0.8 and 0.25, respectively.
system: the intertemporal distortion of the intertemporal allocation is reduced. This second effect can be measured separately by running a fictitious experiment where transitional generations are compensated by lump-sum payments, and the utilities of all generations are equalized. In this case the welfare gain of a reform to a consumption tax is only equal to 1.7% of a life-time wealth. These numbers illustrate that for the main part, the long-term gain in welfare cannot occur without a significant reduction of welfare for transitory generations. Such policies can be justified by the attribution of large weights to future generations, compared to generations living at the present. These weight distributions depend on social welfare choices.

III.C. Models with an Operative Bequest Motive

When individuals save for their children, they take into account a horizon which extends beyond their own lifetime. If these private savings are optimized with respect to the utility of descendants, one can argue by induction, that individuals behave as if they were infinitely lived (Barro, 1974). In this framework each family behaves as a single individual.

An interesting and fairly general case is that of the generalized Koogmans utility function which is separable between consecutive strings of consumption in overlapping period (it is our arbitrarily fixed number). There is a powerful result in this framework: the second best tax on capital income is equal to zero in the long run.
The result is also valid when there are heterogeneous individuals, or when some individuals have an infinite horizon while others are life-cyclers. It suggests that the capital income tax may not be an efficient instrument for income redistribution in the long run.

In the discussion of tax reform, one should distinguish between a change towards a new permanent structure (with tax rates more or less invariant through time), and a situation in which the social planner has some degree of freedom in choosing the future path of tax changes.

The second framework raises the problem of time consistency. For example, the tax on capital is efficient in the short run (where capital is inelastically supplied), and inefficient in the long run (its optimal value is equal to zero under the assumptions considered above). The time inconsistency problem arises because the short run is defined only with respect to the (moving) present.

The framework of tax changes which are time invariant is similar to the one considered by Auerbach et al., in the life-cycle context. The marginal efficiency gains or losses induced by small reforms are analyzed in the infinite horizon context by Chamley (1985). Since

The second best optimizes over the entire dynamic path. For comparative statics between steady states, see Auerbach (1979), and Summers (1981). The work of Jorgenson and his associates represents at this time the most disaggregated model with rational intertemporal optimization. Its framework is similar to the more stylized model of Chamley (1984a), (see for example Jorgenson and Yung (1984), and its references). It came out too recently to be reviewed here.
the results are related to small changes, they cannot be directly compared to those of Auerbach et al., who evaluate large reforms through simulations. However, they illustrate similar issues about efficient reforms.

The tax on capital income has a greater marginal efficiency cost than that of the wage tax. This difference may be significant (20% of marginal revenues for plausible parameter values). This shows that there may be some gain obtained by a shift from the tax on capital income to the wage tax, although a complete substitution may be inefficient (as shown in Auerbach et al.).

The differential inefficiency of the capital income tax compared to the wage tax depends in an important way on the elasticity of substitution between capital and labor in the production function. (This result is asymptotically exact when the growth rate and the discount rate have nearly identical values, and the tax rates are relatively small.)

The other important parameter is the elasticity of substitution between consumption and leisure. It determines almost in a linear way, the efficiency cost of the wage tax.

It is remarkable that the value of the intertemporal elasticity of substitution has little impact on the measure of the welfare

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12 The production function is Cobb-Douglas with capital share equal to 0.2. The elasticities of substitution between consumption and leisure, and between utilities at different dates are equal to 1 and 1/4, respectively and the "share" of leisure in the CES current utility function is 2/3. The economy is on a balanced growth path (with a growth rate of 2%), and there is a general tax on all incomes at the rate of 20%.
effect of tax reform in models with an operative bequest motive. In empirical studies this elasticity would be measured by the inverse of the short-run interest elasticity of consumption.
IV. TAXATION, MONEY AND INFLATION

IV.A. Introduction

Despite the large number of studies which address both theoretical and empirical issues, there are no simple policy recommendations about the inflation problem.

In the long run and on average, the inflation rate is equal to the growth rate of the nominal quantity of money. This is almost a trivial result. If it were not true and the money growth rate would exceed the inflation rate permanently (for example), the velocity of money would tend to zero, which is absurd.

However, the short-run relation between money growth and inflation is more complex. In a frictionless economy where all markets clear instantly and agents have perfect information, there is a one-to-one relation between money growth and inflation. With nominal price rigidities and imperfect information, changes of the inflation rate through monetary policy induce important effects on the level and the composition of real output. The discussion of the effects of the inflation rate much distinguish the short run and the long run.

IV.B. The Long Run

In the long run, inflation does not distort relative real prices. Contracts and institutions adjust to a permanent positive inflation rate. There is complete equivalence between the creation of money and a direct tax on the monetary base. This is the framework of the numerous studies on "money and growth", and of the public finance
approach to inflation (this last framework can also be used for the short run with perfect market clearing).

The inflation tax has three main effects: it decreases the level of cash holding. The revenues from money creation enable the fiscal authority to decrease other taxes, or provide additional services. Finally, the inflation induces a shift from cash balance to capital in private portfolios. The first effect on welfare is negative. The other two effects are, in general, positive (at least if the capital level is low with respect to the Golden Rule).

IV.B.1. The Revenues of the Inflation Tax

When the money growth rate is equal to the inflation rate $\pi$, the revenues from money creation are equal to $R = \pi m$. The level of the demand for the real quantity of money $m$, depends on the opportunity cost for money, i.e., the nominal interest rate $r+\pi$ ($r$ represents the real interest rate):

$$m = L(r+\pi). \quad (14)$$

Note that the proper inflation tax base $m$, is the monetary base (currency plus reserves). Assuming a constant real rate $r$, the level of revenues depend on the inflation rate. It is maximized when the interest elasticity of money is equal to one (Bailey, 1956).

Two remarks should be made here. Given our knowledge of the interest elasticity of money, the revenue maximizing inflation rate is fairly large, greater than 100%, but smaller than the values of
hyperinflation rates. Second, in many economies the ratio between the monetary base and one year's output is relatively small. This implies that the inflation tax base is small with respect to the base of other taxes and that the revenues from money creation are fairly small with respect to total government revenues (see the discussion below).

IV.B.2 The Welfare Cost of Inflation

The most obvious cost is the reduction of the level of cash balances and of their services. This level is determined by the equality between marginal value of cash balances and the opportunity cost, i.e., the nominal interest rate \( r + \pi \). This marginal value of cash balances is a function of the real quantity of money, and can be represented on a diagram by the same curve as the demand for money:

![Diagram](Figure 1)

Calvo and Fernandez (1983), have shown that the revenue maximizing value of the inflation rate is higher in an economy with commercial banks. This occurs because banks pay an interest on deposits and the interest elasticity of the demand for reserves is lower than in an economy with fiat money. Note, however, that the introduction of financial intermediaries lowers the ratio between the monetary base and output; it seems that the levels of revenues which can be raised with the inflation tax are unaffected. The only effect is to raise the required values of the inflation rate. Since banks pay an interest it seems that the welfare effect is the same as in an economy without financial intermediation.
It follows immediately that the welfare cost of a reduction of cash balances by \( \Delta m \) is equal to an area with a width of \( \Delta m \), under the demand curve. For a small change of this inflation rate \( \Delta \pi \), this area is approximated by the quantity \( \varepsilon m \Delta \pi \), where \( \varepsilon \) is the interest elasticity of the demand for money.

IV.B.3. The Optimal Inflation Rate

An increase of the inflation tax revenues enables the government to reduce other taxes by an equivalent amount. Assume that the efficiency cost of these taxes is equal to \( \alpha \) per unit of revenues. The efficiency gain of an inflation increase, net of the welfare cost of reduced cash balances, is equal to:

\[
W = \alpha \Delta R + (r+\pi) \Delta m
\]

\[
= \alpha (m+\pi \Delta m) + (r+\pi) \Delta m
\]

\[
= m [\alpha + (\alpha \pi + r + \pi) \frac{\Delta m}{m}] .
\]

The right hand side is equal to zero when

\[
\varepsilon = \frac{\alpha}{1 + \frac{\alpha \pi}{r+\pi}}.
\]

In the situation where the government attempts to maximize the inflation tax revenues, the efficiency cost of other taxes is implicitly equal to infinity. Neglecting \( r \) with respect to \( \pi \), we find again the rule of Bailey \((\varepsilon = 1)\). In the more general case of a finite value for the efficiency cost of taxation, the above rule gives a lower value for the
inflation rate (assuming that the elasticity $\varepsilon$ increases with the inflation rate).\(^{14}\)

The previous analysis assumed implicitly a steady state framework with exogenous factor prices. A rigorous treatment is given in Phelps (1973). In some models of general equilibrium (see below), the results about the optimal inflation rate are very similar to the ones described here.

The only welfare cost considered here is the reduction of cash balance services. Sometimes this has been regarded as a rather trivial cost. The type of cost-benefit analysis sketched above could easily be extended to include these additional costs. We now consider the popular topic of the incidence of inflation on capital accumulation.

IV.B.4. Inflation and Capital Accumulation

A tax on cash balances increases their cost and induces a portfolio substitution toward other assets (capital, housing) which produce goods and services. This effect has been regarded as an argument for inflation. In order to evaluate this, it is necessary to examine the stylized models used in previous studies and the order of magnitude of the relevant aggregates.

\(^{14}\) In general, the elasticity $\varepsilon$ increases with $\pi$ in theoretical and empirical models of the demand for money (Cagan, 1956; Barro, 1972). The elasticity varies inversely with inflation in the inventory model of Baumol (1952) and Tobin (1956). However, this model is relevant only for a very specific context.
First and most important, the argument that a tax on cash balances improves welfare must rest on some market imperfection in the saving process. When there is no market imperfection, and individuals have an operative bequest towards future generations, there is no need to stimulate capital accumulation through a tax on cash balances. Indeed, such a tax may have no incidence on the capital stock in the long run (Sidrauski, 1967). Second, because the tax reduces the services of money, it has an efficiency cost. In fact money should be subsidized in the first best (Friedman, 1969). In the second best, the cost-benefit analysis described above applies (Chamley, 1983b).

The first type of saving "inefficiency" arises in an economy where individuals optimize in a rational behavior, but ignore the welfare of future generations, and behave as selfish life-cyclers. In this context, the inflation tax by shifting savings from money to capital, increases the level of capital in the economy. If this level is low in the laissez-faire equilibrium (with respect to the Golden Rule level), the inflation tax may induce an increase in welfare. Of course, this welfare gain occurs only in the long-run at the expense of some generations on the transition path (Drazen, 1981).

15 It may have an incidence in the long run if the level of cash balances affects the marginal productivities of capital or labor. In general, the inflation rate has a transitory influence on capital accumulation (Fischer, 1974).

16 The formula given previously is only an approximation when the interaction between money holding and other factors are taken into account in a general equilibrium framework.
It is important to keep in mind that in real economies the ratio between the monetary base and the capital stock is often small (less than 1/10). Even if individuals were to substitute entirely capital for money (at significant cost to themselves), the increase of savings in capital would be relatively small.

Assume for example, that a reduction of real balances per capita $\Delta m$, induces an increase of capital $\Delta k = \lambda \Delta m$, where $\lambda$ is a positive multiplier which may be greater than one.\(^{17}\) Denote by $n$ the exogenous growth rate. On the balanced growth path, the increase of effective consumption net of the reduction of the services provided by cash balances, is equal to:

$$
\Delta z = (r-n)\Delta k - (r+\pi)\Delta m
$$

where $r$ is the rate of return on capital and $\pi$ the inflation rate.

An increase of inflation reduces cash balance and increases effective consumption in the long run, only if the inflation rate is smaller than $(r-n) \lambda - r$. For the life-cycle framework plausible values of $\lambda$ are smaller than two.\(^{18}\) If the capital stock in laissez-faire is

\(^{17}\) $\lambda$ may be greater than one because the increase of capital may stimulate further savings (because of higher output).

\(^{18}\) As an illustration, in a two-period overlapping-generation model with Cobb-Douglas production function and non-negative savings elasticity with respect to the interest rate, $\lambda$ is about equal to $1/(1-\alpha)$ where $\alpha$ is the capital income share.
not significantly below the Golden Rule level (with $r$ greater than twice the growth rate), a positive inflation rate is inefficient: the welfare cost of reduced money services outweighs the benefits of higher capital and output levels.

The same arguments apply in "neoclassical" models of growth with an ad hoc function for the saving rate. This is the framework used by Tobin (1965), in his seminal work, and by others in subsequent studies. These models differ from the life-cycle approach because the capital stock (in the long run) is determined by the equality between the flow of saving and the flow of investment necessary to keep the economy on the balanced growth path.\(^{19}\)

For example, if the saving rate $s$, is a constant, and $k$ and $y$ represent the level of capital and output, respectively,

\[ n(m+k) = s(y+nm). \quad (18) \]

The term $nm$ represents the private income derived from the money creation (lump-sum grants to individuals), net of the capital loss on cash balances.

It follows immediately that the "multiplier" $\lambda$ introduced before is here equal to $\lambda = (1-s)/(1-sr/n)$. Since $sr/n$ is about equal to the capital income share, one can see that $\lambda$ is not much larger

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\(^{19}\) In the life-cycle models, the equilibrium long-run level of the capital-labor ratio is determined by an equality between the supply of capital by households, and its demand by firms. Both are stock functions of the rate of return.
than one, and that the quantitative evaluation which was given above, is valid. A more detailed quantitative evaluation in the neoclassical framework (including the role of financial intermediaries) is given by Summers (1981).

IV.B.5. The Welfare Cost of Permanent Inflation

In the previous discussions, the welfare cost of inflation was caused only by the reduction of cash balances. It is often argued that this is a rather trivial cost. Two remarks can be made here.

First, the "shoe leather" cost is not trivial compared to the amount of revenues generated by the inflation tax. If this had been the case we would have obtained the Bailey rule of revenue maximization, which is not the result of Section IV.B.3.

Second, the previous analysis can easily be extended to take into account other costs. The most important of these costs is obviously the disruptions created in an economy with nominal contracts. Fisher and Modigliani (1978) present a "shopping list" of these costs. The interaction between inflation and the taxation of capital income is especially important and has been the subject of an abundant literature. Also, an important cost may arise when deposits at commercial banks are important instruments for private savings and subject to interest rate ceilings.

Before applying some of these models one should be cautious. As recent U.S. history shows, the tax laws can be amended to deal with the tax surcharge which inflation puts on capital income (or on other incomes for that matter). The long-run distortion depends on the
permanent lag between the inflation rate and the indexation of the tax system.

IV.C. The Short Run

The public finance approach to the inflation tax which was described in the previous section, can be extended to a complete general equilibrium model with market clearing. The results do not differ very much from those of the long-run analysis if the government does not exploit the possibilities for deceptions created by the dynamic framework.

The issue of time consistency arises when the inflation tax can be set arbitrarily at the time of a tax reform. In this case, one may argue that a change of monetary standard (an infinite inflation tax) operates as a lump-sum levy on the existing money and is efficient. However, this policy may generate anticipations of further levies on money in the future. The tax is lump-sum only if individuals do not learn at all, an unlikely situation.

These issues are not yet resolved theoretically (if they will ever be is another question). In some contexts, they may not involve large effects at least for the inflation tax. From a quantitative point of view, the relative magnitude of the effect which depends on the ratio between the stock of money and the present discounted value of government expenditures depends on the same parameters as the relative share of the revenues due to the flow of money creation in the flow of total government revenues (see the discussion below).
A more important issue in short-run analysis is that there is no direct equivalence between money creation and the inflation rate when markets do not clear instantly. More specifically, one can reasonably posit the existence of a short-run Phillips curve. In this situation the variations of the inflation rate are related to the difference between the level of output and its "full-employment" value. The level of output can be manipulated by the creation of money through the "transmission mechanism". A direct implication of this framework is that a reduction of the permanent inflation rate can be achieved only through a temporary recession. Recommendations about the inflation policy depend on a cost-benefit analysis with short-run costs (or benefits if the inflation rate is increased) and long-term gain or losses.

The results depend, as is often the case, on the numerical values chosen for the discount rate and the growth rate. A dramatic example is given by the study in Feldstein (1979).

Also some of the welfare costs of inflation mentioned previously are caused by the lack of full indexation of all contracts and of the tax system. This "imperfection" may be especially relevant in the short run.

20 For a more disaggregated presentation, see Chu and Feltenstein (1978).
IV.D. Is the Issue Important?

In most industrial countries the share of money creation in total government revenues is very small (on average less than 6%).\footnote{21} This number is higher for less industrialized countries as Indonesia, Greece, or Spain (with a share around 14 percent). It exceeds 16% for some South American countries and reaches an average of 46% for Argentina during the period 1960-75\footnote{22} In general, the importance of the issue is in no doubt.

However, it remains to be seen if these relatively large numbers follow from a public finance approach to the problem of inflation. That is, do we observe high inflation rates because this is an efficient way for government to raise revenues when the efficiency cost of other taxes is high, or rather because these inflation rates result from a succession of short-run decisions on macro-economic policies where the government "validates" exogenous shocks? In this latter case the revenues obtained by the money creation can be considered as exogenous by-products in the evaluation of the efficiency of tax systems.

The problems raised at this point are relevant both for the standard public finance approach which relies on general equilibrium methods, and on short-run macroeconomic analysis which does not take market clearing mechanisms for granted.

\footnote{21}{For a presentation of data, see Fisher (1982).}

\footnote{22}{Other noteworthy cases are Jordan (19% for 1960-78), Nepal (17%), Uruguay (28%).}
V. SOME SPECIFIC ISSUES

Some of the fiscal government programs are *sui generis*. They are often considered separately from the general problem of an efficient or equitable fiscal policy, although they should be integrated in the same framework. Two of them are especially considered in this section, the retirement programs and the problem of the flexibility of raising revenues.

V.A. The Public Debt and Social Security

V.A.1. The Public Debt

Discussions about the interactions between government budget surpluses or deficits and capital accumulation are not always based on clear definitions. As Kotlikoff (1983) has emphasized, accounting practices may have little economic meaning. If the government grants a given individual a bond and promises to tax the same individual by an amount equal to the value of the bond at maturity, no real change occurs. Indeed, this is the point made by Barro about the neutrality of the debt when individuals have an operative bequest motive. In this case, the standard accounting practices overestimate the importance of indebtedness of the government.

On the other hand, the usual definitions of the public debt do not include the commitments made by the government to pay retirement benefits. In industrialized countries these commitments dwarf the standard definition of the debt. Social security programs are also becoming important in some developing countries.
In an economy with optimizing agents it is best to forget the concept of "deficit" in economic analysis. What matters are the transfers organized by the government between individuals of the same generations, or across different generations. The important questions are then the degree of individual foresight about these transfers (as social security) and the extent to which they are offset by private transfers between individuals of the same family or across different families. These empirical problems are clearly very difficult and not always well understood. They should bring caution to any discussion about the interaction between government deficits and aggregate savings.

Although some accounting methods may hide important policy changes, they often correspond to institutional constraints. Compare, for example, two programs: in the first, a wage subsidy is given to the young and a consumption tax is levied on the old. The effect is to stimulate savings by the young in order to pay the tax when old. Private individuals' savings will be in private capital. This program could be replaced by a public ownership of some capital. In a stylized model the two programs are equivalent. However, in real economies constraints are often imposed on the possibilities of public investment in the private sector. A good example is the use of the accumulated fund in social security programs. In most cases a minimum requirement for investment in government bonds is explicitly specified.\(^{23}\)

\(^{23}\) See the study by Saito and Shono (1980), on five Asian countries.
V.A.2. Social Security

Retirement programs have been organized by numerous governments in industrialized and developing countries. These programs can be considered from two points of view. First, they improve the allocation of resources within generations: an actuarially fair program with complete funding provides insurance against disability in old age or long lives, when private markets do not provide suitable contingent assets. The creation of new assets has an effect on the accumulation of productive capital. These problems should be treated separately.

An actuarially fair program with complete funding may also force myopic individuals to save for their old age. The introduction of forced savings may have some significant impact on the level of aggregate savings.

An important feature of social security programs is that they never correspond to the model of a program which is actuarially fair inside generations. In all historical cases, some intergenerational transfer occurred. Since the accumulated fund is less than the value of government liabilities, it seems, a priori, that some transfer occurred from future generations towards those living at the present time. It has often been argued that social security programs reduce the level of aggregate savings (Feldstein, 1974c).

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24 For a survey with special emphasis on Chile, see Christine Wallich (1983).

25 For the insurance against liability, see Diamond et al. (1980), for the problems of uncertain life duration, see Sheshinski and Weiss (1981).

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However, the overall effects of such programs may not necessarily be negative if they improve the distribution of welfare, if they protect individuals from their own myopia, or if they introduce better investment opportunities.

A crucial issue about social security, which is especially important during the phasing-in period, is the use of the collected funds. These funds can be invested in private markets, in government bonds or paid directly to individuals (as in pay-as-you-go systems). The choice between private and public investment should be guided by the standard rules. The level of transfers to individuals should be determined by the standard choices between the welfare of poor individuals living today and the welfare of future individuals who will benefit from the returns to investments (private and public).

If the public sector is restricted from investing in private projects, one may have to consider a social security system run by the private sector, very similar to a private pension fund. Private plans often use their special position to grant special advantages to their living members as loans at low rates, etc. (Wallich, 1983). These are equivalent to transfers from future generations to the present. If they are not optimal from the social point of view, specific rules should be established for the use of these funds.

Of course, governments have also used the revenues from social security taxes to be popular among older individuals. These transfers should be evaluated against other alternatives for the use of funds. Although the evaluation of social security programs should ideally be
conducted in the framework of a comprehensive welfare evaluation in fiscal policies, a separate examination of these programs is more feasible. Most countries have introduced some form of retirement program. Contrary to common belief, the fraction of the population covered is very large in some of them (Wallich, 1983). Also, these programs will grow as the fraction of the urban population increases: it is more "taxable" than the rural population, and it may have weaker intra-family ties.

The growth of these programs may have in the future a very large impact on the intergenerational distribution of welfare and on aggregate savings in developing economies. It is important not to repeat some of the errors made in industrialized countries in the period of introduction. A thorough analysis of this problem would be useful at the present time.

V.B. Flexibility in Mobilization of Government Revenues

In static models of taxation, the level of government tax revenues and expenditures are balanced. In the dynamic context, the government may face large variations in expenditures. Such variations when they are foreseen can be dealt with in the standard framework.

In the textbook example of a (planned) war, the government should raise taxes over the entire horizon, before and after the period of high spending. In the period before the "war" the government runs a budget surplus. During the war most expenditures are financed by running down the accumulated surplus and incurring debt. After the war the service of this debt is assumed by the tax revenues. The tax rates
are invariant throughout the entire horizon in order to minimize the efficiency cost of taxation (under the assumption of an additively separable utility function). These results can be extended to the case of a random "extraordinary expenditure."

The main principle which can be outlined from this analysis is that the government should try to evaluate as much as possible the large revenues requirement which are likely to occur in the future. The tax system is devised such that the level of revenues follows through time, a smoother pattern than that of expenditures. A surplus is accumulated for these future contingencies. If an expenditure requirement arises unexpectedly, it is almost entirely financed by running a deficit. This deficit is repaid later by additional taxes.\(^{26}\)

One could suggest that a sudden expenditure requirement should be financed by an "exceptional" capital levy, or by issuing money. The latter policy is equivalent for a practical purpose, to a lump-sum tax on the monetary base.

Exceptional taxes on capital or money are efficient if they remain exceptional. The difficulty here is that they may induce private individuals to believe that further levies will take place in the future. If this occurs, the anticipated rate of return on capital or on money is affected, and the levies may generate an efficiency cost because of this effect on anticipations.

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\(^{26}\) For an analysis of such fiscal policies in various situations, see Lucas and Stokey (1983).
These issues are related to the problem of time consistency of a policy. They are well known, but poorly understood. There is, at the present time, no solution to this problem. It is an area of current research.

However, one may at least suggest that in some cases the distortionary cost of the anticipated effect may be fairly large compared to the efficiency of the lump-sum levy. In this situation, the gains that a benevolent social planner could gain by cheating private agents would be of limited value. The relevant policies would then be similar to those of the perfect foresight type as described in the beginning of this section.

The previous framework assumed that the private sector had an optimizing intertemporal behavior. It is not clear whether the derived results would be valid in an economy with a fixed saving rate. In fact, it seems that in this case the use of levies (on capital through a wealth tax or on money through inflation), may be more efficient. In this case, as in others, the elaboration of policy recommendations would have to be based on a careful evaluation of the main structural features of the economy.

27 For an illustration of the gain generated by the cheating of a benevolent planner, see Fisher (1980).

28 The increase of debt crowds out completely private capital accumulation in this framework. Also the anticipation effect generates no disincentive on saving since the saving rate is independent of anticipations.
A traditional concern in studies on dynamic tax reform is that the taxation of capital income depresses the rate of return available to individuals and the level of private savings. Of course, according to the theory of second-best, the taxation of capital income may be efficient. From a welfare point of view, the incidence of the tax on the supply of savings is a poor indicator for the efficiency or the inefficiency of the capital income tax. Also, even if the objective is to increase the level of saving, it is not clear that there is a positive relation between the rate of return and the saving level.

The measurement of the interest elasticity of consumption is a popular exercise in econometrics. Before trying to measure this effect, one should first explain what is measured. Consumer theory shows that the level of consumption of a given individual depends on his total wealth (human and non-human), and on all the rates of return between the future consecutive periods. If the interest rate changes only between the present period and the next, income effects can be neglected. The partial elasticity of today's consumption with respect to the rate of return between this period and the next is equal to the inverse of the elasticity of marginal utility of consumption (which is equal to the elasticity of substitution in the utility function between consecutive periods). This number is always negative. Various estimates give absolute values smaller than one for this number; some find values lower than 1/4.29

When a change in the rate of return is not purely transitory, income effects cannot be neglected and the overall impact of the rate of return on saving is different and may even become ambiguous. Most empirical studies using regressions of aggregate time series on consumption do not distinguish between the impact of short-term variations of the interest rate and the impact of expectations of future changes. The interpretation of their results is not clear, to say the least. Their application for policy evaluation appears to be limited. For example, a permanent reduction of the capital income tax should have different effects in a "rational" environment from those of a transitory policy. It is not necessary to elaborate this point further, since it has been discussed already in Section II.B.

V.D. Non-Marke'-Clearing Equilibrium

The contemporary theory of public finance is based on the framework of general equilibrium with market clearing. The deadweight loss of taxation arises only because the tax system interferes with the allocative properties of the price mechanism. Also, tax changes which do not affect total revenues involve mainly substitution effects (for small tax rates).

In economies with non-market clearing prices, there is no allocative virtue to corrupt. The concept of excess burden loses some

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30 This remark does not apply to the study mentioned in the previous footnote. Future variations of the rate of return beyond t+1, are included in the forecast of the consumption $c_{t+1}$ at time t, $E_t(c_{t+1})$. This variable becomes observed at time t+1.
of its meaning. An important feature of such economies is the existence of income multipliers: the variation of the price in a non-clearing market produces an income effect which affects other markets.

According to available studies, the redistribution properties of the tax system overshadow the allocative properties. Also, a tax change in a specific market cannot be analyzed in isolation of other markets because of the income interactions with other markets. The complete chain of "multipliers" has to be taken into account.

In fact, we have already seen an example of non-market clearing economy in the neoclassical growth models of Section II.B. In this framework, the impact of a tax change in the current period depended on its impact on the saving rate. For the evaluation of the latter, one has to evaluate the perturbation created for the second period, which depends on the third period effect, and so on.

Another typical example of non-market clearing is found in dual economies where the wage rates in the industrial or in the agricultural sectors are not determined by market equilibrium.31

The literature of second-best without market clearing is not abundant. One should mention that the "disequilibrium" framework is not currently reputable in the AngloSaxon academic world. It may enjoy more popularity in continental Europe.

31 For an analysis of optimal growth in this framework, see Stern (1972).
It is likely that this framework is of more relevance in economies with a market structure which is not yet fully developed. This should be an interesting area for further work.

V.E. Increasing Returns to Scale

Most standard studies on tax reform in general equilibrium framework assume a constant returns to scale technology. This assumption may be reasonable at the industry level for a relatively large country, but it is not valid if the size of a technological project is not negligible with respect to the rest of the economy. In this case, the nice properties of general equilibrium are not maintained.

Brown and Heal (1978) show that there may be distributions of income which are Pareto inefficient. This implies that there are some transfers which make all individuals better off, including the donor. Such properties have an explanation which is related to ideas held in the folklore of common wisdom: Some (efficient) projects need a "sufficient market" in order to recover the fixed cost. When the distribution of income does not generate a sufficiently large level of demand for the project, the equilibrium allocation may be inefficient.32

These results are somewhat disturbing for the analysis of tax reform. They imply that the tax side and the expenditure side of public

\textsuperscript{32} This problem is different from the situation described as "interdependency" in the production sector which is often mentioned in development studies. It corresponds to the case where a given choice of technologies implies product prices such that no other technology can be separately introduced at some profit, although a group of them can be introduced efficiently (see Chenery, 1979).
policy cannot be separated, and that in some cases, only large tax changes can generate welfare gains. It seems a priori that small countries may face this problem. An analysis of this topic in a concrete situation could be fruitful.

V.F. The Open Economy

Most of the studies which address the issue of taxation and saving in a public finance framework consider a closed economy. The introduction of a foreign sector does not require a priori different tools, but may modify significantly some of the policy conclusions.

As an illustration, consider the textbook case of a small country with perfect capital mobility and assume that this country is populated by life-cyclers. The equilibrium rate of return on the balanced growth path can be determined in the following diagram.33

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33 It is implicitly assumed that individuals have a homothetic lifetime utility and that there are constant returns to scale in production (see Tobin, 1967).

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The capital wage ratio is represented on the vertical axis. The curve (D) represents the "demand" for domestic capital. It depends only on the domestic production technology. The curve (S) represents the supply of domestic savings by residents. Assume first that there is no tax, that the world rate of return is equal to $\rho$, and that there is no capital mobility. On the figure, the rate of return is equal to $r_0 > \rho$. If capital is now perfectly mobile, the domestic rate of return falls to $\rho$. Domestic savings decrease to OA (per wage unit) and there is an inflow of foreign capital equal to AB.

This diagram can be used to analyze the effects of standard tax policies in the long run. A wage tax shifts the curve (S) downwards. It does not change the levels of the interest rate, domestic output or total capital. However, the level of domestic investment decreases and foreign capital fills completely the saving gap. The same effect occurs when the capital income of domestic agents is taxed (the schedule (S) is shifted to the right). Other policies could be analyzed by the same method. Note that issues about the intergenerational distribution of resources arise here as in the closed economy. The laissez-faire distribution may be altered to induce a shift towards future generations.

In the same way, the neoclassical model with fixed saving rate can be extended to an open economy. With perfect capital mobility, the level of output is always independent on the domestic saving rate which affects only the relative share of the capital owned by domestic residents and foreigners, respectively.
In some studies with a neoclassical model of an open economy, capital movements with foreign countries are not determined by rates of return differentials but they follow passively the government fiscal policy. This feature is related to the choice of the "closing rule": the level of domestic investment is fixed (by future anticipations and "animal spirit"). The level of domestic saving is also fixed since it depends only on income which is fixed in the short run. When this level is smaller (or greater) than the sum of domestic investment and government deficit, the gap is filled by a capital inflow (outflow) from abroad. The implicit borrowing rate for the government is "the" foreign interest rate. (In a world of perfect capital mobility it would be the same as the domestic interest rate.) The extension of the framework described in Section II.B to an open economy should be a straightforward exercise.

The empirical issue of the degree of capital mobility has been addressed in recent studies. Feldstein-Horioka (1978) and Feldstein (1980) run various tests on samples of OECD countries for the pre-1973 and post-1973 periods, respectively. They find that there is very little capital mobility between countries. In his 1980, study Feldstein finds that "each extra dollar of domestic saving increases domestic investment by approximately 85 cents in a sample of 17 OECD countries."

Harberger (1978) claimed that international capital markets equalize completely the rates of return in different countries. It is well known that international comparisons on rates of return are very difficult. In his 1980 study, Harberger reconsidered the data and found important differences between the rates of return in various countries.
He also claimed that the correlation between domestic investment and saving is much weaker for less developed countries than for the OECD countries included in the Feldstein sample. He concluded that the degree of capital mobility may be between the polar cases of perfect mobility and complete autarky. One can conclude here with the usual call for further empirical studies.

V.G. The Equality Between Saving and Investment in the Short and the Long Run

General equilibrium models with intertemporal optimization assume implicitly that future markets support the allocation of resources. These markets may not exist formally but can be replaced by perfect foresight (in a world without uncertainty) about the spot markets which open at future dates. These assumptions may be reasonable when the economy is on the balanced growth path. In the framework of "neoclassical saving function", the standard closing rule is that saving determines investment. This is justified in an economy with one good (corn). It is less realistic for an economy with many capital goods and uncertainty about the demand for the goods produced by capital in the future. Indeed some studies have used the Kaldorian closing rule according to which investment is determined by anticipations and the level of saving adjust to investment through the variation of the factor prices and the income distribution.

Keynes emphasized the "volatility" of anticipations about the profitability of investment when there are no contracts for future sales. In a celebrated quotation he remarked that "an act of individual saving means -- so to speak -- a decision not to have dinner today. But
it does not necessitate a decision to have dinner or to buy a pair of boots a week hence or a year hence or to cause any specified thing at any specified date. Thus, it depresses the business of preparing today's dinner without stimulating the business of making ready for some future act of consumption."\(^{33}\)

This observation provided the motivation for stimulating fiscal policies: i.e., in the short run an increase in demand financed by government deficit stimulates future expectations and the level of investment. Of course this policy recommendation is at odds with the crowding-out effect that the government deficit induces in the long term (when the operative bequest is not perfect). What may be good in the short term becomes bad in the long term.

This discrepancy arises because the short-run macroeconomic analysis does not assume market clearing. An integrated framework between the short-run "disequilibrium" and the long-run equilibrium does not seem to exist yet. For the present time one can only follow the dichotomy between the short-run non-market clearing where fiscal policies have an effect through multipliers and the long term where price incentives have a central role in the public finance approach to fiscal policy.

\(^{33}\) Keynes (1936), pp. 210-211.
VI. CONCLUSION

This survey of problems addressed in public finance studies on dynamic taxation is selective and incomplete. Even a monograph could not do full justice to the variety of issues. At this point one can make the following remarks.

Some standard statistics (such as the domestic saving rate, the level of government expenditures or investment, etc.) have a limited use for the evaluation of fiscal policy. There is no purpose to increasing private saving if the private rate of return is low, or if currently living individuals are very poor with respect to future generations. The share of the public sector's investment in total investment is not a meaningful indicator without some knowledge about the respective rates of return in the private and in the public sector.

The two main informational requirements for policy evaluation are the response of the private sector to policy, and the social shadow prices associated with public policies. This information is not provided by a description of the flows which take place in an economy in a given instant of time. Indeed, the ratios which can be computed from these accounting exercises have too often been considered as behavioral relations in macroeconomic models. Our knowledge about the interaction between private behavior and policy is very limited, and this remark applies to any economy, including the developed countries. The current controversy about saving incentives in the U.S. is a good example of this problem.
Current studies have emphasized the importance of using a framework of general equilibrium in studies of taxation, both in the static and in the dynamic context. Furthermore, as a rough rule, one should match the degrees of disaggregation in the model and in the tax system. We have also seen that it may be helpful to consider an economy-wide model when markets do not clear and policies have chain effects through a series of multipliers in the entire economy.

Unfortunately, the elaboration of economy-wide models is very difficult, given our knowledge about real economies. There is at the present time no such model for any country (with a public finance approach) which can be considered as suitable for direct policy application.

The main criticism against current versions of disaggregated general equilibrium models is the ad hoc treatment of the saving-investment process. This is, of course, a major criticism in the present context. However, it seems that they could still provide a useful first step in the evaluation of public policies. Bell and Srinivasan (1983) remarked that they are useful in generating shadow prices. As we have seen in Section II, the results can be very sensitive to the behavioral assumptions. It would be very useful at this point to reexamine some of these behavioral relations. The goal is clearly not to construct a saving model with perfect foresight. Some ad hoc formulation may be useful shorthand to capture the economist's knowledge. My only objection to some of the saving functions or "closing loops" currently in use, are that they imply a behavior which seems a bit mechanistic.
These specifications should be amended to incorporate the effects of some policy anticipations (of which retirement programs would be an example).

In this respect, an improved knowledge about the structure of the economy (types of agents -- rural/urban -- structure of exchanges, vehicles for saving, etc.) appears to be fundamental. Possibly, initial efforts could be first devoted to cases of economies with a relatively simple structure. Some interaction between economists with a special knowledge in institutions and others more versed in "public finance issues" is to be called for.

Another alley for work is to analyze separately some of the specific issues mentioned in this survey. Social security seems to be especially important at the present time. A complete evaluation would raise the same problem as those described above (they are relevant for any policy). However, these programs have some degree of autonomy. Most of the time they are handled only from an accounting point of view. Their fundamental economic implications are not always clearly perceived by policymakers. For some countries, these programs are larger than can be expected a priori, and they are bound to grow with the industrialization process. Also, the period of phasing in is especially important. A survey of facts and issues for developing economies could be a very useful first step.

A second issue is to develop a framework of sound accounting for government deficits and investment.
Third, the problem of the inflation rate is also of a specific nature and could be treated independently. The questions here are: how is the inflation rate empirically related to the efficiency cost of taxation (excess burden, administrative cost, tax evasion)? How is it related to short-term macroeconomic policy? In the context of developing economies, should the inflation tax be an important fiscal tool or should it be left to short-term macroeconomic policy?

To conclude, there are two possible approaches for further work. First, one can develop a set of models with sufficient flexibility to address different issues. In order to achieve tractability, simplifying assumptions are necessary, and they have to be introduced with care so that the model does not lose its applicability. Another important property of models is the robustness of results to parametric choices. As mentioned before, current stylized models should be used with some caution in the evaluation of dynamic tax reforms.

It would be convenient to develop a box of tools which could be used readily for actual problems. However, given our information and the diversity of structures in developing economies, it is not clear whether such a "global" method is promising.

The other approach is to address separately some issues which are common to a set of countries having a variety of structures. A few of them have been described in this paper. This "partial" method has already provided the basis for many of the public economics studies in developed economies. It also allows for a more direct interaction between research and policy.
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