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ON THE ALMOST NEUTRALITY OF INFLATION: NOTES ON TAXATION AND THE WELFARE COSTS OF INFLATION

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ABSTRACT

This paper analyzes the nature of the distortions and welfare losses associated with inflation. If inflation were fully anticipated, it would be almost neutral provided the tax system were fully indexed and provided interest is paid on bank deposits (as, to an increasing extent, it is in the United States). When there is uncertainty about the rate of inflation, then the distinction between anticipated and unanticipated inflation may no longer be meaningful. We show, however, that still, under not implausible assumption, inflation with proper indexing is almost neutral.

Part II of the paper analyzes what is perhaps the major source of distortions associated with inflation, the failure of the tax system to be fully indexed. (Appropriate indexing would not eliminate the distortions associated with the present tax structure; it would eliminate the dependence of the magnitude of those distortions on the inflation rate). Three categories of effects are analyzed: (a) direct distributive effects; (b) direct allocative effects; and (c) indirect general equilibrium effects, arising out of the first two. The direct distributive and allocative effects have effects on the prices of different assets and the before tax rate of interest. Since without full indexation, when the rate of inflation changes, either government expenditure, the real value of the deficit, or taxation rates will have to adjust. The precise nature of the equilibrium which emerges will depend on the nature of these adjustments.

The analysis of the allocative effects of inflation focuses in particular on the provisions for depreciation and the treatment of capital gains and interest. The nature of the distortions present provisions and alternative proposals analyzed in detail.

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Inflation is almost universally viewed to be a bad thing, a symptom of mismanagement of the economy on the part of the government. It is now widely thought that, like many diseases, it can appear in a variety of forms; the kind of inflatior that seems to be present in most countries is a kind which, evidently, can be kept under control (although the only medicines promising anything near a full cure are so strong that the patient is likely to die in the process); if properly kept under control, it appears that we can learn to live with inflation, even inflation at moderately high rates. Much of the unhappiness over inflation arises from the failure to anticipate it; and much of that unhappiness is not concerned with welfare losses but with unintended transfers of purchasing power (e.g. from creditors to debtors).

If inflation were fully anticipated, would there be any welfare loss associated with it? And if there is some uncertainty about the rate of inflation, to what extent can it be alleviated by indexing and other institutional reforms?

In this paper, I attempt to clarify the nature of the losses associated with inflation, within a conventional model of a competitive economy. I shall argue that, were inflation fully anticipated, it would be "almost neutral" provided (a) the tax system were fully indexed; and model of inflation presented in this paper is inadequate: inflation arises from and is associated with the presence of conflicting forces, inflexibilities, etc., which are not fully reflected within the competitive model underlying our analysis. It is the resolution of these underlying problems -- not the resolution of their symptom, inflation -- which is of central concern. There are those who would argue that by making the symptom, inflation, easier to live with, e.g. by indexing taxation and provided indexed bonds, it becomes easier to avoid dealing with these underlying problems.

It is apparent that in such an economy, the rate of inflation would have no real effects: inflation would be perfectly neutral. To see this most clearly, consider the standard neoclassical growth model with interest bearing money (the results would extend to a variety of other models as well). The aggregative behavior of the economy can be described by the following basic equations:[1]

(a) The Portfolio Equilibrium Equation:

We postulate a demand for real balances of the form[2]

(1) $$m = m(r, i - \dot{p}/p, y, k)$$

where

m is the real supply of money per capita (the nominal supply of money, per capita, divided by the price level, p)

p is the price level

i is the rate of interest earned by money

r is the return to capital

k is per capita capital

and

y is real income per capita.

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[1] In the model presented in this section, there is no uncertainty; all inflation is perfectly anticipated. As we note below, in this environment, there is no need (apart from savings on transaction costs) to index. The more general case with uncertainty is considered in section 4.

[2] In this equation, as well as in the savings equation to be described below, we can easily introduce tax variables. We assume, however, that all taxes are functions of real magnitudes, i.e. real rates of return, real incomes, etc.

(3) $\quad \dot{m}/m = \theta - n - \dot{p}/p$

(b) The Savings Equation

Real savings per capita, s, are postulated to be a function of the real rates of return on the various assets $(r, i - \dot{p}/p)$, the level of real income and wealth of individuals, and the rate of real-monetary expansion[1]

(4) $\quad s = s(r, i - \dot{p}/p, y(k), \dot{m}, \quad m + k)$.

Several special cases of this savings functions have been discussed in the literature. For instance, in the earlier monetary-growth model of Shell, Sidrauski and Stiglitz (1969),

$$s = s^* \quad (y(k) + \dot{m})$$

They assumed, in other words, the individuals treated capital gains and losses on their money on par with other forms of income. This formulation follows naturally from the Haig-Simons approach to the definition of income.

On the other hand, it has been widely argued that since the real opportunity set of the economy is unchanged by the change in the real

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[1] A still more general specification of the savings function would let the savings rate be a function of the rates of return, incomes, etc., which are expected to previal in the future. Such a generalization would also be consistent with the results reported here.

What is critical about the savings function postulated here is that nominal values -- nominal price levels, the expansion of the nominal money supply, etc. -- do not enter.

(5), the increment in the capital stock. Thus, given p, m, and k at one date, we can solve for p, m, and k at the next period.

2.1 The Experiment

We now need to ask, what are the consequences of a change in the rate of inflation. This, in itself, is not quite a meaningful question, since the rate of change of prices in the economy is an endogenous variable, not an exogenous variable. We therefore need to ask, what is the effect of a change in some policy which leads to a higher rate of inflation. But clearly, the answer to that question is likely to depend on the particular policy chosen.

If the government increases the rate of monetary expansion (θ) and, at the same time, increases the interest payment on debt proportionately then the resulting inflation is perfectly neutral: nothing real changes. More formally, there exists a new equilibrium in which $m(t)$, $k(t)$, and $\theta - \dot{p}/p$ are identical at all t to the initial equilibrium.

To see this, observe that if $\theta - \dot{p}/p$ remains unchanged, from (3), $\dot{m}/m$ remains unchanged, and from (4) s remains unchanged, and hence, from (5) k remains unchanged. Moreover, from (1), on such a path the portfolio balance equation is satisfied at each moment of time.

In the model presented above, there are no government expenditures and no taxes. The analysis may, however, easily be extended to include these. If the government's expenditure (in real terms) is fixed and all taxes are perfectly indexed (in the manner to be described in Part II of this paper), then inflation is perfectly neutral. The real value of the government deficit will be independent of the rate of inflation.

In practice, the rate of interest on government debt is set freely by the market, and moves, accordingly, with the (expected) rate of inflation. What has not been fixed by the market in the United States and in many other countries is the rate of return on bank deposits: this is set by government regulation at zero. In the last few years, however, this has changed: now demand deposits (or forms of financial holdings which are essentially equivalent to demand deposits) yield rates of return which are also market determined. Thus, the only form of financial asset which is not effectively indexed is cash and currency. It is hard to believe that, at the rates of inflation currently being experienced in the United States and other Western economies, this results in a significant distortion in the allocation of resources. (This may not, of course, be the case at much higher rates of inflation, and there may have been significant costs associated with this distortion in the past.)

3.2 Transactions Costs

The previous analysis also assumed that there were no costs associated with changing the prices marked on various goods. In effect, prices were continuously being revised for all commodities, so that all relative prices remained unchanged as we changed θ and i. (Since we assumed that the inflation was perfectly anticipated, it made no difference whether we assumed that prices were fully indexed or simply changed with time.)

Assume, however, that there are significant fixed costs associated with changing prices. Firms will thus change prices at discrete intervals. If information costs were zero, then there could exist co-ordinated price changes, such that, still, at each moment of time, relative prices

To see this most clearly, assume initially some store increased its prices at dates t_1, t_2,... and some other store increased its prices at dates t^1, t^2,.... Thus, at each of the dates there will be changes in the relative price of the two stores, which will induce <u>some</u> individuals to shift their patterns of purchase. Now assume that the rate of monetary expansion doubles, and assume that at each of the dates, each of the firms increases its prices accordingly. It is immediate that, with fixed intervals of price adjustment, the magnitude of price dispersion at each date is increased. This will induce increased search behavior.

Note that all the firms could increase their prices more frequently, and by doing so, keep relative prices at each of the dates at which price changes occur the same (at the higher rate of inflation as they were at the lower rate of inflation). If there were no costs of changing prices, this too would have no effect (but then, price adjustments would be instantaneous). But clearly, if price adjustments are costly, this will necessitate a larger expenditure of resources on price adjustments.

However, neither this pattern of price increase, nor the earlier pattern, constitute an equilibrium. In both cases, search behavior of individuals will be altered, and it will not be optimal for firms to adjust their prices in this manner. (For certain simple models, e.g. quadratic adjustment costs, the equilibrium frequency of adjustment of prices as a function of the rate of inflation may be easily derived;

Assume, moreover, that the rate is expected to continue indefinitely into the future. Then, assume that in a particular period, the government increases the rate of monetary expansion, but then announces that it will return to the old rate of monetary expansion thereafter (and assume, less plausibly, that everyone believes this). Then in the discrete time version of the simple model presented in section 2, there will be a faster rate of inflation (than anticipated) in the given period, but there will be no effects outside the period if the savings function does not exhibit "money illusion" in the particular sense to be described below. Prices rise so that the real money supply is identical, at each date, to what it would have been had the government followed the anticipated rate of increase in the money supply. Clearly, if individuals' investment in capital during the given period is unaffected, then since all the "state variables" are the same as they would have been had the government not increased its money supply faster than anticipated, the subsequent history of the economy is unaltered.

There are three critical assumptions in this analysis:

1. The savings function does not exhibit "money illusion" in the sense that the level of real capital accumulation is unchanged. If all individuals are identical, this will be the case if savings rates are a function of anticipatory variables -- e.g. expected real rates of return on money and capital -- and real state variables -- capital stock, real money supply, and change in the real money supply. But it cannot be a function of the current period's real return on money -- because of the increased rate of inflation, this will be lower than on the original path.

since they have a higher marginal propensity to consume, inflation increases the savings rate; on the other hand, in the model of "capitalists" who lend to the profligate workers who cannot limit their spending to their income, it is the capitalists who are worse off, and in that case, savings rates decrease.

Although the exact effect of unanticipated inflation on the evolution of the economy is not clear, that unanticipated inflation, without indexing, is not neutral is clear. There is more than a once-and-for all adjustment of the price level to a change in the monetary supply; the effects may indeed be long lived.

With full indexing the distinction between anticipated and unanticipated inflation disappears. Unanticipated inflation has no effect (or negligible effects) for exactly the same reason as it did before. But for this result to be true, it is necessary that there be no non-indexed monetary assets, as the discussion of the next section hopefully will make clear.

5. Uncertain Rates of Inflation

In general, inflation is neither anticipated nor unanticipated. Individuals have a probability distribution associated with different rates of price increases. So long as there was some positive probability associated with the observed rate of inflation occurring, it was, in a sense, anticipated; so long as that probability was less than unity, it was, in a sense, not fully anticipated. The distinction between "anticipated" and "unanticipated" inflation does not seem to be a particularly useful one.

Now, however, it is not provided only that individuals are risk averse. To see this, let us consider the special case where

$$\theta^*_t = \lambda\theta_t$$

that is, we will compare two economies which, at each date, are identical except that in one, the rate of monetary expansion is λ times that of the other, and the nominal interest rate is correspondingly greater.

Now assume the two economies were identical in all real respects. Let us consider the real return to holding money is any period. It is a random variable,

$$i - \tilde{p}_{t+1}/p_t + 1$$

in the first economy, and

$$i^* - \tilde{p}^*_{t+1}/p_t + 1 = i + (\lambda - 1)\frac{Ep_{t+1}}{p_t} - \lambda\frac{\tilde{p}_{t+1}}{p_t} + 1$$

in the second.

Clearly, the expected rate of return on money is unchanged, but the variance of the rate of return on money is increased by a factor of λ^2. Thus, even though the coefficient of variation in the rate of increase in the money supply is unchanged, the coefficient of variation in the rate of return on money is increased. Money becomes less attractive. But this contradicts our original assumption that the increase in the rate of monetary expansion was neutral.

The need for indexed securities is limited under two circumstances. First, there will be no need for indexing if there is no uncertainty about the rate of inflation--- all inflation is fully anticipated. Thus, in periods in which the rate of inflation is negligible (or varies within small bounds) there would be little need for an indexed bond; there is no distinction between an indexed and an unindexed bond (or other contract); the unindexed bond would in its provisions fully provide for the future inflation.

Secondly, there will be no need for indexing even if there is uncertainty about the rate of inflation, if all individuals have the same belief about the probability distribution of the rate of inflation and have the same attitudes towards the risks associated with variability in the inflation rate. This might typically be the case in the aggregative models commonly employed in macro-economic analysis; but in any dis-aggregative model, individuals not only differ in their expectations (even if they all have "rational" expectations, if they have access to different information, their beliefs will still differ, as in the recent models of Grossman and Stiglitz (1976, 1980)) and even if they have identical expectations, since some individuals are net lenders and some are not borrowers, their attitudes towards the risks associated with price variability will be markedly different.

Thus, in periods, such as the present, when there is significant uncertainty about the rate of inflation, there would seem to be a prima facie gain from the introduction of an indexed bond.

there were some partially indexed bonds, an individual, by arranging his portfolio appropriately, could effectively obtain 100% hedging; in a partial equilibrium context, that is correct. To see this, assume that there were γ% indexing, i.e. every time prices rose by 1%, the return on the bond rose by γ%.

Assume now there is another, non-indexed bond, yielding a return of $\hat{i}$. If the individual borrows (sells short) at the non-indexed rate an amount α, and buys $(1 + \alpha)$ of the (partially) indexed bond, his real return per dollar is

$$i(1 + \alpha) - \alpha\hat{i} + \frac{\dot{p}}{p}((\gamma - 1)(1 + \alpha) + \alpha)$$

which is perfectly certain, independent of the rate of inflation, if

$$\frac{\alpha}{1 + \alpha} = 1 - \gamma$$

Thus, all that is required for full hedging of the rate of inflation -- within a partial equilibrium context -- is that there be a partially indexed bond.

But this argument does not extend to a general equilibrium context. For note, to accomplish the full hedging, some one needed to lend at an unindexed rate; thus, it is not possible for all individuals simultaneously to hedge completely, if there are some government bonds which are unindexed, or only partially indexed. It immediately follows that in this context inflation will not be neutral.

PART II

TAXATION

In Part I we have considered the effect of inflation on an economy without taxation (or in which taxation is fully indexed).

In our analysis, we have emphasized that inflation is virtually neutral if there is no uncertainty, or would be neutral, even with uncertainty, if all contracts (bonds) were fully indexed. Although we have noted certain limitations on this basic result, these limitations are, in our judgment, minor: they would suggest that inflation is almost neutral.

In Part II we consider the effects of taxation: the present tax system is far from fully indexed, and as a result, inflation is far from neutral. The objective of Part II is to ascertain what exactly would be entailed by full indexing, to suggest that a non-distortionary tax system is in fact not completely attainable, and to analyze the kinds of distortions which arise in the absence of full indexing.

The focal point of our concern is the taxation of capital with a proportional tax.[1] There are three sets of provisions with which we are concerned: the tax treatment of depreciation, the tax treatment of interest payments, and the tax treatment of capital gains. As we shall see, neutrality requires that:

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1 In such a tax system, there is absolutely no need for indexing of wage taxes; indexing of wage taxes is only important within a progressive tax structure. There is thus an important difference between the consequences of the failure to index a wage tax and a capital tax.

Current tax codes do not correspond to either of these idealized systems. As a result, they introduce distortions both in the level and direction of investment, and one of our objectives here is to clarify the nature of these distortions, and the effect of inflation on the magnitude of these distortions. We focus our analysis on tax systems in which interest is fully deductible. There are four important discrepancies between the idealized capital tax described above and current U.S. practices:

(a) physical depreciation rates allowed do not correspond to true physical depreciation.

(b) depreciation is valued at book (historical) cost rather than replacement cost. If the price of machines is rising, this means that the value of the depreciation allowances for the same machine will be higher if investment is postponed. Thus, inflation will serve to discourage investment; the relative magnitude of this effect will depend on the lifetime of the machine.

(c) capital gains are taxed at realization rather than accrual, and when taxed, are taxed at much lower rates; this implies that there is a distortion in favor of assets whose relative price is increasing.

To the extent that capital gains are taxed, the effective tax rate rises with the rate of inflation, and this reduces the return on capital.[1]

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[1] The implications of the tax treatment of capital gains are analyzed in greater detail in the next section.

Assume that the machine suffers from exponential depreciation at the rate δ . (More general patterns of depreciation may also be handled easily.) Then next period, the firm will reduce its expenditures by $(1 - \delta)p_K^t$ where p_K^t is the price of capital at date t.

To finance its original investment, assume that it borrows an amount p_K^{t-1}. (Since, at the margin, the firm should be indifferent between equity and bond finance, so long as it can borrow and lend the assumption that the investment is financed by debt is inconsequential.) This means that to repay the bondholders, it will have to pay $p_K^{t-1}(1 + r)$ where r is the rate of interest (for simplicity, assumed to be invariant with time). Thus, equilibrium requires that the net financial flow from this perturbation be zero, or

$$(6.1) \quad p_o^t \, MPK^t = (1 + r)p_K^{t-1} - (1 - \delta)p_K^t$$

$$= p_K^{t-1}\left(r + \delta - (1 - \delta)\frac{\Delta p_K^t}{p_K^{t-1}}\right) \equiv c$$

where

$$\Delta p_K^t = p_K^t - p_K^{t-1}, \text{ the change in price between } t - 1 \text{ and } t.$$

The RHS of (6.1) is sometimes referred to as the cost of capital. (6.1) says that the value of the marginal product is, in equilibrium, equal to the cost of capital. The cost of capital is equal to the rate of interest plus the rate of depreciation minus the rate of increase in the price of the capital good. This can be viewed in another way. The net return

We proceed in our analysis by stages. First, we consider three special cases: no depreciation, instantaneous depreciation, and true physical depreciation. We then consider the general case. We assume throughout a fixed taxed rate and that interest is tax deductible.[1]

6.3 No Depreciation

The firm receives only $(1 - \tau)$ of the value of the marginal product, but, because of the interest deductibility, the cost of borrowing is $r(1 - \tau)$ rather than r. Thus, the equilibrium condition is

$$p_o^t \, MPK^t (1 - \tau) = (1 + r(1 - \tau)) p_K^{t-1} - (1 - \delta) \, p_K^t$$

or

$$(6.4) \quad p_o^t \, MPK^t = p_K^{t-1} [(r + \delta - \frac{\Delta p_K^t (1-\delta)}{p_K^t}) + \frac{\tau}{1 - \tau} (\delta - \frac{\Delta p_K^t (1-\delta)}{p_K^{t-1}})]$$

Note that such a tax is clearly distortionary. The magnitude of the distortion depends on the magnitude of

$$\frac{\delta}{1 - \delta} - \frac{\Delta p_K^t}{p_K^{t-1}}$$

i.e. the difference between the rate of appreciation in the value of the asset from price increases and the rate of depreciation in the value

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[1] We also ignore the complications introduced by investment tax credits, accelerated depreciation, etc. leaving these as exercises to the reader.

6.5 True Depreciation Rates

Now assume that the government allows depreciation at the rate γ.

The changes in depreciation allowances at each date are set forth in the first two columns of table 1. The net change at date $t + n$ is

$$(6.7) \qquad A_{t+n} \equiv \gamma(1 - \gamma)^n p_K^{t-1} - (1 - \delta)\gamma(1 - \gamma)^{n-1} p_K^t$$

If $p_K^{t-1} = p_K^t$, this equals

$$\gamma(1 - \gamma)^{n-1}[\delta - \gamma] \gtrless 0 \quad \text{as} \quad \delta \gtrless \gamma$$

Thus, with true economic depreciation (depreciation at the true rate), the perturbation in the investment at date $t - 1$ has no effect on depreciation allowances at dates $t + 1$ and beyond.

Thus, when prices are constant and depreciation is allowed at the rate δ the equilibrium condition becomes simply

$$(1 - \tau)p_o MPK^t = p_K^{t-1}(1 + r(1 - \tau)) - (1 - \delta)p_K^t - \tau\delta p_K^{t-1}$$

$$= p_K(r(1 - \tau) + \delta(1 - \tau))$$

or

$$p_o MPK^t = p_K(r + \delta)$$

i.e. the tax is non-distortionary. Again, this result is not surprising, since in the absence of changes in prices of capital goods, setting $\delta = \gamma$ is equivalent to true economic depreciation, which, with interest deductibility, is known to be non-distortionary.

When, however, either prices are changing, or $\delta \neq \gamma$, the expression (6.7) is not identically zero; we cannot simply employ the myopic rules for investment that we have employed so far, which enable us to concentrate on the effects of a perturbation in the investment pattern at date $t - 1$ only at dates $t - 1$ and t. In the more general case, we need to discount these future cash flows originating from the changed depreciation allowances. Since individuals can borrow and lend at an after tax rate of interest of $r(1 - \tau)$, it seems natural to use this as our discount rate. Then, the present discounted value of the depreciation allowances from $t + 1$ on is

$$(6.8) \qquad \frac{\gamma[p_K^{t-1}(1 - \gamma) - p_K^t(1 - \delta)]}{r(1 - \tau) + \gamma}$$

so firms will set

$$(1 - \tau)p_o^t \, MPK^t = r \, p_K^{t-1}(1 - \tau) + p_K^{t-1}\left(\delta = \tau \frac{\gamma(\delta - \gamma)}{\gamma + r(1 - \tau)}\right)$$

$$- \tau\gamma p_K^{t-1} - \Delta p_K^t \left(1-\delta - \tau\frac{\gamma(1 -\delta)}{\gamma + r(1 - \tau)}\right)$$

or

$$(6.9) \qquad p_o^t \, MPK^t = p_K^{t-1}\left[r + \delta - \frac{\Delta p_K^t(1-\delta)}{p_K^{t-1}} + \frac{\tau_f}{+ r(1 - \;)}\right.$$

$$\left.\left[(\delta - \gamma) - \frac{\Delta p_K}{p_K^{t-1}}(1 - \delta)\right]\right]$$

Thus, even with true physical depreciation ($\delta = \gamma$), the tax system is distortionary.

6.6 The General Case

As has been emphasized elsewhere, to attain neutrality requires the use of true economic depreciation, i.e. taxing capital gains on an accrual basis, and allowing depreciation at replacement costs. The net effect of our tax system arises from three distinct errors:

(a) the physical depreciation rate allowed generally does not correspond to the true physical depreciation rate, i.e.

$$\gamma \neq \delta$$

(in general, $\gamma > \delta$).

(b) Capital gains are not taxed on an accrual basis, but only upon realization.

(c) Depreciation is taken at historical costs, rather than at replacement (current value).

The expression (6.9) derived earlier allows us to estimate the net effect of all three distortions taken together.

Clearly, if $\gamma > \delta$, the tax system reduces the cost of capital, and the magnitude of the distortion is even greater than in the case where $\delta = \gamma$. To ascertain the pattern of distortions, we need to know the relationship between γ and δ. For instance, if δ/γ = a constant, then if the constant is small enough, the bias may be larger for shorter lived investments rather than longer lived investments, i.e. the direction of the bias may be reversed.

Allowing depreciation at replacement costs -- without correcting the other distortions -- would exacerbate the distortions in the economy. (This result needs to be modified when we come to inflation.)

6.8 Inflation

The previous analysis focused on an economy in which there was no inflation, but in which there were changes in relative prices. It is easy to show that if there is a general rise in the price level, say at the rate λ , then if all bonds are short term neutrality of taxation requires:

(a) allowing the deductibility of only real interest payments;

but

(b) using replacement cost rather than historical costs to evaluate depreciation.

In addition, we require, as before

(c) the physical rates of depreciation allowed must correspond to the true rates of depreciation; and

(d) there must be instantaneous taxation of real capital gains.

Thus, in addition to the "errors" noted earlier, in inflationary periods the tax system introduces one further error: all interest payments are deductible, rather than just "real" interest payments. In addition, however, the failure to evaluate depreciation to at replacement costs may become more serious in inflationary periods.

$$r = r^* + \lambda$$

Fisher's argument applied, of course, to an economy in which there were no taxes. It is not immediate that this is the appropriate assumption in an economy in which there is a tax distortion.

We next consider the bias if the before tax interest rate adjusted to keep individual's marginal rate of substitution between consumption at different dates unchanged. Again, we assume taxes are not fully indexed. This could, of course, be a full equilibrium only if inflation were fully anticipated (so there were no distributive effects of taxes) and if, when interest rates adjusted in the manner described, there was no distortion in the pattern and level of investment. We show, however, that with present provisions, there will be a bias, although the direction depends on the rate of inflation. We conjecture (but have not proved) that under the usual stability conditions full general equilibrium biases will be of the same sign but will be smaller in magnitude. The precise magnitude will, however, depend on a number of factors: (a) As we have noted several times, with imperfect indexing, inflation will have significant redistributive effects, which alter the aggregate level of savings and the demand for different kinds of assets; (b) the changes in the rate of return on investment will lead to changes in savings behavior; the magnitude of these changes will depend on the elasticity of savings; (c) since the tax system is not fully indexed, inflation will affect the real value of the government's deficit (surplus), and this, in turn, may have significant effects on the economy; if the government attempts to keep the real value of its deficit constant, it will have to change some tax rates. The incidence

Letting g represent, as before, the increase in relative price of the capital good, $g + \lambda$ therefore being the increase in "money" price of the capital good, we can rewrite (6.9) as[1]

$$(6.12) \qquad p_o^{*t}\, MPK^t \approx p_K^{*t-1}[(r^* + \delta - g(1 - \delta)) + \frac{\tau}{(1 - \tau)}[(\delta - \gamma) - \lambda(1 - \frac{\gamma(1 - \delta)}{\gamma + r^*(1 - \tau)}) - \frac{g(1 - \delta)r^*(1 - \tau)}{\gamma + r^*(1 - \tau)}]]$$

where asterisks denote "real" (deflated) values.

What is apparent from (6.12) is that an increase in the rate of inflation actually lowers the cost of capital: the gain from the tax deductibility of interest more than offsets the loss from the depreciation allowances not corresponding to replacement costs.

Note that the smaller γ the larger is the bias. Thus, if γ and δ are correlated, inflation has a larger effect on longer lived investments.

Thus, if depreciation is allowed at replacement value and the other distortions are not simultaneously corrected, the magnitude of the bias will be increased still further.

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[1] We assume the time period is sufficiently small that terms of order $g\delta$, $g\lambda$, etc. can be dropped.

We wish to argue that the distortion arising out of the failure to allow only real interest payments to be deductible is not as serious as the failure to allow depreciation at an indexed value. The reason for this is that although nominal interest payments are deductible to the corporation, nominal interest payments are taxable to the individual. If the individual and the corporation are at similar tax rates, these effects precisely cancel out.

The matter may be looked at another way. Let us assume that the individual's marginal rate of substitution between consumption at date t and $t + 1$ (MRS) remains unchanged, and ask what does this imply for the adjustment in pretax interest rates as a result of inflation. (Recall from our earlier discussion, that in the general equilibrium the marginal rate of substitution will in general change; we make this assumption simply to provide us a "benchmark.") We require

$$MRS = 1 + r(1 - \tau) - \lambda = 1 + r^*(1 - \tau)$$

i.e.

$$r = r^* + \frac{\lambda}{1 - \tau}$$

Thus the equilibrium condition is now not (6.12) but

$$(6.13) \qquad p_o^{*t}\, MPK^t \sim p_K^{*t-1}\left[(r^*+\delta-g(1-\delta) + \frac{\tau}{1-\tau}\left(\frac{1-\delta}{\gamma + r^*(1-\tau)}\cdot (\lambda\delta - gr^*) + (\delta - \gamma)\right)\right]$$

The other two sources of distortion -- the failure to tax capital gains on an accrual basis and the failure of allowed depreciation rates to correspond to true depreciation rates -- would remain. (Indeed, as we have noted, the total distortion may actually be increased by partial reforms.) On the other hand, full indexing would imply that inflation would, itself, not be distortionary; that is, the rate of inflation would, with full indexation, have no effect on the cost of capital. It would ensure neutrality of inflation, not of taxation. (Note that full indexation would also mean that government real income would be invariant to the rate of inflation.)

The argument presented above that full indexation would result in inflation being neutral needs to be modified in one critical respect. Earlier, we argued that if there are costs of adjustment associated with changing prices, and if price changes are not coordinated, the dispersion in relative prices would, in general, increase with the rate of inflation. Full indexation would not, as we noted, affect the distortions arising from the failure to tax changes in relative prices. If the increased dispersion in prices is significant, then the magnitude of the distortions introduced by the tax system may be increased significantly as a result of inflation.

6.11 Progressive Taxation and Distributive Effects of Anticipated Inflation

The analysis presented so far assumes that all individuals face the same marginal (equal average) tax rate. This implies that the change in the before tax rate of interest as a result of inflation has exactly the same impact on everyone within the economy. When different individuals face different marginal tax rates, the after tax rate of

To see the problems that arise more generally, consider an individual borrowing \$100 for a project which at the end of two years is worth \$130, and yields \$10 income at the end of the first year. Assume the interest rate is 10%. The individual borrows \$100. Thus, his income the first period is just enough to pay the interest. At the end of the second period he obtains a net return of \$20 (\$30 minus \$10 interest). Now assume that the rate of inflation increases to 10%; for the moment let us ignore taxes, and assume that the nominal interest payments therefore rise correspondingly to 20%. Inflation increases his receipts the first period by 10%, to \$11, but he still cannot meet his interest obligations: he needs to borrow an additional \$9. It would appear that inflation has had a real effect on the economy. But this is misleading. The "real" indebtedness of the individual has decreased from \$100 to \$90 as a result of inflation (measured in constant dollars). Thus, to maintain indebtedness as the same real level requires that interest payments for multi-period bonds prior to repayment of principle be indexed but not be increased by the rate of inflation although the final payment of principle needs to be indexed. That is, if the real interest rate is r^* and the inflation rate is i, the interest payment during the first period should not be $r^* + i$, but $r^*(1 + i)$. In our example, this would imply again during the first period zero net cash receipts for the borrower, and a constant real income for the lender, and that real income at the end of the second period is unaffected by the rate of inflation.

$$\frac{(t_L - t_B)i}{1 + i}$$

i.e. is proportional to the differences in tax rates and the rate of inflation.

In this particular instance, a policy which is neutral is simply to index the final repayment of principal, i.e. in the first period

$$\frac{r_1(1 - t)}{1 + i} = \text{independent of } i,$$

i.e.

$$r = r^*(1 + i)$$

and at the end of the second period, the real income of the lender is

$$\frac{r_2(1 - t)}{(1 + i)^2}$$

which is independent of i if $r_2 = r^*(1 + i)^2$, where r_2 is the nominal interest payable in the second period of the loan.

Finally, we note that with or without inflation, there is an incentive to relabel interest payments as principal when the borrower is in a lower tax bracket than the lender. The present value of tax savings to the lender are

$$\frac{t_L r^{*2}(1 - t_L)}{1 + r^*(1 - t_L)}$$

while the cost to the borrower is only

The reason that we would argue that this allocative effect is more significant is that, while there may be other instruments available to the government for controlling the overall level of investment in the economy, and thus "correcting" any distortion in the overall savings rate, it is likely to be far more difficult to have specific remedies for various categories of capital goods which would correct the allocative inefficiencies with which we are concerned here.

The capital gains tax also introduces significant inequities: even individuals who have a negative real income may have to pay a tax.

A particular allocative effect which has received widespread attention arises from the taxation of capital gains on the basis of realization rather than accrual: the so-called locked in effect. When individuals sell an asset whose value (in money terms) has increased, a tax is due; the tax can be postponed -- and thus its present discounted value reduced -- by not realizing the return. Thus, individuals are induced to postpone realization, beyond the point where the expected return is equal to the rate of interest. Our analysis suggests that under certain circumstances this locked in effect may not be as serious as is widely believed; we show moreover that the kinds of remedies often suggested (some method of "constructive" realization) are distortionary. The magnitude of the locked in effect is likely, however, to increase with the rate of inflation.

We develop these results within the context of a simple capital-theoretic model.

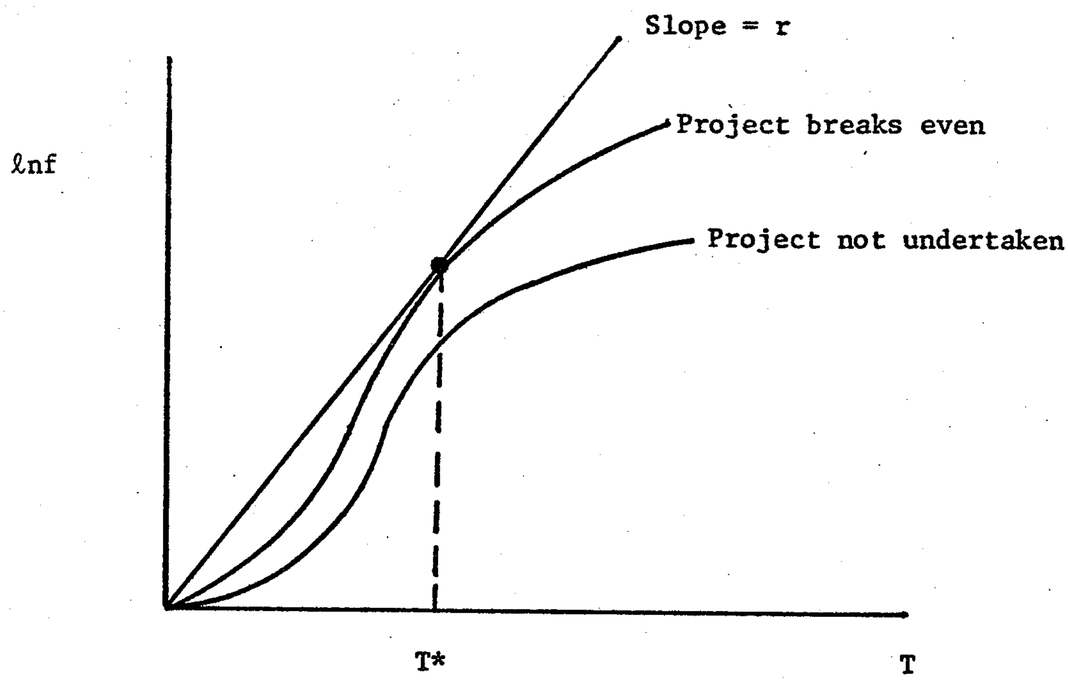

Figure 7.1

The investment is held until

$$\frac{f'}{f + \tau_c/(1-\tau_c)} = r(1 - \tau) \tag{7.4}$$

There is a slight negative locked in effect arising from the capital gains taxation. To obtain an order of magnitude estimate of this effect, assume we are considering a ten year investment, with an average real interest rate of say 7%. Then, with $\tau_c = .2$, the denominator of the left hand size is 10% greater than it would be in the absence of capital gains taxation. But notice that the right hand size is also smaller than it would be in the absence of taxation, because of interest deductibility. While the first effect results in a smaller T, the second effect results in a larger T: for reasonable values of the parameters, the net effect of the tax system is to lead to longer holding

7.2 Multistage Projects

The analysis can be extended to an individual who, over his lifetime, is planning a sequence of investments. The question is, does taxation of capital gains affect the date at which he switches from one project to the next. For simplicity, assume there are only two stages, and that there is constant returns to scale in the second stage. Let V_2^* be the (optimized) value of the second stage per unit of investment, evaluated as of the date of the beginning of the second stage, i.e. $V_2^* = \max_T (f_2(T)e^{-rT} - 1)$. Then the value of an investment program which terminates the first stage at time T_1, and invests the proceeds in the second stage is (in the absence of taxation)

$$e^{-rT_1} f_1(T_1)V_2^*$$

maximization of which again entails

$$f_1'/f_1 = r$$

Now, let us assume there is a sales tax. The firm then maximizes

$$e^{-rT_1} f_1(T_1)(1 - \tau)V_2^*$$

It is immediate that the time of termination of the first project is completely unaffected by such a tax. Again, if we introduce a capital gains tax -- with an allowance for the original purchase price -- we maximize[1]

[1] If there is no interest income tax; with an interest income tax, the modification required is straightforward.

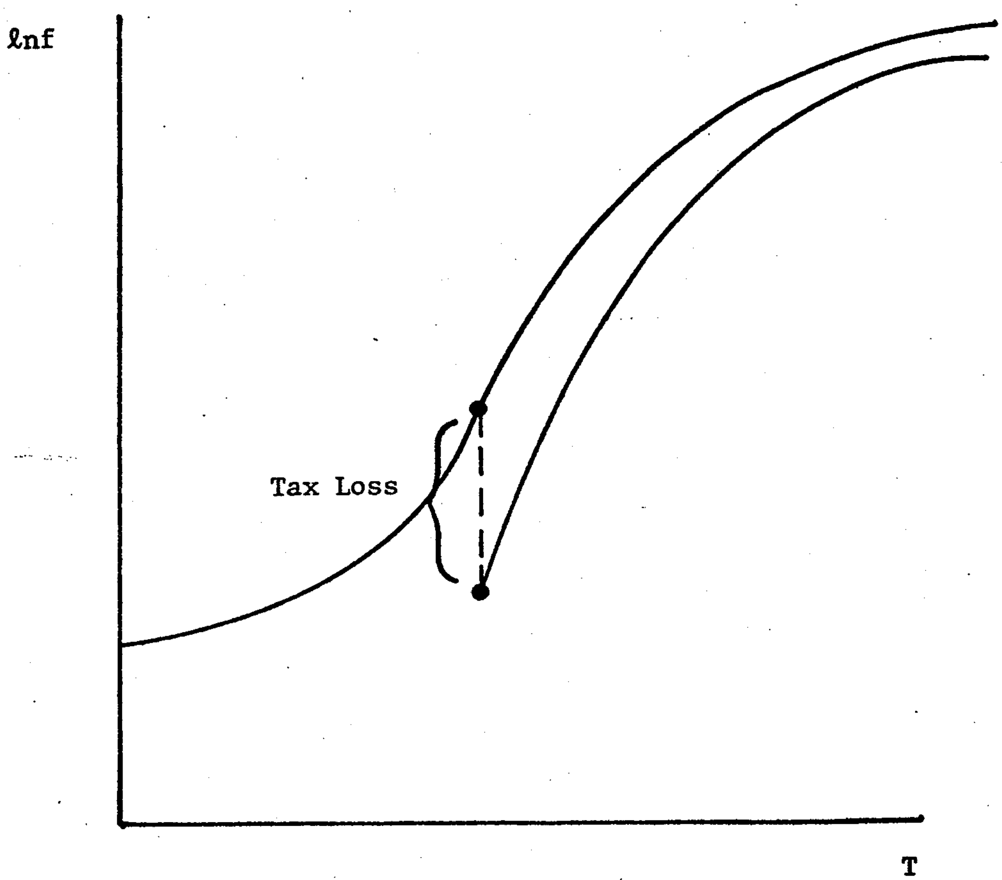

Figure 7.2

Firms thus maximize

$$\left[p(T) - \frac{\tau g}{g-r} p_o \{e^{gT} - e^{rT}\}\right]e^{-rT}$$

i.e.

$$p'-r\,p = -\frac{\tau g r}{g-r} p_o\left[e^{gT}-e^{rT}\right] \quad + \quad \frac{\tau}{g-r}\left[g p_o\,(g e^{gT}-r e^{rT})\right.$$

$$\left. - \frac{r}{g-r} p_o (e^{gT} - e^{rT}) \frac{dg}{dT}\right] > 0$$

since at $p' = rp$, $g > r$ (the average rate of growth exceeds the marginal), and $\frac{dg}{dT} < 0$ (by the second order condition). Thus, this tax results in premature sale of the asset.

This shows that the simplest, and most natural, approach to constructive realization is distortionary. We now show that no non-distortionary system exists.

The general problem can be formulated as follows: does there exist a tax rule based on observables (say the length of the holding period, and the growth rate over the holding period) which is non-distortionary. We show now, for a particular example, that provided the growth functions of different assets are different, no such rule exists.

Assume the individual has a single investment opportunity, a tree which grows at the rate g_1. At some subsequent (random) date, a new investment opportunity becomes available, which grows at the rate

$$e^{gT} - \tau_1(e^{gT}-1) = e^{gT}(1-\tau_1(e^{g(T-t)} - 1) - \tau_2(e^{gt} - 1)$$
$$+ \tau_1 \tau_2(e^{gT} - e^{gt} - e^{g(T-t)} + 1))$$

If all assets grew at a constant exponential rate, this "first best" solution could easily be obtained; for g_1 could be inferred from its past growth rate. But in reality, growth rates vary over time (and indeed are stochastic). Assume at the date at which the new investment opportunity becomes available, the past growth rate has been $\bar{g}_1$, but the future growth rate is expected to be $\hat{g}_1$. Neutrality clearly requires that the individual be indifferent to switching if $\hat{g}_1 = g_2$. But with taxation, even depending on holding periods, we require for neutrality

$$e^{\bar{g}_1 t+\hat{g}_1(T-t)} - \tau_1(e^{\bar{g}_1 t+\hat{g}_1(T-t)} - 1) = e^{g_2 T+(\bar{g}_1-g_2)t}$$

$$\left[1-\tau_1(e^{g_2(T-t)} - 1) - \tau_2(e^{\bar{g}_1 t} - 1) + \tau_1\tau_2(e^{g_2 T} - e^{\bar{g}_1 t} - e^{g_2(T-t)} + 1)\right]$$

It is immediate that this cannot hold for all values of $\bar{g}_1$, $\hat{g}_1$; thus, unless there is a <u>unique</u> relationship between past growth rates and future growth rates for assets, one cannot design a neutral tax structure. (It may, of course, be possible to design second best tax structures; but to do so requires detailed knowledge of the asset structures, time horizons, etc. within the population.)[1]

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[1] For an extremely insightful and more extensive discussion of the issue of locked in effects, see Green and Sheshinski (1978).

Our analysis has shown that taxation will interfere with allocative efficiency, but it appears that although fewer projects will be undertaken, some projects will be kept for longer, while others will be terminated earlier.

7.7 Inflation, Indexation, and Capital Gains

Again, it is important to observe, as we have throughout this paper, that although indexation will not eliminate the distortion arising from these provisions of the tax code, it will result in the neutrality of inflation.

It is sometimes argued that the lower tax rates on capital gains can be justified as compensation for the failure to index for inflation. Although these special provisions do reduce the effective tax rate and, correspondingly, reduce the magnitude of the "locked in effect" they introduce further distortions -- between those assets who yield their returns in the form of capital gains and those assets who yield returns directly. These allocative effects may be significant.[1]

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[1] There is also an increased incentive to convert ordinary income into capital gains. Although such financial effects clearly reduce the effective tax rate, their implications for real resource allocation are more ambiguous.

inflation to 12% increases the tax rate to 350%, while a slight decrease to 8% reduces it to 250%. It was probably never the intention of tax authorities to impose taxes at these rates; even if one believes on equity grounds that income from capital ought to be taxed, it is hard to argue that it should be taxed at these rates.

Moreover, the distortionary effects both in the level of savings and the patterns of investment may be significant. Although the government may have instruments by which it can offset the effects on the overall rate of investment, it may be far more difficult to offset the allocative effects. We have shown in the previous two sections how non-indexed taxation leads to a distortionary impact on different classes of assets.

It is important to realize, however, that one cannot ascertain the full effect of inflation on any single class of assets in isolation. What is critical is the effect on the relative returns to different assets. Thus, to the extent that inflation increases the effective rate of taxation on capital gains, it reduces the return on assets subject to capital gains taxation relative to those -- like housing and durable goods -- upon which the effective capital gains tax rate is negligible.

Moreover, one cannot necessarily infer the effect of taxation on the marginal cost of capital from observing the effect on the average return to capital. If the inflation was unanticipated, there is a transfer of wealth from bondholders to equity holders: the value of shares should (in real terms) accordingly increase. But the rate of interest charged on new loans is increased to reflect the rate of

The analysis of indexing in a world in which inflation is perfectly anticipated is, in a sense, embarrassingly simple. The more interesting questions arise when there is uncertainty about the rate of inflation. The distinction between anticipated and unanticipated inflation becomes, at this point, blurred: individuals have a probability distribution of the rate of inflation; they may indeed have "rational expectations". Still there is a sense in which one could say that every outcome is anticipated; and another sense in which one could say that no outcome is fully anticipated.

If the joint probability distribution of all relative (goods) prices remains unchanged, full indexing would again leave the economy unaffected by the rate of inflation. We have argued, however, that the higher rates of inflation may be associated with greater variability in relative (real) prices; moreover, we have identified certain distortions in our present tax system associated with changes in relative prices. To the extent that this is the case, indexing will not be sufficient to eliminate the effects of inflation on the economy.

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