Tax Policy and Agricultural Investment

James Hrubovcak and Michael LeBlanc

Abstract

Tax policies between 1956 and 1978 stimulated net investment in agricultural equipment by more than $5 billion and net investment in agricultural structures by more than $1 billion (1977 dollars). This technical analysis demonstrates that the investment tax credit has probably been the most effective tax tool in stimulating investment in agricultural assets. This study examines the investment decision in a theoretical framework where the optimal levels of all inputs are determined simultaneously.

Keywords: Tax policy, agricultural investment, equipment investment, structure investment.

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Summary

Tax policies between 1956 and 1978 stimulated net investment in agricultural equipment by more than $5 billion and net investment in agricultural structures by more than $1 billion (1977 dollars). Not only has tax policy led to increased investment in agricultural equipment and structures, it also has increased potential output in the agricultural sector. Attempts to restrict agricultural output and support farm income, the goal of farm commodity policies, may have been offset by investment stimulated by changes in tax policy.

This technical study assessed three tax alternatives: the investment tax credit, the deductibility of interest expenses, and the interaction of all new tax provisions enacted since 1954. The results suggest that the investment tax credit has probably been the most effective tool in stimulating investment. From 1962 to 1978, for example, the investment tax credit accounted for nearly $3 billion, or 12 percent, of net investment in total agricultural equipment and $500 million, or 5 percent, for structures.
Tax Policy and Agricultural Investment

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Introduction

Tax policy has been used extensively to promote capital formation in the United States since the early fifties. Manipulating the tax code to induce investment was an outgrowth of experience gained during World Wars I and II when accelerated depreciation was used to encourage plant expansion for the production of war output (6). Throughout the fifties and sixties, the effectiveness of tax policy to alter investment behavior was accepted as an article of economic faith. Firms would purchase more capital goods if those goods cost less, according to this reasoning. This argument is compelling but incomplete, for it fails to address the question of the magnitude of investment’s response to increases in profitability. Hall and Jorgenson were the first to study the relationship between tax policy and nonfarm business investment (16). They concluded “tax policy is highly effective in changing the level and timing of investment expenditures.” They found, for example, that 41 percent of the investment in manufacturing equipment in 1963 was attributable to the investment tax credit. If these results can be extended to the agricultural sector, they have important implications for food policy as well as fiscal policy. Increases in agricultural investment in general expand the production capacity of the food and fiber sector and induce productivity growth by acting as a medium for technological change. As tax policy has expanded investment, raised production, and lowered prices, it has contradicted other agricultural policies.

This paper examines the effects of taxes on investment in agriculture, thereby assessing the potentially contradictory character of tax and farm policy. The authors separated agricultural capital into four asset classes: short-lived equipment, long-lived equipment, structures, and land. The authors also examined the effects of investment tax credits, interest deductibility, accelerated depreciation, and liberalized amortization on these four asset classes for the period 1955-78.

The effects of tax policies on agricultural investment are examined by placing the investment decision in a theoretical framework where the optimal levels of all variable and quasi-fixed inputs are determined simultaneously. Results from duality theory on restricted variable profit functions are incorporated into a dynamic optimization framework where input use is affected by external adjustment costs (10, 26, 44). An approximation to this “third generation” dynamic framework is used to estimate the structure of the investment functions for the four asset classes. Each investment equation is a function of variable input and output prices, technological change, rental rate for capital, and lagged capital stock. Changes in tax policies affect investment by altering the rental rate of capital. Results from this analysis suggest tax policies are effective in promoting agricultural investment.

Income Tax and the Rental Rate of Capital

The critical role of the rental rate of capital and the financial policy of the firm is well illustrated by the “Marshallian” view of income taxes falling on pure profits. The Marshallian view is that a profits tax does not affect output in either the short run or long run.

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2 Italicized numbers in parentheses refer to literature cited in the References section of this report.

3 For critiques of this analysis see Coen (8) and Eisner (9).

4 Seemingly contradictory findings are provided by Auerbach and Summers who state, “There is little evidence that a change in the investment tax credit is an effective tool for expansionary fiscal policy.... We are skeptical of its longrun effect on capital accumulation” (2).

5 Berndt, Morrison, and Watkins categorize dynamic models as belonging to either the first generation (single-equation models using a Koyck partial adjustment framework) (23), second generation (allowing input interaction, but only a limited theoretical basis for the adjustment process), or third generation (explicitly incorporating dynamic optimization) (5).

6 For a more detailed discussion of this point, see Atkinson and Stiglitz (1) and Robertson (32).
Because taxes are levied (at rate $T$) on net profits, firms receive

$$\pi = (1 - T)(PQ - wL - uK) \quad (1)$$

where $PQ$ is revenue, $w$ is the wage rate, $L$ is the quantity of labor, $u$ is the rental rate, and $K$ is the quantity of capital. Tax rates do not affect the shortrun first-order conditions for capital and labor. In the longer run, entry and exit are determined by the marginal firm which by definition is making zero profits. Longrun output is, therefore, also unchanged.

This Marshallian view of taxes depends on the assumption that the tax base (revenue less cost) excludes the cost of capital ($uK$). The key to levying neutral income taxes by taxing authorities is therefore in the definition of the tax base. The failure to accurately identify the tax base leads to input and output distortions.

Nonneutral tax-induced changes in rental rates affect the capital stock because lower taxed capital inputs are substituted for higher taxed capital inputs or by replacing capital more rapidly than before the tax changes. Assuming perfectly competitive market conditions and a cost-minimizing profit-maximizing behavior, firms adjust their stocks of inputs until the ratio of marginal products of any pair of inputs is equal to the ratio of their respective rental rates. To the degree that inputs are substitutable, a change in tax law which results in a decrease in the rental rate of one input relative to other inputs increases the demand for the lower priced input until the cost minimization conditions are satisfied. Conversely, an increase in the rental rate of one input relative to other inputs will decrease the demand for the higher priced input.

Conversely, an increase in the rental rate of one input relative to other inputs will decrease the demand for the higher priced input. The same tax treatment is not necessarily appropriate for each type of asset. In the presence of an otherwise neutral income tax system, inflation can bias the mix of inputs that is employed. Because tax depreciation deductions are based on the historical cost of assets, inflation reduces the real value of the nominal deductions, with the reduction being the greatest for shorter lived assets.\(^6\) During times of inflation, the use of historical cost tax depreciation for all assets would result in an increased demand for longer lived assets relative to assets with shorter lives.

For the past 30 years, income tax policy has significantly affected the definition of the tax base. In 1954 and again in 1962, amortization of capital expenditures was liberalized by providing for faster writeoffs. Also in 1962, a 7-percent investment tax credit was instituted for qualifying plant and equipment. This tax credit was eliminated in 1969, restored in 1971, and increased to 10 percent in 1975. The asset depreciation range (ADR) system instituted in 1971 and the Economic Recovery Tax Act of 1981 both shortened tax lives.\(^6\)

The rental price of a unit of capital services is the after-tax cost of those capital services internally supplied by the firm. When a firm leases capital services, the rental rate is the price the firm will charge for each unit of capital service leased. Therefore, the rental rate is the rate the firm must charge in order to earn the required after-tax rate of return. The rental rate is a function of the price of the asset, the rate of capacity depreciation, the tax variables, the discount rate, and the rate of inflation. True rental rates are directly observed from market transactions with active rental markets. Implicit rental rates are estimates of the true rental rates that would prevail under given sets of assumptions.

A formula for implicit rental rates is developed from the equality between the purchase price of the asset and the present value of the future rents generated by the asset (22). Assuming constant new asset price expectations and allowing for alternative depreciation patterns, the basic relationship is

$$\hat{q}_i = \int_0^{t_i} e^{-r t} u_i n_i(t) \, dt \quad i = 1, 2, \ldots, m. \quad (2)$$

where $\hat{q}_i$ is the purchase price of the $i$th asset when new, $L_i$ is the service life, $u_i$ is the rental rate expressed in terms of an undepreciated unit of capital, $n_i(t)$ is the capacity of the asset available in year $t$ of its service life, and $r$ is the discount rate.

Equation (2) ignores all tax considerations. When capital income is subject to an income tax, the term on the right side of equation (2) is modified to include the effects of the tax. The modified term includes the present value of the rents generated by the asset, and the present value of the tax savings produced by the investment tax credit and the tax depreciation deductions.

Assuming the firm’s marginal tax rate remains constant at $T$, equation (2) is respecified to accommodate the tax system

$$\hat{q}_i = (1 - T)u_i N_i + \theta \hat{q}_i + T(1 - h\theta)Z_i \hat{q}_i \quad (3)$$

i = 1, 2, \ldots, m.

where $(1 - T)u_i N_i$ is the present value of the future rents, $\theta \hat{q}_i$ is the present value of the investment tax credit, and $T(1 - h\theta)Z_i \hat{q}_i$ is the present value of the future tax depreciation deductions.

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\(^*\)This analysis does not seek to detail each of these tax provisions. Instead, only the key features affecting investment decisions are captured within a stylized rental rate for capital.
If price expectations and the marginal tax rate are constant, the implicit rental rate remains constant over the life of the asset. The capacity of the asset, however, declines over the life of the asset so that

\[
N_i = \int_0^{L_i} e^{-rn(t)} dt \quad i = 1, 2, \ldots, m.
\]

(4)

where \( r \) is the discount rate, the real after-tax rate of return required by the firm.

Although the firm pays taxes on the rents generated by each asset, the firm can deduct the decline in the value of the asset as an expense. If the present value of the depreciation deductions claimed for tax purposes is equal to the true decline in capacity for each asset, the tax system does not distort the asset mix.

If \( Z_i(t) \) is the fraction of the price of the \( i \)th asset deducted from income in year \( t \) of the asset’s tax life \((M_i)\), the present value of the tax depreciation is \( TZ_i\hat{q}_i \), where

\[
Z_i = \int_0^{M_i} e^{-r(t)+p\theta_i}Z_i(t) dt \quad i = 1, 2, \ldots, m.
\]

(5)

and \( p \) is the rate of inflation. However, in years when the tax depreciation base was reduced by the amount of the investment tax credit, the real value of the tax depreciation deduction is \( T(1 - h\theta_i)Z_i\hat{q}_i \), where \( h \) is the percent of the credit which reduces the depreciation base.

In addition to the depreciation deductions, firms may also be eligible to claim an investment tax credit. If firms claim the credit at the end of the first year of the asset’s service life, the present value of the credit is \( \Theta_i\hat{q}_i \), where

\[
\Theta_i = e^{r(t)+p\theta_i} \quad i = 1, 2, \ldots, m.
\]

(6)

A more realistic rendering of the discount rate shows it as a weighted average of the longrun real after-tax interest rate (external financing) and the longrun real after-tax return to equity (internal financing). Because nominal interest charges are deductible from taxable income, the real cost of external or debt financing \((r_d)\) is

\[
r_d = [r_n(1 - T) - p]/(1 + p)
\]

(7)

where \( r_n \) is the nominal interest rate. After combining the real costs of both equity and debt financing, the real cost of capital or real after-tax discount rate is

\[
r = fr_d + (1 - f)r_e
\]

(8)

where \( f \) is the fraction debt financed, \( r_d \) is the real after-tax cost of debt financing, and \( r_e \) is the real after-tax return to equity \((34)\).

The effects of State and local property taxes on the rental rate can be incorporated directly into the discount rate \((19)\). Because property taxes are generally levied in the current year but payable in the next year and property taxes are deductible from the Federal income tax, equation \((8)\) is recast as

\[
r = fr_d + (1 - f)r_e + [(1 - T)S/(1 + p)]
\]

(9)

where \( S \) is the property tax rate expressed as a percentage of the value of the asset.

Given the market price of the asset, equation \((3)\) is rewritten as

\[
u_i = \hat{q}_i[l - \Theta_i - T(1 - h\theta_i)Z_i]/N_i(1 - T)
\]

(10)

which is the rental rate the firm must charge to earn the required real after-tax rate of return. Increases in the real values of the investment tax credit or tax depreciation deductions resulting from changes in tax laws or reductions in the inflation rate decrease the rental rate. A tax rate reduction decreases the tax on the rents generated by the asset, but also reduces the value of the tax depreciation deductions. Reducing the marginal tax rate can only cause higher rental rates if the real after-tax depreciation deductions are greater than the net of credit purchase price. Such a situation implies a negative implicit rental rate.

The Investment Model

Economists have sought a theoretical framework for the partial adjustment or accelerator model since Nerlove’s early applied work \((29, 30)\). Many economists recognized a gap in econometric theory where an elaborate theoretical structure, which existed for determining the level of an input, was combined with an ad hoc theory of adjustment. Eisner and Strotz developed a more rigorous theory of adjustment by casting the firm in a dynamic optimization framework \((19)\). The present value or net worth maximized by the firm depends on the optimal level of inputs selected by the firm and on the path of the current capital stock to the optimal level.

More recently, Lucas \((26)\), Gould \((15)\), and Treadway \((35)\) have extended the work of Eisner and Strotz.
Although the models differ in their complexity, they all have the same underlying structure postulated by Eisner and Strotz. Each specifies an objective function incorporating factor adjustment costs and a production function. The firm is assumed to maximize net worth over a given time period. Adjustment costs are interpreted either as foregone profits due to shortrun rising supply prices in the capital-supplying industry or as increasing costs associated with integrating new equipment into production (reorganizing production and training workers). These costs vary with the speed of capital adjustments. It is also assumed that the values of the expected input and output prices do not change. This static or stationary expectations assumption is required if the dynamic maximization problem is to be well defined (31). Because expectations are static, the firm adjusts to a fixed target considered to be the long-run equilibrium of neoclassical theory. Given these assumptions, a firm maximizing its present value changes capital stock in a manner similar to that suggested by the accelerator model.

Following Berndt, Fuss, and Waverman (4) and Berndt, Morrison, and Watkins (5), the optimal adjustment paths for the quasi-fixed inputs are derived by incorporating a shortrun restricted profit function into a longrun dynamic optimization framework. The assumptions of competitive input and output markets are maintained. In addition, it is assumed that these competitive real prices are known with certainty and remain stationary over time.

In the usual Marshallian framework the relative fixity of inputs slows adjustment to a new equilibrium position. Immediate adjustment is prevented because certain inputs cannot be changed until a given period of time has elapsed after the original decision to alter the inputs is made. If uncertainty is excluded, then the reason for slower rather than faster adjustment is that it costs the firm more to adjust production more rapidly. Following Eisner and Strotz (10), production factors are characterized as being more or less fixed as a function of the cost of varying the input sooner rather than later.

Such a framework assumes that quasi-fixed inputs can be varied at a cost 
\[ C_i(K) = \hat{q}_i + D_i(K) \] 
where \( I_i \) is the gross addition to the stock of factor \( i \) and \( \delta_i \) is the rate of exponential depreciation. Also, the cost of adjustment is defined as
\[ \hat{C}_i(K) = \hat{q}_i I_i + D_i(K) \quad i = 1, 2, \ldots, m \] (12)

where \( \hat{q}_i \) is the purchase price of asset \( i \), \( D_i(K) \) is a twice-differentiable function, and \( D_i(K) > 0 \). Adjustment costs at the initial time \( t = 0 \) are
\[ \hat{C}_i(0) = \hat{q}_i \delta_i K_i \quad i = 1, 2, \ldots, m \] (13)

this formulation assures constant marginal costs of replacement with increasing marginal costs of net change. Costs are expressed in units of the asset price of the quasi-fixed factors.

Net receipts \( \hat{R}(t) \) can, therefore, be written as
\[ \hat{R}(t) = PG(W, K) - \sum_{i=1}^{m} \hat{C}_i(K) \] (14)

where \( P \) is the unit price of output, \( G(W, K) \) is the Unit-Output-Price (UOP) restricted profit function, \( W \) is a vector of normalized (output price) input prices, and \( K \) is a vector of quasi-fixed capital inputs.
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the Hamiltonian necessary for applying the maximum principle is

\[ H(X,K,\dot{K},y,t) = e^{-r}(G(W,K(t)) - \sum_{i=1}^{m} C_i K_i(t)) \]

\[ + \sum_{i=1}^{m} y_i \dot{K}_i(t) \]

(16)

where \( y_i \) are costate variables, the dynamic equivalent of the Lagrange multipliers of static optimization problems and \( C_i \) is the normalized adjustment cost. Costate variables generally vary through time and are assumed to be nonzero continuous functions of time (18).

Necessary conditions for the maximization of \( H \) require

\[ \frac{G_i'(W,K)}{G_i'(K_i)} - r C_i' + C_i'(K_i) \dot{K}_i = 0 \]

\[ i = 1,2,\ldots,m. \]

(17)

These necessary conditions are assumed sufficient to obtain a maximum. That is, the marginal profit associated with the ith quasi-fixed input equals its marginal cost of adjustment. Equation (17) has a stationary solution \( K^*(P,W,r) \) which is obtained by setting \( K_i = \dot{K}_i = 0 \)

\[ G_i'(X^*(K^*), K^*) - u_i - r C_i'(0) = 0 \]

(18)

The variable \( K^* \) is the steady-state or longrun profit maximizing demand for the vector of quasi-fixed factors obtained by solving equation (18).

These results are linked to the partial adjustment or flexible accelerator literature because the shortrun demand for the quasi-fixed factors can be generated from equations (17) and (18) as an approximate solution in the neighborhood of \( K^*(t) \) (24). The approximate solution is the linear differential system

\[ \dot{K} = B(K^*(t) - K(t)) \]

(19)

where \( B \) is an \( mxm \) matrix. For a single capital input the B matrix reduces to

\[ B = -0.5 (r - \frac{4H''(K^*)}{C''(0)}) \]

(20)

This derivation allows the adjustment coefficient, \( B_i \), to depend on economic forces: the discount rate, the cost of adjustment, the production relationship embodied in the profit function, and the profit maximizing behavior of the firm. If, however, the discount rate is constant and the adjustment cost function \( C(K) \) is linear, then the adjustment coefficient is a constant and equation (19) reduces to the classical fixed accelerator model.

The rate of adjustment of the ith capital good generally depends on the difference between the desired and actual stock for all capital goods. Therefore, the simplest form of the accelerator, equation (19), does not generalize easily. Lucas shows, however, that a sufficient condition for \( B \) to be a diagonal matrix is that the stock of the ith capital good demanded is independent of the prices and stocks of other capital goods (26).

This is a strong assumption, but a necessary one if this theoretical framework is to be extended to multiple capital inputs while maintaining a structure that can be estimated as a closed functional form.

Before the theoretical framework can be estimated, the adjustment equation must be expressed as a difference equation, and functional forms for the profit and cost of adjustment functions must be selected. The accelerator equation is respecified in a discrete form by first assuming that shortrun production is conditional on capital stocks at the beginning of the period. Therefore, capital stock adjustments during the period do not affect production until the following period. Second, the adjustment relationship specified in equation (19) is replaced by

\[ K(t) - K(t-1) = B(K^*(t) - K(t-1)). \]

(21)

A quadratic approximation is used for the profit function because it facilitates estimating the model without placing prior restrictions on the elasticities of substitution (12). The quadratic structure generates linear input demand functions and simple expressions for demand and substitution elasticities. In addition, the optimal paths for capital are globally rather than locally valid because the underlying differential equations are linear (36).

The UOP profit function is specified as a quadratic function of normalized input prices and the level of capital at the beginning of the current period.

\[ \pi = b + b_i W_i + \sum_{i=1}^{m} b_i t K_i \]

\[ + \sum_{i=1}^{n} a_i K_i + 0.5(\sum_{i=1}^{n} b_i W_i^2 + a_i \sum_{i=1}^{m} K_i^2) \]

\[ + 0.5 \sum_{i=1}^{n} \sum_{j=1}^{m} c_i W_i W_j + \sum_{i=1}^{m} \sum_{j=1}^{m} c_i W_i K_j \]

where \( a_i's, b_i's, \) and \( c_i's \) are parameters and \( t \) is technological change.

If adjustment costs are external to the shortrun profit maximization decision, then necessary conditions for
optimal capital adjustment are derived by applying equation (17). The steady-state solution is obtained by setting $K_i = K_i^* = 0$.

$$K_i^* = -(a_i + b_{it} t + \sum_{i=1}^{n} c_{ij} W_i - u_i)/a_{ii} \quad (23)$$

$$i = 1, 2, \ldots, m$$

where $u_i = q_i (r + \delta)$ is the normalized rental rate associated with the $i$th quasi-fixed factor.

The nonlinear adjustment relationship of equation (20) is simplified by assuming $C(K)$ is linear and the discount rate is constant. The difference equation reduces to a fixed accelerator model. There are several motivations for these simplifying assumptions. First, preliminary parameter estimates based on the more complicated nonlinear model lead to dubious parameter values and poor predictive ability. The adjustment coefficient for some of the equations are less than zero. For equations with a logically consistent adjustment process there was little variation in the size of the adjustment rate suggesting that a fixed rate assumption is likely to have little effect on the structure of the estimated equations. Finally, the nonlinear model structure makes it generally difficult to achieve convergence when estimating the model.

The estimated model is obtained by substituting the steady-state solution for capital and the implicit rental rate of capital into the difference equation (21) and appending a stochastic error having classical properties

$$K_i(t) - K_i(t-1) = a_i^* - b_{it}^* t + \sum_{i=1}^{n} c_{ij}^* W_i$$

$$+ B_i^* u_i^* - B_i K_i(t-1) + e_i \quad (25)$$

where $a_i^* = -B_i a_i/\epsilon_{ii}$, $b_{it}^* = -B_i b_{it}/\epsilon_{ii}$, $c_{ij}^* = -B_i c_{ij}/\epsilon_{ii}$, and $B_i^* = -B_i/\epsilon_{ii}$. The original parameters in equation (24) are recoverable because each is identified in equation (25).

**Data**

The analysis uses aggregate time series data for 1955 through 1978. Except for the implicit rental rates, a detailed description of the data is available in Ball (5). The data were aggregated using a discrete Tornquist approximation of a Divisia index. Tornquist price indices are computed first, and then implicit quantity indices are computed by dividing value (revenue or expenditures) by the Tornquist price index.

Labor data were formulated to account for differences in the productivity of different types of workers and changes in quality due to education. Fertilizer data use information on primary nutrient content to account for quality changes. For capital, the separation of price and quantity components of outlays is based on the correspondence between the value of an asset and the discounted value of its services (14). The implicit rental rate or service price depends on the asset price, rate of economic depreciation, service life, tax treatment, and the discount rate. Asset prices, the rate of economic depreciation, and service lives are taken from Ball (5). The tax parameters such as the depreciation method, tax life, and investment tax credit are based on eligibility requirements at the time the asset was purchased. If more than one option was allowable, the method resulting in the lowest rental rate was selected. The marginal ex ante Federal income tax rates developed for this analysis are interpreted as the expected tax rate an investor or firm would pay on an additional dollar of income prior to undertaking any new investment. These ex ante rates are estimated for sole proprietorships from U.S. Department of the Treasury data for 1962-78 (table 1).

Prior to the Revenue Act of 1964, the lowest marginal tax rate applied to all taxable income below $2,000. It was assumed that the appropriate marginal tax rate corresponded to the lowest tax bracket. Therefore, the ex ante marginal tax rate from 1955-61 was 20 percent.
The discount rate is assumed to be a weighted average of the longrun real interest rate (external financing) and the longrun real return to equity (internal financing). Weights were computed from Bureau of Census data (40, 41). Interest rates are those charged by Federal land banks on new farm loans. The longrun rate of return to equity is based on Gertel and Melichar (13, 27).

Estimated Model

A maximum likelihood system estimator was used to capture interequation covariance among the four investment equations. The structure of the equations is given by equation (25). The values of the estimated parameters and their associated asymptotic standard errors are reported in table 2. Predictions from the estimated model closely parallel observed investment behavior for each asset (figs. 1-4). Single equation R²'s and Durbin-Watson statistics are, respectively: long-lived equipment, 0.74 and 1.91; short-lived equipment, 0.78 and 1.66; structures, 0.52 and 2.18; and land, 0.65 and 1.96.

The estimated parameters generate a plausible model structure. The parameters associated with the rental rate for each asset have the expected sign. The adjustment rates are reasonable because they are dynamically stable. The highest rate, 0.78, is associated with land, and the lowest, 0.17, is associated with structures. Increases in normalized variable input prices generally decrease investment for each asset (12 out of 16 parameters). Only energy price increases tend to increase investment.

Optimal levels for each asset class are computed using equation (23). Except for land, the optimal capital stock exceeds the predicted capital stock for nearly every observation (table 3). Predicted stocks of short-lived equipment (1956-61) exceed the optimal levels, but in these cases the difference is less than 5 percent. The predicted stock of land exceeds the optimal level in all years except 1959 and 1973. However, the predicted stock of land never exceeds the optimal level by more than 5 percent.

Table 1—Estimated marginal income tax rates, per farm, 1955-78

<table>
<thead>
<tr>
<th>Year</th>
<th>Adjusted gross income</th>
<th>Taxable income</th>
<th>Marginal income tax rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>1962</td>
<td>4,853.33</td>
<td>1,968.00</td>
<td>20%</td>
</tr>
<tr>
<td>1963</td>
<td>5,033.17</td>
<td>2,129.85</td>
<td>20%</td>
</tr>
<tr>
<td>1964</td>
<td>5,907.53</td>
<td>2,916.78</td>
<td>20%</td>
</tr>
<tr>
<td>1965</td>
<td>6,718.01</td>
<td>3,646.21</td>
<td>19%</td>
</tr>
<tr>
<td>1966</td>
<td>7,028.83</td>
<td>3,935.39</td>
<td>19%</td>
</tr>
<tr>
<td>1967</td>
<td>7,381.25</td>
<td>4,243.12</td>
<td>19%</td>
</tr>
<tr>
<td>1968</td>
<td>8,128.65</td>
<td>4,915.78</td>
<td>19%</td>
</tr>
<tr>
<td>1969</td>
<td>8,633.66</td>
<td>5,370.29</td>
<td>19%</td>
</tr>
<tr>
<td>1970</td>
<td>8,689.38</td>
<td>5,482.44</td>
<td>19%</td>
</tr>
<tr>
<td>1971</td>
<td>9,507.02</td>
<td>5,571.11</td>
<td>19%</td>
</tr>
<tr>
<td>1972</td>
<td>11,404.88</td>
<td>6,694.15</td>
<td>19%</td>
</tr>
<tr>
<td>1973</td>
<td>13,765.56</td>
<td>8,765.56</td>
<td>19%</td>
</tr>
<tr>
<td>1974</td>
<td>14,311.56</td>
<td>9,311.56</td>
<td>19%</td>
</tr>
<tr>
<td>1975</td>
<td>14,626.73</td>
<td>9,626.73</td>
<td>19%</td>
</tr>
<tr>
<td>1976</td>
<td>15,814.81</td>
<td>10,442.59</td>
<td>19%</td>
</tr>
<tr>
<td>1977</td>
<td>14,661.82</td>
<td>11,661.82</td>
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</tr>
<tr>
<td>1978</td>
<td>19,133.01</td>
<td>16,133.01</td>
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</table>

Table 2—Estimated parameters

<table>
<thead>
<tr>
<th>Item</th>
<th>Coefficient</th>
<th>Value</th>
<th>Asymptotic standard error</th>
</tr>
</thead>
<tbody>
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<td>Short-lived equipment</td>
<td>a₁*</td>
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<td>1,060.900</td>
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<td></td>
<td>B₁</td>
<td>.276</td>
<td>.062</td>
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<tr>
<td></td>
<td>B₁*</td>
<td>-14,737.900</td>
<td>4,487.060</td>
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<tr>
<td></td>
<td>b₂₁*</td>
<td>92.410</td>
<td>25.360</td>
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<tr>
<td></td>
<td>c₃₁*</td>
<td>1,807.200</td>
<td>2,161.100</td>
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<tr>
<td></td>
<td>c₃₂*</td>
<td>447.000</td>
<td>768.600</td>
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<tr>
<td></td>
<td>c₃₃*</td>
<td>1,317.880</td>
<td>1,175.500</td>
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<tr>
<td></td>
<td>c₃₄*</td>
<td>784.350</td>
<td>1,044.200</td>
</tr>
<tr>
<td>Long-lived equipment</td>
<td>a₂*</td>
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<td>B₂</td>
<td>.179</td>
<td>.057</td>
</tr>
<tr>
<td></td>
<td>B₂*</td>
<td>-31,168.300</td>
<td>10,022.200</td>
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<tr>
<td></td>
<td>b₂₃*</td>
<td>211.090</td>
<td>58.300</td>
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<tr>
<td></td>
<td>c₄₁*</td>
<td>4,562.330</td>
<td>1,403.200</td>
</tr>
<tr>
<td></td>
<td>c₄₂*</td>
<td>2,108.940</td>
<td>1,177.500</td>
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<tr>
<td></td>
<td>c₄₃*</td>
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<tr>
<td></td>
<td>c₄₄*</td>
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<td>1,725.200</td>
</tr>
<tr>
<td>Structures</td>
<td>a₃*</td>
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<td>3,137.500</td>
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<td></td>
<td>B₃</td>
<td>.168</td>
<td>.154</td>
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<tr>
<td></td>
<td>B₃*</td>
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<td>c₅₁*</td>
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<tr>
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<td>c₅₂*</td>
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<td>c₅₃*</td>
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<tr>
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<td></td>
<td>B₄*</td>
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<td>20,894.400</td>
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<td>b₅₁*</td>
<td>-2,733.740</td>
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<td>c₆₁*</td>
<td>81,387.900</td>
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<td></td>
<td>c₆₂*</td>
<td>32,563.900</td>
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<td>c₆₃*</td>
<td>-84,935.100</td>
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</tr>
<tr>
<td></td>
<td>c₆₄*</td>
<td>38,347.500</td>
<td>3,435.600</td>
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</table>

Note: Coefficient symbols are defined as follows: s is short-lived equipment, l is long-lived equipment, b is structures, t is land, a is labor, c is chemicals, e is energy, and f is feed-seed. All other symbols are defined in equation (25).
Figure 1
Net Investment in Short-Lived Equipment, 1956-78
Billion 1977 dollars

Figure 2
Net Investment in Long-Lived Equipment, 1956-78
Billion 1977 dollars

Figure 3
Net Investment in Structures, 1956-78
Billion 1977 dollars

Figure 4
Net Investment in Land, 1956-78
Billion 1977 dollars
Table 3—Predicted and optimal capital stock, 1956-78

<table>
<thead>
<tr>
<th>Year</th>
<th>Short-lived equipment</th>
<th>Long-lived equipment</th>
<th>Structures</th>
<th>Land</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td>K*</td>
<td>K</td>
<td>K*</td>
</tr>
<tr>
<td>1956</td>
<td>12,144</td>
<td>11,648</td>
<td>31,078</td>
<td>33,387</td>
</tr>
<tr>
<td>1957</td>
<td>11,949</td>
<td>11,436</td>
<td>31,452</td>
<td>33,162</td>
</tr>
<tr>
<td>1958</td>
<td>11,737</td>
<td>11,181</td>
<td>31,984</td>
<td>34,420</td>
</tr>
<tr>
<td>1959</td>
<td>11,667</td>
<td>11,483</td>
<td>32,803</td>
<td>36,557</td>
</tr>
<tr>
<td>1960</td>
<td>11,547</td>
<td>11,233</td>
<td>32,916</td>
<td>33,433</td>
</tr>
<tr>
<td>1961</td>
<td>11,474</td>
<td>11,281</td>
<td>33,075</td>
<td>33,801</td>
</tr>
<tr>
<td>1962</td>
<td>11,726</td>
<td>12,387</td>
<td>33,653</td>
<td>36,302</td>
</tr>
<tr>
<td>1963</td>
<td>12,042</td>
<td>12,874</td>
<td>34,246</td>
<td>36,959</td>
</tr>
<tr>
<td>1964</td>
<td>12,414</td>
<td>13,390</td>
<td>35,068</td>
<td>38,832</td>
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<tr>
<td>1965</td>
<td>12,836</td>
<td>13,943</td>
<td>36,145</td>
<td>41,076</td>
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<td>1966</td>
<td>13,334</td>
<td>14,643</td>
<td>37,570</td>
<td>44,093</td>
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<td>1967</td>
<td>13,755</td>
<td>14,859</td>
<td>38,827</td>
<td>44,583</td>
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<tr>
<td>1968</td>
<td>14,090</td>
<td>14,971</td>
<td>40,056</td>
<td>45,684</td>
</tr>
<tr>
<td>1969</td>
<td>14,129</td>
<td>14,229</td>
<td>40,894</td>
<td>44,730</td>
</tr>
<tr>
<td>1970</td>
<td>14,216</td>
<td>14,445</td>
<td>41,850</td>
<td>46,229</td>
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<tr>
<td>1971</td>
<td>14,554</td>
<td>15,441</td>
<td>43,035</td>
<td>48,459</td>
</tr>
<tr>
<td>1972</td>
<td>14,929</td>
<td>15,916</td>
<td>44,505</td>
<td>51,237</td>
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<tr>
<td>1973</td>
<td>15,888</td>
<td>18,405</td>
<td>47,058</td>
<td>58,748</td>
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<tr>
<td>1974</td>
<td>17,163</td>
<td>20,512</td>
<td>49,193</td>
<td>58,965</td>
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<tr>
<td>1975</td>
<td>17,945</td>
<td>19,998</td>
<td>50,402</td>
<td>55,939</td>
</tr>
<tr>
<td>1976</td>
<td>18,469</td>
<td>19,845</td>
<td>50,948</td>
<td>53,447</td>
</tr>
<tr>
<td>1977</td>
<td>19,071</td>
<td>20,653</td>
<td>51,535</td>
<td>54,224</td>
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<tr>
<td>1978</td>
<td>19,534</td>
<td>20,750</td>
<td>52,498</td>
<td>56,908</td>
</tr>
</tbody>
</table>

Note: K and K* are defined in equations (11) and (18), respectively. K = predicted capital stock. K* = optimal capital stock.

than 1 percent. The optimal capital stock for all assets except land increase from 1956 to 1978: short-lived equipment (78 percent), long-lived equipment (70 percent), structures (63 percent), and land (−18 percent). The growth in stocks of equipment and structures increase at a decreasing rate since the early seventies. 11

Tax Policy Effects

The effects of the investment tax credit, interest deductibility, and the complete set of tax changes instituted since 1954 on net investment and optimal capital stock are assessed for each of the four asset classes. 12 The effects of these tax policies are manifested through changes in the rental rates. The magnitude of the effects is determined by comparing net investment and optimal capital stock under the tax regime prevailing during 1955-78 to three alternative simulations assuming: (1) no investment tax credits, (2) no interest deductibility, and (3) all provisions revert to a pre-1954 tax environment.

Investment Tax Credit

The importance of the tax credit relative to other tax policy changes is that it represents a dollar-for-dollar reduction in tax liability. A tax credit of 7 percent for qualifying plant and equipment investments was first instituted in 1962 and then repealed in 1969. 13 The tax credit was, however, restored in 1971 and increased to 10 percent in 1975. The results from this analysis suggest the investment tax credits of 1962 and 1971 had significant effects on both short- and long-lived equipment investment and, to a lesser extent, on structures.

11This result parallels declines in the rate of measured productivity growth in agriculture beginning in the midseventies.
12The effects of accelerated depreciation on net investment are also examined. The results indicate virtually no effect and are, therefore, not reported.
13In this analysis both short- and long-lived equipment qualify for the investment tax credit. Only crop storage structures beginning in 1962 and unitary livestock structures beginning in 1971 are eligible for the credit. Land does not qualify for the investment tax credit.
This increase in net investment resulting from the tax credit represents about 5.8 percent of the optimal stock of long-lived equipment in 1978. The relatively greater impact on short-lived equipment compared with long-lived equipment represents a bias toward short-lived assets. Short-lived assets are purchased more frequently and, therefore, receive a greater amount of benefit from the credit.

The effects of the tax credit on short-lived and long-lived equipment and structures have the same pattern. The largest effects occur in 1962 and 1971. The smallest effects occur in 1973 and 1974 when high rates of inflation and high output prices diminish the differences between the rental rates with and without the investment tax credits. Also, net investment for both classes of equipment and structures is greater for the "without-credit" simulations in 1969 and 1970 and again in 1973 and 1974. This seemingly anomalous result occurs when there is no difference or only a small difference between the rental rates for simulations with and without the credit. The "anomalous" result is explained by the effect of lagged adjustment on net investment in period t.

The effects of tax policy enter the investment functions through the rental rate and the optimal level of capital stock. Because the optimal capital stock is the steady-state solution to the dynamic optimization problem, tax

### Table 4—Net investment under alternative tax policies, 1956-78

<table>
<thead>
<tr>
<th>Year</th>
<th>Short-lived equipment</th>
<th>Long-lived equipment</th>
<th>Structures</th>
<th>Land</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>K</td>
<td>K&lt;sub&gt;net&lt;/sub&gt;</td>
<td>K&lt;sub&gt;int&lt;/sub&gt;</td>
<td>K&lt;sub&gt;pre&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>Million 1977 dollars</td>
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</tr>
<tr>
<td>1956</td>
<td>-190</td>
<td>-190</td>
<td>-237</td>
<td>-245</td>
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<tr>
<td>1957</td>
<td>-195</td>
<td>-195</td>
<td>-244</td>
<td>-242</td>
</tr>
<tr>
<td>1958</td>
<td>-212</td>
<td>-212</td>
<td>-249</td>
<td>-265</td>
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<tr>
<td>1959</td>
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<td>-70</td>
<td>-100</td>
<td>-107</td>
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<tr>
<td>1960</td>
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<td>-120</td>
<td>-152</td>
<td>-158</td>
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<td>1961</td>
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<td>-74</td>
<td>-92</td>
<td>-92</td>
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<td>578</td>
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<tr>
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<td>309</td>
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<td>593</td>
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<td>1964</td>
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<td>383</td>
<td>170</td>
<td>822</td>
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<td>245</td>
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<tr>
<td>1970</td>
<td>87</td>
<td>251</td>
<td>56</td>
<td>232</td>
</tr>
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</table>

Note: The following symbols are used above:
- K is net investment under 1955-78 tax provisions,
- K<sub>net</sub> is net investment without the tax credit,
- K<sub>int</sub> is net investment without interest deduction,
- K<sub>pre</sub> is net investment under pre-1954 tax provisions.
effects on the optimal capital stock represent the fully adjusted or longrun impact on capital stock. In the presence of the investment tax credit in 1962, the optimal capital stock for equipment is $48.7 billion and $37.2 billion for structures (table 5). Without the tax credit, the optimal capital stocks decrease to $46.2 billion and $37 billion, respectively. By 1978, the optimal capital stock is 5.3 percent higher for total equipment (7 percent higher for short-lived equipment and 4.8 percent higher for long-lived equipment), and 1.3 percent higher for structures.

### Interest Deductibility

The deductibility of interest payments from income was allowed throughout 1955-78 for all of the asset classes. Unlike the investment tax credit, the deductibility of interest payments is not a dollar-for-dollar reduction in taxes, but instead is affected by the firm’s tax rate. The presence of the interest deduction has a significant effect on all assets resulting in net investment increases of $360 million for short-lived equipment, $1 billion for long-lived equipment, $701 million for structures, and $3.5 billion for land.

Although these increases in net investment are less than those caused by the investment tax credit, the interest deduction supplements the credit for much of the period studied. Because the investment tax credit had such a significant impact on rental rates, the importance of the interest rate as a determinant of net investment was overshadowed. Prior to the enactment of the credit in 1962, the interest deduction averted a $213-million drop in net investment in short-lived equipment and an $805-million drop in land. In addition, from 1956-61, the interest deduction increased net investment by $54 million for long-lived equipment and $282 million for structures. Again, in 1969-70, when the investment tax credit was repealed, the deductibility of interest charges became an increasingly important determinant of net investment. The interest deduction increased net investment by $55 billion for short-lived equipment, $137 billion for long-lived equipment, and $98 billion for structures over this 2-year period.

### Table 5—Optimal capital stock under alternative tax policies, 1956-78

<table>
<thead>
<tr>
<th>Year</th>
<th>Short-lived equipment</th>
<th></th>
<th>Long-lived equipment</th>
<th></th>
<th>Structures</th>
<th></th>
<th>Land</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Million 1977 dollars</td>
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<td></td>
<td></td>
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<tr>
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<td>11,181</td>
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<td>11,483</td>
<td>11,181</td>
<td>11,131</td>
<td>36,557</td>
<td>36,556</td>
<td>35,731</td>
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<td>12,387</td>
<td>12,078</td>
<td>12,113</td>
<td>36,302</td>
<td>34,735</td>
<td>35,485</td>
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<td>1963</td>
<td>12,874</td>
<td>12,964</td>
<td>12,564</td>
<td>11,583</td>
<td>36,959</td>
<td>35,383</td>
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<td>1964</td>
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<td>38,832</td>
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<td>38,009</td>
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<tr>
<td>1965</td>
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<td>12,903</td>
<td>13,700</td>
<td>12,584</td>
<td>41,076</td>
<td>39,223</td>
<td>40,381</td>
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<td>1966</td>
<td>14,643</td>
<td>13,702</td>
<td>14,409</td>
<td>13,384</td>
<td>44,093</td>
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<td>13,438</td>
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<td>43,736</td>
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<td>13,519</td>
<td>45,684</td>
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<td>44,759</td>
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<tr>
<td>1969</td>
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<td>14,146</td>
<td>13,853</td>
<td>13,700</td>
<td>44,730</td>
<td>44,730</td>
<td>43,658</td>
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<td>14,445</td>
<td>14,360</td>
<td>14,020</td>
<td>13,899</td>
<td>46,229</td>
<td>46,229</td>
<td>44,970</td>
</tr>
</tbody>
</table>

Note: The following symbols are used above:
- K*[75] is the optimal capital stock under 1955-78 tax provisions,
- K*[57] is the optimal capital stock without the tax credit,
- K*[int] is the optimal capital stock without interest deduction,
- K*[pre] is the optimal capital stock under pre-1954 tax provisions.
During the interim period from 1962-68 and again after 1970, relatively stable real interest rates, coupled with favorable tax treatment and relatively low inflation rates, reduced the impact of the interest deduction on investment. In 1964-65 and during the early seventies, net investment was greater without the interest deduction as the capital stock continued to adjust from impacts in previous periods. Not until the late seventies as high rates of inflation eroded the value of the investment tax credit did the interest deduction have a significant impact on net investment.

The optimal capital stock has also increased over the period studied as a result of the deductibility of interest expenses. In 1956, the optimal capital stock for the equipment categories and for the structure category without the interest deduction was less than 2 percent and for land was less than 0.2 percent smaller than the optimal capital stock with the interest deduction. By 1978, the optimal capital stock without the interest deduction was 2.4 percent smaller for short-lived equipment, 2.7 percent smaller for long-lived equipment, and 1.9 percent and 1 percent smaller for structures and land, respectively. The relatively greater impact of the interest deduction on the optimal capital stock of land emphasizes the importance of the interaction of the investment tax credit and the interest deduction on the optimal stocks of the other asset categories. In addition, unlike the investment tax credit, the interest deduction reduces the rental rate for longer lived assets relative to assets with shorter lives. As interest rates fall, investors are less concerned with committing resources over a longer period of time. Therefore, the demand for longer lived assets increases relative to the demand for shorter lived assets.

Pre-1954 Tax Laws

The pre-1954 scenario captures the impact of all the tax changes occurring since 1954. Under this scenario, tax lives are set equal to economic lives, the tax depreciation method is limited to the straight line method, and no additional first year depreciation or investment tax credit is assumed. Interest expenses, however, are deductible from income for tax purposes. For short-lived and long-lived equipment, net investment and the optimal stock are almost identical to the scenario in which the investment tax credit was not enacted. This reinforces the result that of all the tax changes, the investment tax credit has the greatest impact on molding the structure of the capital stock. However, this does not mean that other tax changes have no impact. Total net investment under the pre-1954 scenario is $625 million less for short-lived equipment, $1.8 billion less for long-lived equipment, and $683 million less for structures without the shorter tax lives, accelerated depreciation methods, and additional first year depreciation option.\(^1\)

The effect of all the tax changes since 1954 have the greatest impact on the optimal capital stock of short-lived equipment. In 1956 the optimal stock of short-lived equipment was 2.3 percent less under the pre-1954 scenario. In 1978, the optimal stock of short-lived equipment was 11.6 percent less under the pre-1954 scenario. From 1956 to 1978 the difference between the optimal level of long-lived equipment and structures and the optimal level under the pre-1954 scenario increased from 2.3 percent to 10.1 percent and from 0.8 percent to 3.1 percent, respectively.

Conclusions

The effects of tax policy on net investment in short-lived and long-lived agricultural equipment, farm structures, and land are examined. The study included three tax alternatives: the investment tax credit, interest deductibility, and the interaction of all new tax provisions promulgated since 1954. The results generally support the Hall and Jorgenson thesis that tax policy is effective in changing the level of investment \(\left(\text{16}\right)\). Nearly 20 percent of net investment in agricultural equipment during the period of 1956-78 is attributed to tax policy. The results also suggest that the investment tax credit was probably the most effective tool in stimulating investment.

The results in this analysis are subject to the static price expectation assumptions implicit in the dynamic optimization of profit as well as the simplified accelerator structure used to estimate the investment system. Furthermore, it is assumed that changes in tax policy are instantaneous and perceived to be permanent. There are good reasons to expect information on new tax measures to diffuse throughout the economy. In addition, tax credits may be temporary and depreciation allowances may increase.

Nevertheless, the weight of this analysis suggests that a significant share of investment in agricultural assets can be attributed to tax policy. To the extent that investment leads to output expansion and induces productivity growth, tax policy and farm commodity programs are contradictory. This contradiction does not

\(^1\)Land was never eligible for the investment tax credit, additional first-year depreciation deduction, or accelerated depreciation methods.
suggest that tax policy is not necessary to achieve tax neutrality or that it may not help alleviate cash flow problems and buoy income, the ultimate objective of farm policy. Attempts to restrict agricultural output are, however, partially offset by investment stimulated by changes in tax policy.

**References**


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