Proceedings from Perspectives on Food and Agricultural Policy Research Workshop

University of Maryland University College
Center of Adult Education
College Park, Maryland
October 4-7, 1981

Sponsored by:
Farm Foundation
University of Maryland
Economic Research Service, U.S. Department of Agriculture
American Agricultural Economics Association

THE DISTRIBUTIONAL IMPACTS OF AGRICULTURAL PROGRAMS*

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Scholars of all persuasions agree that economic policies emanating from our political system aim at slicing the pie in a particular fashion and/or increasing its size. As a result, economists interested in policy analysis must not limit their analysis to efficiency issues but must also investigate equity implications. In the latter regard, it is our view that much remains to be accomplished by our profession on both conceptual and empirical fronts. Our efforts in developing methodologies and models capable of analyzing distributional issues should intensify.

The purpose of this paper is to present several new approaches for analyzing distributional impacts of agricultural policies. To gain some perspective on the potential value of these approaches, we have to realize their role within the process of modeling for policy analysis. Figure 1 (Rausser and Hochman, 1979, p. 22) depicts a graphical presentation of this process. The process outlined in this figure is useful for prescriptive or normative analysis–aiding policy makers in evaluating alternatives and selecting more nearly optimal policies. It can also be used to structure positive analysis in order to improve our understanding of political economics of agricultural sector policies. The outline presented in Figure 1 suggests that methodological efforts should be directed at developing approaches for estimating policy makers' decision criteria and for predicting the effects of policy decisions on the performance of the economic system under examination and, in particular, on the values of variables which enter the decision makers' decision criteria.

In Rausser, Zilberman, and Just (1980), we critically reviewed recent approaches for estimating decision makers' criteria and in incorporating such estimates in an overall framework for policy analysis in agriculture. Here, our emphasis is on modeling the performance of the agricultural sector and other sectors of the economy under different sets of agricultural policies.

The focus is on the determination of variables that affect the relative and absolute well-being of identifiable segments of the agricultural sector and the economy as a whole. To be sure, these distributional effects may have significant impacts on the collective political behavior of each of its groups and their reactions to different policies.

Alternative approaches for analyzing the distributional effects of agricultural policies represent variations in degrees of aggregation, detail, and focus. At the highest level of aggregation, agriculture is viewed as one sector of the U.S. economy. The effects of agricultural policies on the well-being of the agricultural sector and on the state of the whole economy are considered. In particular, this very aggregate analysis investigates the impacts of agricultural policies on the terms of trade, the general inflation rate, the exchange rate, employment, money supply, interest rates, etc. To conduct this type of analysis, one has to incor-

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**Giannini Foundation Paper No. 639 (reprint identification only).*

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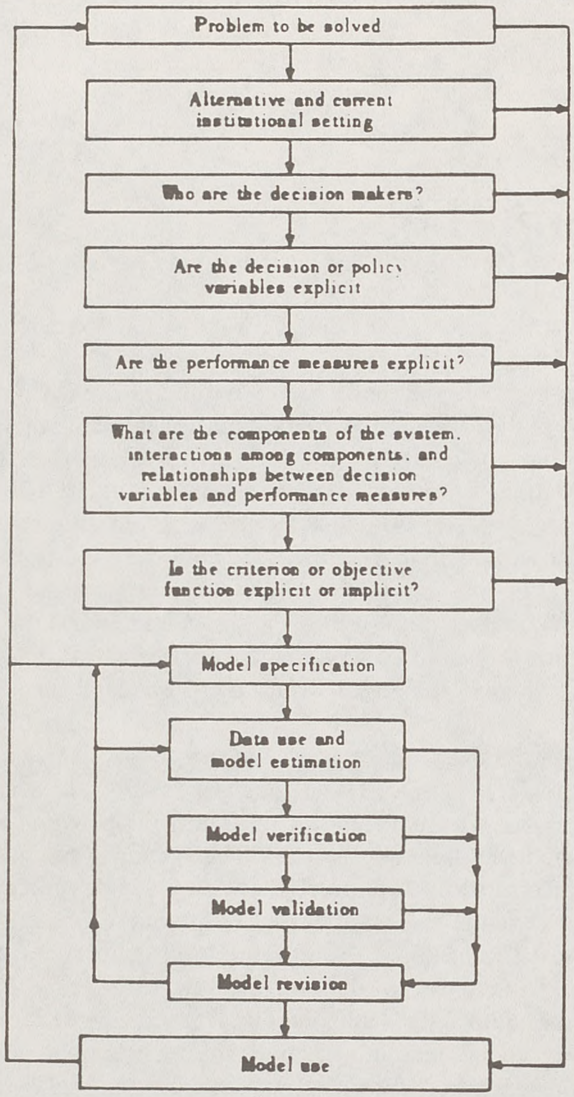

Figure 1. Modeling process for decision-making purposes.

porate several aggregate relationships describing the behavior of the agricultural sector in a macroeconomic model of the economy.

In this setting, both sector and general economic policies must be explicitly included in the model representation, and their direct and feedback effects must be assessed. In the last section of this paper, we report some early attempts that have been undertaken at Berkeley to empirically construct such a model.

At a less general level of aggregation, agricultural policies have important distributional effects among groups of a particular commodity system or among commodity systems. For example, beef import quotas affect the welfare of beef producers, pork producers, and consumers as well as the welfare of grain farmers, fertilizer firms, and so on. Traditional partial welfare analysis, using the concepts of consumers' and producers' surplus, is especially appropriate for this type of analysis. In the context of U.S. agriculture and particular commodity systems, this type of analysis has been conducted frequently. The emphasis in these frameworks is on the flow effects of various policies in both the short and long run.

For the long run, in a world of rapid technological change, consumers benefit more than producers if demand is inelastic and vice versa if demand is elastic under sector policies that have been pursued by the U.S. government. In any event, these types of distributional impacts will not be examined here.[1]

A less aggregative framework for distributional impact analysis concentrates on between-group effects, e.g., the effect on labor, land, and capital in terms of factor shares. Floyd (1965), for example, has investigated the distributional effects of farm price supports on land and labor. In a household rather than a farm observation unit context, a conceptual framework has been advanced by Becker and Tomes (1979) to examine the distribution across families as well as generations. This formulation, which combines economic and sociological approaches, has not, as yet, been formally extended to include the effects of governmental policy.

At the household level, much has been accomplished in context of developing countries. For Korea, Adelman and Robinson (1977) generate a functional distribution of income obtained from a general equilibrium model. They derive income flows for household classified into 15 occupational groups. Within each occupational group, income is assumed to be distributed across households according to a two-parameter, log-normal distribution.

In a more recent study along similar lines, Lau, et al. (1981) develop a model to analyze the effects of policy instruments (price supports, minimum wages, taxes, subsidies, demographic policies, and land and capital redistribution) on the supplies of output and labor; the demands of factors; consumption, income, and expenditure; and their distribution among households. Here, no underlying distribution is assumed; instead, a microsimulation is conducted to empirically generate the distribution of each dependent variable for which Gini coefficients of concentration are reported. This framework assumes perfect labor markets which allows household production decisions to be treated separately from consumption decisions. All assets are assumed to be of homogeneous quality, credit markets are not included, and policy effects on asset markets are neglected.

For U.S. agriculture, a few studies, Bonnen (1968), Schultze (1971), and Gardner and Hoover (1975) have examined the distributional flows of selected farm programs. In the case of the U.S. farm program benefits, both Bonnen and Schultze observe that differences in the degree of benefit concentrations among different programs depend primarily on the degree of concentration of their production and sales among large producers. These studies are largely descriptive with no attempt to establish causal linkages.

To establish the causal linkages and provide frameworks that will be valuable to policy makers, we must examine within group distributional impacts. In this setting, within group variation among participants in the agricultural production component, is the appropriate level of aggregation for assessing the impacts of agricultural policies.

It is important to understand how different policies affect the structure of agriculture, the control of factors of production, and the tendency to adopt new technologies by different types of farms. Unfortunately, agricultural economists have not developed rigorous models to address these issues. The following section will report recent theoretical models and their resulting testable hypotheses which aim at correcting this deficiency.

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[1] *For a complete survey of the partial welfare analysis approach, as well as general equilibrium welfare analysis under both certainty and uncertainty, the reader is referred to Just, Hueth, and Schmitz (1981).*

POLICIES AND THEIR IMPLICATIONS FOR STRUCTURE AND CONTROL

During the last decade, much interest emerged on the control and structure of U.S. agricultural production. The role of governmental programs—which has been focused on wheat, feed grains, cotton, and rice—has been addressed, on numerous occasions, with respect to effects on the structure and control of agricultural production. Unfortunately, little in the way of concrete results—conceptual or empirical—is available. As Gardner (1978) noted

> "The current state of affairs, in sum, is that agricultural economists have not been able convincingly to establish a connection one way or the other between policy and the structure of agricultural production . . ." (p. 842).

One of the principal reasons for this state of affairs is that most analyses of governmental intervention are performed only in terms of output markets (Brandow, 1977). Such investigations are grossly inadequate because governmental policies impinge directly on asset markets, as well as on flow markets, for both inputs and outputs. In general, the distributional consequences (or the control and structural implications) of agricultural policies depend upon the ownership, utilization, quality, and technology associated with assets. In fact, our basic premise is that *the distributional effects of agricultural production policies can be examined seriously only through their indirect effects on asset markets.*

In three conceptual papers (Rausser, Just, and Zilberman, 1980b; Just, Zilberman, and Rausser, 1981; and Hochman et al., 1982), we have developed a conceptual framework for capturing the distributional implications of governmental intervention in the agricultural sector, recognizing its most important features. These features include (a) competitiveness, (b) asset fixity, (c) rapid technological change, (d) variable asset qualities, (e) institutional limits on credit availability, and (f) partial separation of asset ownership and utilization. Many of these features were documented in the early works of Theodore Schultz, Willard Cochrane, and Glenn Johnson. Schultz (1975) has also called our attention to the large differences in the rates of returns to resources among regions as well as across producers.

Much of this variation emanates from differences in production techniques, land quality, human capital, and wealth controlled by individual producers. The limitations of credit availability for producers of different size classes have been noted in recent empirical studies. This evidence strongly suggests that large farmers carry larger debts. They borrow more to invest in capital; and their ability to borrow more stems, in part, from their higher repayment capacity (Baker, 1977; Quinn, 1975; and Riboud, 1977).

Formulation 1

In general, the distributional implications of agricultural policy depend on farm size, land quality, equity, capital, and existing technology. Assume an agricultural sector consisting of I farms denoted by indexes, $i = 1, \ldots, I$. To reflect the distribution of farm size and land quality, let $L_i' = (L_{i1}, \ldots, L_{iJ})'$ represent acreage endowments of qualities $j = 1, \ldots, J$ owned by farm i at the beginning of a production period. Before implementing production decisions, a producer may choose either to buy additional land or sell existing land. Thus, let $\Delta L_i = (\Delta L_{i1}, \ldots, \Delta L_{iJ})'$ be a vector representing the change in ownership of various land qualities ($\Delta L_{iJ} > 0$ represents net purchases and $\Delta L_{ij} < 0$ represents net sales). In addition, the farmer may choose to augment his landholdings for the duration of the production period by renting additional land from external sources represented by $Z_i = (Z_{i1}, \ldots, Z_{iJ})$ where $Z_{ij} < 0$ corresponds to leasing some of his own land to another farmer.

In this context the vector A_i of acreages of various qualities utilized by farm i in crop production must satisfy

$$0 \leqslant A_i \leqslant L_i + \Delta L_i + Z_i \tag{1}$$

and, of course, the farmer can neither sell nor lease to another farmer more land than is actually owned,

$$\Delta L_i \geqslant -L_i \tag{2}$$

$$Z_i \geqslant -L_i - \Delta L_i. \tag{3}$$

To consider the distribution of capital stock and technology in the industry, suppose there are S_0 types of existing technologies in the industry; and every farm's existing technology, s_i^0, may be classified into one of these types denoted by $s = 1, \ldots, S_0$. The technology type thus specifies the complete machinery complement, structures, etc. In addition, with the new production period, $S_1 - S_0$, new technologies become available. Following the putty-clay approach, a farm may continue operating with its existing technology or incur costs of investment k_s in adopting a new technology s, $s = S_0 + 1, \ldots, S_1$ (for simplicity, assume $k_s = 0$ for $s = 1, \ldots, S_0$). The cost of new technological investments attributable to the present production period is thus γk_s, where γ reflects the cost of capital and depreciation and, thus, appropriately "annualizes" the relevant investment value.

Moreover, following the putty-clay assumption, each technology is associated with fixed input-output coefficients which may be arrayed in an L x J matrix H_s where elements $H_{s\ell j}$ denote the amount of variable input ℓ required per acre of type j land using technology s. In addition, each technology is associated with a 1 x J vector of productivities, y_s, where elements y_{sj} define the yield per acre on land of type j under technology s. And, finally, each technology is associated with a linear capacity constraint, $\tilde{c}_s A_i \leqslant b_s$, which may be rewritten without loss of generality as

$$c_s A_i \leqslant 1 \tag{4}$$

where $c_s = (c_{s1}, \ldots, c_{sJ})$ is a 1 x J vector of constraint coefficients. For example, c_{sj} reflects the maximum of type j land that can be farmed with technology s (e.g., with machine sizes specified by technology s). In addition, the constraint implies that capacity utilization may be substituted proportionally between land types. Of course, realistically, capacity may be doubled by purchasing twice as much machinery, buildings, etc. (incurring investment costs γk_s), but this may be simply represented as an alternative technology, $s' \neq s$.

Assuming a competitive industry, each farm regards its output price P and the vector of input prices $V = (V_1, \ldots, V_L)$ as given. Thus, with technology s, total revenue from the sale of production is $Py_s A_i$, and variable costs of production (excluding rental expense) are $\mu_s A_i$ where $\mu_s = VH_s$ is a vector of average costs per acre. Suppose, also, that the land and rental markets are competitive with respect to 1 x J price vectors, $W = (W_1, \ldots, W_J)$, and $R = (R_1, \ldots, R_J)$ corresponding to the various land types. Thus, the net investment in new land is $W\Delta L_i$, and net rental expense is RZ_i.

Now further suppose each farmer expects land to appreciate and has a subjective expectation of land prices W_i^* at the end of the production period. Expected capital gains on landholdings are thus given by $[W_i^* - (1 + \Theta) W] (L_i + \Delta L_i)$ where Θ is the effective interest rate on the farmer's land investment (including opportunity cost on land held free of debt). In this context, suppose the farmer has a myopic objective for the present production period of maximizing his total gains π_i defined by the sum of short-run profits less the annualized cost of new capital investments plus capital gains from land appreciation,

$$\pi_i = (Py_s - \mu_s) A_i - RZ_i - \gamma k_s$$

$$+ [W_i^* - (1 + \Theta) W] (L_i + \Delta L_i). \tag{5}$$

Finally, to reflect the role of equity in allowing farms to capitalize on opportunities offered or encouraged by new policies to expand landholdings or upgrade technologies, assume that the industry does not have access to a perfect capital market. Suppose that farms have different credit lines available to them, possibly depending on their equity, management, etc. Let m_i represent the total funds available to farm i at the beginning of the production period including both internal liquidity and external credit. Then the new investment in land and alternative technologies must satisfy

$$k_s + W\Delta L_i \leqslant m_i. \tag{6}$$

The farmer's myopic decision problem thus becomes a maximization of π_i in equation (5) subject to the constraints in (1), (2), (3), (4), and (6). The farmer's decision involves choice of production technology, the quantities of output and inputs including land rental, and land portfolio adjustment. For conceptual purposes, the decision problem may be broken into two stages. First, optimal production plans and land transactions can be determined by linear programming for a given technology, i.e.,

$$\max_{A_i, Z_i, \Delta L_i} \pi_i, \tag{7}$$

subject to constraints (1), (2), (3), (4), and (6). Suppose the resulting decisions, which are functions of P, R, V, and W, are denoted by A_i^*, Z_i^*, and ΔL_i^*, and let the resulting maximum under technology s be denoted by $\pi_i(s)$. The optimal technology is then found by maximizing over s,

$$\max_{s \epsilon \&_i} \pi_i(s), \tag{8}$$

where $\&_i = (s_i^0, S_0 + 1, S_0 + 2, \ldots, S_1)$ is the set of potential technology choices for farm i. Let the optimal technology choice from the problem in (7), which is also a function of prices P, R, V, W, be denoted by η_i.

Given the above framework for each individual farm, the farm responses can be simply aggregated into market relationships. Each farm's output supply curve for given input, rental, and land prices is $y_{\eta i}^* A_i^*$; hence, market supply is $X^S(P) = \Sigma_{i=1}^I y_{\eta i}^* A_i^*$. Letting $X^D(P)$ represent market demand for agricultural output ($X^{D\prime} < 0$), the market equilibrium condition is thus

$$X^D(P) = \sum_{i=1}^{I} y_{\eta_i^*} A_i. \tag{9}$$

Similar equilibrium conditions can also be developed for input markets, but they are not given here explicitly since the results in the remainder of this paper are derived assuming fixed input prices (elastic input supply).

While input and output prices are determined by the interaction of the agricultural sector with external forces from the rest of the economy, the prices and rental rates of land are determined internally. For example, for given input and output prices and given rental rates, an individual farm's demand for lands of various types (supply, if negative) is ΔL_i^* (W), which is a function of land prices according to the above optimization problem. Supply is equal to demand for each type of land, and equilibrium prevails in the industry only if

$$\sum_{i=1}^{I} \Delta L_i (W) = 0. \qquad (10)$$

Similarly, the demand for rental land of various types (supply, if negative) is given by Z_i^* (R) for given prices of land, other inputs, and output. The rental markets are thus in equilibrium only if

$$\sum_{i=1}^{I} Z_i^* (R) = 0. \qquad (11)$$

Consider now the role of agricultural policy instruments corresponding to diversion policies. Specifically, consider the introduction of voluntary acreage controls and diversion payments. Suppose a farmer has the option of either diverting or not diverting a fraction, $1 - \omega$, of the land he farms (including rented land). If he diverts $1 - \omega$ of his land, he receives a payment for normal production on the nondiverted land.

Since the payment is based on regional average yields, he receives a payment of $\tilde{P}$ per acre of nondiverted land where $\tilde{P}$ is based on a payment rate per acre and normal average yields for the region. If the farmer does not comply and divert $1 - \omega$ of his land, then he receives only the market price. Let λ_i be a dichotomous decision variable where $\lambda_i = 1$ corresponds to compliance with the diversion program and $\lambda_i = 0$ corresponds to noncompliance. The farmer's decision problem for a given technology choice in (7) thus becomes

$$\max_{\lambda_i, A_i, Z_i, \Delta L_i} \tilde{\pi}_i (s) = [P y_s + \tilde{P} \lambda_i e - \mu_s] A_i - R Z_i - \gamma k_s \qquad (12)$$

$$+ [W_i^* - (1 + \Theta) W] (L_i + \Delta L_i)$$

subject to

$$\lambda_i e [\omega (L_i + \Delta L_i + Z_i) - A_i] \geqslant 0 \qquad (13)$$

and the constraints in (1), (2), (3), (4), and (6) where $e = (1, 1, \ldots, 1)$ is a $1 \times J$ row vector.

To examine the distributional implications of diversion policy and the performance of markets, assume initially that firms do not have the opportunity of adopting new technology. Hence, every farm operates with its existing technology s_i^0. Moreover, for the sake of simplicity and without loss of generality, assume the capacity of each technology is independent of the land quality utilized, i.e., $c_{sj} = c_s$, for all s and j. Finally, the total amount of land available of quality j is presumed fixed at L_j.

The assumption of fixed technology implies that, along with a fixed amount of available land of quality j, land utilization and associated gains from operations can be treated separately from landownership and its associated gains. The component k_s is zero, and thus the link between landownership and land utilization is eliminated. In other words, the tradeoff between land transactions and capital good investment does not exist. Given a perfect rental market, the optimal land utilization will involve the maximization of industry gains from operation. This can be shown by comparing the equilibrium conditions derived from individual firm behavior and conditions obtained from industry maximization of gains from operation.

PROPOSITION 1: The key determinants of compliance are the diversion payment per diverted acre, $[\omega/(1-\omega)]\ \widetilde{P}$, and the minimum rental rate, $\overline{R}$. Specifically, for full compliance, $[\omega/(1-\omega)]\ \widetilde{P} > \overline{R}$; for partial compliance, $[\omega/(1-\omega)]\ \widetilde{P} = \overline{R}$; and for no compliance, $[\omega/(1-\omega)]\ \widetilde{P} < \overline{R}$.

PROPOSITION 2: The firm land-use equilibrium for a given output price maximizes industry total gain from utilization and diversion, where diversion is treated as an additional technology, i.e., the land-use equilibrium satisfies

$$\max \sum_j \left\{ \sum_{s=1}^{S_0} (Py_{sj} - \mu_{sj})\, \widetilde{A}_{sj} + \widetilde{P}\, \frac{1-\omega}{\omega}\, \widetilde{A}_{0j} \right\}$$

subject to the constraints

$$\sum_j \widetilde{A}_{0j} \leqslant (1-\omega) \sum_j L_j$$

$$\sum_j \widetilde{A}_{sj} \leqslant N_s\, c_s^1, \quad s = 1, \ldots, S_0$$

$$\sum_{s=0}^{S} \widetilde{A}_{sj} = L_j, \; j = 1, \ldots, J.$$

PROPOSITION 3: Given output price, an increase in diversion payments will be reflected by rental rate adjustments such that all increased benefits will accrue to landowners rather than operators. In the case of full participation, the increased diversion payment will increase rental rates leaving quasi rents unchanged. In the case of partial participation, the increase in the diversion payment tends to increase land rental rates and reduce quasi rents.

PROPOSITION 4: For given output price under partial participation, an increase in diversion requirements tends to reduce rental rates and increase quasi rents. Under full participation, more stringent diversion requirements will result in lower quasi rents, but their effect on rental rates is unclear. Reduction in utilized land tends to increase rental rates, but the reduction in payments per diverted acre tends to reduce rental rates.

Corollary 1: An increase in diversion payments or a reduction in diversion requirements, under partial participation, leads to increased concentration measured by the average land size of active farms.

PROPOSITION 5: An increase in the diversion payment and a reduction in the diversion requirement under partial participation tends to increase land prices but a lower rate than rental fee increases resulting from such changes.

PROPOSITION 6: Under partial participation, an increase in diversion payment and/or a reduction in diversion requirement will affect the tendency to adopt the new technology through (a) a positive credit effect, (b) a negative capital cost effect, and (c) a negative quasi-rent effect for a given output price assuming that the modern technology has larger capacity.

Corollary 2: If the modern technologies are not smaller in scale than the older ones, an increase in diversion payment and/or a reduction of diversion requirement under partial participation will affect the quasi rent differential between the new and the old technologies such that (a) the tendency to adopt new cost-reducing technologies will decline and (b) the tendency to adopt new output-increasing technologies may increase. This effect is stronger when the demand elasticity is lower.

As illustrated by this formulation, the distributional effects of agricultural policy can be distinguished in terms of three behavioral units: operators (active farms), landowners, and investors in new technology. Introduction of a policy in which the effective diversion payment on diverted land, $\widetilde{P}\ \omega/(1-\omega)$, exceeds the existing minimal rental rate will influence operators by decreasing their number (Corollary 1), increasing the minimal rental rate (Propositions 3 and 4), and decreasing the quasi rent to technology (Propositions 3 and 4). These are the initial effects.

The second-round effects result from increasing output prices as a result of reduced supply. The minimal rental rate increases further in the second round while the quasi rent to technology and the number of active farmers increase. These results suggest that the compliance percentage would decrease after second-round effects.

The initial effect of the above policy on owners is an increase in land prices with a further increase in such prices after the second-round effect on output prices. These effects, in conjunction with the effects on active farms, suggests that the number of absentee owners will initially increase; but this increase will be tempered by the second-round effects on output prices. In other words, for the short run (with fixed technology), the net result of increased diversion payments and/or reduced diversion requirements is to motivate a separation between operation of farm units and ownership, i.e., an increase in absentee ownership.

For technology adoption, a distinction may be made between operators and owners as investors. In the case of operators, the effect of increased diversion payments and reduced diversion requirements is to increase rental rates and reduce quasi rents to technology for both output-increasing and cost-reducing investments. The second-round effects through the output markets simply augment the change in rental rates while partially reversing the change in quasi rents to technology.

For the owner-operator, land prices initially increase and are followed by a further increase once the reduced supply generates a higher output price. This change augments the wealth position of owners; it improves their collateral and expands the availability of credit. The expanded availability of credit, along with perhaps better credit terms, provides further incentives for large landowners to adopt modern technologies; hence, a high correlation is expected between large landowners and large-scale technologies.

The short-run effects of policy on distribution and equity must be distinguished from the long-run effects. The usual conclusions of static analysis, which suggest that producers are able to capture the gains from technological progress under diversion policies, must be modified once dynamic effects are explicitly recognized. As Corollary 2 clearly illustrates, under certain circumstances, increases in diversion payments and reductions in the diversion requirements (under partial participation) can possibly increase the tendency to adopt new output-increasing technologies. Ultimately, such technologies, given the inelastic nature of output demand, will lead to augmentations of consumer surplus as a direct result of such diversion policies. Moreover, the short-run effects of such policies enhance credit availability and thus motivate further technology adoption.

This latter effect sheds light on the importance of agricultural credit policies in capturing the effects of diversion policies. In any dynamic empirical analysis of agricultural policy on the distribution and structure of landownership in U.S. agriculture, both credit and diversion policy must be examined simultaneously.

Some of the more interesting results of this formulation pertain to program compliance across various agricultural regions. In particular, land and rental markets are separated by geographical boundaries beyond which transportation and coordination costs make farm expansion unprofitable. Hence, the results of this analysis can be applied to agricultural regions individually or by groups. In particular, diversion program compliance tends to be greater in agricultural regions with higher costs, less efficient marginal technology, and lower quality marginal land.

Formulation 2

The purpose of this formulation is to examine the effects of agricultural policy, income tax policy, monetary policy, and financial institutions in the formation of land price expectations, land price appreciation, and related wealth accumulation in the agricultural sector. The model assumes that each firm maximizes its expected net wealth period by period where changes in wealth are affected by farming operations, capital gains on land assets, capital gains on alternative investments, debt payments on both operating capital and land capital, and the rate of taxation on these various gains and losses. The resources of each farm consist of cash on hand or in alternative liquid assets, owned land, and credit availability which depends on the farm's asset position.

Farmers make decisions regarding how much land to buy or sell, how much land to rent, how much debt to carry on both operations and land ownership, how much to invest outside of agriculture, and whether or not to participate in government programs. The government program considered is much like that instituted during the 1970s and consists of a subsidy or deficiency payment, tied to either individual or regional production norms, plus set-aside requirements. With some alternative interpretations, this framework also lends itself to analysis of price support and diversion policies. Farmers are assumed to face uncertainty with risk neutrality and diversified land price expectations.

Assume that I individuals are either active or potential holders of agricultural land and are denoted by $i = 1, \ldots, I$. Suppose that each holds the objective of maximizing its expected annual gains in wealth from ownership and/or operation,

$$G_i = T_i + C_i - f_i\,(T_i + \alpha C_i), \tag{14}$$

where

T_i = expected net taxable income
C_i = expected capital gains
α = proportion of capital gains which are taxable

and

$f_i\,(\;)$ = a linear tax function associated with the marginal tax bracket for individual i.

Capital gains consist of expected appreciation in the value of owned land,

$$C_i = (W_i^* - W)(L_i + \Delta L_i) \tag{15}$$

where
W_i^* = land prices at the end of the period expected by agent i
W = land prices at the begining of the period,
L_i = land owned by individual i carried over from the previous period

and

ΔL_i = the change in land holdings through purchases ($\Delta L_i > 0$) or sales at the beginning of the period.

Suppose that land prices expected at the end of the period possibly depend on current land prices,

$$W_i^* = W_i^0 + \epsilon_i\, W \tag{16}$$

where ϵ_i is a scalar parameter reflecting the rate by which individual i revises his expectations in response to current land price adjustments. For example, if $W_i^0 = 0$ and $\epsilon_i = 1$, then individual i myopically assumes that land prices will not change; if $\epsilon_i = 0$, then individual i does not adjust his land price expectations from W_i^0 as current land prices adjust.

Expected net taxable income consists of expected income from farming plus rental income plus net interest income (expense). Specifically,

$$T_i = (\pi_i + \lambda_i\gamma_i)\, A_i - RZ_i - \Theta_i\,(D_i + \Delta D_i) - \hat{\Theta}\, S_i + \tilde{\Theta}_i\,(H_i + \Delta H_i) \tag{17}$$

where

π_i = $(\pi_{i1}, \ldots, \pi_{iJ})$ = a vector of expected quasi rents per acre associated with utilization of various land qualities by farmer i ($\pi_1 < \ldots < \pi_J$). The values of this vector vary among individuals to reflect human capital differences

λ_i = a scalar variable indicating participation in a government price support and/or diversion program ($\lambda_i = 1$ for participation and $\lambda_i = 0$ for non-participation

γ_i = $(\gamma_{i1}, \ldots, \gamma_{iJ})$ = a vector of expected government payments to farmer i per acre associated with various land qualities

A_i = $(A_{i1}, \ldots, A_{iJ})'$ = a vector of acreages of various qualities utilized by individual i for production

R = $(R_i, \ldots, R_J)$ = a vector of rental rates on lands of various qualities,

Z_i = $(Z_{i1}, \ldots, Z_{iJ})$ = a vector of net rentals of various land qualities by individual i ($Z_{iJ} > 0$ implies obtaining the use of land through leasing from someone else, while $Z_{ij} < 0$ implies renting the use of land to someone else)

$\hat{\Theta}_i$ = a scalar parameter representing the long-term interest rate on land debt for individual i

D_i = a scalar variable representing the accumulated (land) debt carried over from the previous period by individual i

ΔD_i = a scalar decision variable indicating the principal payment on land debt at the beginning of the period

$\hat{\Theta}_1$ = a scalar parameter representing the short-term interest rate on operating debt for individual i

S_i = a scalar variable representing short-term operating debt carried through the growing season by individual i

$\tilde{\Theta}_i$ = an opportunity return on funds (e.g., the rate of interest on savings or alternative liquid investments) for individual i

H_i = liquid reserves carried over from the previous period by individual i

and

ΔH_i = change in liquid asset position at the beginning of the period for individual i.

Each farmer faces several major constraints. The utilization constraint implies that a farmer cannot utilize more land than he controls through ownership and rentals; the rental constraint implies that a farmer cannot rent more land than he owns; and the ownership constraint implies that a farmer cannot sell more land than he owns.

The long-term credit constraint implies that a farmer can borrow against his land but only up to a fixed ratio, ρ,

$$D_i + \Delta D_i \leqslant \rho W\,(L_i + \Delta L_i). \tag{18}$$

The short-term credit constraint implies that a farmer can borrow up to some fixed proportion, $\hat{\beta}$, of the cost of planting and growing a crop,

$$S_i \leqslant \hat{\rho}'\mu A_i, \tag{19}$$

where $\mu = (\mu_1, \ldots, \mu_J)$ = a vector of operating capital requirements (the cost of planting and growing a crop to maturity) per acre associated with various land qualities. Land transactions and operating capital can be financed by either cash or debt as implied by the transaction identity,

$$\omega \Delta L_i + \mu A_i = + RZ_i = \Delta D_i + S_i - \Delta H_i \tag{20}$$

In addition, each farmer faces physical financial constraints that debt must be nonnegative,

$$D_i + \Delta D_i \geqslant 0, \tag{21}$$

$$S_i \geqslant 0, \tag{22}$$

and cash on hand must be nonnegative,

$$H_i + \Delta H_i \geqslant 0. \tag{23}$$

Finally, in the event of government program participation ($\lambda_i = 1$), a farmer must consider the assocated *diversion constraint,* where $1 - \omega$ is the proportion of land which must be diverted under program participation.

This framework is used to analyze the behavior of individual farms and to determine the properties of a general equilibrium in an agricultural economy consisting of many farms of this type with diversified resources. Equilibrium adjustments are considered in the agricultural land market, the land rental market, the agricultural product market, the agricultural operating capital market, and the long-term agricultural credit market. The equilibrium characterizes the relationship of both land and rental prices across different qualities of land and facilitates the examination of the qualitative impacts of the various policies considered on each of these markets. A few of this framework's qualitative implications which can serve as hypotheses for related empirical work are as follows:

1. Land prices and rental rates of higher quality lands utilized under government-program participation will be higher than in the absence of government programs.

2. The land prices and rental rates of land utilized outside government programs will reflect expected returns from operation less the cost of financing the operation.

3. An increase in government-program price supports or diversion payments will tend to increase participation in government programs and to increase land values and rental rates on all qualities of land; however, the principal effect on land prices and rental rates for land qualities not utilized under participation is through the product price, whereas the major effect on land prices and rental rates of diversion quality lands is through an increase in the rental rates and land values on marginal quality land.

4. A change in monetary policy that increases the cost of short-term capital tends to reduce rental rates and land prices on all qualities of land. The effect of an increase in the cost of long-term capital associated with agricultural land investment is to reduce the ratio of agricultural land prices to rental rates. Thus, the effect of tighter monetary policy is to reduce the effect of land prices through an effect on the ratio of land price to rental rate as well as through the effect on rental rates of more costly short-term capital. As a result, the tendency to participate in government programs will increase and product prices will increase accordingly.

5. If the expected rate of land price appreciation corrected for tax considerations among those individuals who hold land exceeds the cost of long-term capital for land investment

and the rate of return on alternative investments, then a disequilibrium will result in the land market such that the only sales of land are involuntary where the resulting upward spiraling prices fuel higher land price expectations and less interest on the part of owners in selling land. (The same phenomena could occur in a downward price spiral.)

6. If some individuals who own land have reservation prices, these reservation prices will tend to bound the price spirals. A key determining factor in this regard is whether individuals formulate land price expectations in absolute or in relative terms.

7. The effect of higher rate of exemption on capital gains for tax purposes and the effect of escalation in the tax structure generally increases the ratio of land prices to rental rates and encourages inflationary land price spirals.

8. The effect of an increase in the down-payment requirement on short-term operating capital in agriculture is to reduce the interest rate on short-term debt and, as a result, to increase the rental rate on all qualities of land and reduce participation in voluntary government programs. Land prices will increase accordingly.

9. The effect of an increase in the return from alternative investments outside agriculture is to reduce land prices and rental rates; to increase participation; and, thus, to increase product prices. The entrance of foreign investment into U.S. agriculture (which suggests a reduction in the rate of return on alternative investments) would have the opposite effect. If existing landholders hold absolute rather than relative price expectations, the entrance of foreign investors can occur more rapidly with smaller impacts on land prices.

Formulation 3

This formulation addresses the effects of agricultural policies, especially price supports and targets, on the tendency of firms of different sizes to adopt modern technologies. Unlike the previous formulations, it assumes that farmers are risk averse and treats the yield and price uncertainties explicitly. Because of these added features, thus far, our analysis has been limited to the behavior of the individual farmer. It is assumed that there are only two crop varieties—a traditional and a modern one. This formulation considers a single farm with fixed landholdings, $\bar{L}$. The farm faces two technologies—the planting of a traditional crop, which has a subjective distribution of quasi rents per acre given by π_1 which is distributed $N(\mu_1, \sigma_1)$, and a modern technology which requires set-up cost of k dollars per period. Under the modern technology, the farmer can allocate some of his land to the traditional crop and some of his land to a new crop variety, with a subjective quasi rent per acre π_2 which is distributed $N(\mu_2, \sigma_2)$. The quasi rents of the two crops may be correlated with $\operatorname{cov}(\pi_1, \pi_2) = \sigma_{12}$, i.e.,

$$\begin{pmatrix}\pi_1\\ \pi_2\end{pmatrix} \sim N\left[\begin{pmatrix}\mu_1\\ \mu_2\end{pmatrix}, \begin{pmatrix}\sigma_1 & \sigma_{12}\\ \sigma_{12} & \sigma_2\end{pmatrix}\right]$$

with the covariance matrix assumed to be positive definite. Suppose that, under normality, the farmer's objective can be represented in a mean-variance framework with risk aversion coefficient $\emptyset > 0$. Let L_1 denote the amount of land allocated to the traditional crop, and L_2 the amount of land allocated to the modern crop. Assume that risk aversion is mild enough to lead to full employment of land when only one crop is considered; hence, $L_1 = \bar{L}$ under the traditional technology, and the expected utility in this case is

$$\bar{U}_1 = \mu_1 \bar{L} - \emptyset \sigma_1 \bar{L}^2 .$$

One has to determine the optimal allocation of land between the modern and the traditional crops to find the expected utitlity under the modern technology, i.e.,

$$\bar{U}_2 = \max_{L_1, L_2} \mu_1 L_1 + \mu_2 L_2 - \emptyset(\sigma_1 L_1^2 + \sigma_2 L_2^2 + 2\sigma_{12} L_1 L_2) - k$$

subject to

$$L_1 + L_2 \leqslant \bar{L}, \qquad L_1, L_2 \geqslant 0.$$

Define

$$L_2^* = \frac{\mu 2 - \mu 1 + 2\emptyset \bar{L} (\sigma 1 - \sigma 12)}{2\emptyset V}$$

where

$$V = \sigma_1 + \sigma_2 - 2\sigma_{12}.$$

It can be formally shown that the amount of land allocated to the modern crop under the modern technology is

$$L_2 = \begin{cases} 0 & \text{if} \quad L_2^* < 0 \\ L_2^* & \text{if} \quad 0 \leqslant L_2^* \leqslant \bar{L} \\ \bar{L} & \text{if} \quad L_2^* < \bar{L}. \end{cases}$$

The farmer will select the modern (traditional) technology if $\bar{U}_2 > \bar{U}_1$ ($\bar{U}_2 < \bar{U}_1$). Assuming that the modern crop variety has higher mean and variance of quasi rent per acre than the traditional one, formulas have been derived for the smallest farm size that will adopt the modern technology. It can be shown that, while the area allotted to the new crop may increase with farm size (if $\sigma_{12} < \sigma_1$), the share of land allocated to the new crop variety will decline with farm size. The effects of changes in price-support policies on the choice of technology and the area allocated to the modern crop by adopters were investigated under various assumptions regarding the correlations between output and quasi rents of the two crop varieties. Some of the results are:

PROPOSITION 1: For given distributions of the price of the crop and its outputs from old and new varieties, the impact of a price support will always increase the amount of land devoted to the new crop variety if there is unit correlation between the profits of the two varieties. However, in other cases, especially when the covariance between the output of the two varieties decreases, it is possible that L_2^* will decrease as a result of price support. The range of such cases depends on the specific parameters of price of output distribution.

PROPOSITION 2: Price-support programs will reduce the decline in the share of land allocated to the modern variety as farm size increases in the case of unit correlation between quasi rents per acre. A sufficient condition for this effect is that V will decline with the price support.

PROPOSITION 3: In evaluating price-support programs that result in equal rates of change in the variances of the quasi rents per acre of both crop varieties, the following two relevant cases, with relatively low-fixed and relatively high-fixed costs, can be isolated.

Low Fixed Costs.—Price support programs will result in an increase in the land share of the modern variety and will encourage adoption of the modern technology.

High Fixed Costs, Low Covariance.—In most cases, price-support programs result in an increase of the share of crop 2 while, under other rather complicated conditions, price-support programs may result in an increase of the share of crop 1.

High Fixed Costs, High Covariance (i.e., $\sigma_1 < \sigma_{12}$).—In most cases where the price support has as small effect on expected revenues, the share of crop 2 will be increased by a price-support program while, in other cases, large-size farms will increase the share of crop 1, while medium-size farms will increase the share of crop 2.

PROPOSITION 4: A sufficient but not necessary condition for price-support programs to increase the share of the modern second crop is that price support will result in a greater absolute rate of decrease of variance of the profit of crop 2 than that of crop 1.

PROPOSITION 5: In the case of zero covariance between profits, the impact of price supports vary according to various sizes of land endowments and fixed costs. In particular, for low fixed costs, price-support programs will encourage the cultivation of crop 2 through the resulting increase in expected revenue. However, their effect, through reducing variance, depends on relative risk of the two crops. For high fixed costs, price-support programs will always increase the share of crop 2. An increase in the fixed costs will further encourage the increase in the share of crop 2.

EMPIRICAL ESTIMATION

We have only recently begun to investigate the empirical confrontation of the above three formulations. The micro economic foundations for each of the three models require some nonconventional approaches to empirical estimation. In particular, we are faced with short-run fixities and mixtures of discrete and continuous choices. Moreover, for some applications, we are faced with regime decision outcomes which require the estimation of switching decision functions as various constraints become binding. As argued in Rausser, Just, and Zilberman (1980a), these special features can be incorporated into an empirical model specification by either merging (1) various programming and econometric formulations along the lines of Heady and his associates or (2) mixed, discrete/continuous choice econometric models. Both of these two formulations are tractable and will be employed in our empirical work.

The plan for our empirical work is to begin with the most aggregative versions of the various propositions appearing in Formulations 1 through 3. Given that the various propositions are validated or at least not rejected at the most aggregated level, we then propose to proceed sequentially to the most microlevel that is implied by the various formulations. In this fashion, we hope to keep the model construction cost at a manageable level and to assess more accurately the potential benefits from additional disaggregation. The formal approach for proceeding sequentially in this fashion has been referred to as preposterior analysis.[2]

At an aggregative or industry level, we will investigate four alternative empirical models. The first and the simplest will use cross-section data on the distribution of farm sizes. For each year that census data are available, analytical distributions will be estimated (exponential, Pareto, etc.). This will allow us to generate a time series of parameters characterizing the distribution of farm sizes. Based on the propositions appearing in Formulations 1 through 3, functional relationships will be specified between these parameters and the relevant policy variables. If significant relationships are found, we shall proceed to the second empirical model.

In the second empirical model, again, emphasis will be on testing the validity of the propositions derived from the conceptional formulations. A few geographic locations will be selected and various data series on dependent variables, such as land prices, participation rates, and quasi rents, will be specified as functions of a number of explanatory variables, emphasizing both sector and general economic policy variables. If significant relationships are captured here on the basis of specific locations, we shall proceed to collect and summarize cross-section data (the observation unit will be individual farms) that are available from local ASCS offices for the last four years (a period over which they maintain their data files).

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[2] *In the context of the current formulations, the approach for assessing alternative dimensions and specifications of the empirical models are outlined in Rausser, Zilberman, and Just (1981).*

These cross-section data will then be combined with the time series data that are available for specific geographic locations to estimate "error components" models. The estimation of the latter empirical model should provide more power in assessing the validity of the testable hypotheses that are implied by the various propositions resulting from Formulations 1 through 3.

The third empirical formulation at the industry level will involve the specification of a programming formulation along the lines of Heady and his associates. For example, in the case of Formulation 1, an aggregate linear programming model can be specified once various farms or regions are classified in accordance with s, the vintage of technology that applies. This formulation will allow the effects of various sectoral and general economic policies on participation rates, land allocations, quasi rents, adoption of new technologies, and the like to be determined.

The above empirical model can be extended in a joint programming/econometric formulation or in the context of a mixed, discrete continuous choice model by linking individual technology and land quality clusters with market representations for assets (land, capital, and credit) along with inputs and outputs. In this fourth empirical model, representative farm clusters will be constructed as defined by the conceptual formulations.

For example, in the case of Formulation 2, a minimum of seven functional clusters must be defined that vary in accordance with the owner-operator status, the human capital level, and program participation status. Each of these categories could be further decomposed in accordance with the vintage of technology and the variation in land quality. To link the representative firm clusters with market phenomenon, "balancing" equations must be introduced to move from the firm cluster behavioral representations to the total demand and supply equations for land transactions, rental transactions, and credit demand. The resulting aggregate relationships will allow the general equilibrium effects of various sectoral policies on both the flow and asset markets.

Once this model is constructed, actual policies over the last two decades can be introduced into the model; and the model representation of U.S. agricultural production component can be simulated. Various validation tests will then be utilized to determine how closely the model generated results corresponds to actual aggregate indices for farm size distributions, technology distributions, debt equity ratios, and so on.

Ultimately, the representative firm cluster empirical formulations can be decomposed if the potential benefits from such decompositions outweigh their associated costs. This, of course, will depend upon how sensitive the empirical results are to alternative policies.

At the other end of the spectrum at the micro level, typical farms can be specified along the lines of Jensen, Hatch, and Harrington (1981). For these typical firms, farm behavior can be simulated over time as a function of various sectoral policies and general economic policies. Here, under risk neutrality, a multistage linear programming formulation could be employed along the lines of Formulations 1 and 2.

Incorporation of risk aversion would require the specification of a general or piecewise quadratic programming model. Each of these two formulations would be dynamic and would require a specification of the relevant equations of motion so that assessments could be made of the probability of bankruptcy for different types of farms. In such an illustrated formulation, it is rather simple to imagine a number of potential applications.

Finally, at the micro level, individual farm data from the U.S. Department of Agriculture's numerative surveys could be employed along with the participation data and other socio-economic characteristics that are available from local ASCS offices to estimate directly mixed, discrete continuous/choice models. Here, the sample data would refer to individual farmer's behavior, and the various tests could be made to determine which farms are sufficiently homogeneous. This effort would provide a basis for corroborating the fourth empirical formulation that is discussed above at the industry level.

We have only begun to evaluate each of the six empirical formulations discussed above.

To be sure, the empirical requirements of the three basic theoretic formulations are rather demanding. Nevertheless, some simplifications can be introduced which will allow tractable empirical formulations to be constructed. At this juncture, we will continue to pursue each of the six empirical models outlined above as parallel developments until a major breakthrough is achieved which will allow us to concentrate on one particular empirical framework.

It should be emphasized that the three conceptual formulations stand on their own as potentially useful equalitative tools for assessing the distributional impacts of various policies. For example, at the micro level, given the identification of appropriate conditions associated with the various propositions, the relative effects of policies can be determined on, say, large owner-operators with variable land qualities and large debt versus a renter with little land quality variations versus absentee landlords.

The effect of specific policies on the distribution of farm sizes and the adoption of large-scale technology depends on the regimes captured by the propositions appearing in Section 2. Hence, it is crucial to identify where and when the regimes hold for worthwhile qualitative policy impact analysis.

DISTRIBUTIONAL IMPACTS: SECTOR VERSUS GENERAL ECONOMIC POLICIES

As the formulations appearing in Section 2 reveal, general economic policies can have effects on the performance of the U.S. agricultural sector which mask the effects of sector policies. Correspondingly, the effectiveness of sector policies depend upon the terms of trade between the agricultural sector and the balance of the U.S. economy. These influences have become increasingly important over the past decade as the U.S. agricultural sector became more integrated with both the domestic and international economies. The dramatic integration with world markets resulted, in part, from the introduction of flexible exchange rates and the significant increases in agricultural exports. Although governmental intervention continues to be pervasive, an increased dependency on the market forces within the U.S. agricultural and food system has occurred, particularly in labor, credit, and capital markets.

The increased integration that has been witnessed during the last decade has raised a number of important issues regarding (1) the effects of shocks sourced in agriculture (both sourced in the domestic general economy and those sourced in the international economy); (2) the comparative effectiveness of sector versus general economic policies in the U.S. agriculture sector; (3) the weight that should be given to the effects of agricultural and food sector policies on the general economy as well as the agricultural sector; and (4) the sensitivity of the distributional impacts of sector policies resulting from shifts in the terms of trade between agriculture and the general economy.

The serious evaluation of these issues requires an understanding of the interrelationships between the U.S. agricultural sector, the balance of the U.S. economy, and the international economy. Such interrelationships are crucial in the assessment of direct and indirect effects of various policies–sector as well as fiscal and monetary. The ultimate effects of monetary, fiscal, and exchange rate policies, as well as direct agricultural price support, acreage diversion, and reserve stockholding and trade restriction policies on food price inflation and general price inflation, obviously depends on the nature and extent of the direct and indirect causal links among the three identified components.

Available evidence strongly suggests that the effects of these policies on prices, quantities, and employment entail complex time paths involving feedback relationships and that much can be gained by an integrated treatment of the agricultural sector and economywide policies.

A preliminary framework has been constructed for assessing the issues outlined above (Freebairn, Rausser, and de Gorter, 1981). Initially, our purpose has been to capture the effects of policy changes and of noninstrument shocks on the performance of the agricultural sector and on the general economy. Policies include macroeconomic measures emanating from fiscal, monetary, and exchange-rate spheres as well as agricultural sector policies such as acreage diversions, price supports, storage subsidies, and trade import quotas. Examples of noninstrument shocks include droughts and surges in Soviet grain-import requirements.

The framework is designed to generate an assessment of a number of performance measures including general economic inflation, national income, and agricultural sector returns and asset values. The framework assumes the form of a three-sector quantitative model—agriculture, the balance of the U.S. economy, and the international economy. Special emphasis is placed on the interrelationships among the three sectors (e.g., price, income, and foreign accounts) and on the explicit inclusion of sector as well as general economic policy instruments. The model is constructed explicitly for policy analysis; it is not intended to serve as a forecasting tool. At this juncture, the model reported is only a preliminary attempt to assess the effects of policy changes and of other exogenous shocks in one sector on each of the three sectoral components.

The sequence is to determine (1) the effect of sectoral policies on agriculture; (2) the effect of the resulting endogenous variables in the agricultural sector on the general economy; (3) the effect of fiscal and monetary policies on the general economy; and (4) the effect of the resulting general economy endogenous variables on the agricultural sector. This is accomplished by treating the links between U.S. agriculture, the U.S. general economy, and the international economy endogenously. In essence, the purpose of the model is to determine quantitatively the forward and feedback links between the agricultural and general economies.

A review of the models presented in the literature strongly suggests that what is missing is an integrative focus on the role of (1) inflation, (2) exchange rates, and (3) the effect of sector versus general economic policies. None of the currently available modeling efforts concentrate on this integrative focus. Various separable elements are available and will be briefly discussed here.

Inflation Focus

Among the first serious evaluations of food prices and inflation was that published by Hathaway (1974). He argued that food price inflation in the early 1970s was largely the result of increased demand plus production shortfalls. D. Gale Johnson (1973) argued, by contrast, that the large price increases in international markets occurred primarily because consumers and producers were prevented from reacting to price changes that resulted from governmental policies designed to stabilize domestic prices. In his view, all of the adjustment to the production shortfalls and demand increases was imposed upon a rather limited segment of the worldwide market for grains. In support, he offered the classic example of sugar prices from early 1974 through early 1975.

An additional explanation by Lawrence (1980) emphasized the role of speculators in this price explosion. Commodities were treated as assets as well as inputs into consumption. They argue against the view that a rise in primary commodity prices represents solely a change in relative prices.

Some have argued that the rapid accumulation of international monetary reserves is a source of the disturbances. However, the transition mechanism between reserves and commodity prices has not been modeled adequately. Recently, Lawrence (1980) has argued that their consequences in commodity market behavior can be appreciated fully only when these markets are embedded in a general equilibrium model of a dualistic economy which has both auction and customer markets.

A formal model of a dualistic economy is developed which includes three markets: a money market, a primary commodity market that clears in the short run by price adjustments, and a manufactured goods market that clears in the short run by quantity adjustments. Because expectations are presumed to be rational, in the long run nominal changes are neutral; but, in the short run, unanticipated monetary disturbances affect relative primary commodity prices. Commodity booms may stem from monetary factors in addition to changes in the conventional determinants of supply and demand. Monetary changes are allowed to operate through channels other than those of interest rates and the level of aggregate demand. For such a dualistic economy representation, macroeconomic externalities associated with commodity price fluctuations provide a rationale for direct governmental intervention.

Another model of the fixed price/flex price variety of the inflation process has been presented by Van Duyne (1980). Output in this model is supply determined, and the inflation rate depends solely on the rate of growth of the nominal money stock.

In the short run, though, shocks to food prices can induce substantial and persistent bursts of inflation even if the rate of growth of the money supply is fixed. This framework is used to test the hypothesis that consumers' expectations are biased in the sense of their placing too much weight on the recent behavior of food prices. An acceptance of this hypothesis suggests that shocks to food prices may have magnified effects on subsequent rates of inflation. The results obtained do not support this hypothesis; thus, Van Duyne argues that sectoral antiinflation policies, such as agricultural export controls and meat price ceilings, are less effective and, hence, less justifiable than is generally presumed.

Still other studies have emphasized the effect of inflation on the performance of the agricultural sector. Tweeten and Griffin (1976) have investigated prices paid to, and received by, farmers in relationship to the general price level. This and other related studies incur possible specification errors by omitting other real factors determining prices received and paid. Also, this work neglects the substantial conceptual empirical evidence that inflation affects all prices including wages, the exchange rate, and incomes; that these effects are highly interrelated and involve feedback; and that a dynamic general equilibrium analysis is required to capture the various interdependencies.

Several studies have investigated the effects of inflation on agricultural finance from simple perspectives (e.g., Lins and Duncan, 1980) and on farm assets and values (e.g., Melichar, 1979). In general, these studies support the view that inflation has real effects on the structure and performance of the agricultural production component and on income distribution.

Focus on Exchange Rates

The theory of exchange rate determination has evolved from the traditional Keynesian (Mundell, 1968, and Fleming, 1962) model to the modern asset-market portfolio balance approach—a framework better suited to the analysis of inflation, expectations, and portfolio substitution. This modern approach was initiated by Dornbusch (1975) and Frankel (1979) who integrated the "monetarist" approach of Bilson (1978) and Frenkel and Johnson (1978) with that of the Keynesian models. More recently, the central role of the current account in influencing exchange rates has been integrated into the portfolio balance models of Branson (1977), Kouri and Porter (1974), and Rodriguez (1980) and empirically tested by Hooper and Morton (1980).

The effects of exchange rates on U.S. agriculture were initiated and highlighted by Schuh (1974). He argued that the exchange rate was overvalued during the 1960s. This exacerbated the adjustment problems facing U.S. agriculture, and the devaluations and movement to flexible exhange rates during the 1970s led to significant structural changes. The movement away from the fixed exchange rate scheme made U.S. agriculture more vulnerable to international economic events and policies while, at the same time, freeing U.S. agriculture from the implicit export tax burden of the overvalued dollar in the latter days of the Bretton Woods system.

Empirical analysis on the effects of exchange rates on agriculture includes that by Chambers and Just (1979, 1981). The second study constructed a dynamic quarterly model to analyze the time path of effects of the exchange rate on prices received; quantities produced; consumption; exports; and inventory stocks for wheat, corn, and soybeans. Johnson, Grennes, and Thursby (1977) have reported a similar analysis for the wheat commodity system. These empirical studies suggest that the exchange rate elasticity of price is greater than unity, that there is a complex time pattern of adjustment, and that the pattern differs across commodities.

However, these empirical investigations are very partial in their perspective. They ignore any effects of exchange rate changes on domestic price inflation and incomes which, in turn, impact on agricultural input costs and output demand. However, Shei (1978) analyzes the effects of the devaluation on the general economy and supports the view that the partial equilibirum approach over-estimates the domestic price effect of a devaluation on agricultural prices by a substantial margin.

Considerable controversy has arisen on whether exchange rates have real as well as nominal effects. In large part, the resolution of this controversy depends on rigidities in the economy, expectation formations on prices and further exchange rate changes, and whether the initial state is one of equilibrium or disequilibrium. In any event, the principal factors and causal mechanisms determining exchange rates, now that market forces rather than governmental decree play a dominant role, have been subject to considerable debate.

Focusing on the capital component of the balance of payments, there is a growing body of theory and empirical studies supporting the view that monetary and fiscal policies affect capital flows; and this component, in turn, is an important causal force explaining short-term movements of exchange rates. Both Frankel (1979) and Driskill (1981) provide supporting empirical studies for the monetary approach. These efforts, along with other studies on the traded goods and services component, suggest that the exchange rate and agriculture must be imbedded in the model which recognizes economywide behavior along with monetary, fiscal, and official foreign reserves policies.

The specification of exchange rate determination is intimately tied to the export demand relationships facing U.S. agricultural commodites. In most empirical studies to date, the exchange rate is treated as exogenous in the latter relationships. Most efforts to date operate with net export demand functions along the lines of Houthakker and Magee (1969) and, thus, omit potential causal factors that are likely to bias estimates of export price elasticities downward. Bredahl, Meyers, and Collins (1979) have specified a framework which allows for partial responses of domestic to world prices resulting from policy intrusions, transport cost, and product heterogeneity.

Work along similar lines in an empirical setting may be found in Abbott (1979) as well as P.R. Johnson (1977). This work is motivated, in large part, by the controversy surrounding the price transmission elasticity for different countries due to national agriculture and trade policies, including the sensitivity of these policies to market conditions. For these reasons, empirical estimates of the export demand elasticities for particular commodities vary widely. For aggregate net export demand in the United States, these estimates range from less than unity up to approximately 10.

Operationally, it is indeed likely that the time path of adjustment will depend upon short-run inventories, lagged supply response, and eventual policy reactions to market prices. Hillman (1978), P.R. Johnson (1977), and Bale and Lutz (1979) have discussed these issues. Zwart and Meilke (1979) have investigated these issues for wheat and argue, based on their results, that overseas policies have exaggerated the instability of world excess demand for U.S. agricultural commodities. This empirical work supports the views of D. Gale Johnson.

Focus on General Economic versus Sector Policies

The studies surveyed in this section strongly suggest that output prices and input costs of the agricultural sector are significantly influenced by economic events in the rest of the economy and the trading world. The studies provide building blocks of an integrative framework which attempts to capture the interrelationships between agriculture, the domestic economy, and the international economy. These interrelationships establish a dynamic pattern of feedback effects among prices, outputs, and incomes among the different sectors. A general equilibrium representation of these interrelationships allows analysis of the full effects of the agricultural sector, general economy, and trade policies.

The traditional sector or commodity policies pursued by the U.S. government are currently viewed by much of the profession as inadequate for dealing with the new instability affecting U.S. agriculuture (Schuh, 1980). Over the last three years, this instability has been magnified by U.S. monetary policy and the resulting volatility of interest rates and exchange rates.

Unfortunately, there has been no quantitative analysis on the effectiveness of general economic policies versus sector policies on the performance of the U.S. agricultural sector. In general, there remains a dearth of analysis on the indirect and feedback effects resulting from these two general types of policy interventions. Schnittker (1973), Hathaway(1974), Cooper and Lawrence (1975), and Prentice and Schertz (1981) have investigated policy options for ameliorating the effects of volatility in the agricultural sector on general economy prices and macro economic performance.

However, to our knowledge, no studies have attempted to quantify the effects of such policies in a fashion which recognizes the price and quantity interlinks between commodity policies, general inflation indices, the exchange rate, and aggregate economic activity. The only empirical investigation pointing in this direction is based on the Wharton macro and agricultural sector econometric models (Chen, 1977). In this study, the "parity price" values for 19 commodities were introduced into the Wharton agricultural model using inputs from the Wharton macroeconometric model. The resulting simulations of the Wharton agricultural model were fed into the Wharton macroeconometric model to generate revised general inflation levels, national income levels, world trade, and related magnitudes. These revised values were, in turn, fed into the agricultural model, and the effects were evaluated. The simulation indicated large increases in farm income, the consumer price index, and treasury costs with significant reductions in domestic and export demand.

The specific purposes of the model constructed by Freebairn, Rausser, and de Gorter (1981) is designed to provide answers to the following questions:

I. What are the effects of alternative exogenous shocks on the agricultural sector and the general economy?
II. Should sector policies in agriculture be designed to deal with specific shocks on the agricultural sector?
III. In analyzing various policies and their effects on the agricultural sector, are sector policies more or less important than macroeconomic policies?
IV. In evaluations of agricultural sector policies, what is the relative magnitude of effect on the general economy as well as the agricultural sector?

The last two questions are largely self-explanatory, while (I) and (II) may require some elaboration. Analysis conducted to date on the macroeconomy investigates only the effects of agricultural droughts or production shortfalls (Gordon, 1975). In quantitative models of the general economy, export demand booms have not been analyzed. Proper identification on the source of shocks is imperative in evaluating the optimal design of accommodating monetary and fiscal policies as well as sectoral policies.

To be sure, an export boom versus a domestic drought or governmental supply restrictions implies far different levels of export receipts and national income. If export demand for agricultural grains is elastic, a drought or supply control will result in a fall in export income. By contrast, an outward export demand shift would have the opposite effect. Given agriculture's 20 percent contribution to U.S. export receipts, these two alternative sources of shocks can have opposite and significantly different implications for optimal exchange rate and monetary policies. Policy reactions to these forces will have secondary repercussions on the agricultural sector and on the balance of the domestic economy.

To respond adequately to each of the issues (i-iv), a quantitative model must be constructed to determine the effects of the following shocks:

1. A dramatic shift in grain export demand.
2. A dramatic environmental induced change in agricultural crop production.
3. A change in agricultural policy such as price-support schemes, land-use controls, and public holding of stocks.
4. A change in fiscal policy.
5. Changes in monetary policy, including sterilization or no sterilization of changes in foreign account and in government deficit; and accommodation or not, for real shocks in the agricultural sector and the blance of the international economy.
6. Changes in exchange rate policy couched in terms of fixed, flexible, and government-managed floating exchange rate regimes.

To assess the effects of these shocks, some key features are incorporated into the model representation. The key features of the model include explicit treatment of public versus private grain storage, detailed agricultural sector policies, and policy reaction functions for both monetary and agricultural sector instruments; a flex price specification for the agricultural sector and a fixed price specification for the domestic economy; explicit links with the international economy and endogenous determination of the exchange rate; and explicit links between the domestic economy and the agricultural sector through agricultural input markets; inventory investment equations for agriculture and the balance of the economy along with fixed investment relationships for breeding stocks in the livestock sectors; and margin relationships between farm and retail prices. The special features integrated in one model distinguish the representation presented here from what is available in the literature.

To be sure, many of the building blocks are available in the current literature; but, as yet, the integration of these particular features have not appeared in any of the academic or commercially constructed models. The actual model is defined in terms of the performance variables, the policy and other exogenous variables to be manipulated, and the key underlying causal relationships and identities. As previously noted, the model focuses primarily on policy analyses rather than forecasting. It is designed to assess the time path of direct and indirect effects of a changed policy or other exogenous variable in one sector of the economy on itself as well as the other sectors.

Performance Variables

The effects of alternative values of exogenous variables are analyzed by their time pattern of effects on related performance variables. For the general economy, these variables are aggregate inflation (measured by the consumer price index) and real income (measured by the gross national product). Performance variables from the agricultural sector include commodity-level measures of prices and quantities produced, domestically consumed, exported or imported, and held for stock.

More aggregate measures include net income to crop producers (wheat, coarse grains, and soybeans); net income to livestock producers (beef, hog, poultry, egg, and dairy); and the value of agricultural land. The effects on the relative importance of trade and private capital flows and effects on the exchange rate or change in official reserves are analyzed. Initially, the study will consider the expected changes in the performance variables; but, at a later stage, assessments of the relative variability of key performance variables under alternative scenarios will be assessed.

Exogenous Variables

The effects of two sets of exogenous variables are analyzed. For the noncontrollable exogenous variables, they are a weather-induced fall in domestic crop production and a boom in overseas demand for U.S. crop products. Both variables were attributed some of the blame for the stagflation experience of the 1970s. The model can also be used to assess the effects of exogenous changes in rest-of-world prices including oil.

A second set of exogenous variables is the policy variables. At the general economy level, these include fiscal policy either as a change in government expenditure and/or in taxation collections and monetary policy via the purchase of government securities and/or changes in bank reserve requirements. Future studies could also consider changes in fiscal policies as they affect investment and depreciation components of the user cost of capital variables. The level of the exchange rate can be set directly or indirectly by changes in the holdings of net official reserves.

The model constructed, however, focuses largely on experimentation with a diversity of agricultural instrument variables. These include crop acreage set-aside provisions and diversion rates; loan rates; direct income grants and deficiency payments; direct government storage purchases and subsidies on private storage; government food purchases and disposals; and, in the case of livestock products, regulations on allowable import levels and domestic milk prices.

In practice, many of the policy instruments will be adjusted as a policy set. For example, an expansionary policy package could involve expansion of the money supply, expansionary fiscal policy, and devaluation. A farm income support package might entail a policy mix of acreage restrictions, government storage expansion, deficiency payments, and lower livestock imports. Moreover, policies which help quell inflation and thus exert downward pressure on farm input costs could be considered part of a farm income support package.

All policy instrument variables are not to be regarded as strictly exogenous. For particular scenarios, some are treated as endogenous policy reaction functions. An accommodating monetary policy and an acreage diversion rate positively related to accumulated grain stocks are two examples.

At the conceptual level, the model is specified in such a manner that a diversity of potential policy variables can be manipulated. However, in practice only some of these instruments will be varied for particular dynamic path assessments. Other variables can be held constant or they can be modeled by endogenous policy reaction functions.

Model Structure

The model provides links, both direct and indirect, between the exogenous variables and the performance variables. It is based on behavioral relationships and identities. A quarterly time period is used. This degree of temporal disaggregation permits an understanding of the dynamic interrelationships between different prices in the models which would be glossed over with an annual model. On the whole, the agricultural sector is specified as a flex price model and the rest of the economy as a fixed price model.

The agricultural sector is composed as a series of supply and demand equations with price playing the key equilibrating role. Agricultural crop production is disaggregated into wheat, coarse grains, and soybeans; cotton, tobacco, fruits, vegetables, and other crops are not included. Demand equations are specified for domestic food demand, export demand, private storage demand, government storage demand, and government export disposal. Planted acreage equations representing planned supply are expressed as functions of expected market prices, government policies regarding loan rates and diversion payments, and input costs.

The planted acreage equations are related to general economy movements in wages, interest rates, and material costs. Actual supply is explained by planted acreage, seasonal conditions, technology, and current output prices. Livestock products are disaggregated into beef, pork, poultry, eggs, fluid milk, and manufactured milk products. Domestic supply is influenced by expected and past output prices, by feed costs, and by costs of nonfarm purchased inputs. Particularly in the cattle and hog subsectors, allowance is made for cyclical response behavior. Domestic supply plus government-determined import volumes are equated with domestic demand to determine prices.

Retail-to-farm-price link equations are influenced by the costs of nonfarm labor and materials. A set of identities determine income to the crop and livestock activities. The income measure is defined as gross receipts less expenditure on nonfarm inputs and, in the case of livestock, less expenditure on livestock feed.

Aggregate demand is broken down into private consumption expenditure, private fixed capital investment, change in inventories (which, in turn, is segregated into nonfarm and crop commodity inventories), government expenditure, and exports less imports (which also are broken down into agriculture and nonagriculture components). Aggregate supply is represented by price and wage equations. Nonfarm price is determined as a markup over wages (adjusted for productivity) and material costs. Wages are explained by a price expectations-augmented Phillips framework. These equations together provide the key relationships explaining nonfarm prices, wages, and real income. The general price level is a weighted average of nonfarm prices and food prices.

A conventional money-demand equation is equated to the money supply to determine interest rates. Changes in the money supply result from the government budget deficit plus the net surplus of foreign transactions plus the net change in the Fed holdings of government securities. The interest rate, together with price expectations, enters the consumption, investment, and inventory equations of aggregate real demand, the supply and inventory demand equations in the agricultural sector, and net foreign capital movements.

A balance-of-payments identity ties the international accounts together. Only for agricultural exports is the large-country assumption imposed. For simplicity, the world demand for other exports and the world supply of livestock foods and other imports are assumed to be perfectly elastic. International trade in goods and services is influenced by world price movements and the exchange rate. Net changes in private overseas and foreign capital stocks are influenced by relative domestic to overseas interest rates and by expected movements of the exchange rate. The exchange rate is either predetermined, as was the case before 1973, or set to balance the supply of and demand for foreign currency with an inclusion of exogenous changes in net official revenues. The latter is zero in the case of flexible exchange rates—the 1981 reference—and nonzero for a managed or dirty float—the 1973-1979 experience.

Expected prices play key roles at several points including agricultural supply, the wage equation, and in the aggregate expenditure equations. Initially, adaptive price expectation models are assumed, in part because they appear to have as much empirical support as alternative models (for example, Feige and Pearce, 1976, and Stein, 1981). Given the interest in, and appeal of, the rational expectations model, the effect of rational and other expectation models will be evaluated in future specifications of the model.

Needless to say, clearly the type of expectations model can have a dramatic effect on the policy analyses. As a simple example, a drought-induced reduction in agricultural output and exports would have a greater effect on the exchange rate and wages with an adaptive expectations model than with a rational expectations model. The latter would treat the disturbance as a temporary and reversible aberration, while the former would regard it as the start of a new trend.

A number of crucial intersectional links should be highlighted. Changes in agricultural prices, due to seasonal factors and overseas demand or government policies, feed directly into food prices and, more importantly, indirectly into animal-based food prices because of changed livestock production costs. The latter involves complex lags. Higher food prices lead to higher wages and, in turn, by the markup equations to higher nonfood prices. These prices, in turn, raise costs to agricultural producers, which affect their production decisions, and the cycle of cause and effect develops. Changes in monetary and fiscal policies influence the money supply and interest rates which alter aggregate demand and prices. They also affect international capital flows, commodity inventory demand, and agricultural input costs.

Changes in aggregate consumption alter the domestic demand for agricultural products. Exchange rate movements, which are, themselves, influenced by changes in domestic demand, domestic and overseas prices, and directly by policy, affect foreign demand for exports, supply of imports, and the money supply. These changes set in force pressures for further changes in prices, wages, incomes, and production decisions. Other sectoral interdependencies are represented in the model, but the above discussion outlines some of the more important links.

The dynamic econometric model presented in Freebairn, Rausser, and de Gorter (1981) attempts to incorporate the interactive and feedback effects of macroeconomic policies, sectoral policies, and noninstrument shocks on key performance variables in agriculture and the general economy. Previous frameworks focusing on agriculture are viewed as too partial (Eckstein and Heien, 1978; Hathaway, 1974; and D.G. Johnson, 1973) or too simplistic in their evaluation of various sources and types of shocks. Moreover, the perspective offered by macroeconomists has failed to treat the agricultural and food system adequately and failed to identify the appropriate source of the shock in evaluating macropolicies. To correct the narrow focus and partial treatments of inflation, exchange rates, and dichotomous sectoral macropolicies, this model representation is integrative in scope and distinguishes key features of public versus private decisions, policy reaction functions, and fix/flex prices.

The results indicate that policy and noninstrument shocks (1) have different short-run and long-run effects in terms of both magnitudes and direction on key performance measures, (2) have effects that result in sectoral policies which are substitutable or complementary with macroeconomic policies in either the short or long run with some reversals occurring due to the dynamics of the meat sector, and (3) are either exacerbated for some policies or ameliorated for others by including the endogenous policy reaction functions.

CONCLUDING REMARKS

During the post-World War II period, agricultural economists were the major pioneers in the development and use of quantitative models. The early work in applied econometrics, linear programming and other operations research models, and benefit-cost analysis owes much to the efforts of agricultural economists. They were also among the first to address a number of important issues, namely, the dynamics of technological change and adoption along with its welfare implications (Griliches, 1957 and 1958), human capital, and the implications of agents' abilities to deal with disequilibria (Schultz, 1975). Much of the work accomplished within agricultural economics in the late 1940s and early 1950s was in response to pressing problems and available knowledge of the day. This and the subsequent achievements have kept agricultural economics in high esteem (Dorfman, 1980, and Leontief, 1971).

As always—and particularly at this juncture—we, as a profession, can no longer live on past achievements. The recent changes in the economic and political environment facing

U.S. agriculture cries out for more attention on the distributional impacts of sectoral policies. As highlighted by much of the discussions and other presentations at this conference, agricultural economists will be increasingly called upon to assess not only the efficiency impacts of various policies but also their distributional implications. To accomplish this task successfully, we must develop new conceptual and empirical formulations which address squarely the concerns of policymakers and various interest groups. If we continue to pursue the development of conventional efficiency formulations, the weight given to our work in public debates and actual policy implementation will be nil.

The performance of the next generation of agricultural economists specializing in public policy will depend largely upon their ability to develop new conceptual and quantitative frameworks for analyzing distributional impacts. The "tool kit" of the current deans of agricultural policy analysis have emphasized sound judgment and descriptive analysis. Such efforts will continue to serve our profession well. However, the major advancements will come with the development of frameworks that can theoretically and empirically sort out the equity implications of various policies at different levels of aggregation, namely, between the U.S. agricultural sector and the balance of the U.S. economy, between commodity systems, between components of commodity systems (producers versus assemblers versus distributors versus consumers), and within groups of particular components.

For these advancements to be credible to policy makers, parallel efforts will have to be undertaken to build better data bases than those that are currently available. Data must be collected and maintained on asset distributions among distinguishable groups of people in addition to quantity flows and prices. Obviously, more disaggregated data are required to allow identification of sources of variation within commodity systems and the distributional implications of various policies.

With rapid advancements in computer technology, the cost of collection, storage, and the manipulation of data bases is certainly declining. This declining cost structure should provide the opportunity for coalitions among the U.S. Department of Agriculture and land grant system to develop the design and actual construction of such new data bases.

The development of new conceptual frameworks and their application to improved data bases to analyze distributional impacts will assure a significantly positive marginal productivity of agricultural economists. The presentation in this paper illustrates some of the directions that can be taken in developing new conceptual and empirical formulations. It represents only one small step toward the ultimate objective of constructing operational-quantitative models which are of direct use in the evaluation of alternative policies and their implementation.

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