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Farm Machinery Investment and the Tax Reform Act of 1986

Michael LeBlanc, James Hrubovcak, Ron Durst, and Roger Conway

The Tax Reform Act of 1986 significantly changed incentives for investing. This analysis specifically examines how changes in marginal tax rates, depreciation schedules, and the investment tax credit altered the cost of capital and net investment in agriculture. A stochastic coefficients econometric methodology is used to estimate an investment function which is then used to simulate the effects of tax reform. Estimates indicated that relative to prior law, the Tax Reform Act will reduce the capital stock of farm machinery and equipment by nearly $4 billion.

Key words: adjustment, investment, stochastic coefficients, tax reform.

The Tax Reform Act of 1986 was the most comprehensive overhaul of the federal income tax system in 60 years. The Act substantially reduced marginal income tax rates and broadened the tax base by eliminating many of the exclusions, deductions, and credits introduced into the tax code through the years. By broadening the tax base, framers of tax reform legislation sought to more consistently match taxable and economic incomes.

Previous work established that both the timing and magnitude of agricultural capital formation are shaped by provisions of the Federal Income Tax Code (Hardesty, Carman, and Moore; Innes and Carman; LeBlanc and Hrubovcak). This analysis examines how the Tax Reform Act of 1986 altered agricultural investment in machinery and equipment.[1] Specifically, we examine how changes in marginal tax rates, depreciation schedules, and the investment tax credit altered the cost of capital and net investment in agriculture.

An econometric estimate of an investment function is combined with a rental price variable to simulate the effects of changes in tax provisions on the demand for net investment.[2] Changes in important tax provisions are traced by first identifying their effects on the implicit rental rate of capital and then on investment in farm machinery and equipment.

Our analysis, unlike other tax studies, uses a stochastic coefficient econometric methodology (Swamy and Tinsley) to estimate the agricultural investment function. The stochastic coefficient approach allows the signs and magnitudes of the investment function's estimated parameters to vary through time. There are several statistical or econometric reasons for using a stochastic coefficient approach. Parameter variability may be generated by omitted variables (Duffy), incorrect functional form (Rausser, Mundlak, and Johnson), the use of inexact proxy variables, or changing aggregation weights over micro units (Zellner 1962, 1969). In addition, the "true" coefficients may be generated by a time-varying random process.

The most compelling reason for adopting a stochastic coefficients approach, however, is the more intuitive notion that the structure of the economy is always changing. Changes in economic or policy variables result in a new environment that may, in turn, lead to new decisions, institutional arrangements, and microeconomic and macroeconomic structures (Lucas 1976). The importance of parameter variation for the analysis of the effects of tax reform on agricultural investment is assessed by examining the stability of coefficients estimated using a stochastic coefficients formulation.

Tax Policy and Reform

For the past 30 years, tax policy has significantly redefined the economic cost of capital formation. Beginning in 1954, and again in 1962, the Eisenhower and Kennedy administrations sought to "unleash new incentives to economic growth" by allowing for faster amortization of investments, through accelerated

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depreciation and shortened tax lives (*Economic Report of the President*). Investment spending was encouraged in 1962 with the passage of a 7% investment tax credit and again in 1964 when corporate tax rates were reduced.

Since 1964, economic behavior has been shaped by a 10% income tax surcharge (Expenditure Control Act of 1969), the repeal of the investment tax credit and depreciation limits placed on certain assets (Tax Reform Act of 1969), accelerated depreciation and the investment tax credit reinstated (Revenue Act of 1971), an increase in the investment tax credit and reduced corporate tax rates (Tax Reduction Act of 1975), and lower corporate tax rates and reduced capital gains taxation (Tax Reduction and Simplification Act and Revenue Act of 1978). More recently, to mitigate the negative effects of inflation on capital investment while simultaneously stimulating economic growth, the Economic Recovery Tax Act of 1981 further accelerated depreciation, increased the investment tax credit for some assets, and increased the scope and power of the investment tax credit by allowing firms to "sell" investment credits to other firms.

As a result of all these changes, a large number of critics argued the federal income tax laws had become inequitable, inefficient, and irreconcilably complex. The dissatisfaction with the tax code led to a series of proposals to overhaul the tax code to provide a more efficient, equitable, and simple tax system. Some of the better known proposals were introduced by Senator Bradley and Representative Gephardt, Senator Kemp and Representative Kasten, the Reagan Administration, the House Ways and Means Committee, and the Senate Finance Committee. The law which was ultimately enacted, the Tax Reform Act of 1986, was a compromise and combined elements from many of the proposals. The key elements of the Tax Reform Act of 1986 included reduced marginal tax rates, changed depreciation schedules, the elimination of capital gains and dividend exclusions, and elimination of the investment tax credit for most assets.

In 1988, the new tax system had only two tax rates: 15% and 28%.[3] The personal exemption gradually increased to $2,000 in 1989, while the deduction for state and local sales taxes, the spousal deduction, and the capital gains exclusion were repealed. The standard deduction for a joint return increased to $5,000 in 1988. Rate brackets, personal exemptions, and standard deductions continued to be indexed for inflation.

The Act retained a Modified Accelerated Capital Recovery System (MACRS) which divided depreciable property into eight classes: 3, 5, 7, 10, 15, 20, 27.5, or 31.5 year property. Most farm equipment was defined as seven-year property, an increase of two years compared to prior law. An increase in the tax life of farm equipment was offset by increased accelerated depreciation deductions for these assets from 150%, under prior law, to 200% declining-balance. Despite serious proposals to index depreciation deductions for inflation, depreciation deductions continue to be based on historical costs. The investment tax credit was repealed retroactively as of 1 January 1986, one year prior to the effective date for most changes under the Tax Reform Act.

Implicit Rental Rates

The effects of changes in federal income tax policy on investment can be captured through changes in implicit rental rates on machinery and equipment (Hall and Jorgenson). Implicit rental rates are developed from the equality between the purchase price of the asset and the present value of the future rents generated by the asset:

$$q = \sum_{t=0}^{L} \frac{[Un_t(1 + \pi)^t]}{[1 + i]^t}, \tag{1}$$

where q is the purchase price of an asset when new, L is the service life, U is the rental rate expressed in terms of an undepreciated unit of capital, n_t is the real capacity of the asset available in year t of its service life, π is the inflation rate, and i is the nominal before-tax interest rate.[4]

When capital income is subject to an income tax, the right side of equation (1) is modified to include the effects of the tax. The modification includes the present value of the after-tax rents generated by the asset and the present value of the tax savings produced by the investment tax credit and the tax depreciation deductions. In addition, the nominal before-tax interest rate must be adjusted to reflect the tax deductibility of interest expenses. If it is assumed the firm's marginal tax rate remains constant as T, equation (1), respecified to accommodate the tax system, becomes

$$q = (1 - T)UN + \Theta q + T(1 - h\theta)Zq, \tag{2}$$

where $(1 - T)UN$ is the present value of the future rents, Θq is the present value of the investment tax credit, and $T(1 - h\theta)Zq$ is the present value of the future tax depreciation deductions.[5]

If price expectations and the marginal tax rate are constant, the rental rate is constant over the life of

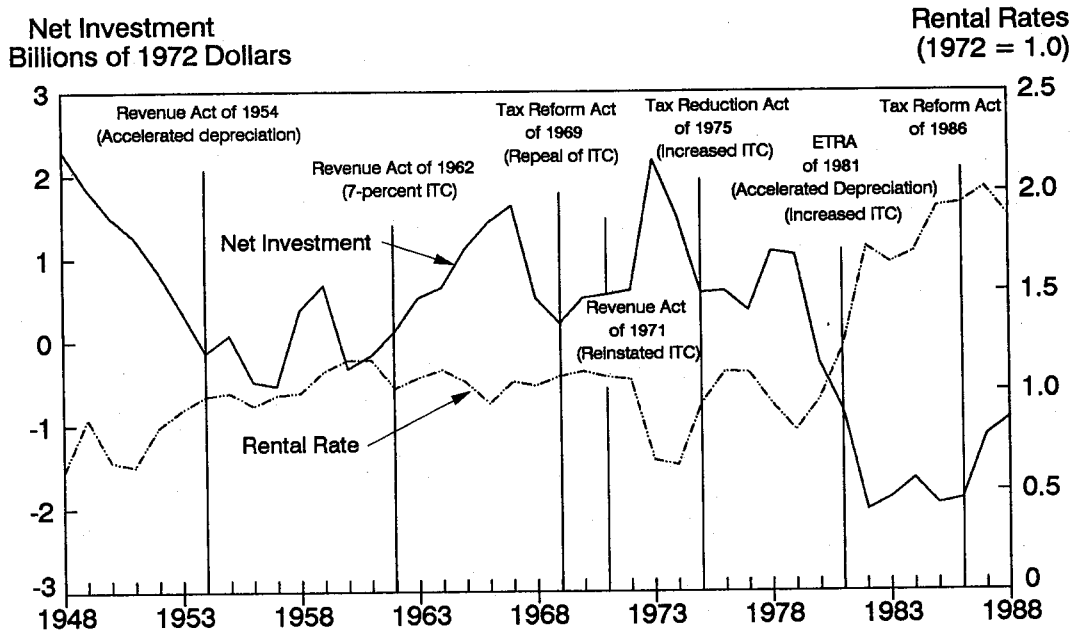

Figure 1. Net investment, rental rates, and changes in tax laws

the asset. The productive capacity of the asset, however, declines over the life of the asset so that

$$N = \sum_{t=0}^{L} \frac{n_t(1 + \pi)^t}{[1 + i(1 - T)]^t}. \tag{3}$$

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 depreciation deductions claimed for tax purposes is equal to the true decline in capacity for each asset, tax depreciation allowances do not distort the asset mix. If z_t is the allowable tax depreciation rate in year t of the asset's tax life (M), the present value of tax depreciation deductions is TZq, where

$$Z = \sum_{t=0}^{M} \frac{z_t}{[1 + i(1 - T)]^t}. \tag{4}$$

In addition to the depreciation deduction, firms also may 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 Θq, where

$$\Theta = \frac{\theta}{[1 + i(1 - T)]} \tag{5}$$

and θ is the nominal rate of the investment tax credit.

If the purchase price of the asset is known, equation (2) can be rewritten as

$$U = \frac{q[1 - \Theta - T(1 - h\theta)Z]}{N(1 - T)}, \tag{6}$$

which is the rental rate the firm must charge to earn some required real after-tax rate of return.

Figure 1 describes the relationship between net agricultural investment, the capital rental rate, and major tax changes which have occurred during the last 40 years. Movements in the rental rate closely parallel movements in net investment, particularly since 1979. The rental rate, by linking tax policy changes with changes in interest rates and prices, provides a valuable connection between the effects of

tax policy and net investment. A simple comparison between net investment and key tax policy changes suggests no direct relationship. Comparing the rental rate with net investment suggests a strong but not transparent relationship.

The Theoretical Investment Model

To formalize the relationship between net investment and the rental rate, we adopt a partial adjustment framework. This form has been used successfully in other empirical work and is based on comparatively well-developed theoretical foundations.[6]

The underlying structure includes an objective function incorporating factor adjustment costs and a production function.[7] The firm maximizes net worth over a given period. Adjustment costs are interpreted as either foregone profits because of short-run rising 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 output prices do not change. This "myopic" or stationary expectations assumption is required to define the dynamic maximization problem. Because expectations are static, the firm adjusts to a fixed target considered to be the long-run equilibrium of neoclassical theory.

The optimal adjustment path for a quasi-fixed input is derived by incorporating a short-run restricted profit function into a long-run dynamic optimization framework. The assumptions of competitive input and output markets are maintained. In addition, it is assumed that competitive real prices are known with certainty and remain stationary over time.

It is assumed that a quasi-fixed input can be varied at cost $C(\dot{K})$, where $\dot{K}$ equals dK/dt and

$$\dot{K} = I - \delta K, \tag{7}$$

where I is the gross addition to the stock of the quasi-fixed factor and δ is the rate of exponential depreciation.

If $C(\dot{K})$, the adjustment cost function, is normalized on output price, then normalized net receipts are written as

$$R(t)/P = G(W, K) - C(\dot{K}), \tag{8}$$

where $G(W, K)$ is the unit-output-price (UOP) restricted profit function, P is the unit price of output, K is a quasi-fixed capital input, and W is a vector of input prices normalized on output price.[8]

If the firm requires a rate of return, r, the present value of net receipts (V) at time $t = 0$ is

$$V_0 = e^{-rt} \int_0^{\infty} R_t \, dt, \tag{9}$$

where R_t is the nominal value of net receipts in time t.

The firm's long-run dynamic problem is to choose time paths for the variable input, $X(t)$, and the quasi-fixed input, $K(t)$, to maximize V_0 given K_0, $X(t)$, and $K(t)$ are all greater than zero. That is, because the restricted profit maximization condition assumes short-run optimizing behavior conditional on the price of the variable input, output prices, and the capital stock, the optimization problem facing the firm is to find the time paths of $X(t)$ and $K(t)$ among all the possible input/output price combinations, thereby maximizing the present value of net receipts.

If static price expectations are assumed and profits and adjustment costs are normalized on output price, then the Hamiltonian necessary for applying the maximum principle is

$$H(X, K, \dot{K}, y, t) = e^{-rt}\{G[W, K(t)] - C[\dot{K}(t)]\} + y\dot{K}(t), \tag{10}$$

where y is a costate variable.

A solution to equation (10) is linked to the partial adjustment and flexible accelerator literature because the short-run demand for the quasi-fixed factor can be generated as an approximate solution in the neighborhood of K_t^*, which is the steady-state, or long-run, profit maximizing demand for the quasi-fixed factor in time t (Lucas 1967). The approximate solution is the linear differential equation

$$\dot{K}_t = \beta(K_t^* - K_t), \tag{11}$$

where β is an adjustment coefficient. In its most general form, β is variable and depends on economic forces. A simpler adjustment relationship which enhances econometric tractability is derived by assuming $C(\dot{K})$ is linear and the discount rate is constant. The differential equation reduces to a fixed accelerator model.

The Empirical Investment Model

Before the theoretical framework can be econometrically 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 short-run 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 (11) is replaced by

$$K_t - K_{t-1} = \beta[K_t^* - K_{t-1}]. \tag{12}$$

A quadratic approximation is used for the profit function because it facilitates estimating the model without placing a priori restrictions on the elasticities of substitution (Fuss, McFadden, and Mundlak). 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 (Treadway 1974).

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:

$$\Pi = b + \sum_{i=1}^{n} b_i W_i + a_k K + 0.5\left[\sum_{i=1}^{n} b_{ii} W_i^2 + aK^2\right] + \sum_{i=1}^{n}\sum_{j\neq i}^{n} b_{ij} W_i W_j + \sum_{i=1}^{n} c_i W_i K, \tag{13}$$

where the as, bs, and cs are parameters and W_i represents normalized variable input prices.

If adjustment costs are external to short-run profit maximization and the UOP profit function is given by equation (13), then the necessary conditions for maximizing the present value of profit imply an optimal steady-state capital stock of the general form

$$K^* = \frac{-\left(a_k + \sum_{i=1}^{n} c_i W_i - U\right)}{a}, \tag{14}$$

where U is the normalized rental rate.

The estimated model is obtained by substituting the steady-state solution for capital, equation (14), and the implicit rental rate of capital, equation (6), into the difference equation (12) and appending a stochastic error with assumed classical properties.

For profit maximizing firms, the optimal capital stock is

$$K_t^* = \alpha_k + \sum_{i=1}^{n} \alpha_i W_{it} + \alpha_u U_t, \tag{15}$$

where $\alpha_k = -a_k/a$, $\alpha_i = -c_i/a$, and $\alpha_u = 1/a$. The investment model is then expressed as

$$K_t - K_{t-1} = \beta_0 + \sum_{i=1}^{n} \beta_{iw} W_{it} + \beta_u U_t + \beta_k K_{t-1}, \tag{16}$$

where $\beta_o = \beta\alpha_k$, $\beta_i = \beta\alpha_i$, $\beta_u = \beta\alpha_u$, and $\beta_k = -\beta$.

Data

Our analysis uses aggregate time-series data for 1948–88. Net additions to the stock of farm machinery are explained by the normalized prices of agricultural chemicals, energy, labor, land, the implicit rental rate of capital, and the lagged capital stock. Variable input prices and the rental rate of capital are normalized on an index of agricultural output prices. The prices-received index is an aggregate index of all farm products and includes payments received through agricultural commodity program participation.

A detailed description of the prices for chemicals, energy, labor, and output is available in Ball. The price 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. Land prices [U.S. Department of Agriculture, Economic Research Service (USDA/ERS) 1985] measure the value of land and buildings for all farmland.

Implicit rental rates (U) for tractors and long-lived farm equipment are estimated separately and then aggregated into a single rental rate for farm machinery. Rental rates for each category are functions of the price of assets, service lives, rates of capacity depreciation, the tax treatment of assets in each category, and discount rates.

A single price index series for both farm machinery categories is from the U.S. Department of Commerce's Bureau of Economic Analysis (BEA) capital stock study. The service lives for each equipment category are 85% of the depreciation lives specified in *Bulletin F*. The service lives for tractors and long-lived equipment are nine and 13 years, respectively. The rate of economic depreciation for each category is determined using the double-declining balance depreciation method where the capacity of assets in the ith category in year t is represented as

$$n_{it} = \left[1 - \left(\frac{2}{L_i}\right)\right]^{t-1} \qquad i = 1, 2 \tag{17}$$

for $1 \leq t \leq L_i$, and $n_{it} = 0$ for $t \geq L_i$.

The tax treatment of each asset category, using allowable tax depreciation methods and tax lives, is based on the amount of tax saving over the service life of an asset. Before 1955, tax depreciation allowances were limited to the straight-line rate, and tax lives were set equal to averages of *Bulletin F* lives. During 1955–80, assets in each category were depreciated under the sum-of-years' digits method. In 1962, the minimum allowable tax lives were shortened to 10 years for tractors and long-lived equipment. In 1971, the asset depreciation range (ADR) system was introduced, and the allowable tax lives were reduced. The tax lives of tractors and long-lived equipment fell from 10 to eight years, respectively. In 1981, the Economic Recovery Tax Act introduced the Accelerated Cost Recovery System (ACRS), allowing faster depreciation and reducing the tax lives for tractors and long-lived equipment to five years.

The marginal *ex ante* federal income rates are interpreted as the expected tax rates an investor or firm would pay on an additional dollar of income before undertaking a new investment. Farm income data suggest farmers fell into the lowest marginal income tax bracket prior to 1962. The *ex ante* marginal income tax rate from 1955–61 was, therefore, 20%. Rates from 1962–79 were estimated for farm sole proprietorships using Treasury Department data (U.S. Department of the Treasury). Post-1979 estimates of marginal income tax rates use actual statutory tax brackets but employ USDA data for on-farm and off-farm income as proxies for Internal Revenue Service taxable income.

All capital purchases are assumed to be debt financed. Nominal before-tax interest rates are rates charged by federal land banks on new farm loans (USDA, National Agricultural Statistics Service). An aggregate index of stock tractors and long-lived equipment was developed from USDA estimates of farm capital purchases (USDA/ERS 1989). Stock estimates were converted to constant dollars by deflating with price indexes from the BEA capital stock study. The constant dollar investment series was depreciated with the appropriate service lives to estimate a constant dollar machinery stock using the perpetual inventory method.

The Estimated Model

A first-order variant of the generalized ARIMA stochastic coefficients process model developed by Swamy and Tinsley is used to estimate the investment model [equation (16)] for 1948–88. As indicated above, net investment is specified as a linear function of the normalized prices of agricultural chemicals, energy, labor, land, and the capital rental rate and lagged capital stock. Because the parameters in the investment equation are assumed to be time varying, the investment model is written

$$K_t - K_{t-1} = \beta_{0t} + \sum_{i=1}^{n} \beta_{it} W_{it} + \beta_{ut} U_t + \beta_{kt} K_{t-1}, \tag{18}$$

where β_{0t}, β_{it}, β_{ut}, and β_{kt} are time-varying parameters which take the general form

$$\beta_t = \bar{\beta} + e_t \tag{19}$$

$$e_t = \Phi e_{t-1} + v_t \tag{20}$$

$$E(v_t) = 0 \tag{21}$$

$$E(v_t v_s') = \Delta_v \text{ if } t = 0 \wedge 0 \text{ otherwise}, \tag{22}$$

where, for the model considered here, β_t, $\bar{\beta}$, e_t, and v_t are 7×1 vectors, and Φ and Δ_v are 7×7 matrices.

Table 1. Parameter Estimates and Associated Statistics for the Stochastic Coefficient Investment Model

Parameter	Coefficient	Asymptotic Standard Error	Asymptotic t-Statistic
Intercept	5,989.0	1,035.3	5.785
Land Price	2,421.5	1,320.5	1.834
Labor Price	1,646.2	1,156.0	1.424
Chemical Price	613.3	616.5	0.995
Energy Price	−2,364.4	1,021.5	−2.315
Rental Rate	−3,449.5	613.2	−5.626
Lagged Stock	−0.17621	0.0336	−5.244

Note: Parameter estimates are mean values conditioned on the estimates (second iteration) of Δ_v and Φ. Equation (18) was used to generate the parameter estimates.

Parameters are composed of a fixed component, $\bar{\beta}$, and a stochastic component, e_t, which follows a first-order autoregressive process defined by equation (20). Equations (19)–(22) represent a special case of a more general variable coefficient specification which potentially allows the explicit modeling of structural change for "simultaneous equations" complications, and more general specifications of the error processes (Swamy and Tinsley).

The mean values for the estimated stochastic coefficients with associated asymptotic statistics are presented in table 1. The values of the asymptotic t-statistic for the intercept, land price, energy price, rental rate, and lagged capital stock variables exceed or approach two.[9] Parameter signs suggest a plausible model structure and are consistent with a partial adjustment interpretation. Predictions of net investment for 1948–88 using mean parameter estimates also lend credibility to the model's structure (fig. 2) as does a five-year out-of-sample forecast exercise (table 2) showing reasonable net investment forecasts during a period of significant policy changes.[10]

The logic of the parameter estimates is clearly illustrated by comparing the historical movements of net investment with input prices and capital rental rates (fig. 3). The close relationship between the variables is most evident from 1960–88. The sharp decline of relative input prices in 1973–74 is coincident with a spike of increased investment. The precipitous decline of net investment in the post-1979 environment closely mirrors large increases in relative energy prices and capital rental rates. Relative land prices partially offset the combined effects of rising energy prices and capital rental rates.

Our parameter estimates indicate changes in net investment are largely explainable by changes in normalized energy prices, land prices, and capital rental rates. If the parameter estimates are standardized by multiplying by the standard deviation of the associated exogenous variable and dividing by the standard deviation of net investment, then it is possible to order the regressors in terms of the importance of their effect on investment.[11] This computation weights the size of the estimated coefficient by the magnitude of historical variations in the endogenous and exogenous variables. Such an ordering indicates land price (1.14), rental rate (−1.12), energy price (−.96), and lagged capital stock (−.74) are the most important determinants of net investment, and the wage (.51) and chemical price (.13) are the least important.

Table 2. Forecast Evaluation Statistics for 1984-88

Year	Actual Investment	Forecasted Investment
	Millions of 1972 Dollars	
1984	−1,794	−1,443
1985	−2,099	−2,965
1986	−2,039	−2,184
1987	−1,280	−2,290
1988	−1,074	−1,298

Root Mean Square Error = 626.99
Mean Absolute Percentage Error = 33.55%

Note: Mean value for net investment during 1984–88 was −1,657.2.

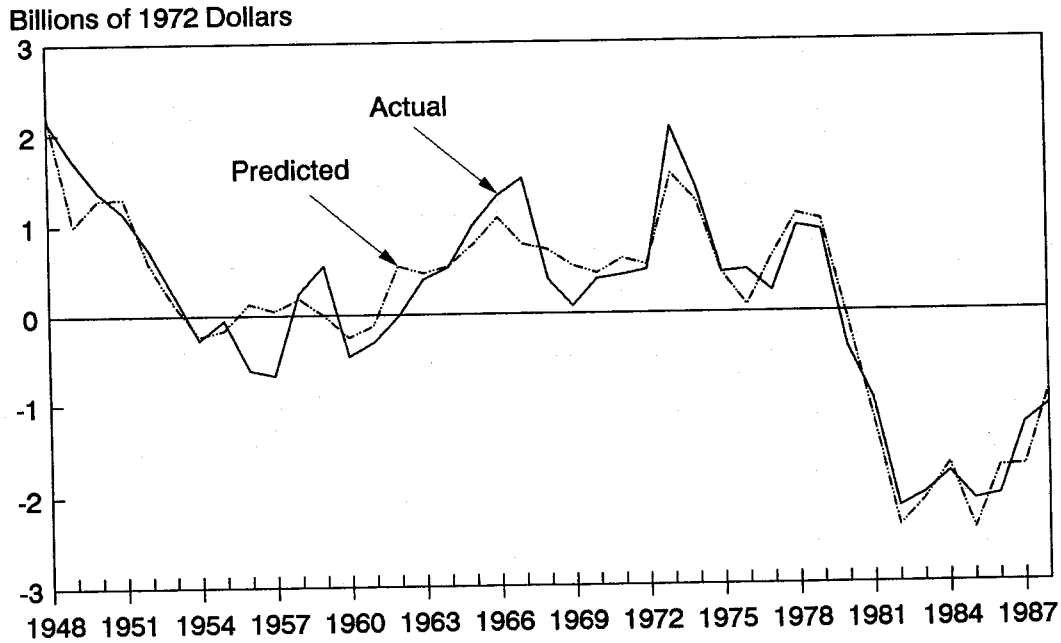

Figure 2. Actual and predicted net investment

Increases in normalized land prices increase net investment in machinery and equipment. If land prices increase 10% over aggregate output prices and all other effects are constant, then net investment in machinery and equipment is estimated to increase $260 million in the short run (one year). The fully adjusted long-run effect is a $1.5 billion increase. A neoclassical interpretation argues that the strong investment stimulus is generated by the substitution of machinery and equipment for land in the aggregate production function. An alternative explanation is that the strong effect reflects the importance of land

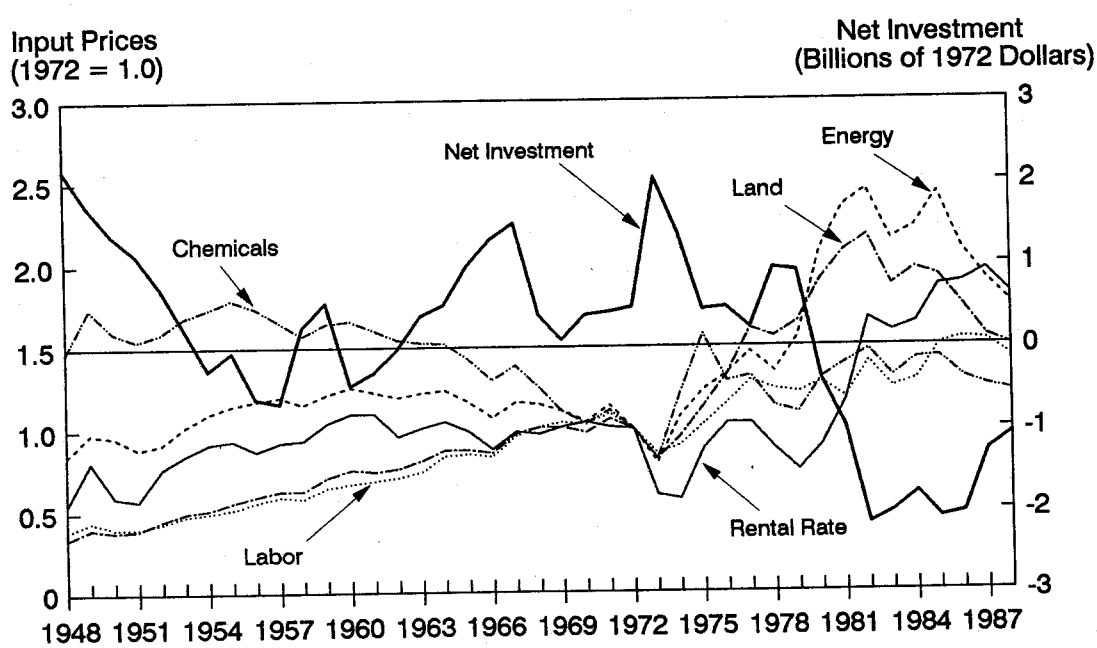

Figure 3. Normalized input prices and net investment

as a source of financial capital and a measure of farm well-being. Capital gains associated with higher land values provide farmers collateral for purchasing machinery and equipment.

Changes in the rental rate and energy prices are nearly as important as changes in relative land prices for determining the rate of net investment. Unlike land prices, however, increases in the capital rental rate and increases in energy prices decrease net investment. It is worth reemphasizing that changes in tax policy are manifested through changes in the capital rental rate. In addition, the large effect of changes in normalized land prices on net investment historically have been offset by increases in the capital rental rate and energy prices. A 10% increase in the capital rate is estimated to decrease short-run investment by $360 million and machinery and equipment stocks by about $2.2 billion. A 10% increase in energy prices decreases short-run net investment by an estimated $320 million and the capital stock by about $1.9 billion.

The mean parameter estimates (table 1) demonstrate the importance of land prices, rental rates, and energy prices for determining net investment. Small variances through time suggest overall parameter stability (fig. 4). Parameter stability is somewhat surprising given the significant amount of technology and policy change that has occurred from 1950–88 (fig. 1). The coefficients of variation for all the parameters, excluding the parameters associated with lagged capital stock and chemical prices, are small.[12] The coefficients vary symmetrically around mean values. The most important parameter for our analysis of the Tax Reform Act is the rental rate parameter. This parameter also shows little variability and no apparent historical pattern or evidence of being affected by changes in policy.

The parameter associated with lagged capital stock shows the greatest variability. Coefficient values range from a high (absolute value) of nearly .21 in 1957 to a low of about .12 in 1949 (fig. 4). Its coefficient of variation is .40. No clear structural explanation can be offered for the pattern of variation. An alternative rendering of the partial adjustment model which allows the adjustment parameter to depend on economic forces suggests the adjustment parameter is a nonlinear function of the discount rate, the cost of adjustment, and the relative profitability of the investment decision.[13] Highly profitable capital investment opportunities are pursued more quickly (adjustment to optimal levels is faster) than less lucrative opportunities. Exploratory regressions of the adjustment coefficient on a variety of economic variables, including interest rates and income measures, revealed no substantive relationship.

The presence of only modest parameter variability suggests fixed coefficient estimates are a reasonable alternative to the more general stochastic specification of the partial adjustment model.[14] Even when there is little parameter variation, however, the stochastic coefficient estimator differs from the fixed coefficient approach because assumptions regarding the variance-covariance matrix differ. Fixed coefficient and stochastic coefficient parameter estimates may, therefore, greatly differ.

Effects of Tax Reform

Specific provisions of the Tax Reform Act of 1986 as well as the combined effects of these provisions are examined by linking the estimated investment function with implicit rental rates. Estimates of implicit rental rates for farm machinery under prior law and key provisions of the Tax Reform Act of 1986 are provided in table 3.

The rental rates are calculated using equation (6). Beginning in 1987, the first year all provisions were effective, rental rates increased dramatically over prior law. Eliminating the investment tax credit had the most significant effect on implicit rental rates and therefore on net investment and capital accumulation. Eliminating the credit increased the rental rate on farm machinery by 11% over prior law. Changes in rental rates caused by the depreciation provisions were nearly equal to the changes caused by the new marginal tax rates (table 3).

Net Investment

Estimated net investment for 1987 and 1988 under prior law is compared with three sets of simulations to isolate the effects of the key provisions of the Tax Reform Act. The first simulation alters the rental rate by eliminating the investment tax credit. The second simulation captures changes in tax lives and tax depreciation allowances after eliminating the investment tax credit. The third accounts for new depreciation provisions, eliminates the credit, and incorporates lower marginal tax rates.[15]

All simulations are conducted in two steps. First, parameter values for 1987 and 1988 are computed.[16] These stochastic parameters are then combined with implicit rental rates to determine net investment and the capital stock. Net investment and the capital stock change due to the action of the lagged capital stock on the demand for net investment. Because the partial adjustment model contains this dynamic

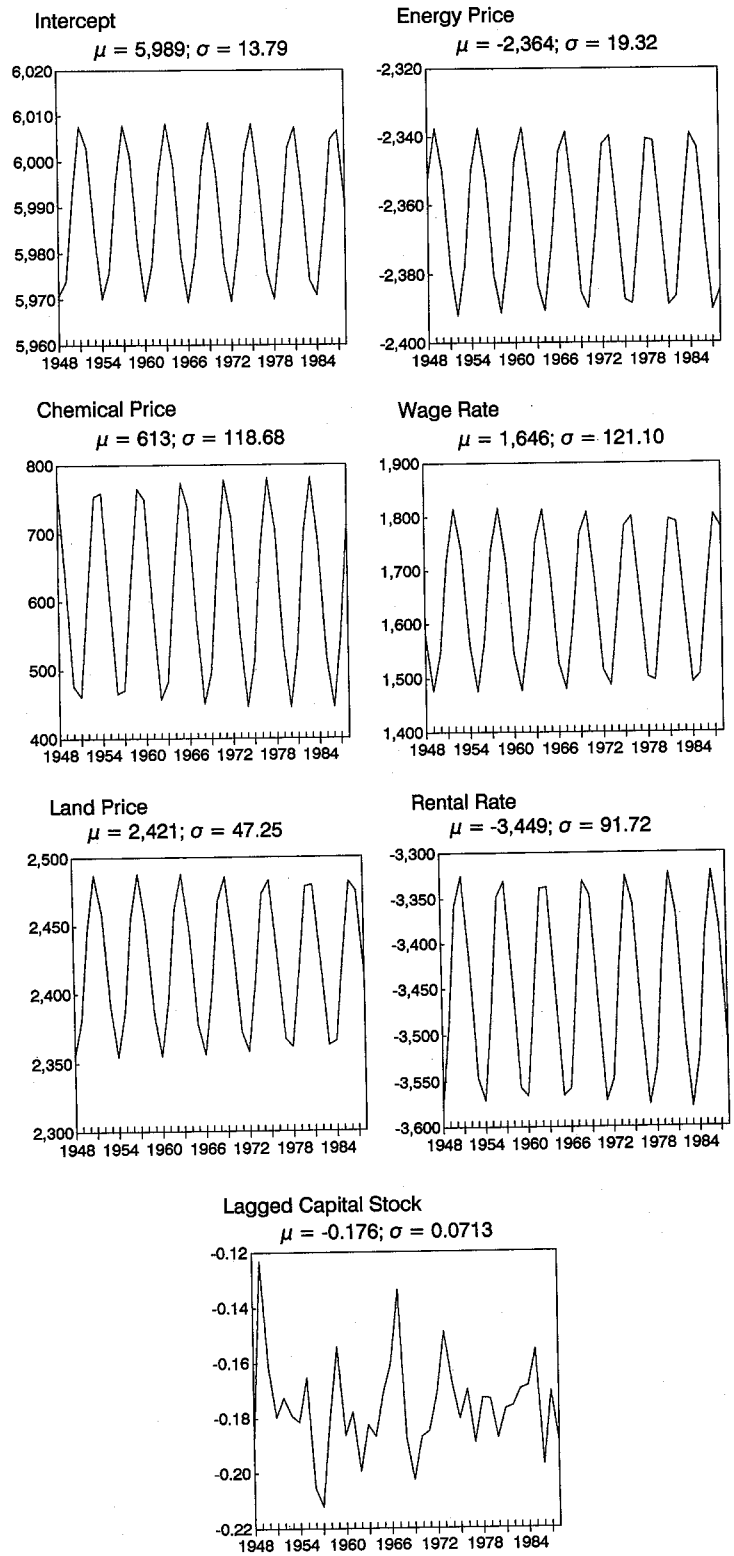

Figure 4. Estimated coefficients, 1948-88

Table 3. Cumulative Effects of the Tax Reform Act on Implicit Rental Rates for Farm Capital

Tax Provision	Rental Rate[a]	Incremental Percent Change
Prior Law	.2272	—
Eliminate the Investment Tax Credit	.2526	11.1
Modified Accelerated Cost Recovery System	.2546	0.8
New Marginal Tax Rates	.2560	0.6
Overall Impact	.2560	12.7[b]

Note: Specific effects are estimated by first eliminating the investment tax credit, then adding the Modified Accelerated Cost Recovery System, and finally introducing the new marginal tax rates.
[a] Rental rates are expressed per $1 of additional investment.
[b] Overall change from prior law.

element, lagged capital stock as well as the rental rate vary among simulation scenarios. All other exogenous variables are constant among scenarios.

Under the Tax Reform Act, the implicit rental rate of capital increases and net investment decreases relative to prior law (table 4). A higher overall rental rate in 1987 and 1988 means the Tax Reform Act reinforced the unfavorable agricultural market conditions and further depressed agricultural investment. Even under prior law, net investment in equipment and machinery is estimated to be negative. Capital expenditures on equipment and machinery are insufficient to offset reductions in capital stock due to depreciation.

Changes promulgated under the Tax Reform Act lead to deeper and more prolonged simulated declines in net investment. Net investment is estimated to be $589 million lower in 1987 and $417 million lower in 1988 than would occur under prior law (table 4). The almost $200 million difference between 1987 to 1988 reflects the dynamic effect of lagged capital stock on net investment. Change in the rental rate between the two years is small. The large relative effect in 1987 results from the largest absolute adjustment occurring in the first year.

The overall effects of the provisions of the Tax Reform Act are decomposed to isolate the effects of new depreciation provisions, eliminating the investment tax credit, and changing the marginal tax rate. Eliminating the tax credit accounts for 89% of the decline in investment associated with tax reform.[17] The tax credit is most prominent because it is a dollar-for-dollar reduction in tax liability. Removing the investment tax credit accounts for $522 million of the $589 million difference between investment under the Tax Reform Act and prior law in 1987 and $372 million of the $417 million in 1988. An additional decrease in net investment of $40 million in 1987 and $24 million in 1988 results from adopting the new depreciation rates and tax lives introduced by the Tax Reform Act. Subsequent adoption of the new marginal tax rates causes an additional decline in net investment by $27 million in 1987 and $21 million in 1988 (table 4).

The decline in net investment caused by the new marginal tax rates is somewhat surprising because the marginal tax rate decreases under the Tax Reform Act, from 22% to 15%. The decline in the marginal tax rate increases after-tax income but reduces the value of interest and tax depreciation deductions.[18] The level of debt financing will, therefore, also affect investment over the simulation period. If farmers

Table 4. Changes to Net Investment from Provisions of the Tax Reform Act of 1986 (Millions of 1972 Dollars)

Year	Eliminate Investment Tax Credit	Modified Accelerated Cost Recovery	New Marginal Tax Rates	Tax Reform Act
1987	−522	−40	−27	−589
1988	−372	−24	−21	−417

Note: Changes are changes from prior law.

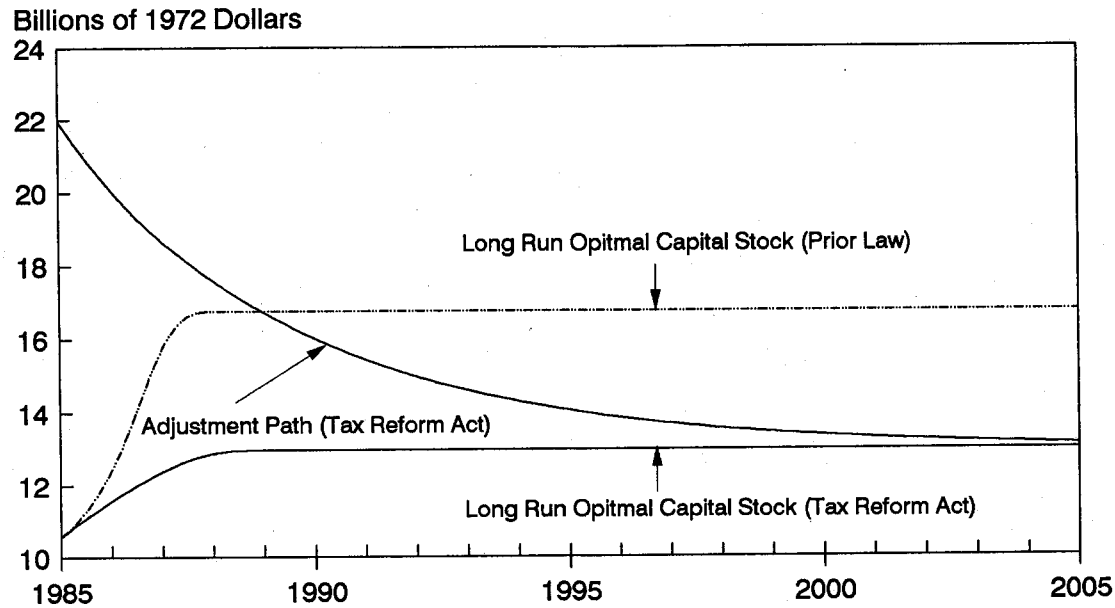

Figure 5. Adjustment to optimal capital stock

reduce the level of debt financing or before-tax interest rates fall as a result of the provisions in the Tax Reform Act, the decline in net investment would be offset.

Optimal Stock

The optimal capital stock is the steady-state solution to the dynamic optimization problem given in equation (15). Tax effects on the optimal capital stock reflect the fully adjusted or long-run impact on capital. Tax reform significantly decreases the optimal capital stock for agricultural equipment and machinery. The comprehensive package of tax reform provisions examined here leads to short-run net investment changes in the hundreds of millions of dollars. The long-term effect on optimal capital stock is estimated to be nearly $4 billion or nearly a 25% reduction from prior law (fig. 5). An estimated adjustment rate of about 18% means relatively slow adjustment. The largest adjustment occurs in the near term, with about 80% adjustment by 1990 and over 90% adjustment by 1995. The adjustment path assumes no new shocks to the system.

A $4 billion or 25% estimated decrease in the equipment and machinery capital stock is consistent with other studies. Schink and Urbanchuk, for example, estimate total agriculture sector investment declines of nearly 10% or over $6 billion for the period 1986–93.[19] In an earlier study, LeBlanc and Hrubovcak estimate that nearly 20% of net investment in agricultural equipment during the period 1956–78 is attributable to major changes in the treatment of interest deductibility, depreciation, tax rates, and investment tax credits. Our $4 billion estimate, while not directly comparable to the results from these studies, offers an estimate of agricultural tax effects of a similar magnitude.

Summary and Conclusions

Examining how agricultural investment is affected by tax reform provides decision makers, in government and business alike, a glimpse of the future agricultural capital infrastructure. Agricultural investment decisions take on added importance given the recent deflationary environment in the agricultural economy. Investment decisions reflect or are indicators of agricultural stress and readjustment. While policy makers tend to be interested in commodity prices and production, important insights about the future of both are implied by changes in the capital stock. A smaller capital stock will lead to less production and higher prices in the future.

Our study adds to the growing list of analyses which provide evidence of the importance of tax policy for shaping agriculture. The Tax Reform Act reinforces current trends in net investment and capital accumulation. The Tax Reform Act led to higher rental rates and less investment than under prior law. Negative net investment means capital expenditures are insufficient to maintain the current level of capital stock; therefore, the capital stock erodes. Although investment decisions are driven primarily by expectations of future profitability, the Tax Reform Act put additional pressure on agricultural readjustment through changes in the capital stock. Our estimates indicate the Tax Reform Act will reduce the capital stock of machinery and equipment by nearly $4 billion.

Within the Tax Reform Act, the most controversial provision is the repeal of the investment tax credit. The repeal of the credit accounts for the bulk of the expected decline of agricultural investment resulting from tax reform. Although no reasonable change in the Tax Reform Act is likely to alter the current decrease in agricultural capital, reinstatement of the credit would provide incentive for some operators to expand. The effects of tax reform legislation will not be known for several years. However, the results of this analysis suggest important implications for agriculture because the Tax Reform Act of 1986 increases the cost of owning capital and thereby decreases the demand for capital.

Like previous studies, a rental rate in conjunction with an econometrically estimated investment function is employed to analyze the effects of tax policy on investment. Unlike other studies, however, a stochastic coefficient approach is used to estimate the structure of the underlying investment model. The varying parameter approach is meant to combat a multitude of econometric difficulties and capture structural change in the investment function. The danger inherent in failing to account for structural change is to incorrectly estimate the effect of policy change due to the application of the "incorrect" structural model. Our results suggest the overall structure of the investment model to be relatively stable, although variability in the parameters associated with chemical prices and the lagged capital stock is evident. For the time period and structural model used in this analysis, tax simulations from either a stochastic or fixed coefficient approach generate results of the same order of magnitude.

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Notes

[1] Machinery and equipment comprise approximately 50% of depreciable farm assets (USDA/ERS 1989). Machinery and equipment include tractors, harvesters, and combines, but exclude trucks and structures.

[2] Our analysis follows the general methodological approach adopted by Hall and Jorgenson.

[3] The phase-out of the benefits of the 15% bracket and the personal exemption allowance through the use of a 5% surtax produced an effective marginal rate of 33% for high-income taxpayers. This provision has no impact on our analysis since most farmers fall in the 15% bracket.

[4] Equivalent rental rates can be derived from a dynamic profit optimization framework by constraining the rate of change of the flow of capital services to be proportional to the flow of net investment (Jorgenson; Chirinko).

[5] In some years the depreciation basis of an asset was reduced if the investment tax credit was claimed. The expression $(1 - h\theta)$ allows for this adjustment. In years when no basis adjustment was necessary, $h = 0$.

[6] Nerlove has documented the application of the partial adjustment model to numerous economic problems.

[7] See Eisner and Strotz; Lucas (1967); Gould; and Treadway (1971).

[8] The restricted unit-output-price profit function is a profit function normalized on exogenous output prices and represents the locus of short-run maximized profit of a firm as a function of output price, input prices, and quantities of fixed factors (Lau). The profit function is nonincreasing and convex in W (normalized input prices) and nondecreasing in P and K.

[9] It is difficult to associate significance to results dependent on large sample statistical properties. The small sample statistical properties of these asymptotic results are unknown.

[10] Because there is no statistical procedure to identify a "true" model, one cannot test whether the stochastic model is the correct specification. A typical first step is to assess the reasonableness of parameters, both sign and magnitude. Beyond the "reasonableness test," analysts often adopt an instrumentalist approach and select among competing policy models based on out-of-sample forecast performance. Any assessment of forecast performance, however, depends on the assumed evaluation criteria (loss function).

[11] This computation is analogous to the beta coefficient often reported in ordinary least squares regressions.

[12] The coefficient of variation is the standard deviation of the parameter estimates for 1948–88 divided by the mean of the parameter estimates over the same period. The largest coefficient of variation is associated with the lagged capital stock (.40) when compared to the normalized prices for land (.02), labor (.07), chemicals (.19), energy (.01), rental rate (.03), and the intercept (.002).

[13] See, for example, Gould.

[14] Fixed coefficient estimators are a restricted case of the more general stochastic coefficient estimator.

[15] The marginal income tax rate fell from 22% under prior law to 15% under the Tax Reform Act. Between 75–80% of all farmers are in the 15% bracket (Durst).

[16] Recall, parameters are composed of a mean, $\bar{\beta}$, and a random term, e_t. Therefore, to conduct the simulations, only

the random portion of the parameter must be computed based on the estimated autoregressive process. The $\bar{\beta}$s remain unchanged.

[17] This finding is counter to the results of Gustafson, Barry, and Sonka. In their research, farmers indicated that the investment tax credit was a minor factor in machinery investment decisions.

[18] Because nominal before-tax interest rates are held constant during the simulations, a reduction in the tax rate causes the after-tax interest rate to increase.

[19] Schink and Urbanchuk's analysis specifically examined the Department of Treasury Tax Reform Plan. The provisions of the Tax Reform Act of 1986 examined in our analysis are nearly identical to the major provisions of the Treasury Plan. Our analysis, however, examines only machinery and equipment, comprising 50% of depreciable farm assets (USDA/ERS 1989), rather than all of the assets in the sector.

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