

**A Framework for Analyzing Specific  
Agricultural Policy Reform**

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## A FRAMEWORK FOR ANALYZING SPECIFIC AGRICULTURAL POLICY REFORM

The agricultural sectors of the United States and other developed countries have been subjected to a myriad of policies and regulations that have contributed to unsatisfactory production patterns and resource allocations both within and between countries. Furthermore, such policies have imposed heavy financial burdens on governments that have transferred substantial resources to support the farm sector. The General Agreement on Tariffs and Trade (GATT) strives to improve the efficiency of agricultural trade and production patterns globally. It is proposed that GATT will reduce the set of permissible agricultural policy instruments, thereby eliminating some policy options that have contributed to several of the undesired consequences in the past. Used correctly, the feasible set of policies is believed to allow for a gradual down scaling of agriculture's excess supply and to make the sector more flexible and progressive. Ultimately, once the restricted set of policies is introduced, it is expected that a sustainable growth path will be achieved.

A framework for assessment of agricultural policy instruments is introduced in this paper. It is used to investigate the impacts of instruments considered for the policy reform following GATT; to analyze operational principles that allow effective implementation of these policies; and to consider issues of eligibility criteria, monitoring, and enforcement. This framework is derived from a political economic perspective of developed-country agriculture and the desire to achieve effective design and implementation of policy reform. This perspective is presented in the next two sections. It is followed by an analysis of the objectives of the agricultural policy reform and a model of setting specific policy instruments. The constructed framework will be used in the last two sections to analyze a subset of proposed policy

instruments and to address dynamic adjustment and implementation aspects of the policy reform.

### **Stylized Features of the Agricultural Sector in Developed Countries**

The literature on agricultural policy (Brandow's 1977 survey) has established some stylized facts on the characteristics of the agricultural sector in developed countries. These findings should be incorporated into models and frameworks for agricultural policy analysis. The following is a presentation of these stylized facts and their implications for the performance of the agricultural sector and the analysis and design of policy reform.

#### **High Rate of Technological Change**

Agricultural technology in the 20th century has gone through extensive processes of technological change. New innovations and practices have been introduced almost continuously. They have altered market conditions and have led changes in the structure of agriculture. Both public and private research contribute to this technological evolution. Hayami and Ruttan (1985) have demonstrated that economic conditions induce innovations, and the direction and nature of new technologies are affected by resource scarcities, relative prices, and regulations.

The importance of economic incentives and conditions in affecting the evolution of agricultural technology in the United States is emphasized in Cochrane's (1979) book. He argues that labor scarcity was the main problem of U.S. agriculture during the 19th century and that the major innovations during this period were mostly laborsaving devices such as reapers, thrashers, combines, and steel plows. These innovations allowed for fast expansion of the land base with relatively small numbers of settlers. While the yields per year of the major crops (wheat, corn, etc.) did not

change much during the 19th century, U.S. output grew substantially as acreage increased.

As most of the continental United States was settled toward the end of the 1800s, and land became more scarce and costly, yield-increasing innovations and practices became the major source of increased agricultural output. Cochrane (1979) suggests that the quest for higher yields led to the research and extension activities that resulted in the introduction and adoption of chemical fertilizers, pesticides, and improved varieties (e.g., hybrid corn) during the 20th century. The relative scarcity of labor has led to the development of capital-intensive equipment and practices for the application of new inputs and the continuous introduction of laborsaving tillage and harvesting technologies in the United States.

Technological change has been a major contributing factor largely responsible for the continuous increase in agricultural supply, the increased capital intensity of agriculture, and the growing dependency on chemical inputs. As we approach the end of the 20th century, it seems that agricultural resources (such as water and topsoil) and environmental quality are becoming more scarce. The increase in the value of these inputs suggests the development and adoption of innovations that will conserve water and reduce soil erosion and pesticide use.

Scientific breakthroughs in genetics and biochemistry and a substantial reduction in the computing costs over the last 15 years suggest that many of the developments of the future will rely heavily on the use of biotechnology and computers. The direction of technological change in agriculture should also be affected by changes in macroeconomic conditions and tax laws. The increase in real interest rates and the tax reforms of the 1980s, in particular the move away from cash accounting and the treatment of capital gains as ordinary income, are likely to lead to less incentives for capital-intensive technologies in agriculture. Nevertheless, it

seems likely that technological changes will continue to improve productivity and increase agricultural supply over time.

### **Low Price and Income Elasticities of Demand**

Agricultural products are basic commodities—essential products which command very high prices when scarce but very low prices as they become abundant. Table 1 (estimated by Wohlgenant 1989) presents farm-level demand and income elasticities for major food groups in the United States. It shows that the demand elasticities for major agricultural commodities are less than unitary and, in some cases (eggs), very close to zero. The cross-price elasticities of food items are positive, indicating that these commodities are substitutes. Income elasticities of nonmeat items are close to zero and may be even negative (vegetables). The demand for meats is quite responsive to income, and the income elasticities of chicken and beef are slightly less than one. Wohlgenant's (1989) estimates of income elasticities of the demand for beef and chicken seem to be higher than in other studies. The results of Haidacher et al. (1982) suggest that (the retail level) income elasticities of these products are closer to zero than one. Haidacher et al. also find that demand and income elasticity for food quality are quite high, and consumers are ready to pay substantially more for higher quality food. While overall demand elasticities for vegetables are quite low, these demand elasticities vary throughout the year. Demand and income elasticities for fruits and vegetables are low during their season (summer) and become quite high during their off-season (Nuckton 1985).

Demand functions for agricultural products in many other developed nations have features similar to those in the United States (Tweeten 1979). It seems that the growth potential of the markets for standard agricultural commodities in developed nations is quite limited, but product quality improvements may increase farmers' revenues substantially. Mellor (1988) argues that developing countries have the

TABLE 1  
Farm-Level Derived Demand Elasticities

Farm quantity	Price						
	Beef and veal	Pork	Poultry	Eggs	Dairy	Vegetables	Income
Beef and veal	-0.79	0.06	0.02	0.02	-0.02	0.00	1.02
Pork	0.09	-0.51	0.04	-0.01	0.00	0.00	0.64
Poultry	0.10	0.14	-0.42	0.02	0.01	0.05	1.13
Eggs	0.08	-0.02	0.02	-0.15	0.01	-0.01	-0.05
Dairy	0.00	0.01	0.00	0.00	-0.61	0.01	0.08
Vegetables	0.01	0.01	0.06	-0.01	0.03	-0.43	-0.21

Source: Wohlgenant, MK (1989) Demand for farm output in a complete system of demand functions, Amer J Agr Econ 71:241-252

potential to provide faster growing markets for agricultural commodities, since demands for these commodities grow in those nations faster than supplies. The rapidly growing nations of Asia (e.g., Korea, Taiwan, and Thailand) provide especially good markets for feed grains and meat products because the food consumption patterns of these countries have not yet stabilized and the income elasticities of their meat demands are quite high.

The design of policies to direct the development and modify the decomposition of the productive capacity of agriculture should take into account the differences in elasticities of demand between commodities, the increased earnings potential associated with higher product qualities, and the difference in the dynamics of the markets for agricultural commodities between developed and developing nations.

### **Substantial Randomness and Uncertainty**

Agricultural systems are subject to much randomness and uncertainty. Much of the randomness results from natural phenomena. The production of crops depends heavily on weather conditions, and yields vary as rainfall and climatic conditions change from year to year. Pest and disease problems are other contributors to the randomness in agricultural production. Economic conditions are also contributors to the randomness faced by agriculture through their impacts on inputs' prices, credit terms, and demand conditions.

Prices of agricultural commodities are varying quite substantially over time in response to changes in demand and supply conditions around the globe. There has been much variability in real prices of agricultural inputs over the last 20 years. The prices of many agricultural inputs (fuels, fertilizers, and pesticides) depend heavily on the price of oil, and the random variations in oil prices destabilized the prices of these inputs. Some inputs are imported, and their prices vary as exchange rates fluctuate. The real prices of credit for short- and long-term agricultural activities have varied in



response to economic conditions and government policies. Actually, government activities have been major resources of randomness and uncertainty for the farm sector (Rausser 1988).

Some of the government activities, besides monetary policy, which are likely contributors to randomness and uncertainty facing farmers include (1) the agricultural commodity programs and marketing orders; (2) immigration laws, the minimum wage, and workers' health and safety regulations; (3) pesticides and environmental quality regulations; and (4) tax policies at both the state and national levels.

There is a growing body of evidence that farmers are risk averse and are ready to give up some of their average income in return for less variability of the economic conditions they face (Zilberman and Buschena 1990). The evidence suggests that smaller farmers are likely to be more adverse to risk<sup>1</sup> than larger farmers. Moreover, farmers are especially susceptible to downside risk, and their desire is to manage this exposure (Antle 1987).

Many agricultural inputs and activities (irrigation, pesticide use, etc.) and institutional regulations and activities (insurance, futures markets, inventories, etc.) have emerged to manage the randomness and uncertainty faced by farmers. Some government policy interventions (inventory management policies, crop insurance schemes, and water reservoir management) are also designed to reduce randomness and instability facing producers and consumers. Redesign of such policies should recognize the impacts of public stabilization activities on private storage activities (Wright 1985). It is also important to provide coordination mechanisms for the control of different types of stocks, both inputs and outputs (Just, Lichtenberg, and Zilberman 1990a).

## **Asset Fixity**

Glenn Johnson (1958) coined the term "asset fixity," and its interpretation has been the subject of much controversy. According to Tweeten (1979), it was originally used to denote situations when gaps between purchase and resale (scrape value) prices of agricultural assets result in fixed asset-use levels (asset fixity) under a wide range of prices. It was also used to denote what Williamson (1985) defined as asset specificity, namely, the tendency of many agricultural assets and forms of capital to be specialized and not easily convertible to other uses. This rigidity is not restricted to physical assets such as the tomato harvesters or milking barns, etc.; it also applies to different forms of human capital. Hence, the transition of workers and assets in and out of the agricultural sector is not smooth. Changes in economic conditions—in particular, periods of down scaling and reduction of demand for agriculturally related skills—are likely to result in severe human adjustment problems. The specificity of many agricultural assets and skills cause their value to vary substantially with prices and conditions of agricultural commodities.

## **Competitive Structure**

In spite of the dramatic changes in technology and substantial increases in the sizes of farm operation, the agricultural sector has, on the whole, a competitive structure (Tweeten 1979). Family farms are still probably the dominant form of operation, even though many of them have become businesses grossing several million dollars annually. A competitive structure seems to exist in the production of major field crops, livestock, and dairy products. There is much vertical integration and centralization in the production of poultry and eggs, and there is a substantial amount of vertical interaction in the production of some fruits and vegetables. In spite of these cases, the competitive model is very useful as a basis for analysis in the farm sector.

Competitive behavior has been assumed in empirical analyses of price determination along the food marketing chain (Wohlgenant 1989). Rausser, Perloff, and Zusman (1987) question this assumption and suggest that contract theory and models of noncompetitive behavior are more appropriate for modeling the input markets as well as the assembly, processing, and distribution components of the food marketing chain. The nature of the products and the prevalence of long-term contracts in these markets led to rather fixed prices for processing and handling components of food items. This rigidity of response to change in economic conditions stands in contrast to the flexibility of raw farm product prices.

### **Imperfect Credit Markets**

Agriculture, like many other sectors of the economy, frequently faces imperfect credit markets. In particular, bankers use other signals besides interest rates to allocate credit, so that not all the demand for funds at a given interest rate is met. As a result, some of the better investment projects may not be financed. It has been argued (Stiglitz 1988) that credit market imperfections are the results of lack of perfect information on behalf of the lenders. Banks may not flawlessly discriminate between loan requests, and they have developed several mechanisms to assist them in screening applications and insuring repayments although these devices have their faults. Collateral financing has been used in many agricultural investments that might have caused discrimination against individuals with small landholdings with worthy projects. Moreover, instability of prices and income has affected the ability of farmers to borrow and invest. Credit is likely to be more easily available in periods of agricultural prosperity than agricultural recession, thereby hampering the ability of the farm sector to withstand hostile environments.

The growing reliance on debt-service financing in the agricultural sector in the middle 1980s may reduce some of the inequities and inefficiencies that are associated

with collateral financing. But even with debt-service financing, credit markets are far from perfect. Credit availability constraints are likely to limit farmers' ability to adjust to stricter policy regulations.

### **Exhaustible Agricultural Systems**

Agricultural production is the outcome of an interaction among human activities, natural resources, and the physical environment. Such activities involve the deployment of resources that are exhaustible or have a slow renewal rate. Topsoil, groundwater, and water quality are obvious examples of such agricultural resources. Hueth and Regev (1974) argue that pest vulnerability to pesticides is another exhaustible resource that has to be preserved. The potential greenhouse effect suggests that some view even temperate weather as an exhaustible resource. In any case, heavy dependence on the use of chemical inputs, groundwater, and soil-eroding practices may cause depletion of exhaustible agricultural resources and is likely to reduce the productive capacity of the agricultural sector in the long run.

Agricultural production activities are also partially responsible for environmental externality problems. Agricultural runoff and seepage of agricultural chemicals contaminate bodies of water, reducing their value as sources of drinking water as well as fishing and recreation sites. Straw burning and intensive tillage practices pollute air resources and reduce air quality. These externality problems must be taken into account in the designing policies that affect the agricultural sector.

The externalities, and particularly the resource exhaustibility problems associated with agricultural production systems, are becoming increasingly severe over time. For example, the intensive use of center-pivot irrigation of the last 20 years has led to substantial depletion of the Ojallala aquifer, leading to curtailment of irrigation activities in some parts of Texas, the High Plains, and Oklahoma (El-Ashry and Gibbons 1983). In the literature on exhaustible resources (Dasgupta and Heal

1979), it is argued that, unless rates of technological change are extremely high, the efficiency prices of exhaustible resources tend to increase over time. Moreover, free market prices of exhaustible resources may diverge substantially from their efficient prices, and government intervention may be needed to assure efficient utilization of these resources. Social management of natural systems involving exhaustible and slow-to-renew resources such as forests and fish populations requires that long-term dynamic considerations be incorporated explicitly into policymaking frameworks.

### **Heterogeneity**

The agricultural sector and individual agricultural industries are subject to much heterogeneity. There are many differences in environmental conditions, economic situations, and productivities between regions in the United States. The qualities of natural resources such as water and soil are the subject of much heterogeneity. It was suggested (see surveys by Feder, Just, and Zilberman 1985; Thirtle and Ruttan 1987) that heterogeneity is a major cause for the gradual processes of diffusion of new technology in agriculture. Farm size differences were found to be the major explanatory variable for differences in the tendency to adopt "lumpy" technology such as tractors and computers (Putler and Zilberman 1988). The dimensions of heterogeneity among individuals that were found to substantially affect technological choices include education or human capital, age, wealth information, and risk preferences.

The surveys present evidence that differences in physical features such as weather, land quality, and infrastructure were responsible for differences in adoption patterns between regions. Heterogeneity of the farm population is reflected by the partial participation in many government commodity programs. Rausser, Zilberman, and Just (1984) demonstrated that high-quality lands are more likely to be utilized by participants in diversion programs who tend to divert low quality lands. Calvin (1988)

found that size, financial situation, and productive capacity affect program participation choices.

The sweeping aside of heterogeneity and variability can indeed be dangerous. It has been shown on many occasions that the use of aggregate relationships, which assumes average behavior to be representative, can lead to a very erroneous policy analysis. For example, an analysis of the impact of pollution regulations with a representative farm is likely to conclude that the introduction of a pollution tax will reduce both total output and the pollution/output ratio. Hochman and Zilberman (1978) showed that, for the case of a polluting industry where more cost-effective, modern producers are also more pollution intensive (generating more pollution per unit of output), a pollution tax tends to reduce total pollution but may increase the pollution/output ratio since it may cause the older, less cost-effective, and polluting producers to terminate their operations. They also showed that, with heterogeneity, a tax may attain a regional pollution target at least cost but a standard may attain it with more output and cause smaller increases in price. The recognition of heterogeneity is also essential for analyzing intergroup equity. There has been much concern about the impacts of policies on the distribution of income within agriculture and the structure of agricultural industries (Tweeten 1979). Moreover, the impacts of regulation may vary drastically across regions because of their inherent heterogeneity.

Table 2, taken from Lichtenberg, Zilberman, and Harper (1988), demonstrates the differences in regional welfare effects associated with government regulation using parameters of the cotton industry at the late 1970s. The table presents the relative welfare impacts of regulations (e.g., pest control) that increase producer costs by 1 percent. Cotton producers are divided to four regions (Southeast, Delta, Plains, and West), and impacts of policies affecting each of these regions are estimated for all producer groups, consumers, and society as a whole. The analysis recognizes export demand for the product; accordingly, the impacts of the cost-increasing policies on

TABLE 2

Welfare Impact of a 1 Percent Increase in Cost  
(Percentage Change in Welfare)<sup>a</sup>

Region affected by regulation	Producers' surplus				Total producers' surplus	Domestic consumers' surplus	Net domestic surplus	Export revenue
	Southeast	Delta	Plains	West				
From a percent increase in cost								
Southeast	-5.41	0.20	0.16	0.20	0.10	-0.10	0.06	0.11
Delta	2.02	-2.96	0.46	0.58	0.07	-0.30	0.00	0.31
Plains	0.53	0.15	-0.12	0.14	0.02	-0.08	0.01	0.07
West	0.70	0.20	0.15	-0.50	-0.08	-0.10	-0.08	0.11

<sup>a</sup>Surpluses and export revenue in millions of dollars.

Note: The Delta states are Arkansas, Louisiana, Mississippi, Missouri, and Tennessee; the southeast consists of Alabama, Georgia, North Carolina, and South Carolina; the Plains states are Texas and Oklahoma; and the West is California, Arizona, and New Mexico.

Source: Lichtenberg E, Zilberman D, Harper, C (1988) Heterogeneous production and input regulation in agriculture. Unpublished manuscript, University of California at Berkeley

export revenues are considered. It shows that the overall effects of a 1-percent increase in cost in any of the regions are quite small. However, increases in cost in three of the regions are likely to increase overall U.S. welfare due to increases in price and export revenues. On the other hand, an increase in California's cost will reduce overall welfare because of the low supply elasticity of producers in that state.

A 1-percent increase in cost across the board will have a substantial effect on the overall domestic welfare. It will reduce consumer welfare and the welfare of growers in the Southeast and Delta (those regions with high cost and elastic supply) and increase the welfare of California and Plains producers (lower cost and inelastic supply). Relatively, the distributional impacts reflecting heterogeneity among producers in this example are much larger than the overall efficiency effects.

#### **Agricultural Policies and the Tendencies to Oversupply in Agriculture**

Agricultural economists such as Schultz (1953) and Cochrane (1958) have argued that the inherent features of the agricultural sector can lead to an "oversupply" trap—namely, situations where rates of return in the agricultural sector are far below the rest of the economy. The inelastic nature of the demand for agricultural products, the constant development of new agricultural technologies and product varieties, and the "rigid" nature of agricultural assets and inputs (the transformation of agricultural labor and many forms of capital to nonagricultural uses is rather costly) are among the causes of this oversupply problem. In recent years, however, it has become increasingly clear that government policies have made the situation worse. Government price support and inventory management programs actually contributed to increased production and inventory accumulation. Income-support schemes, such as diversion payment and even some set-aside programs, are likely to contribute to oversupply.



Past policies have not decoupled income support levels from the actual production levels. Instead, they presented incentives to farmers to overinvest and overproduce. A recent study (Just, Lichtenberg, and Zilberman 1990b) demonstrates empirically that deficiency payments contributed substantially to extensive introduction of center-pivot irrigation and overexploitation of resources in the Midwest. Rausser, Zilberman, and Just (1984) argued that, because of land quality heterogeneity, farmers tend to set aside lower quality lands, and that action serves to increase per-acre yield after diversion. High and secure target prices tend to encourage use of variable inputs above what is suggested by market prices, and that serves as another source of increased supply. Finally, it has been recognized that the use of current performance as a base for future transfers has made modified target prices (reflecting diversion requirements) serve as a "de facto" price with respect to long-term decisions. This, too, has contributed to an upward bias in agricultural supply.

Another major concern, closely related to the "oversupply" problem, is the instability of agricultural production levels and prices. The "oversupply" problem, caused by inherent properties of the agricultural sector and modified by government policies, has resulted in agricultural prices and returns that, on the average, are too low. However, the extensive economic literature on stabilization has demonstrated that price and quantity fluctuations have been sources of much welfare loss. The instability and randomness of agriculture mentioned above have been major contributors to price instability, but other factors (especially economic variables affecting demand, such as exchange rates and overall income fluctuations) have also been sources of instability. Moreover, the inelastic nature of demands of agricultural products has magnified the fluctuation in prices in response to variations in supply. Government has constantly attempted to reduce the variability of agricultural prices

through inventory control policies. These policies have been very costly because they have led to rapid accumulations of grain stocks.

Research on the economics of stabilization (Newbery and Stiglitz 1981; Wright 1985) has indicated some of the pitfalls associated with programs aimed at stabilizing prices. They argue that public inventory control activities, in part, served to replace private storage activities and are also a form of income transfer to producers. They also argue that public inventory support programs may reduce economic welfare by leading to excessive stock accumulation. Thus, any policy reform aimed at addressing the oversupply problem should reduce the tendency to accumulate excessive inventory levels while limiting agricultural prices within a reasonable range.

#### **Policy Reform: The Replacement of Coupled Policies with Less-Coupled Policies**

The low prices and returns for producers in the farm sector, representing excessive productive capacity and requiring increasing government supports, have been major issues of concern. The sustainability and the environmental consequence of agricultural production activities have also become subjects of much concern. A major cause for the excessive supply and production in agriculture is the introduction and intensive use of modern inputs such as chemical fertilizers and pesticides. Many of the inputs used by agriculture are exhaustible resources; they include water stocks and quality, topsoils, and vulnerability to pesticides (which reflects a worrisome increase in pesticide resistance). Continuous depletion of these agricultural resources place at risk the sustainability of existing production levels—not to mention the ability to increase production in the long run.

Moreover, the use of modern inputs in agriculture has resulted in substantial externality costs. Agricultural chemicals are major contaminants of bodies of water reducing productivity of many fisheries and risking the health of consumers. For

example, the use of DBCP in California has resulted in a substantial cost (up to \$100 per person annually in the Fresno area) of providing safe drinking water (Lichtenberg, Zilberman, and Bogen 1989). While it is difficult to quantify the costs of groundwater contaminations by agriculture, a partial estimation of these costs (excluding unquantifiable biological effects) done by Christensen and Ribaudo (1987) showed it to be higher than \$2.5 billion annually. Thus, the "flip side" of the "excessive supply" problem is the excessive depletion of agricultural resources and negative externalities imposed by agriculture. Note that a reduction in production levels may alleviate both problems, and policies addressing one problem (the excessive supply problem) may also serve to address the other problem.

Another issue of concern is maintenance of the competitive structure of agriculture and the traditional life-style viability of rural communities. This concern is of much importance in Europe where countries such as France and Germany have made substantial efforts to preserve their rural communities and life style. Technological changes, combined with the rise in labor cost and reduction in food prices, tend to increase the size of viable agricultural operations. The resulting structural change in the average farm size implies substantial reduction in the number of farms. This process endangers the survival of many "family farms" and preservation of the rural sector.

Equity and distributional considerations play a crucial role in policy design. As Peltzman (1976) argued, the distributional effects of a policy determine its political palatability. As proposed in Just, Rauser, and Zilberman (1990), policy analysis and design efforts have to estimate the distributional implications of a proposed policy and suggest compensation arrangements that will assure the policymaker political support. One has to distinguish between intersectoral and intrasectoral considerations and admit both in the policy framework. One manifestation of intersectoral heterogeneity is farm size distribution. Regional heterogeneity is

another source of concern, and regional considerations are especially important in determining the political response to agricultural policy reform. Furthermore, the intraregional impacts of certain policies (especially resource use and environmental regulations) may be larger than the other efficiency effects. Regional impacts must be assessed in the design of policy reform, and regional considerations should have a high priority in the design of compensation schemes needed to politically facilitate welfare-improving policies.

Intrasectoral effects include impacts of policies aimed at one agricultural commodity which spill over to the production and consumption of other products. The first type of impacts includes assessment of, say, sugar import quotas on corn production and prices or impacts of policies affecting the supply and price of corn on the livestock sector.

Agricultural policies have been viewed over the last 55 years as part of a policy whose ultimate objective was to provide sufficient and affordable food to the U.S. population. Food-aid policies (Food Stamps; Women, Infants, and Children; P.L. 480) have been included as part of this overall policy mixture. Accordingly, policy reform must explicitly address impacts of policies on consumers' welfare, especially welfare of the poor. Finally, a major impetus for the design of agricultural policy reforms is the heavy burden that the finance of agricultural programs imposes on government. Implied government expenditures must necessarily be a key criterion for assessment of any new policy design.

The changes and problems of the agricultural sector dictate several key objectives that a comprehensive policy must consider. These objectives are (1) to secure food supplies at reasonable prices; (2) to prevent hunger and assure adequate nutritional intake for critical population groups (children, pregnant women, etc.); (3) to assure stable and fair returns and income to farmers and the rural sector; (4) to control depletion of agricultural natural resources and work toward a sustainable agricultural

system; (5) to maintain environmental quality and control the negative environmental side effects of agricultural production; (6) to protect the health and safety of farmers, farm workers, and consumers; (7) to preserve the integrity of the rural sector and protect the viability of "family farms" and the competitive nature of agricultural industries; (8) to obtain efficiency in resource allocation and production patterns; (9) to promote innovation and flexibility in agriculture and food production; and (10) to reduce the burden imposed on government financing of agricultural and food programs and policies.

A consensus has emerged that past policies have been inefficient in terms of objectives (1)-(10) and that income-support policies "overshot" in providing food supply at affordable prices. New policies should avoid this trap and achieve their objectives without expanding supply. This suggests the need for "decoupling"—setting entitlements criteria that do not affect production while achieving other goals.

Government policies have resulted in excess productive capacity of agriculture in the United States, Western Europe, and other developed countries. A policy reform should consist of two elements. First, it should induce gradual down scaling of agricultural sectors of these countries so that, within a transitional period, agricultural markets will attain a sustainable set of equilibria which improves welfare and the performance of the agricultural and food production sectors. Once agricultural markets approach these equilibria, government policies will allow sustainable growth in the future, with the sector becoming more flexible and progressive. The design of a policy reform requires the identification of effective policy instruments and the development of procedures for setting their levels as well as for their enforcement, monitoring, and adjustment over time. The assessment and selection of policies should be done within a decision-making framework that operates to increase economic efficiency while recognizing and incorporating political economic constraints. The next section

introduces such a framework and spells out its implications regarding information and assessment criteria for the policy instruments' selection.

### **A Framework for Selection of Policy Instruments**

Just, Rausser, and Zilberman (1990) argue that a framework must balance efficiency and equity considerations when selecting welfare improving and politically feasible policy reforms. Thus, a framework for the determination and analysis of policy reform should develop functional relationships measuring the economic welfare effects and political feasibility of policy instruments.

Welfare economics provides justification for the use of appropriate summation of economic surpluses as a measure of economic welfare and efficiency. The recent literature on political economy (Becker 1983; Peltzman 1976; Rausser 1982; Gardner 1988; de Gorter 1983) provides alternative frameworks for modeling the politically feasible set of agricultural policies. The model here applies assumptions and formulations that are similar to the ones used in recent empirical political economic models of agricultural policy choices (de Gorter 1983; Guttman 1987). Specifically, it assumes that a policymaker presents a proposal for a vote by a legislative body (e.g., U.S. Congress or Parliament in a European country) or even a referendum by the general population. The choices of the voters (congressmen, senators, Parliament members, or the general public) are assumed to be affected by the impacts of the policy on the welfare of different groups they represent, belong to, or support. It is also assumed that the policymakers cannot predict voters' responses to policy proposals and that proposals are shaped so that the voting uncertainty is controlled.

#### **The Model**

Assume that a legislative body has  $N$  members. Let  $i$  be a member indicator;  $i$  assumes values from 1 to  $N$ . The legislators vote whether to accept or reject specific

policy proposals, and each member has one vote. Let  $X$  be a policy proposal vector. It is a vector of values of specific policy instruments, such as price support, set-aside level, etc. Assume that there are  $K$  policies, and  $x_k$  is the value of the  $k$ th policy,  $k = 1, K$ .

Suppose that there are  $M$  identity interest groups in the economy, and let the variable  $j$  be a group indicator,  $j = 1, M$ . The groups considered in the analysis may include consumer and producer groups of different products at different locations, workers, input providers, owners of resources, environmental groups, etc. An individual vote may be concerned about the welfare of several groups. The welfare of group  $j$  as a function of policy proposal  $X$  is denoted by  $w_j(X)$ . Let  $W(X) = [w_1(X), w_2(X), w_M(X)]$  be a vector of welfare functions.

The selection of a new policy is done under uncertainty regarding legislative behavior, hereafter for the sake of generality referred to as voter behavior. Voter  $i$ 's response to policy  $X$  is denoted by his voting function,  $v_i(X)$ . When the voter supports the policy,  $v_i(X)$  is equal to one; when he/she does not vote for it,  $v_i(X)$  is equal to zero.

Following McFadden (1976), the voters' choice function is presented as a sum of a systematic and a random element, i.e.,  $v_i(X) = h_i[W(X)] + \varepsilon_i$ . The systematic element,  $h_i[W(X)]$ , is the probability that voter  $i$  will support policy  $X$  and is a function of the impacts of the policy on the welfare of the different groups. The random element is denoted by  $\varepsilon_i$ , a random variable which has a zero expected value.

The political support for policy  $X$ , measured by the fraction of voters who vote for it, is denoted by the random function

$$V = \frac{\sum_{i=1}^N v_i}{N}$$

The decomposition of the individual voting functions to systematic and random elements leads to similar decomposition of total political support to

$$(1) \quad V(X) = H[W(X)] + \theta$$

where

$$H[W(X)] = \frac{\sum_{i=1}^N h_i[W(X)]}{N}$$

is the mean level of support to policy  $X$  (expected fraction of voters which will support  $X$ ) and  $\theta = \sum_{i=1}^N \varepsilon_i / N$  is the random deviation of political support from its mean. Obviously, expected value of  $\theta$  is zero. For simplicity of exposition, it will be assumed throughout most of the paper that  $\theta$ 's behavior is unaffected by the policy considered.

To derive the politically feasible set of policies, assumptions on the behavior of the policymaker have to be introduced. It is assumed that the policymaker considers only policies that have a high likelihood of attaining a minimum level of political support. Thus, two parameters that define the feasible set are  $S$ , the threshold level of political support, and  $\alpha$ , the degree of statistical reliability that the threshold has met.

Let  $Pr$  denote probability. The politically feasible set of policies is defined by

$$\{X: Pr[V(X) \geq S] \geq \alpha\}.$$

Let  $F_{\theta}(\cdot)$  be the cumulative distribution of  $\theta$ . This definition and the decomposition of  $V(X)$  in equation (1) yields

$$F_{\theta}\{S - H[W(X)]\} = Pr[V \leq S].$$

Using this equation, the feasible set becomes



$$(2) \quad (X: F_{\theta}\{S - H[W(X)]\} \leq 1 - \alpha).$$

When policies are determined by a majority rule,  $S$  is likely to be at least one-half. Policy designers may aim at a wider base of supports, represented by a higher threshold level, so that the survival of the policy is protected from slight changes in the political power structure. The choice of the reliability factor is similar to the choice of significance level in a statistical test. Therefore, the statistical reliability factor is likely to be .9 or .95. Higher levels of the reliability factor can be interpreted as reflecting a higher aversion to risk by the policymaker.

Let  $B(X)$  denote the gain in efficiency (relative to the initial situation) as a function of a policy reform vector  $X$ . A reasonable measure of efficiency, to be used on constructing  $B(\cdot)$ , is the sum of producers' and consumers' surpluses and net government expenditures in the affected markets. Using this definition and the definition of the politically feasible set (2), a policy reform that maximizes efficiency gains subject to the political feasibility constraint is found by solving<sup>2</sup>

$$(3) \quad \max_X B(X)$$

subject to  $F_{\theta}\{S - H[W(X)]\} \leq 1 - \alpha$ .

The solution to the decision problem (3) is a safety rule of the type presented in Roumasset, Boussard, and Singh (1979). Lichtenberg and Zilberman (1988) applied a similar safety-rule formulation to analyze regulatory choices of activities covering environmental and health risks. They argued that many government regulations under uncertain situations are consistent with this rule. The use of this safety rule for choices under uncertainty is consistent with the widespread use of classical statistics for testing scientific hypothesis.

Using the Lagrange multiplier technique, the optimization problem (3) can be presented as

$$(4) \quad \max_X \left\{ B(X) + \lambda [1 - \alpha - F_\theta \{S - H[W(X)]\}] \right\}.$$

When  $\lambda$  is the shadow price of the political constraint, it denotes the marginal efficiency gain associated with a marginal reduction in the probability of meeting the political support threshold. When the political constraint is binding and  $\lambda > 0$ , efficiency is sacrificed to increase the probability of political support for the policy. Thus, when the political constraint is binding, efficiency is below its maximal level, but the welfare of the groups that have political power is higher than under the maximum-efficiency outcome.

The first-order condition to the optimization problem is

$$(5) \quad \frac{\partial B}{\partial X} = \lambda f_\theta \{S - H[W(X)]\} \frac{\partial H}{\partial W} \frac{\partial W}{\partial X}$$

where  $\partial B/\partial X$  is a  $(K \times 1)$  vector of the marginal contribution of policies to efficiency,  $f_\theta(\cdot)$  is the density function of the random variable  $\theta$  (and thus is the first derivative of the cumulative distribution function),  $\partial H/\partial W$  is a  $1 \times M$  vector of the marginal impacts of changes in welfare of the  $M$  different interest groups on the mean support, and  $\partial W/\partial X$  is an  $M \times K$  matrix of the marginal impacts of each of the  $K$  policies on the welfare of each of the  $M$  groups. The optimality condition (5) states that the policies will be set at levels where their marginal efficiency effects are equal to the value of their marginal contribution to probability of reaching the political support threshold. In particular, the optimal level of policy will be determined where

$$(6) \quad \frac{\partial B}{\partial x_k} = \lambda f_\theta \{S - H[W(X)]\} \sum_{j=1}^M \frac{\partial H}{\partial w_j} \frac{\partial w_j}{\partial x_k}.$$

In this case,  $x_k$  is set so that its marginal contribution to efficiency is equal to the product of  $\lambda f_\theta$  at  $\{S - H[W(X)]\}$  and the sum of the effects of a marginal change in policy  $k$  on the mean support resulting from changes in the welfare of the different interest groups. Condition (6) implies that, when the density function varies little around the optimal solution and the mean support can be approximated as a linear function of the welfare of different groups, the policy choice problem can be approximated by the following maximization problem:

$$(7) \quad \max_x \left\{ B(X) - \sum_{j=1}^M \beta_j W(X) \right\}$$

where  $\beta_j \doteq \lambda f_\theta \frac{\partial H}{\partial w_j}$ .

There is a wide body of literature that uses agricultural policy as a result of a maximization of weighted sum of the welfare of different groups (Zusman 1976, Rausser 1990, de Gorter and Zilberman 1990). Applied works on the economics of regulation (McFadden 1976) estimated a social welfare function that is a weighted sum of welfare associated with several social objectives. The decision-making framework presented here gives rise to an approximate linear policy choice problem.

Condition (6) also implies that the optimal levels of two policies,  $k$  and  $l$ , are determined such that the ratio of their marginal contributions to efficiency is equal to the ratio of their marginal contributions to political support, i.e.,

$$(8) \quad \frac{\partial B / \partial x_k}{\partial B / \partial x_l} = \frac{\sum_{j=1}^M \frac{\partial H}{\partial w_j} \frac{\partial w_j}{\partial x_k}}{\sum_{j=1}^M \frac{\partial H}{\partial w_j} \frac{\partial w_j}{\partial x_l}}$$

The left-hand side of equation (8) can be viewed as a marginal efficiency rate of substitution (MES) and the right-hand side as a marginal political rate of substitution (MPS) but, at an optimal solution, the two are equal.

The optimal policy  $X$  depends on the political support target  $S$  and the reliability of support  $\alpha$ . The marginal cost of reliability (in terms of efficiency) is  $\lambda$  (since  $-dL/d\alpha = \lambda$ ) and the marginal cost of the political support target  $s$  is  $dL/dS = \lambda f\theta$ . Both marginal costs are likely to be increasing<sup>3</sup> since the cost-conscious policymaker is likely to obtain the support of voters who are more inclined to support the reform first and pursuing voters who are less favorable later. The ability of the policymaker to attain and secure support is quite limited, however, since changes that increase the political support base reduce overall welfare and make the nonsupporter worse off. Thus, the cost of further support may become prohibitively expensive.

For each level of efficiency, one can form a political feasibility frontier denoting the highest attainable combination of  $\alpha$  and  $S$ . Figure 1 depicts this frontier. Each of the curves is likely to be concave, since the marginal costs of  $\alpha$  and  $S$  are increasing. The curve AB denotes the possibility frontier for the efficient solution (not constrained optimization). Higher political feasibility frontiers correspond to lower efficiency levels. The upper bound of the political feasibility frontiers is presented by curve CD.

To illustrate the properties of this political possibility frontiers, consider the case where the random variable  $\theta$  is normally distributed with mean 0 and variance  $\sigma^2$ . For a given policy  $X$  and reliability of support  $\alpha$ , threshold of political support is equal to

$$S = H[W(X)] + Z_{1-\alpha} \cdot \sigma$$

when  $Z_{1-\alpha}$  is a value of standardized normal random variable where the cumulative distribution is equal to  $1 - \alpha$ . Thus, the threshold support will be equal to  $H[W(X)]$  when  $\alpha = .5$ , equal to  $H[W(X)] - 1.65 \sigma$  when  $\alpha = .95$ , and  $H[W(X)] - 1.96 \sigma$  when

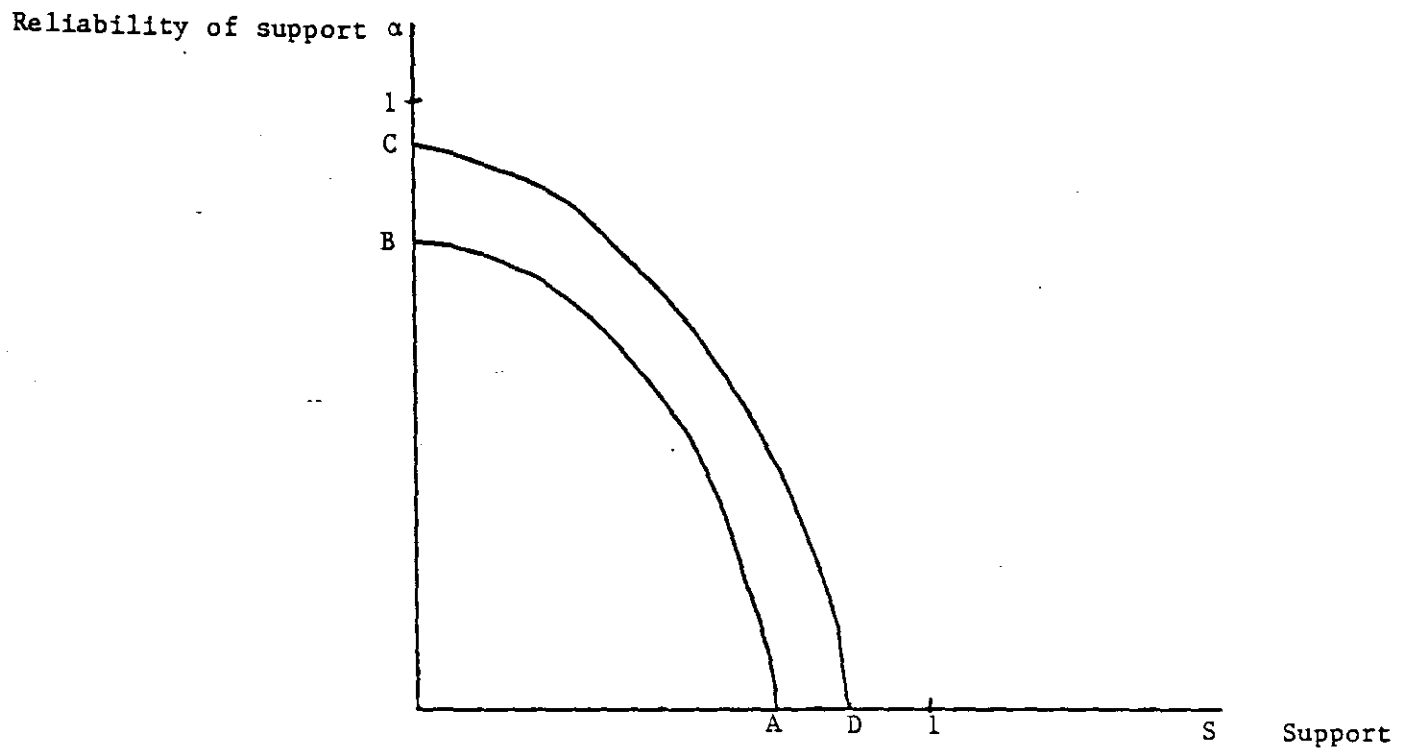


FIGURE 1. The Trade-Off Between Political Support and Its Reliability

$\alpha = .975$ . This example illustrates that, for a given policy, the marginal reduction in support threshold needed to increase the reliability of support is increasing with  $\alpha$ .

The analysis thus far assumed that the random elements of the voting functions are not affected by the policy choice. The analysis can be expanded to allow policy selection to affect both the systematic and random elements of the voting function. Using the formulation suggested by Just and Pope (1979), the aggregate voting function can be presented as  $V = H[W(X)] + U[W(X)]\theta$  where  $U(\cdot)$  denotes the impact of policies (through welfare of different groups) on the random elements of voting behavior. With this extension, the determination of an optimal use of a policy will consider its marginal impacts on efficiency, expected voting behavior, and the variability of voting behavior. Under this assumption, each political possibility frontier will correspond to several policies that yield the same efficiency effects. Some of the policies will attain higher support thresholds and others will lead to high political reliability.

### Considerations for Policy Reforms' Assessment and Design

The model presented above provides directions for information gathering and criteria for assessment and design of individual policies and policy mixes. These criteria should guide both quality and quantity assessment of new policies and be used for designing qualitative decision-making tools. Some of the key considerations for assessment and design of individual policy reforms include:

Efficiency Impact.—Impact of the policy on efficiency of resource allocation. Standard surplus measures can be estimated to provide aggregate efficiency impacts on traded goods, even under conditions of uncertainty (Just, Hueth, and Schmitz 1982; Pope and Chavas 1985). One may need to develop and apply quite ingenious mechanisms to assess efficiency impacts on nontraded goods including risks to life

and limb, environmental amenities, etc. (Lichtenberg and Zilberman 1988; Mitchell and Carson 1987).

Distributional Impacts.—One has to identify the gainers and losers from every proposed policy and regulation. Such analyses should take into account several of the dimensions of heterogeneity in the agricultural economy—e.g., sectors, sizes, and regions. Some of the big national agricultural models (C.A.R.D.) can be used to provide initial data and information for these types of analyses, especially when a high degree of detail is required.

Surplus measures can be utilized to obtain the distributional effects of policies within markets. For example, analysis of the market effects of a pesticide control policy can apply surplus measures to estimate the impacts of the policy on consumers, producers in different regions (differentiating users from nonusers), pesticides, other input manufacturers, etc. (Lichtenberg, Parker, and Zilberman 1987). While applications of this type of analysis seem straightforward, note that appropriate incorporation of international trade considerations, monopolistic and oligopolistic behavior, and imperfect information and uncertainty consideration within this framework requires much ingenuity and effort. Still, these distribution effects can be presented in clearly defined monetary terms. Quantification of nonmonetary effects of policies might be very difficult, and expression of these effects in monetary terms is sometimes impossible. For example, a pesticide control policy may affect the health and well-being of growers, pesticide applicators, farm workers, and consumers; and the estimates of such effects are subject to very high degrees of uncertainty (Harper 1987). There is much controversy regarding the appropriate procedure for monetary assessment of days lost due to diseases and lives lost due to accidents (Zeckhauser 1975). Therefore, for analysis, it may be useful to present estimates of the real impacts of policies on health and lives with a given degree of statistical significance (Lichtenberg and Zilberman 1988).

Policy Ramifications of Distributional Impacts.—The distributional effects of policies are represented by the function  $W(X)$  in the model. The model suggests that assessment of political support for policies also requires knowledge of  $H(W)$ , the weight that different impacts have in shaping voting behavior.

Several studies (de Gorter 1983; Guttman 1987) have applied econometric techniques such as logit and Tobit to congressional voting data to estimate impacts of certain factors (including some proxies for distributional effects) on voting behavior. These studies clearly show that voting patterns of individual representatives are consistent with the economic interest of the regions represented by these representatives. Further applications of these kinds of models, using appropriate measures of distributional effects as explanatory variables, are needed to allow better prediction of voting patterns in response to policy changes.

Assessment of Policy Mixtures.—Solving the decision problem in (3) requires knowledge of the efficiency and distributional impacts of alternative policy instruments. The assessment of these policy impacts should not be restricted to analyses of impacts of individual policy instruments but should include assessments of the impacts of policy instruments' mixtures. Policy instruments may have complementarity or substitution relationships. They operate jointly and in correlated manners to affect distributions of key variables such as farmers' earnings and food prices and quantities. These correlations and dependency relationships suggest that prices of a policy mix are likely to be different sums of outcomes and impacts of the individual components.

Just, Lichtenberg, and Zilberman (1990a) have demonstrated that independent management of grains and water inventories by uncoordinated activities of government agencies may lead to substantial welfare losses. Lichtenberg and Zilberman (1986) have shown that the market efficiency impacts of environmental regulations in agriculture are likely to be substantially overestimated when the



existence and effects of commodity programs are ignored. Therefore, policy analyses and policy design should develop mechanisms for coordinated management of policy instruments and also assess impacts of policy mixtures.

Policymaking as an Iterative Process.—The construction of a policy reform is an intensive and iterative process involving several rounds of negotiations at different levels. There are many participants in this process including government officials who may initiate the process, representatives of interest groups (lobbyists), and the voters. These voters (congressmen and senators) are not passive participants in the process but, rather, active participants in negotiations and modifications of proposals. There are many who view these process as a game with many participants and who analyze its outcome accordingly (Abler 1985).

The model presented above may provide the agencies which initiated the policy reform with a good initial proposal and help to guide them in negotiations and when updating reform parameters. Figure 2 illustrates how the approach presented here can be incorporated in the iterative process of shaping the policy reform. First, a data collection and modeling effort will be taken to estimate parameters needed to predict impacts of alternative policies and the political importance of different power groups. Parallel to these data collection and estimation efforts, different interest groups and their political representative organizations should be identified. These available information will be used in the establishment of an initial proposal that will be negotiated with representatives of interest groups and other political power brokers. The negotiation process may lead to either the implementation of a proposal (with some modifications) or to a reassessment of political realities, redesign of policy, and a new round of negotiations. These negotiations will continue until an acceptable formula is reached.

As both political and physical realities are changing over time, key elements of the policy reform will have to be modified and updated. Thus, the legislative process

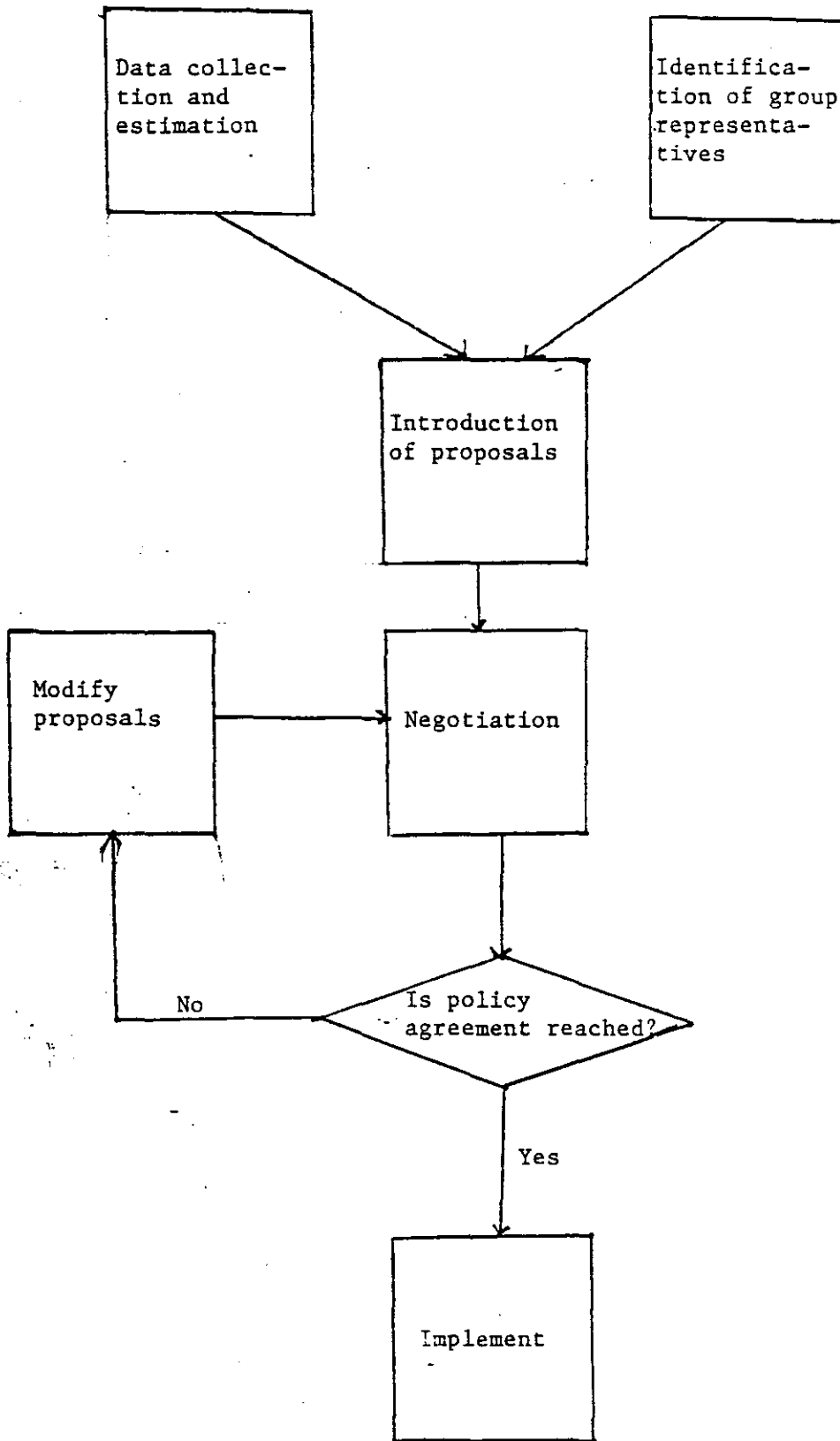


FIGURE 2. Schematic Presentation of the Policy Reform Process

described in Figure 2 will have to be conducted once every 5 or 10 years. The modeling approach presented here will provide a consistent and systematic framework for assessment of realities and introduction of policy changes.

Policy Adjustments Over Time.—The formal model presented above does not explicitly introduce dynamic aspects of the policy reform, but these aspects should not be overlooked. The objective of the policymaker is to enhance and improve efficiency over time, relative to the initial conditions. Policy reforms should include two components—dynamic adjustments that will lead the agricultural economy worldwide to a sustainable competitive equilibrium and control policies that assure maintaining the equilibrium once it is attained. Given the oversupply problem, the dynamic adjustment will result in down scaling of the overproductive capacity of agriculture and the design of efficient orderly transfers of resources to other sectors. Because of their importance, dynamic aspects will be addressed in detail later in this paper.

Impacts of Policy Instruments on Policy Objectives.—Some of the classic works on the economics of public policy (Tinbergen 1967) view policy design as the choice of instruments to attain social objectives. One of the implications of the model presented here is that policies are evaluated by their contribution to efficiency and the weighted welfare of different groups in the economy, where the weights reflect the political power of the different groups.

Since surplus measures are used to evaluate the groups' welfare, interest groups are designated in correspondence to (market and nonmarket) goods analyzed in the model. Thus, producers of corn in different states, consumers of milk, and users of water which was contaminated by wheat production are examples of the types of interest groups treated by the model. Measures of welfare of these types of groups are likely to be related and even expressed in terms of objectives such as producers' income, affordable food, and water quality. Hence, the model implies that policy instruments are selected in a way that maximizes social welfare as a

multidimensional function of policy objectives. Thus, the outcome of the "political-economic" framework presented here can be expressed in terms of the Tinbergen framework. In the next section, the impacts of some of the instruments proposed as part of the policy reforms are analyzed qualitatively. Impacts of policy instruments will be analyzed in terms of policy objectives presented earlier and in terms of welfare of certain groups.

### **Instruments for Agricultural Policy Reform**

The multitude of policy objectives in agriculture suggests that a large number of policy instruments should be employed. Some instruments will be designed and controlled to attain target levels of specific objectives, but overall analysis of a policy package should recognize that individual instruments affect several objectives simultaneously.

A key feature of the agricultural policy reform is the restriction of the set of agricultural policy instruments to those that attain desirable policy objectives without causing excessive agricultural productive capacity. The following is the analysis of the impacts of policy instruments that should be considered as elements of the policy reform. It is argued that they can be combined to achieve multidimensional policy objectives while being "less coupled" than current policies.

#### **Minimum Income Assurance Programs**

This is a "safety net" program that assures farmers (and other members of the rural community) a certain income floor. Entitlement for the program will depend on income, wealth, and a socioeconomic factors (e.g., family size). This program may have two goals. One is to assist the very poor and raise their income and living standards constantly. The other is to assure rural citizens adequate income at low

points of the business cycles. The two goals may require separate mechanisms and are likely to be relevant for separate populations.

The first goal is a standard antipoverty goal and is appropriate for the very poor and disadvantaged in the rural sector. The second goal is to protect farmers and other members of the rural community from "hard time" periods when prices are low, yields are low, etc. Farmers may not be in the greatest need for such a program to the extent that they are protected by crop insurance or may use futures markets, etc. Individuals who provide services to farmers—small dealers, farm workers, etc.—are at least as vulnerable economically to the downside of agricultural business cycles as farmers; and such programs may protect them. To avoid government or public sector failure, eligible individuals—farmers, farm workers, and agro-businessmen—may need to buy the rights for this income-support program by paying a fee or a premium.

#### General Assistance

The goal of assuring minimum income to all members of most sectors may be obtained best within the framework of general assistance (welfare) programs that exist in many countries. Such programs may have stipulations that may discriminate against the rural sector (partly because this sector has benefited from sector-specific programs). As agricultural support programs are being down scaled and eliminated, the range of entitlements of farmers and rural people for the benefits of general welfare programs should increase.

#### Decoupled Revenue Support Programs

The minimum income assurance program mentioned above is, in essence, a welfare program applicable only to part of the farm sector's population. However, low farm product prices affect all members of the farming community and reduce farm incomes across the board; revenue assurance programs address this issue. In the

program considered here, each entitled farmer is assigned a target revenue and an output base and receives the difference between the target revenue and output base times actual price when this difference is positive. This program is essentially a deficiency payment program where each farmer is assigned a revenue base instead of a yield and acreage base. The key elements of this program are that it will continue over a long planning horizon and it will not be modified according to past behavior. (The revenue base may be linked to some inflation index.) Disallowing modification of the base according to performance will serve to reduce the impact of the program on supply (it cannot be eliminated if producers are risk averse).

It is difficult not to modify entitlement bases as time passes since there are dynamic changes in land allocation, and base assignments need to resemble reality. Therefore, one cannot maintain a decoupled revenue support program forever. Such a program will be used for a transition period when agriculture is down scaled and the range of support provided by the program will gradually decline. During such a period, excessive supply has to be eliminated and output price has to rise sufficiently to allow a fair return (income) from farming without support. Once agricultural markets attain equilibria, it is desirable to minimize the use of revenue support programs.

#### Land Retirement Programs

The excessive production of agriculture gives rise to policies that attempt to reduce this capacity while serving other social objectives. Programs that restrict and control the use of exhaustible agricultural resources and agricultural pollution can serve this purpose. Some of these programs can be similar in structure to existing set-asides or conservation reserve programs, namely, farmers will be paid a certain amount for taking their land out of production for a certain period of time. One may envision programs of different durations to allow policymakers more flexibility. One program may remove land from agricultural use permanently while another may

restrict production of certain crops for a short period of time. Currently, soil conservation is the main criterion for the selection of land to be removed from the production base. This has to be extended to include the conservation of sustainability of other resources. In situations where social prices for, say, water resource depletion, water quality contamination, and pesticide damage have not been established, reduction or elimination of production for periods where the desired volume of output is low (because of excess supply) may serve as a useful second-best policy. The regulatory agency has to rank regions by severity of the environmental and resource degradation problems associated with their agricultural resources utilization and identify conditions, priorities, and compensation schemes for removal of vulnerable lands from production.

#### Land-Use Controls

Land retirement should not be the only mechanism to control land use. Land-use controls that constrain the allowable crops and practices on certain lands can be used to control supply and address environmental problems. For example, certain tillage practices should be disallowed in locations with severe soil erosion problems. Production of crops that use certain chemical inputs intensively may be disallowed in certain regions with sensitive environmental conditions. Again, the controls can be modified according to market conditions and can be used to improve supply and production management and to reduce the accumulation of hazardous material in the environment.

#### Pesticide, Water Quality, and Drainage Control and Taxation

Supply restriction and control can be attained by regulation of use of inputs other than the land. The use of certain "sensitive" chemicals can be allowed only at time periods when one expects low supply. Management of water stock and reservoirs and

control of water delivery from government-owned water sources can be made dependent on market conditions (Just, Lichtenberg, and Zilberman 1990a).

Taxation and subsidization of inputs are alternative mechanisms for improving environmental quality, reducing depletion of exhaustible resources, and controlling agricultural supply. Taxation or subsidization of input usage should be designed so that wedges between private and public costs of inputs should be reduced or even eliminated. For example, pesticides use fees should be set at levels that correspond to the environmental and health effects of the pesticides. Reduction or elimination of water price subsidies provides another means of reducing the wedge between private and private costs. There is a growing body of evidence that increase in water prices leads to adoption of efficient irrigation technology and water conservation (Casterline, Dinar, and Zilberman 1989). The use of monetary incentives (taxes and subsidies) for externalities and exhaustible resources control was shown to be most desirable in many circumstances (Fisher 1981).

Buchanan and Tullock (1975) argued, however, that the use of taxes to control externality problems may be subject to much political opposition and require some transfers in return. Moreover, agricultural pollution taxation may require substantial monitoring efforts. Zilberman, Shah, and Chakravorty (1989) suggested using a pay schedule based on observable technology choices in cases where the actual externality or resource use levels are difficult to monitor. Thus, individuals who use technologies that are more environmentally sound will be subsidized by penalty monies collected from individuals who use less environmentally sound technologies. For example, in cases with excessive water use, users of furrow irrigation will be penalized while users of low energy precise application (LEPA) irrigation will be subsidized.



### Rural Preservation Policies

Preservation of rural communities and traditions is an important policy objective that gives rise to policies that slow the introduction of supply-increasing technological change and presents criteria to raise the income of the farm sector without affecting supply. In essence, a well-preserved rural environment is a positive externality from a societal perspective. This positive externality will not be incorporated in market resource allocation and is the cause for government interventions. Such interventions may include subsidies of public goods and services in rural areas. The relatively small population base of many rural communities may make self-financing of public goods (education facilities, medical centers, roads, etc.) quite expensive, and the support of such institutions by the central (nonregional) government will improve the well-being and vitality of the rural sector. Another form of rural sector support is by subsidization of inputs such as electricity and energy.

Rural preservation consideration may result in policies limiting the size of farming operations and constrain the adoption of labor-replacing policies. Such policies are likely to reduce the productivity and the earnings of farmers and farm workers and may be accompanied by an income-support policy. Parallel to the introduction of these agricultural growth control policies, efforts should be made to promote tourism and similar sources of income that benefit from and can partially support the preservation of rural communities.

### Input Mobility and Retirement Programs

Elimination of excessive productive capacity in agriculture is an important element in a transition to a more market-oriented farm sector. Thus, new policy regimes should consider programs that encourage the transition of resources from the agricultural to the nonagricultural sector. Such programs may include (1) educational and training programs to endow the underemployed rural population with marketable

skills in the urban sector, (2) placement programs to ease and facilitate transition of resources to locations where they may have a high return, and (3) retirement programs that may accelerate retirement of marginal operations and assure removal of their resources from active production.

### Marketing Programs

One way to address the oversupply, low-return problems of agriculture is to institute programs that increase demand for agricultural products and increase the value added of agriculture and the share of agricultural production in the food bill. Marketing policies are intended to accomplish these tasks.

One category of marketing policies includes advertising and the promotion of educational activities that attempt to increase demand-affecting preferences and knowledge of the consumers. A second category includes the establishment of product standards. Such standards reduce consumer uncertainty regarding quality and increase the choices available which, in turn, is likely to increase demand. Establishment of quality standards is especially important in the context of international trade. Standards and product definitions may vary across countries, but they have to be clearly defined and used to guide producers in exporting countries.

### Research Development and Extension Program

The importance of research and extension activities in fostering changes in agriculture has been emphasized by Schultz (1953), Cochrane (1979), and Ruttan (1982). Much of the agricultural research activities have been supported by the government, and the control of the extent and direction of public research provides the government with important policy instruments. Research and extension can be harnessed to address the excess supply problem by emphasizing efforts to introduce new uses for agricultural resources. These efforts may include development of new products as well as improvement in quality and characteristics of existing agricultural

products. For example, by developing and introducing food products with specific health-enhancing characteristics (e.g., low cholesterol eggs), agriculture can capture some of the public willingness to pay for health maintenance.

An important part of the research and extension activities required for extending the range of products in agriculture is in marketing and demand. Improved information about consumers' needs and preferences (especially in far-away markets) and more effective marketing channels will help to facilitate transformation of agricultural industries to new and profitable product lines. Agricultural research policies should not be limited to the finance and management of public research. They should provide the incentive for private research activities and encourage private investors to develop new uses to agricultural resources.

#### Consumer Aid

A move to a more market-oriented agricultural sector, with lower support levels and a reduced supply level, may result in higher food prices that will affect the well-being of consumers, particularly the poorer ones. This welfare reduction can be countered by consumer welfare support programs. They can be in forms of increased food aid programs (in terms of the food-stamp program) or as direct income subsidies.

#### **Dynamic and Implementation Aspects of Policy Reform**

Establishment of Eligibility, Enforcement, and Monitoring Criteria.—There is a growing recognition that implementation plans should be incorporated explicitly to the design of new policy regimes. The new economic models of information and regulation (see surveys of Hart and Holmstrom 1987) have argued that agency and moral hazard problems may lead to failure of otherwise very worthwhile policies. The performance of many agricultural and food policies have been plagued by such implementation problems in the past. For example, the problem of "slippage" that prevented past

diversion policies from attaining expected reduction in supply was the result of eligibility criteria that did not recognize within-region (and within-farm) heterogeneity of land quality and productivity. In particular, program yields have been established according to regional yield averages, rather than actual performance of individual farmers or plots. Furthermore, there has been no practical ways to prevent farmers from directing lands of lower quality while farming higher quality lands. Thus, one plausible reason for the enactment of these unsatisfactory eligibility criteria in the past has been the lack of mechanisms for monitoring and enforcement of more exact criteria.

Monitoring capabilities are the key for the establishment of effective enforcement procedures, and these two elements determine regulator abilities to establish effective eligibility criteria. In designing new regulations, policymakers should recognize the limitations of their monitoring and enforcement abilities and the "moral hazard" problem these limitations may cause. Monitoring and enforcement capabilities are likely to improve over time as results of technological progress. Governments can induce such technologies by initiating research and development efforts to improve information networks, data gathering, and analysis techniques. As aerial surveillance capabilities improve, data processing costs decline, and the use of computers and communication equipment becomes widespread, the ability to introduce more effective monitoring schemes increases; and improved monitoring may lead to improved implementation and more effective policies. Therefore, policies have to be revised and modified as implementation capabilities improve over time.

Design of eligibility criteria should also take strategic behavior by farmers and other economic agents into account. Farmers may modify their behavior to establish eligibility for future program benefits whenever possible. de Gorter and Fisher (1989) argued that this type of strategic behavior has been a significant contributor to the oversupply problem. Some farmers might have increased their acreage by cultivating marginal lands to increase their entitlement to future diversion programs and

deficiency payments. Thus, whenever possible, eligibility criteria should be dependent on parameters that cannot be modified.

Policy Variation Over Time.—Policy design and assessment should be done within a dynamic context. Dynamic processes and the resulting changes over time of key variables and parameters should be incorporated in policy modeling. For example, predicted values of changes over time in prices of inputs or outputs—as well as processes of learning, adoption, and technological changes—should be incorporated in policy models. Furthermore, efficiency assessment will compare expected net present values associated with alternative policies, and distributional analysis should predict streams of benefits and costs for individual groups. Emphasis on dynamic modeling is especially crucial, given the current dependency of agriculture on exhaustible resources and the excess supply problem that requires the design of a gradual adjustment mechanism that will lead to sustainable equilibria.

To reduce uncertainty regarding government activities, policymakers should explicitly communicate the final targets of policy reform and the projected evolvement of policy parameters in attaining these targets. For example, if elimination of excess supply is one of the key objectives of the policy reform, policymakers should explicitly identify the length of the adjustment period and the planned policy interventions during this period.

The uncertainty conditions under which policy design is conducted and the large number of random events which affect agriculture suggest that policy plans should have many contingencies and adjustment rules. The early phase of policy reform, when agricultural productive capacity is down scaled, should include automatic rules (Just and Rausser 1985) to adjust to situations that deviate from the expected scenario. It is important to communicate the adjustment rules ahead of time and thus reduce the uncertainty facing decision makers. Inconsistency and unpredictability of

government policies in the past have made government actions another source of uncertainty. Well-specified adjustments may reduce this problem.

The randomness and uncertainty that affect agriculture make it unreasonable to assume that the adjustment process will lead to a unique sustainable market equilibria. The equilibria levels of prices and quantities of different commodities depend on many random variables and, thus, are random variables themselves. The introduction as part of the dynamic adjustment rules to the policy plan aims to assure that the agricultural economy will approach sustainable equilibria under all circumstances.

The performance of the agricultural sector and public policies should be scrutinized and reevaluated over time. Given changes in the state of the agricultural economy, the technology (in particular, in monitoring and assessment capabilities), and the distribution of political power among groups over time, policy reform plans should be reassessed and redesigned periodically, say, every 10 years. Processes of policy redesign will evaluate all the dimensions of performance of agriculture, the states of agricultural resources, and the economy. They will use the process described in section 2 of this paper to identify effective monitoring, enforcement, and eligibility criteria and to introduce efficiency-enhancing and politically feasible agricultural policies.

### Conclusions

Attempts to make agriculture more efficient, flexible, and self-reliant must recognize the characteristics of this sector as well as economic and political constraints. Agriculture in developed countries has tended toward excessive capacity, resulting in low farm product prices and low returns to farmers. Past government policies have actually contributed to this excess supply problem, mostly because program benefits were linked to output. An essential element of a new policy regime

is the introduction of less-coupled policies, i.e., the use of policy instruments whose benefits are not directly linked to output.

New policy instruments must serve several objectives, including the provision of affordable food, stable and fair farm income, sustainable resource base, environmental quality, rural preservation, and a balanced budget. The relative weight attached to each objective depends on the political support it commands. It was argued that the optimal policy instruments should be determined so the rate of political substitution between two instruments is equal to the rate of efficiency substitution between the instruments where support reflects both the extent and strength of political support. This optimality rule can be utilized in designing new policy regimes and should guide an iterative process of negotiation that leads to policy decision.

Policies should be viewed within a dynamic context and lead to sustainable reform, with specific instruments guiding the adjustment process toward a long-run stable equilibrium. Since agriculture currently has excess capacity, a major objective of policies in the near future is to down size the production capacity of agriculture. Policies will divert excess resources outside the sector, support conservation activities to reduce supply, and encourage the development of other uses of agricultural resources.

Mechanisms for monitoring and enforcement should be designed as part of the policy reform, and much emphasis should be given to abuse prevention. Efforts should be made to establish eligibility criteria which are dependent on variables (land quality, weather, etc.) that are not modifiable by individual actions. Finally, policies should also be evaluated and reassessed periodically. Changes over time must reflect change in power distribution among groups.

## Endnotes

<sup>1</sup>They have higher absolute risk aversion.

<sup>2</sup>It is assumed that the functional relations lead to an interior solution, namely, the efficiency function is concave in the  $x$ 's and the cumulative distribution is a concave function of the policy variables over the relevant range of values.

<sup>3</sup>Lichtenberg and Zilberman (1988) showed for a similar problem that, under reasonable conditions, the marginal cost of reliability is increasing.



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