2 A Summary of the Theoretical Models

This chapter summarizes four rather abstract models of a very simple economy with a constant and known rate of inflation. These models, persented in chapters 3 through 6, examine what happens to asset yields and capital intensity when the rate of inflation changes from one "permanent" level to another. Within this framework, it is possible to examine the implications of different tax rules, especially different forms of indexing and of inflation nonneutrality. These theoretical models represent my own attempt to understand how inflation and the tax system interact to influence the rate of capital formation.

The first of these theoretical studies, reported in "Inflation, Income Tax Rules, and the Rate of Interest" (chap. 3) introduces a corporate tax and a personal tax on investment income into a simple neoclassical monetary growth model. The model is then used to study the effect of inflation on the rate of interest and on the capital intensity of the economy. Except for the capital income taxes, this model is very similar to the one developed by James Tobin (1965).

Tobin obtained his famous conclusion that inflation *increases* capital intensity by analyzing an economy in which all taxes were assumed to be of a lump sum variety. The capital-increasing effect of inflation is also a possible special case in my own more general analysis. But the richer description of the tax system shows that the tax rates and saving behavior together determine whether an increase in the rate of inflation will increase or decrease the steady-state capital intensity of the economy. In this more general model and with plausible parameter values, the most likely effect of an increase in the rate of inflation is a fall in the real net

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rate of interest received by savers and therefore a decrease in the capital intensity of production in the economy.

The model that leads to this conclusion involves two important simplifying assumptions. First, all corporate investment is financed by debt; equivalently, and perhaps more plausibly, only debt finance is used at the margin so that the corporate income tax produces revenue for the government because it taxes the intramarginal equity income.[1] The second assumption is that firms use a correct measure of economic depreciation in calculating taxable profits; in particular, inflation does not reduce the value of depreciation allowances. Both of these assumptions are replaced by more realistic descriptions of corporate finance and historic cost depreciation in subsequent papers that are described below. Although these more general analyses give results that more accurately reflect reality, analysis of the present model with debt-only finance and with economic depreciation is useful for highlighting some important features of the general mechanism by which inflation affects capital intensity and asset yields.

In this model, the effect of inflation on capital intensity depends on two countervailing forces. First, there is the liquidity or portfolio composition effect emphasized by Tobin (1965) and Mundell (1963). An increase in the rate of inflation raises the nominal interest rate, implying a higher cost of holding money balances. This induces a shift in portfolio composition from money to real capital. The portfolio composition effect in this two-asset model unequivocally implies that inflation raises capital intensity. This effect was the basis of Tobin's conclusion.

There is, however, a second effect of inflation that depends on the nature of the tax system and of saving behavior. Because the tax system is based on nominal interest payments and receipts rather than real interest payments and receipts, inflation is likely to alter the real net rate of interest received by savers. If saving is sensitive to the rate of return, inflation will alter the saving rate and therefore the long-run capital intensity of production. Although a positive relationship between the real net rate of return and the saving rate is not an unambiguous implication of economic theory,[2] it appears to be supported by empirical research and by the examination of plausible parameter values in theoretical models;[3] unless I say otherwise, I shall therefore be assuming in this chapter that a higher real net rate of return increases the saving rate or at least does not decrease it. I might add that only the first of the three theoretical models that I will describe assumes a variable saving rate; in the others, individuals save a fixed fraction of disposable income.

1. See Joseph Stiglitz (1973) for a model that incorporates this assumption of marginal debt finance.

2. This is time even for compensated changes in the rate of return; see Feldstein (1978*c*).

3. See Boskin (1978), Feldstein (1981*a*), Feldstein and Tsiang (1968), and Summers (1980).

The effect of inflation on the real net rate of interest depends on the entire tax structure. It is easy but wrong to fall into the trap of arguing as follows: "Since inflation raises the interest rate by the rate of inflation, and the inflation premium is subject to tax, the *net* interest rate rises by less than the rate of inflation and the *real net* interest rate therefore falls. For example, if an economy has a 4 percent interest rate with no inflation, an 8 percent inflation will raise the interest rate to 12 percent. With a 50 percent personal tax rate, the original 4 percent interest rate would leave a net yield of 2 percent; the 12 percent rate would leave a net yield of only 6 percent or 2 percent less than the rate of inflation. Thus the real net rate falls from a positive 2 percent to a negative 2 percent."

This argument is wrong in assuming that the interest rate necessarily rises by the rate of inflation. This famous theoretical proposition of Irving Fisher (1930) was based on an economy with no taxes. When borrowers can deduct their interest costs, they can afford to pay a higher inflation premium. More specifically, with economic depreciation and no other adverse effects of inflation on real profitability, the borrower can afford to raise the interest rate that it pays until the inflation rate equals the rise in the interest rate net of the borrower's tax deduction. Thus, if the borrower is in the 50 percent tax bracket, the interest rate will rise by two percentage points for every percentage point of inflation. In the numerical example that I considered in the previous paragraph, an 8 percent rate of inflation would raise the interest rate by 16 percentage points to 20 percent. The net interest rate to the lender in the 50 percent bracket is thus 10 percent and the net real rate becomes 2 percent, exactly what it was in the absence of inflation.

This example illustrates a general proposition that is shown more formally in the paper: The real net rate of return to savers will remain unchanged if and only if the tax rates paid by borrowers and lenders are equal. If the tax rate of borrowers exceeds that of lenders, the real net return to lenders will rise and saving will be encouraged. Conversely, if the tax rate of lenders is higher than that of borrowers, the real net return to lenders will fall and saving will be discouraged. The net effect of inflation on capital intensity in this case depends on the relative strength of the saving effect and the portfolio composition effect. Some calculations in the paper itself show that the relative size of the relevant money balances is so small that even a quite small sensitivity of saving to the net rate of interest will cause the saving effect to be more important than the portfolio composition effect.

The relation between the two tax rates and the real net rate of return can be derived explicitly by noting that, with all debt finance and economic depreciation, the real return on capital net of the corporate income tax [$(1 - \tau)f'$ where τ is the corporate tax rate and f' is the marginal product of capital] must equal the real net cost per dollar of borrowed funds [$(1 - \tau)i - \pi$ where i is the nominal interest rate and π is the rate of inflation]. Thus,

(1) $$(1 - \tau)f' = (1 - \tau)i - \pi$$

or

(2) $$i = f' + \pi/(1 - \tau)$$

The net rate of interest to the saver is $i_N = (1 - \theta)i$ or

(3) $$i_N = (1 - \theta)f' + \frac{1 - \theta}{1 - \tau}\pi$$

The real net rate of interest to the saver is $r_N = i_N - \pi$ or

(4) $$r_N = (1 - \theta)f' + \frac{\tau - \theta}{1 - \tau}\pi$$

Thus the real net rate of return to the saver rises or falls with inflation according to whether or not the borrowers' tax rate exceeds the lenders' tax rate.

These calculations highlight the importance of the deductability of nominal payments by borrowers and the taxation of nominal payments received by savers. While this emphasis is useful, it implies too strong a condition for inflation to depress capital intensity. A more general model shows that inflation can reduce capital intensity even when the borrowers' rate exceeds the lenders' rate if we also recognize the historical cost method of depreciation, the tax treatment of inventory accounting profits, and the taxation of capital gains. I will return to these more general conclusions later in this chapter.

But first, the implied impact of inflation on the interest rate in the first model deserves further comment. Equation (2) implies that $di/d\pi = 1/(1 - \tau)$ or approximately 2 and not the point-for-point relation between changes in inflation and in the interest rate that was predicted by Irving Fisher for a taxless economy and that has in fact been observed at least approximately in the United States in recent years. The difference between the pure inflation effect implied by the model and indicated by equation (2) and the actual one-for-one movements that have been experienced reflects four features of the U.S. economy that the present model ignores: (1) the additional tax burdens caused by inflation because of historic cost depreciation and inventory accounting rules; (2) the role of equity financing and the taxation of the return to equity; (3) the presence of government debt and debt management policies; and (4) the presence of other debt instruments that are not affected by inflation in the same way as the corporate bond market but that are close substitutes for corporate bonds in investors' portfolios (i.e., residential mortgages, state and local bonds, foreign bonds). A richer model that incorporates these features has implications that are consistent with the observed behavior of interest rates. The simpler model is nevertheless useful in focusing on the partial effect of nominal interest deductibility and taxation.

Despite its simple structure, or perhaps because of it, the current model also provides insights into the welfare effects of inflation. The economists' traditional objection to a positive constant rate of inflation is that it imposes an efficiency loss by distorting the demand for money balances.[4] This traditional conclusion refers to an economy with no distorting taxes. Phelps (1972) has stressed that the increase in the money supply that causes inflation is also a source of government revenue that in itself permits a reduction in the tax rate that distorts labor supply. Phelps concluded from this observation that the optimal inflation rate is positive and may even be substantial. The appropriate analysis is more complex when we recognize the nonneutrality of existing taxes on capital income.[5] Even in the absence of inflation, the net return to savers (r_N) is less than the marginal product of capital (by the rate of personal income tax: $r_N = (1 - \theta)f'$) and this distortion between the gross and net rates of return is itself a welfare loss. A positive rate of inflation affects the tax wedge between the marginal product of capital and the net return as well as the amount of revenue that the government collects at existing tax rates (and therefore its ability to reduce—or its need to increase—the distortionary tax on labor income). The effects of inflation on the "investment tax wedge" and on revenue are of opposite signs. If the lenders' tax rate exceeds the borrowers', inflation increases tax revenues but worsens the tax wedge between the marginal product of capital and the net return; conversely, if the borrowers' tax rate is higher, inflation reduces tax revenue but improves (i.e., reduces) the distorting wedge between the gross and net rates of return. Determining the optimal steady-state rate of inflation requires balancing at least three effects of inflation on economic welfare: (1) the welfare loss that results from reduced liquidity, (2) the change in welfare that results from the increase or decrease in the differential between the marginal product of capital and each individual's marginal rate of substitution, and (3) the change in other distorting taxes that results from the increase or decrease in the net tax revenue in response to inflation.

Although the analysis is necessarily more complex in richer models, the same conflict between the investment tax wedge and the revenue effect remains. With parameter values that provide a realistic description of the

4. See Bailey (1956), Friedman (1969), and Feldstein (1979).

5. Indeed, even within his own more limited framework, Phelps's conclusion is not correct. Recall that Friedman has shown that, ignoring the revenue effect of inflation, the optimal rate of inflation is not zero but is negative and equal to the marginal product of capital. The force of Phelps's argument is only that, when the revenue effect is considered, the optimal tax rate should be greater than this negative number and not that it should be positive.

U.S. economy, inflation does raise extra tax revenue (that could be used to reduce the distortionary tax on labor income) but accomplishes this only by increasing the distortionary wedge between the net return to savers and the pretax marginal product of capital. Since the existing mix of labor and capital income taxes places too heavy a relative tax on capital income even in the absence of inflation (i.e., the welfare loss of collecting the existing amount of total tax revenue could be reduced by switching more of the tax to labor),[6] the effect of inflation on the relative rates of tax on capital and labor is undesirable.

As I have emphasized several times, two important limitations in the realism of this first model are (1) the exclusive focus on debt finance and (2) the assumption that firms are allowed economic depreciation. Dropping these restrictions has important implications for the effects of inflation on the equilibrium of the economy. Jerry Green, Eytan Sheshinski and I extended this first model (in "Inflation and Taxes in a Growing Economy with Debt and Equity Finance," presented in chapter 4) to recognize that firms finance investment by both debt and equity (in a ratio that depends on tax rates and on the rate of inflation) and that the "historic cost" method of depreciation causes the effective tax rate on corporate income to rise with the rate of inflation. A complete analysis of such a model would follow the procedure of the first model and trace out the full general equilibrium effects that a change in the permanent rate of inflation would have on the asset yields, portfolio composition, the real rate of return, and the capital stock. We followed a simpler and more partial analysis. We took both the saving rate and the ratio of real money balances to real capital as fixed. This implies that the capital stock and the pretax marginal product of capital remain fixed when the inflation rate changes. In this framework we examined how a change in the rate of inflation alters the yields on debt and equity. It is easy to see how this could then be extended to allow for the general equilibrium effects of changes in the saving rate, portfolio composition, and capital intensity.

The analysis in this new paper showed that the historic cost method of depreciation has important effects on the yields of *both* debt and equity. Because depreciation for tax purposes is limited to the original or "historic" cost of the firm's capital stock, a higher rate of inflation reduces the real value of the depreciation allowance and thereby raises the real tax burden on corporate income. This extra real tax reduces the net return that firms can pay to the suppliers of debt and equity capital. This reduction in the real net return to capital is divided between debt and equity in a way that depends on the substitutability between debt and equity in the portfolios of individual investors. In general, inflation reduces both the real net return to equity and the real net rate of interest.

6. See Feldstein (1978*a*).

Understanding the role of historic cost depreciation helps to resolve the puzzling and counterfactual implication of the simpler model that the nominal interest rate rises by approximately twice the increase in the rate of inflation. Put simply, historic cost depreciation reduces the firm's ability to pay such high interest rates. With a constant marginal product of capital (f') and a constant debt to equity ratio, the relation between the interest rate and the rate of inflation can be written $di/d\pi = (1 - \delta)/(1 - \tau)$ where δ is the extra tax per 100 units of capital that is collected when the inflation rate rises by one percentage point. Thus, if a 10 percent inflation rate and historical cost depreciation together mean that the tax rate on capital rises by five percentage points, $\delta = 0.5$ and $di/d\pi = .5/(1 - \tau)$ or approximately one. More generally, the effect of inflation on the nominal interest rate depends on the relative magnitudes of the historical cost depreciation penalty (δ) and the benefits of deducting nominal interest rates (as measured by the corporate tax rate, τ). The analysis in our article is based on an approximation that δ is approximately 0.2, implying that the interest rate rises by significantly more than the inflation rate but that calculation still ignored the inventory accounting penalty, government debt management, and other financial assets.

The effect of inflation on the real net return to savers can be summarized by a simple expression if we limit attention to the special case in which investors wish to hold debt and equity in fixed proportions. With this assumption, it is not necessary to worry about changes in risk premia that would otherwise influence the interest rate and the yield on equities. In this case, the effect of inflation on the *real net* interest rate is given by

$$(5) \qquad \frac{dr_N}{d\pi} = \left[\frac{\tau - \theta}{1 - \tau} - \frac{\delta(1 - \theta)}{1 - \tau}\right]$$

The first term reflects the effects of basing taxes on nominal interest payments and expenses. The real net return to the saver rises or falls with inflation according to the relative tax rates on borrowers and lenders for the reasons that have been discussed above; this part of equation (5) is the same as the previous equation (4). The second term reflects the adverse effect of historical cost depreciation on the net return on debt. Note that $\theta \geqslant \tau$ is a sufficient (although not necessary) condition for inflation to reduce the real net return on debt.

The comparable effect on equity can also be calculated most easily if we assume that the debt equity ratio is constant. The Feldstein-Green-Sheshinski analysis then shows that:

$$(6) \qquad \frac{de_N}{d\pi} = -[c + \delta(1 - \theta)]$$

where e_N is the real net of tax return per unit of equity and c is the effective rate of capital gains tax. This is unambiguously negative. Note that the assumption that the debt-equity ratio is fixed implies that the gap between the real net yields on debt and on equity varies with inflation.

In general, inflation will also influence the firm's debt-equity.ratios. Although the nature of this dependence is complex, in the simple case in which the only nonneutrality in the tax system is in the treatment of interest (i.e., when there is economic depreciation and no taxation of nominal capital gains), inflation raises the debt-equity ratio in the economy if the borrowers' tax rate exceeds the lenders' tax rate ($\tau > \theta$) and reduces it if the borrowing rate is lower. It is easy to see why this is so since the higher tax rate for borrowers means that the government loses money to investors on every dollar of debt, therefore encouraging the substitution of debt for equity.

In this paper, Green, Sheshinski and I also examined the effects of alternative indexing rules. It is clear from equation (6) that indexing depreciation and capital gains ($\delta = c = 0$) would make the real net return to equity independent of the inflation rate as long as the debt-equity ratio remained unchanged. With economic depreciation ($\delta = 0$), the real net rate of interest is affected only by the difference between the tax rates on borrowers and lenders (equation 5). In the special case of equal tax rates, there is no need to adjust the tax treatment of interest payments and receipts in order to keep both the real net yield on both debt and equity unaffected by inflation. Indeed, even if the debt equity ratio is not fixed, the analysis in the paper shows that the net yields are unaffected by inflation if there is economic depreciation, no taxation of nominal capital gains, and equality of tax rates on borrowers and lenders. (Of course, the complete neutrality is true only if everyone has the same rate and not just if the average rate among borrowers equals the average rate among lenders. Even if the averages are equal, the individuals with the highest marginal tax rates will lose and those with the lowest marginal tax rates will gain.)

Illustrative but plausible parameter values suggested to Green, Sheshinski, and me that "With our current tax system, inflation decreases the net rate of return and therefore is likely to decrease the rate of saving. This in turn would decrease the ratio of capital to labor and thus increase the marginal product of capital. This in turn would partially offset the fall in the after-tax rate of return, but the qualitative results of our analysis would remain unchanged."

A theoretical model cannot be a complete picture of reality and still be simple enough to be analytically useful. Examining different models that emphasize different aspects of a problem can, however, provide useful insights about the complex reality that is of ultimate interest. In this spirit, the third paper ("Fiscal Policies, Inflation, and Capital Formation," chap. 5) explores another facet of the general subject of the interrelationship between inflation, fiscal policy, and capital formation: the role of government bonds and monetary (or debt-management) policy. More specifically, the monetary growth model with which I began in the first model is extended by recognizing that the government can finance its deficit by alternative combinations of money and bonds. The monetary policy that is selected (i.e., the combination of money and bonds) determines the extent to which a government deficit causes inflation, crowds out private investment, or both. The analysis emphasizes that the impact of any monetary policy depends crucially on the structure of the tax rules.

The importance of government bonds in this model of the economy is that they provide an alternative asset which, unlike money, *has* a nominal yield that can vary with the rate of inflation and into which individuals can channel their saving instead of acquiring claims to physical capital. This rechannelling of saving represents an important way in which inflation can reduce real capital accumulation even if the saving rate itself is not sensitive to the real rate of return. The availability of government bonds is thus a reason why, contrary to Tobin's earlier conclusion, a higher rate of inflation may not succeed in increasing investors' willingness to hold real capital and may have just the opposite effect.

The existence of both government bonds and money also provides a further way of explaining the observation that the real pretax interest rate has remained constant. The puzzling implication of the models that I have already described (i.e., that inflation would raise the real pretax interest rate) reflected the absence of any monetary or debt-management policy. The current analysis shows how the government can reduce the real yield on bonds by decreasing the ratio of government bonds to money. The government, in other words, can validate Irving Fisher's propositions by a relative increase in the money supply.

A surprising result of the formal analysis of this model is that the real per capita government deficit can increase permanently without inducing any changes in either inflation or capital intensity. This will happen, however, in a fully employed economy only if there is a corresponding reduction in the share of government spending in national income. In contrast, if the government's share of national income is constant, a permanent increase in the real per capita deficit must be accompanied by an increase in the rate of inflation, or by a decrease in equilibrium capital intensity, or both.

With the existing tax system and the type of monetary policy that has been pursued in the United States, an increase in the deficit is likely to cause both a higher rate of inflation and a reduced capital intensity of production. More specifically, this is the likely implication of a monetary policy that keeps the real interest rate on government debt constant by adjusting the mix of bonds and money when the size of the deficit changes. The basic reason for this is that an increase in inflation reduces the real net yield on private capital because of historic cost depreciation and other tax accounting rules. If the real net yield on government bonds is maintained while the real net yield on private capital falls, there will be incentive for individuals to switch from real investment to the holding of government debt. Capital intensity will fall except in the unlikely event that the adverse effect of inflation on the demand for money outweighs the positive effect of inflation on the demand for bonds. The greater responsiveness of bond demand than of money demand is quite likely in view of the relative magnitudes of both types of assets and the greater substitutability between debt and capital than between money and capital.

The formal analysis in this paper also shows that the reduced capital intensity in this case is accompanied by an increased rate of inflation. To prevent such an increase in the rate of inflation would require a greater rise in the interest rate, enough to cause the demand for government liabilities (i.e., the sum of bonds and money) to increase enough to absorb an increased deficit without a higher proportional rate of growth of either money or bonds. To state this same point in a slightly different way, the faster growth of government liabilities can be absorbed without increasing the *proportional* growth of either money or bonds (and therefore the inflation rate) if the *levels* of money and bonds that are demanded (i.e., the denominators of the proportional growth rates) are increased. The higher interest rate would make this possible by increasing the demand for bonds by more than it decreases the demand for money.

Although such a policy would prevent inflation, the government deficit would reduce real capital accumulation. The analysis makes it clear that a higher rate of real capital accumulation can only be achieved by either a reduction in the government deficit or an increase in private saving. If private saving is responsive to a higher real yield, the policy of high interest rates and the prevention of inflation can together increase private saving. Other specific fiscal incentives that reduce the wedge between the marginal product of capital and the real after-tax return might also be used to increase the rate of saving. In this context, a reduction in the subsidy for spending on consumer durables, housing, and other forms of what we might call "consumption capital" would also encourage the accumulation of more plant and equipment.

An explicit analysis of the effect of inflation on the equilibrium demand for housing capital is presented in chapter 6, "Inflation, Tax Rules, and the Accumulation of Residential and Nonresidential Capital." The essential framework is a monetary growth model with taxation of nominal corporate and household income. The model of chapters 3 and 4 is extended to include both a general goods sector and an owner-occupied housing sector. To facilitate this analysis, the earlier models are simplified by assuming that both savings and money demand are inelastic and that all investment is financed by debt.

Within this framework, the analysis shows that an increase in the rate of inflation raises the amount of housing stock per person and reduces the amount of plant and equipment. It is clear from the structure of the analysis that the same conclusion would hold in a model with all equity finance. If the saving rate is an increasing function of the real net-of-tax return, the total of both types of capital would be reduced but the change in the mix in favor of housing would remain. The basic reason for all of these effects is the adverse impact of historic cost accounting on the profitability of the corporate capital relative to the implicit return on housing capital.

This brings me back to the point with which I began this chapter. It is now time to turn to the four theoretical studies themselves and then to the empirical research presented in later chapters that they led me to—research on the impact of inflation on effective rates of tax as well as research on the effects of inflation on the real yields on corporate debt and equity as well as research on the effect that the interaction of inflation and our tax rules has had on private saving and on business fixed investment. I hope, however, that even this brief review of the four simplified models indicates the types of theoretical thinking that helped me to clarify my own analysis about the nature of the interaction between inflation, taxes, and capital formation.