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CONTENTS

MODELING PHASED REDUCTION OF DISTORTIONARY POLICIES IN THE U.S. WHEAT MARKET UNDER ALTERNATIVE MACROECONOMIC ENVIRONMENTS

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1. INTRODUCTION

Throughout much of the developed world, macroeconomic policies afforded a unique period of macroeconomic stability in the two decades following World War II. As a result, concern regarding the macroeconomic linkages with food and agricultural systems largely disappeared. In the early 1970s, with the major changes in monetary policies and central bank behavior, macroeconomic linkages were once again recognized as prime factors complicating the performance of the agricultural and food systems.

The roller coaster ride that agriculture experienced over the 1970s and 1980s has been significantly influenced by macroeconomic and international linkages (Rausser et al, 1966). Agriculture's prosperous condition in the 1970s was followed by a recession in the early 1980s. This more recent history stands in sharp contrast to the basic stability of the 1950s and 1960s. It is also important to recall that this roller coaster experience of the 1970s and 1980s is not unprecedented. For example, the period from 1900 through 1950, is surprisingly similar to the 1970s; and the late 1920s through the 1930s have some basic characteristics of the 1980s.

The effects of policy adjustments (or trade liberalization) on output and input markets, especially land markets, cannot be be isolated from a country's domestic macroeconomic

conditions or from world economic conditions that arise during the process of phased reductions in coupled subsidies. To illustrate the importance of domestic and international economic conditions, consider U.S. agriculture in the early 1980s. Suppose a GATT code had been established with phase reductions in coupled subsidies of 20 percent in 1980, 20 percent in 1981, 20 percent in 1982, and 10 percent thereafter per year for the next four years. This reform would have been difficult indeed to implement in the face of high real rates of interest, an appreciating dollar on world markets, slow growth in worldwide income, and a domestic recession. During this three-year period, market overshooting (Rausser et al., 1986) would have driven agricultural prices to unbelievably low levels, creating a policy disequilibrium. Interest groups could have been expected to exert pressure to change any orderly plan to phase out coupled subsidies. This would have added to the inherent instability of the market and detracted from credibility of governments in implementing reform.

Unfortunately, few studies have examined the dynamic path resulting from phased subsidy reduction[1] and even fewer studies recognize that such paths are conditioned on the macroeconomic environment. If the dynamic path is very sensitive to such forces, the credibility of governments in implementing reform can be enhanced by the design of "flexible" agricultural policy reforms. Flexible policy rules can explicitly incorporate macroeconomic and international linkages into automatic adjustment roles. The design of such policies should make clear what the adjustments will be so that the changes can be anticipated by producers, processors, distributors, consumers, and others involved in the sector. Such flexibility could be expected to result in smoother, more orderly changes in prices.

Accordingly, the main premise of this chapter is that macroeconomic linkages are relevant to agriculture and that quantitative results of trade liberalization will diverge under various realizations of the underlying macroeconomy. Since much of the distortionary impact of U.S. agricultural policy is conditioned on realized agricultural prices, any structural change in the form of exogenous shocks to supply or demand will alter the level of distortion for a given setting of the relevant policy instruments. More specifically, macroeconomic variables

such as exchange rates, income, and interest rates may significantly alter the short-run path of prices and production in U.S. agriculture, given the removal of distortionary agricultural policies. No quantitative experiments have been designed that fully examine the short-run macroeconomic effects on agriculture under trade liberalization.

The purpose of this study is to examine the effects of phased reduction of U.S. agricultural policy instruments under alternative macroeconomic environments. To what degree are the effects of policy reform determined by exchange rate, income, and interest rates? Are predictions regarding the effect of policy reform robust to various realizations of the macroeconomic environment; can the policy analyst simply shift the results of previous studies by a "macroeconomic constant"?

After assessing the major limitations of studies that have analyzed trade liberalization for the U.S. agricultural sector (section 2), we turn to the policy instrument set in section 3. Based on a constructed econometric model reported in Appendix A, a policy simulation model of the U.S. wheat market is presented in section 4. After examining the properties of the policy simulation model in section 5, simulation experiments on phased reductions in U.S. wheat subsidies are reported in section 6.

2. U.S. Agricultural Policy and Ad Valorem Equivalents

Studies on trade liberalization—such as Tyers and Anderson, 1986; Roningen, Sullivan, and Wainio, 1987; Robinson, Kilkenny, and Adelman 1989; and Hertel, Thompson, and Tsigas, 1989—aggregate distortionary agricultural policies into a scalar measure which is then normalized into an ad valorem equivalent.

Tyers and Anderson (1986) use the domestic to border price ratio as a measure of intervention. The methodology of Tyers and Anderson is inadequate for evaluating policy reform in "large" counties, such as the United States, that affect world price. More specifically, U.S. acreage controls will not be measured as distortionary to the degree that the resulting domestic price effect equals the border price effect. Also, the distortionary impact of

U.S. stock policy via the loan rate and Commodity Credit Corporation activity will not be captured by border measures.

Roningen, Sullivan, and Wainio (1987) measure support to agricultural production as the ratio of total value of policy transfers to total producer revenue. They estimate this measure for 1984 and implicitly assume that it is an adequate proxy for the producer incentive; however, production controls that are coupled to direct pyments are neglected. To simulate unilateral trade liberalization by the United States, they remove the ad valorem equivalent of the estimated producer subsidy and recalculate domestic supply, demand, trade, and market-clearing world price.

Robinson, Kilkenny, and Adelman (1989) and Hertel, Thompson and Tsigas (1989) estimate a measure of the distortionary aspects of U.S. agricultural policy, rather than the total transfer which may include transfers that are relatively neutral with respect to the production decision. In computing the net producer incentive equivalent (PIE), they explicitly account for the implicit tax of the set-aside requirement and the price-enhancing effect of acreage reduction. Robinson, Kilkenny, and Adelman compute this net measure of distortion for 1986; and Hertel, Thompson, and Tsigas use 1984 as the base year. Both studies then solve for equilibrium values for a given base period with the distortionary policies in place and then recompute the long-run equilibrium for an undistorted system.

Notice that the short-run effects of policy reform and the partial reduction of program instruments cannot be evaluated without accounting for endogenous participation. The main problem is that the *level* of acreage set-aside is endogenous even when the diversion rate is exogenous.

The preceding measures of distortion to production are not robust proxies for evaluating the distortionary impact of the U.S. farm program. Whalley and Wigle (1990) have shown that ad valorem equivalent modeling may lead to inaccurate results when program participation is endogenous and conditioned on production controls.[2]

3. THE POLICY SET

The current set of policy instruments in the U.S. wheat program is essentially as established by the Agricultural and Consumer Protection Act of 1973. The major instruments used in the wheat program are target price, acreage controls, and loan rate.

While the major policy instruments have remained intact since 1973, the settings of the program instruments are subject to discretionary change by Congress and the Secretary of Agriculture. Participation in the program is voluntary and is also subject to change on an annual basis. A brief summary of the characteristics of the major policy instruments follows. For a more detailed explanation of the policy set, see Gardner (1987, 1989) and Wright (1984).

3.1 Deficiency Payments

Producers who participate in the wheat program are eligible for deficiency payments. The value of the deficiency payment is determined by the difference between the legislated "target" price and which ever is higher, the market price or the loan rate. Producers receive this deficiency payment for a pre-determined program yield times acreage planted. Acreage planted by participating producers is often (but not always) constrained to not exceed the producers base acreage minus a uniform rate of acreage to be set-aside (the diversion rate). Base acreage is determined by a 5-year moving average of acreage planted and considered planted. Acreage considered planted consists of acreage planted, set-aside, and diverted. The program yield has been fixed since 1987. Prior to 1987, program yield was based on a rolling average of past yields. Over the last decade, deficiency payments have ranged from less than 5 percent of market price to over 50 percent of market price, even though the target price has varied by no more than 6 percent in any given year.

3.2 Acreage Controls

In order to be eligible for program benefits, one must first establish "base" acreage. Subject to legislative discretion, yearly diversion rates are established that limit the amount of one's base acreage eligible for payments through the Acreage Reduction Program (ARP). A uniform rate is set which is the percentage of a participating producers' base acreage that must be set-aside for the crop year. During the 1980s, the diversion requirement has been as high as 30 percent of base acreage.

3.2 The Loan Rate

The Commodity Credit Corporation (CCC) is required by law to accept wheat as collateral from program participants in exchange for a loan. The amount of the loan is equal to the number of bushels placed as collateral times the legislated "loan rate." The terms of the loan are nonrecourse in that, if the producer wishes to default on the loan, the grain held as collateral serves as payment in full. In general, the loan rate serves as a price floor in that the CCC stands willing to purchase any amount necessary to support price at the loan rate. Within the loan period of 9 months, producers can pay back the loan plus interest and sell at the market price if they wish.

3.4 The Farmer-Owned Reserve

The Farmer-Owned Reserve (FOR) has played a controversial role in U.S. agricultural policy since its inception in 1977 (Salathe, Price, and Banker 1984; Wright 1984). In general, the FOR is a loan program much like the CCC loan program. The primary difference is that grain entered into the FOR is unaccessible for three or more years unless a predetermined release price is hit. It is important to note that, while the 3-year constraint is legislated by Congress, it has been subject to change. During the 1980s, significant quantities of grain were, in fact, released prior to the 3-year constraint within the guidelines of payment-in-kind (PIK) programs.

3.5 Additional Voluntary Division Programs

Several other program instruments have been used to divert acreage from production over the minimum required amount. These programs have been available to producers that comply with the basic (minimum) diversion rate. For example, added voluntary diversion has taken place under PIK programs based on an approximately one-to-one basis of diverted production. This program instrument has been used sparingly; however, for the several years that it has been used, the effect on the market has been significant. In 1983, over 18 million acres were set-aside under the PIK program.

Since 1986, producers have been offered the additional flexibility of diverting additional acreage. Under the acreage reduction program (ARP), producers receive deficiency payments on 92 percent of diverted acreage in excess of the minimum required. When the program was instituted in 1986, the maximum amount of diversion eligible for payments under this program was 50 percent of the farmers' base acreage. Currently, farmers may divert 100 percent of their base acreage and remain eligible for payment on the acreage diverted in excess of the ARP constraint. This paid diversion program is thus called the *0-92 Program* since producers can plant 0 percent of their base acreage while receiving deficiency payments on 92 percent of eligible acreage. Typically, less than 5 percent of the wheat base has been entered into the 0-92 Program.

The Food Security Act of 1985 authorized the Conservation Reserve Program (CRP) with the intent of removing 40 million to 45 million acres of fragile cropland from production (Young and Jagger 1989). The CRP removes acreage from production for 10-year periods. Payment for this is based on individual bids by the producer which are essentially rental payments by the government. Over 10 million acres of wheat base have been entered into this long-term diversion program since its inception in 1986. Wheat program statistics for 1985-1990 are shown in Table 9-1.

Table 9-1. 1985-1990 Wheat Program Statistics

Year	Target Price	Deficiency	Loan Rate	Commodity Credit Corporation	Farmer-Owned Reserve
	dollars per bushel			million bushels	
1985	4.38	1.08	3.30	602	596
1986	4.38	1.98	2.40	830	632
1987	4.38	1.81	2.28	283	467
1988	4.23	0.69	2.21	190	287
1989	4.10	0.32	2.06	125	150
1990	4.00	N.A.	1.95	N.A.[a]	N.A

Year	Base Acres	Set-aside[b]	Conservation Reserve Program[c]	Participation	Acreage Reduction Program
	million acres			percent	
1985	94.0	18.8	0	73	30[d]
1986	91.6	21.0	0.6	85	22.5
1987	87.6	23.9	4.2	88	27.5
1988	84.8	22.5	7.1	86	27.5
1989	82.3	9.8	10.3	78	10.0
1990	80.5	6.6	N.A.	80	5.0[e]

[a]Data not available.

[b]Includes Acreage Reduction Program, Payment in Kind, and 0-92 programs.

[c]Cumulative.

[d]Includes 10 percent Cash Land Diversion (CLD) Program

[e]Farmers had option to plant 105 percent of base in 1990.

Source: USDA ERS Wheat Outlook and Situation Yearbook (various issues, 1985 through 1991.)

addressed. This study will focus its attention on the following aspects: acreage eligible for program payments is predetermined; participation in the program is voluntary; in order to receive program payments, one must comply with acreage controls; and the supply response of producers outside the program can be significant.

4.1 Production

Production is separated into acreage response and yield response. Given that participation in the farm program is voluntary, acreage response must be further disaggregated into participant acreage response and nonparticipant acreage response. Participation, itself, is determined within the system. This framework follows that of the current generation of econometric policy simulation models—e.g., the U.S. Department of Agriculture's Food and Agricultural Policy Simulator, FAPSIM (Gadson, Price, and Salathe 1982); the Center for Agricultural and Rural Development world wheat trade model (Devadoss, Helmar, and Myers 1990); and the model presented in Just, Rausser, and Zilberman (1991).

When program participation is voluntary, based on a predetermined level of base acreage, and based on effective acreage controls, the aggregate acreage relationship can be defined as

$$AP \equiv (1-\alpha)Q^m + \alpha\overline{Q} \tag{1}$$

where aggregate acreage planted, AP, is the sum of acreage which would have been planted in a free market, Q^m, weighted by the level of acreage not entered into the program ($1 - a$); and the production constrained level of program acreage, $\overline{Q}$, weighted by the level of program participation, α, since $\overline{Q}$ is defined as base acreage times one minus the diversion rate.

First, notice that, given the level of base acreage and the diversion requirement, acreage planted by program participants can be identified with knowledge of the equilibrium value of

program participation. As Just, Rausser, and Zilberman note, U.S. agricultural policy regimes change often; and, given the limited observations, identification is problematic. For any given setting of the primary program instruments (target price, loan rate, diversion requirement, and additional voluntary diversion payments) the level of distortion and attractiveness of program participation is dependent on the current state of the system. In order to lessen the identification problem, we assume that farmers compare anticipated profit per acre under program compliance to that under noncompliance. As such, we presume that program participation can be described by the level of anticipated profit above that which would be anticipated from planting outside of the program provisions. Specifically, when market price is greater than or equal to the loan rate, excess profit per acre from program participation π^p is defined as the value of anticipated deficiency payments minus foregone returns due to the diversion requirement, plus payments on any additional diversion programs when in effect.

$$\pi^p \equiv \left[\left(\max\left(P^T, P^m\right) - P^m\right)(1 - DVR)\right]\overline{Y} - \left[\left(P^m - vc\right)DVR\right]Y + ADP \qquad (2)$$

where P^T is the target price, P^m is the expected market price, vc is a measure of variable costs per bushel, DVR is the proportion of acreage a farmer must divert in order to participate in the program, Y is planned yield per acre, $\overline{Y}$ is program yield, and ADP is additional diversion payments.

Notice that, in order to solve for total acreage planted, we must identify the amount of acreage that is planted by non-participating producers, $(1 - \alpha)Q^m$. Since we observe the outcome of a distorted market, we cannot directly observe the level of acreage which would have been planted in a free market, Q^m; however, acreage planted by nonparticipants (APNP) is approximately determined by the observable expected market price, variable costs of production, the relative price of substitute crops, and the amount of acreage entered into the program.[3]

The CRP has been an important program since its inception in 1986, with a total wheat enrollment as of August, 1990, of 10.3 million acres. For this study, acreage enrolled in the CRP is operationally considered exogenous. Since only a small amount of acreage had been entered into the CRP during the sample period used for estimation (1.6 acres in 1986 and 3.6 acres in 1987), this should have a very limited effect on the parameters as estimated. Furthermore, by the first period of the simulation experiments run for this study (1991), the stated goal of the CRP should be achieved, thus CRP acreage can be held fixed at estimated 1991 levels. The effect of the CRP on planted acreage must be accounted for as an important structural shift in the reduced-form acreage decision. Operationally, we have treated CRP acreage as an additive shift in the reduced-form acreage equation.

Total production is simply total acreage planted times yield per acre. Yield per acre is presumed to be determined by expected market price, variable costs of production, acreage set-aside which enters to capture the effect of "slippage," and a time trend to capture exogenous technical change.

All values are in real, rather than nominal terms. Quoted futures prices are used as proxies for the producer incentive price in the estimation process.[4] For forward simulation, production decisions by farmers are based on that price which clears the market. The advantage of this procedure, as compared to using lagged prices in the simulation process, is that we can evaluate policies in a system where farmers are able to react to their current environment.

4.2 Demand

The proposition that the macroeconomy has a pervasive effect on the agricultural sector is well developed. Andrews and Rausser (1986) point out that macroeconomic disturbances have been central in agricultural policy developments at least since the late 1800s. Shultz (1945); Schuh (1974); Johnson, Grennes, and Thursby (1977); Chambers (1979); Chambers

and Just (1981); and Rausser et al. (1986) demonstrate that the macroeconomic environment significantly effects agricultural prices and incomes.

Following the general theme of the literature cited, the exchange rate, real interest rate, and income are specified as exogenous shifters of export demand, food demand, feed demand , and market-held storage.

Food demand is determined by own price, income, and lagged food demand. Relative price of other food grains is not entered since we found little substitutability among wheat and other similar grains in food demand.

Feed demand is determined by own price, the relative price of wheat to corn, income, and lagged feed demand. Given the nature of this project, we let income serve as the reduced form parameter for the derived demand for feed. Lagged feed demand captures the dynamic adjustment in the livestock sector.

For this study we have specified a single-equation reduced-form representation of export demand. Since we are evaluating unilateral policy reform, the reduced-form coefficient on price should capture much of the response in the world wheat market with respect to U.S. policy shocks. Large trade models such as those described by Baily (1989) and Devadoss, Helmar, and Meyers (1990) typically disaggregate the world market into regional submodels. Operationally, these models basically identify various intercepts; however, if we have little a priori knowledge of how these intercepts will change given policy reform, the added identification is superfluous. Excess demand is specified as being a function of U.S. price, exchange rate, world income, and lagged excess demand. Price and exchange rate have been entered as separate regressors for two reasons—following Chambers and Just (1979), we will allow for separate effects of exchange rates and prices; and, as a practical matter, deflating price by the exchange rate would add undue complexity to system estimation.

The Export Enhancement Program (EEP) is not considered to have a direct effect on export demand. As Gardner (1989) explains, so long as any transactions by countries

receiving EEP subsidies are occurring at the market price, it is the market price which is the relevant price at the margin and, thus, the market price is indeed the proper proxy. The EEP will have have an important indirect effect, however. The transfer of wheat from CCC-held storage to the market represents additional availability and, hence, lower equilibrium price. When private storage co-exists with public storage, measurement of this effect is difficult since the market may have anticipated this outflow and adjusted privately-held stocks accordingly. This price-depressing effect of EEP storage transfers and adjustment of private storage is modelled explicitly in the storage equations.

Typically, storage has been an important means of government intervention in the wheat market since the early 1950s. Inflow to government storage is solved for by first solving for equilibrium price. If price is less, then the predetermined-loan-rate stocks flow into government control until equilibrium price is equal to the loan rate. Government release is assumed to be exogenous. This study is meant to evaluate policy, not forecast it; thus, a behavioral release equation is unnecessary.

When private rational speculative storage is allowed to exist, private storers will hold stocks such that current price equals the discounted expected value of the commodity in the next period unless there is a stockout. Since the government does not generally destroy its reserves of grains, any government acquisition will eventually be returned to the market. The market (private storers) must form an expectation on the means and timing of government storage disposal. Market storage is determined by the endogenous current price of wheat and expected future price, along with the exogenous interest rate. Future net government release serves as an instrument for future expectations and ties together the government/market storage relationship in an explicit form.

5. PROPERTIES OF SIMULATION MODEL

5.1 Model Validation

Conventional validation techniques have been employed to analyze the dynamic and parametric stability of the simulation model. Given the nonlinearity of the system, analytical representation of the dynamic properties of the model is difficult. As an alternative, the dynamic properties were simulated by imposing a once-and-for-all shock to the model and then running the model forward to determine whether the values of the endogenous variables converge. The stability checks showed strong convergence in less than 10 periods, implying that the model is dynamically stable.

In order to assess the parametric stability of the model, in-sample simulations were run on both the individual structural equations and the simulation model as a whole. As estimated, the structural equations track the observed relationship well as measured by goodness-of-fit and anticipation of observed turning points. The model as a whole also did well in explaining movement in variables endogenous to the system. For a complete description of the validation techniques and results, see Labson (1990).

5.2 Multiplier Analysis

In order to better understand and identify the model as specified, reduced-form impact multipliers were computed. The multipliers were computed by first solving the system for equilibrium values with the exogenous and predetermined variables at their mean values over the 1974-1987 sample period. The system was then shocked by increasing a given exogenous variable by 10 percent. The proportional difference in the first period is the impact multiplier. The results are reported in Table 9-2.

5.3 Macroeconomic Shocks

The exchange rate is shown to have an important effect on exports and price. A 10 percent appreciation of the dollar leads to a 7.7 percent decrease in the real price of wheat.

TABLE 9-2. Impact Response to a 10 Percent Shock to Exogenous Variables Evaluated at Their Mean Values

	Exogenous Variables					
		Gross National Product				
Endogenous Variables	Exchange Rate[a]	United States	Rest-of-World	Interest Rate	Diversion Rate	Target Price
	percent					
Real Price of Wheat	-7.7	2.1	0.6	-0.5	0.8	0.0
Food Demand	0.1	1.8	0.0	0.0	0.0	0.0
Feed Demand	2.8	7.0	-0.2	0.2	-0.3	0.0
Export Demand	-8.2	-0.4	0.7	0.1	-0.2	0.0
Market Storage	0.4	-1.4	-0.4	-1.3	-0.6	0.0
Participation Rate	2.1	-0.6	-0.2	0.2	-1.5	0.0
Nonparticipant Acreage	-5.9	1.6	0.5	-0.4	2.1	0.0
Total Acreage	-2.2	0.6	0.2	-0.2	-0.4	0.0
Production	-3.3	0.9	0.3	-0.2	-0.3	0.0
Acreage Set-aside	1.5	-0.4	0.1	0.1	6.1	0.0
Crop Receipts	-10.7	3.0	0.9	-0.8	0.5	0.0
Government Payments	0.0	0.0	0.0	0.0	0.0	0.0

[a]Rest-of-world currency per dollar.

Notes: 10.0 = unit elasticity

All values are rounded to nearest tenth of a percent.

The 7.7 percent change in price has a limited effect on U.S. food and feed demand for wheat (0.1 percent and 2.8 percent). Even though the 10 percent change in the exchange rate has a less than unit effect on exports (8.2 percent), the observed variation in the exchange rate over the last 20 years has been of a magnitude to make the realized effects substantial. Notice that the 7.7 percent decrease in price makes participation in the program more attractive since the opportunity cost of diversion decreases with market price and therefore program participation increases. The 2.1 percent increase in participation increases acreage set-aside by 1.5 percent, thus the decrease in price has two important effects on total acreage planted. The standard own-price effect leads nonparticipating producers to curtail production; and, since participation is endogenous, the increase in acreage set-aside leads to further reduction in total acreage planted.

A 10 percent increase in the real interest rate decreases market storage by 0.6 percent, and thus price decreases by 0.5 percent. The impact response to real interest rates is relatively small; however, the observed volatility of observed ex post real rates over the last 20 years suggest that interest rate shocks can and do have a measurable effect on storage, price, production, and crop receipts.[5] A 100 percent increase in the ex post real interest rate evaluated at its sample mean value of 1.64 percent would decrease mean price by 5 percent, or 21 cents per bushel.

5.4 Policy Shocks

In the initial period, as the diversion rate is increased, program participation decreases (1.5 percent) which, in turn, dampens the positive effect on diverted acreage and results in a less-than-unit response in set-aside with respect to a change in the diversion rate (6.1 percent).[6] Since set-aside acreage is typically less than 25 percent of total acreage planted in the United States, a 6.3 percent change in set-aside acreage translates to only a 0.4 percent change in acreage planted and a 0.8 percent change in price. This result does not imply that the diversion requirement is unimportant. Given that we have observed changes in

the diversion requirement of more than 100 percent, the realized effect on the sector can be significant. At mean values, a 100 percent increase in the diversion requirement would decrease acreage by 3.2 million acres in the first year and increase market price by 34 cents per bushel.

When the exogenous variables are set at their mean sample values, equilibrium price is 53 cents above the average target price.[7] Given the deterministic nature of the model, a 10 percent change in the target price has no effect on the system as specified. The combination of a fixed target price and random market price implies that a positive option value of participation exists even when expected price is greater than the target price. The option value of the fixed target price is likely to be very small when the expected price is so much greater than the target price, however. A casual inspection of quoted option values on wheat futures contracts leads us to believe that a 10 percent change in the mean target price represents less than a 5 cent per bushel change in the option value of program participation, or less than a 1 percent change in the participation rate.

5.5 Structural Change and Impact Response Multipliers

The reduced-form relations exhibit significant nonlinearities which stem primarily from endogenous participation, the loan rate, and thetarget price. Given the nonlinearity of the reduced-form relations, the effect of an exogenous shock on the system is conditioned on the state of the system. This is precisely the point made in the introduction section that the effects of policy reform on the sector are conditioned on the macroeconomy. Furthermore, the effects of macroeconomic shocks on the sector are conditioned on the policy environment. The computed impact multipliers evaluated at observed 1985 values for the exogenous and predetermined variables are shown in Table 9-3. This setting represents an adverse macroeconomic environment with low equilibrium price.

Comparison of the effect of an exogenous change in the exchange rate on the sector evaluated at 1985 values clearly demonstrates that multipliers in distorted markets are

conditioned on the state of the system. It can be seen in Table 9-3 that a 10 percent appreciation of the dollar results in a 2.5 percent reduction in price. This is only about one third of the effect when equilibrium price is well above the loan rate. When equilibrium price is near the loan rate, the fall in price is constrained due to CCC acquisition. Quantities exported fall and government payments rise significantly as compared to the more favorable environment as represented in Table 9-2.

A 10 percent increase in the diversion requirement has a greater effect on total acreage planted as compared to the more favorable equilibrium. Given the relatively low market price, the opportunity cost of diversion is of less consequence, thus farmers are less likely to leave the program and plant at market price. Notice that, even though the percentage change in participation is greater given the 1985 values, the absolute change in participation is smaller.

Given the 1985 settings, the target price is effective. Since deficiency payments are based on fixed base acreage and program yields and as the target price is increased, production decreases as program participation becomes more attractive; this, in turn, serves to divert acreage which would otherwise have been planted. Note that this result is in stark contrast to the overly stylized model of per-unit subsidy often used in trade liberalization studies which suggests that lowering the U.S. target price unambiguously decreases total U.S. production.[8]

6. Simulation Experiments

As specified and estimated, the model can simulate the effects of various U.S. agricultural policies and macroeconomic environments on the U.S. wheat sector. The simulation exercises that follow are not meant to be forecasts of future equilibrium values, rather, they are meant to study the system given contrasting settings of the exogenous and predetermined variables.

In order to examine and identify the conditional effects that the macroeconomy, sectoral policy, and initial conditions have on the U.S. wheat sector, the exogenous variables of

TABLE 9-3. Impact Response to a 10 Percent Shock to Exogenous Variable Evaluated at Observed 1985 Values

Endogenous Variables	Exogenous Variables: Exchange Rate[a]	Gross National Product: United States	Gross National Product: Rest-of-World	Interest Rate	Diversion Rate	Target Price
	percent					
Real Price of Wheat	-2.5	1.8	0.5	-1.1	1.4	3.3
Food Demand	0.0	1.9	0.0	0.0	0.0	0.0
Feed Demand	0.5	5.4	-0.1	0.2	-0.3	-0.6
Export Demand	-15.7	-0.4	1.0	0.2	-0.3	-0.7
Market Storage	1.3	-0.9	-0.3	-3.2	-0.7	-1.6
Participation Rate	3.5	-2.5	-0.8	1.5	-5.2	7.4
Nonparticipant Acreage	-6.3	4.6	1.4	-2.7	8.5	-10.2
Total Acreage	-1.3	1.0	0.3	-0.6	-0.6	-1.2
Production	-1.6	1.2	0.3	-0.7	-0.4	-0.9
Acreage Set-aside	3.5	-2.5	-0.8	1.5	4.3	7.4
Crop Receipts	-4.0	3.0	0.9	-1.8	1.1	2.4
Government Payments	44.5	-8.8	-2.7	5.4	-13.9	42.6

[a]Rest of world currency per dollar.

Notes: 10.0 = unit elasticity

All values are rounded to nearest tenth of a percent.

concern have been grouped into distinct regimes, or sets. These sets are then used in simulation experiments in order to obtain the time path of the endogenous variables.

The time span of the experiments is 5 years. For the phase-out experiments, the target price, loan rate, and diversion requirements are reduced in equal increments such that they would be eliminated within 10 years. As such, the phase-out experiments covered in this study represent the first half of complete phaseout of the distortionary programs. This research strategy fits the intent of the project since we wish to quantify the comparative short-run effects (1 to 5 years) of various macro/policy regimes, rather than the comparative long-run steady state values of the system.

Since the thrust of this project is to understand the combined effects of the macroeconomy and policy on agriculture, rather than to explain the macroeconomy itself, the macroeconomic sets used for the experiments correspond to past observed macroeconomic environments. Two distinct regimes will be used which roughly correspond to the "tax subsidy" application of Rausser et al. (1986). The dichotomous relationships between the macroeconomic environments of the 1970s and the 1980s serve well to isolate the possible roles of the macroeconomy on agriculture. A third macroeconomic set, the "base" set, will be used which is defined by a fairly static macroeconomic environment. This base set will be helpful in comparing our results to other studies which commonly evaluate policy shocks over static macroeconomic environments. Rather than list the values for the exogenous variables for each set, a summary is given which describes the important areas of interest. In particular,

> *BASE MACROECONOMIC SET*: This set is defined by a static macroeconomic environment. It describes a macroeconomic environment similar to that observed in 1989. U.S. gross national product (GNP) is fixed at a constant 1.2 percent growth rate. Rest-of-world (ROW) GNP is assumed to closely follow that of the United States and is also set at 1.2 percent. The exchange rate is fixed at its 1989 level, and real interest rates are set at the 1989 ex post rate of 3.52 percent.

1981-1985 MACROECONOMIC SET: This set corresponds to the observed macroeconomic environment for 1981-1985. U.S. and ROW GNP increases at the average rate of increase observed over the 1981-1985 period at 2.56 percent and 2.14 percent per year, respectively. The exchange rate (dollar) appreciates at the average rate observed over the 1981-1985 period of 10.5 percent per year. Real interest rates trend from an initial value of 3.52 percent to the average ex post rate observed from 1981 to 1985 of 4.85 percent.

1975-1979 MACROECONOMIC SET: This set corresponds to the observed macroeconomic environment for 1975-1979. U.S. and ROW income increase at their observed averages of 3.22 percent and 2.87 percent per year, respectively. The exchange rate (dollar) depreciates at 2.6 percent per year, and the real interest rate trends downward at 1.07 percent per year to the average ex post rate observed from 1975-1979 of -1.07 percent.

The policy sets evaluated are:

BASE POLICY SET: This is a static policy set which can be used to look at the macroeconomic experiments abstracting from policy shocks. Target price and loan rate have been fixed at 1990 values. Dversion rate is set at 12.5 percent, and CCC stock outflow is fixed at 25 million bushels per year. Voluntary set-aside is set at 4 million acres per year for all simulations. For all policy sets, acreage entered into the Conservation Reserve Program is fixed at an anticipated level of 12.1 million acres for 1991.

ALL INSTRUMENTS POLICY SET: This policy set reduces the major policy instruments (loan rate, target price, and diversion requirement) in equal increments of 10 percent per year.

PAYMENT ACREAGE POLICY SET: This set is defined as a 1960s-style payment acreage that is proportional to program base acreage. Program base acreage, target price, loan rate, and diversion requirement are frozen at 1991 levels, since payment acreage is reduced in equal increments over the simulation experiments.

6.1 Base Macroeconomic Set Simulations

Two simulations were run with the exogenous macroeconomic variables of interest set as defined by the base macroeconomic set. First, equilibrium values for the 1991-1995 period were computed given the base policy set. Then, under the same base macroeconomic set, the target price, loan rate, and diversion requirements were reduced as defined by the all instruments policy set. Simulation results for these two experiments are reported in Tables 9-B1 and 9-B2 of Appendix B.

The results depicted in Figure 9-1 and Appendix Tables 9-B1 and 9-B2 demonstrate the effect of phased reduction of the major policy instruments in a macroeconomic environment similar to that observed in 1989. When the program instruments are held at their 1991 base setting, the real price of wheat increases by 21 percent—primarily due to the relatively low value of the dollar and 1.2 percent rate of growth in income, which increase export and domestic demand. Given sustained strength in prices and crop receipts, total acreage planted increases steadily throughout, starting at 79 million acres in 1991 and increasing to 94 million acres by 1995. No government payments are incurred.[9]

Given the settings of the base macroeconomic set, the effect of policy reform on the sector is overshadowed by the price effects of the favorable macroeconomic environment. When the program instruments are held constant, the real price of wheat increases by 21 percent through 1995. When phased reduction of the program instruments is combined with a favorable macroeconomic environment, the price of wheat increases, but by slightly

Base Macro Set
Real Price of Wheat

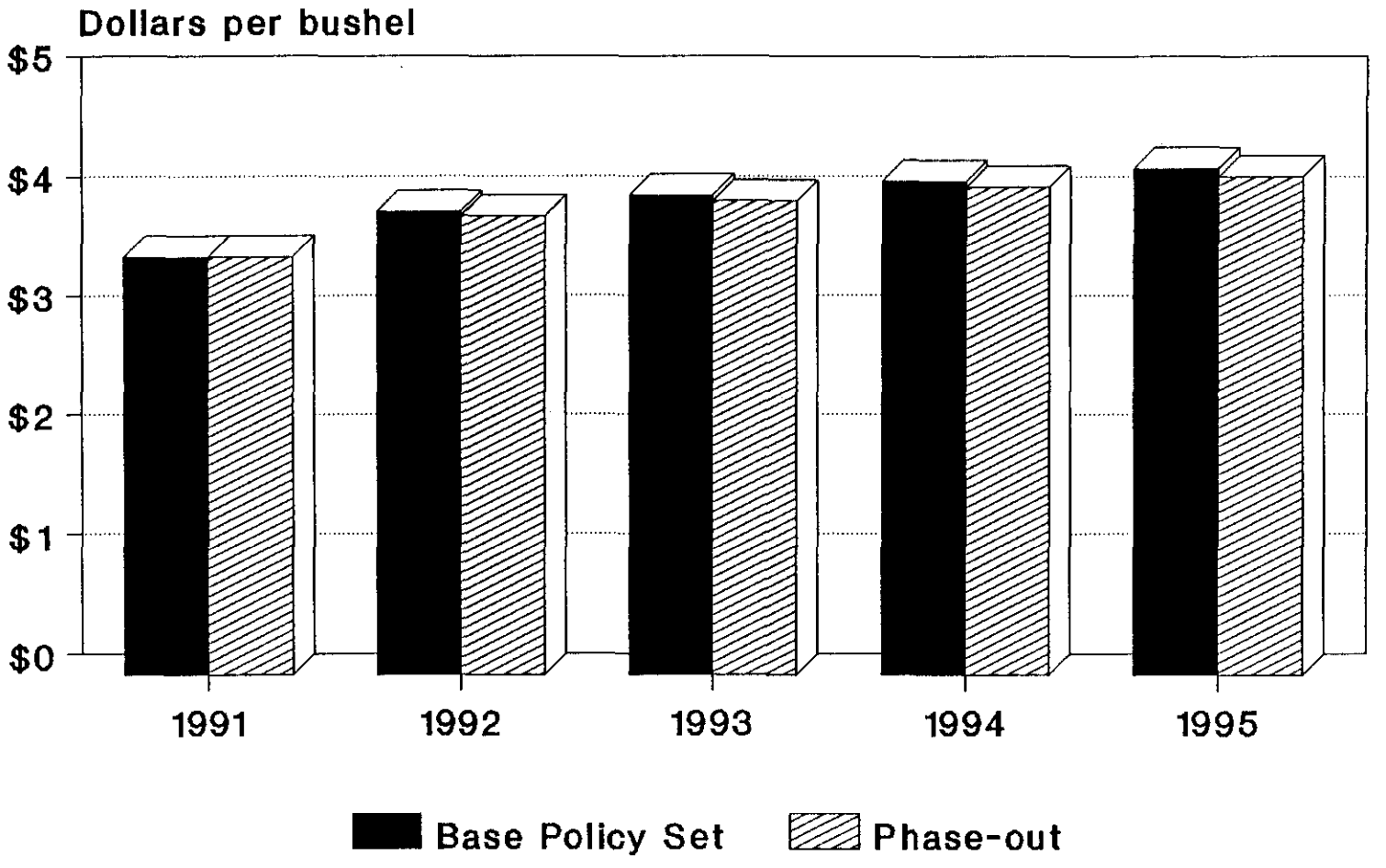

Fig.1

less than that of the base policy scenario. As shown in Figure 9-1, by the fifth year of phased reduction, equilibrium price is only 6 cents per bushel lower due to policy reform.

The cause of this apparent "noneffect" can be directly attributed to the combination of a low-valued dollar and the corresponding high market price. A strong market price represents a high opportunity cost of diversion and, thus, a low rate of program participation. Given the relatively low distortionary impact of the program in the base policy scenario, it should come as no surprise that the effect of policy reform will be minimal. It is important to remember that the level of distortion is directly related to the observed macroeconomic environment. The next set of experiments demonstrates that policy reform can have a significant impact on a weak agricultural sector.

6.2 The 1981-1985 Macroeconomic Set

The early 1980s exhibited a sharp decline in agricultural prices and farm income. Rausser et al. (1986) attribute much of this decline to an appreciating dollar, low income growth, and high real interest rates. Given the 1981-1985 macroeconomic set and the base policy set, equilibrium prices and crop receipts drop dramatically (Appendix B, Table 9-B3). The appreciating dollar contributes to a 53 percent decrease in export demand. The high real interest rates help to depress price further since market stocks increase only slightly. Over the 5-year simulation period, price falls by 44 percent and yearly crop receipts fall by more than 50 percent. As price falls below the target price and the costs of diversion decrease, acreage enters the program and over 9 million acres are diverted from production. Government payments rise to almost $3 billion per year due to deficiency payments alone.

Now compare the effects of phaseout, given the adverse 1981-1985 macroeconomic set as shown in Appendix B, Table 9-B4. Again, as the dollar appreciates, export demand falls—and thus price, production, and crop receipts. Program participation rises over the simulation period due to weak prices; however, this is tempered by a decreasing target price. The declining diversion rate increases participation, but not as much as in the case of the

base policy set. The combination of lower participation and a smaller diversion rate as compared to the base policy scenario mean that almost 5 million acres that would have been set-aside come into production, depressing price by 53 cents per bushel in 1995. By 1955, gross annual income of wheat producers, as defined by crop receipts and government payments, fall by almost $2.7 billion as a result of policy reform.

Contrary to the implications of the base macroeconomic scenario, in Figure 9-2 it is clearly demonstrated that phaseout of the major program provisions can have a very severe impact on the sector and that the degree of impact is conditional on the macroeconomic environment. Since we have imposed an adverse macroeconomic set, prices, production, and farm income are expected to fall, all else held constant. The important point, however, is that, given the 1981-1985 macroeconomic set, prices fall by an extra 31 percent from what they would have been had the wheat program been left at its 1991 setting. Contrast this to the base scenario in which phaseout has only a negligible effect on prices, production, and farm income. The reason for this conditional effect is that program participation, acreage set-aside, and price are jointly determined. Given this joint dependence, the distortionary impact of a given policy set is partly determined by the realized macroeconomic environment. Since the costs and benefits of program participation are not constant across various macroeconomic sets, neither is the effect of reducing the program settings.

In order to better understand the mechanism driving these results, we can compare participation rates and prices under the base macroeconomic set and the 1981-1985 macroeconomic set during phaseout. Under the favorable macroeconomic conditions as described by the base macroeconomic set, phased reduction of the policy instruments leads to an increase in participation. This seemingly perverse relationship is primarily because of the high opportunity cost of diversion and the lack of anticipated deficiency payments because of the high market price. As the diversion requirement is lowered, participation increases. The additional acreage entered into the program and the attendant required set-aside help to offset the acreage coming into production due to the exogenous decline in the diversion rate.

1981-1985 Macro Set

Real Price of Wheat

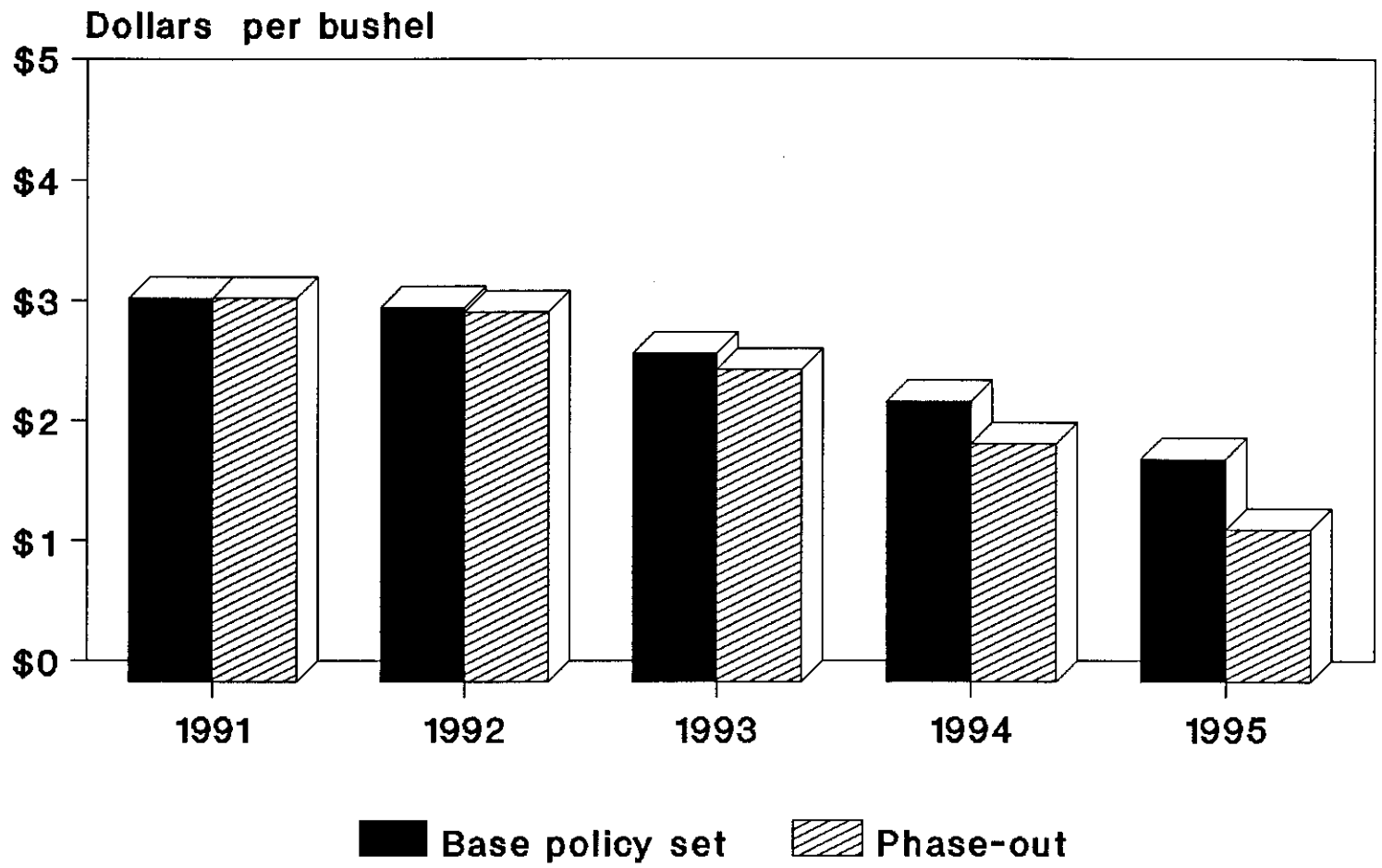

Fig. 2

This effect tempers the price-depressing effect of phaseout over the simulation period. The converse holds under an adverse macroeconomic environment. As the price of wheat declines due to the adverse macroeconomic set, the opportunity cost of diversion is less important, and the reduced target price overshadows the smaller opportunity costs of diversion as the program instruments are reduced. In this case, participation does decrease as compared to the base policy set. Given the smaller diversion rate under phaseout, less acreage is enrolled in the program so that total acreage set-aside is almost 5 billion acres less than it would have been without phased reduction of the policy instruments, which leads to a decrease in price of 57 cents per bushel by 1995.

6.3 The 1975-1979 Macroeconomic Set

The macroeconomy of the late 1970s provided an extremely beneficial environment for agriculture (e.g., Rausser et al. 1986). The exchange rate (dollar) starts at a relatively low level and declines by about 1.5 percent per year, which increases export demand, price, production, and crop receipts. The low (negative) ex post real interest rate induces storage in the face of high prices, thus contributing to strong prices.

The 1975-1979 macroeconomic set is much like the base macroeconomic set. Given the similarity, prices, production, and crop receipts are much like those reported in the base simulation experiment shown in Appendix Table 9-B1. An important point to note is that the macroeconomic environment of the late 1980s, as approximated by the base macroeconomic set, is very beneficial to agriculture relative to the last several decades. Studies using static macroeconomic sets based on the macroeconomic environment of the late 1980s are implicitly basing their results on a particularly favorable macroeconomy as compared to its past performance.

Given the macroeconomic settings of the 1975-1979 period, prices, production, and crop receipts show vigorous increase with or without policy reform (Figure 9-3). The low value of

1975-1979 Macro Set
Real Price of Wheat

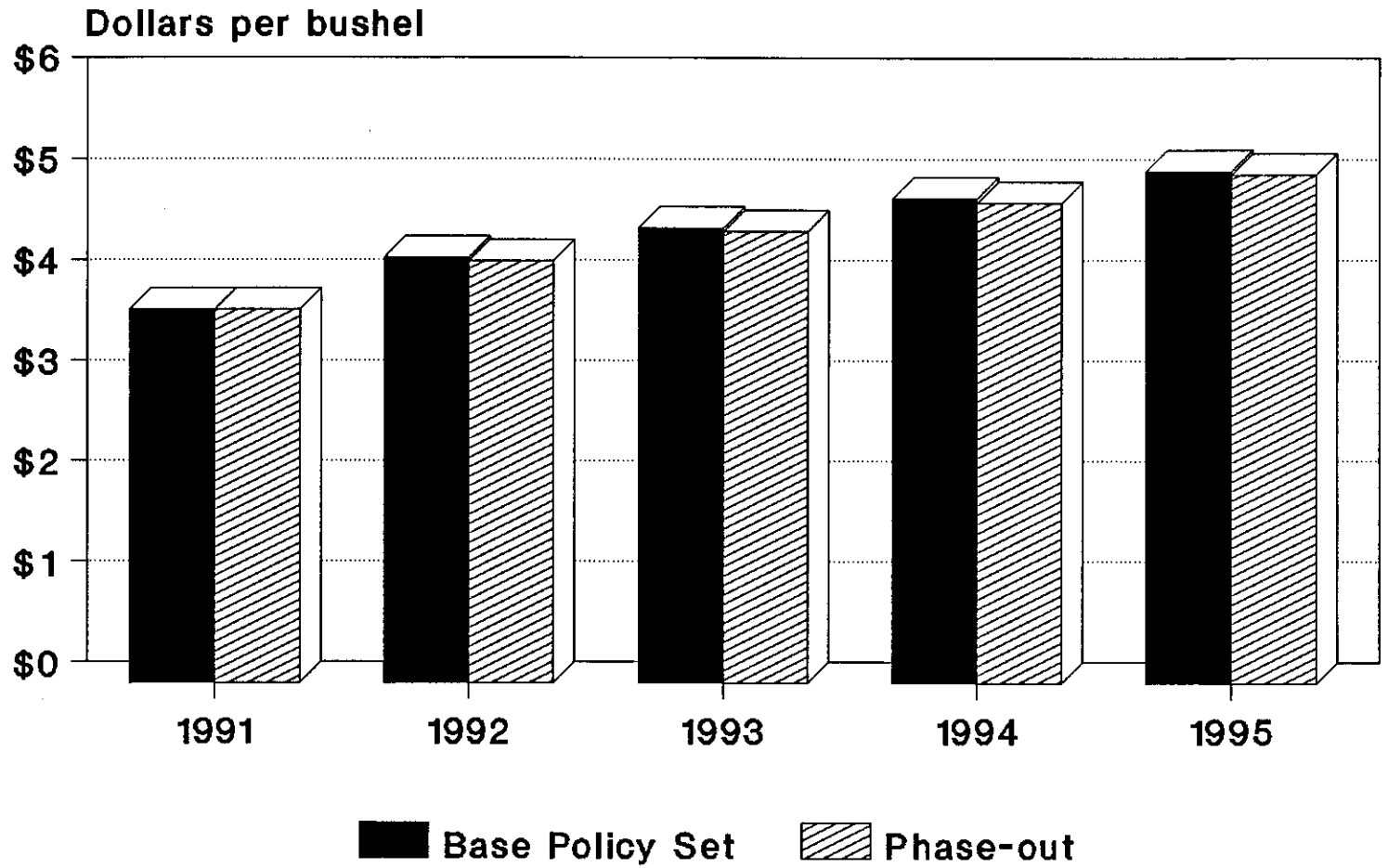

Fig.3

the dollar, combined with strong growth in U.S. and ROW income, increases export demand appreciably.

When the program instruments are held constant in the face of increasing price, program participation and total acreage set-aside decrease due to the opportunity cost of the diversion requirement. However, given the large opportunity cost of diversion, participation increases as the program is phased out. This increase in participation helps to keep acreage out of production as a result of the declining but positive diversion rate, and to hold prices to what would have been obtained under the experiment holding the wheat program in place.

6.4 The Conditional Effects of Phaseout

In Table 9-4 and Figures 9-4 and 9-5 we summarize the conditional effects of phased reduction of the major policy instruments as reported in the preceding six experiments. The table shows comparisons between final period 1995 values for a given macroeconomic set with program instruments held constant and those under phased reduction of the program instruments. The reported values of Table 9-4 are percentages and should be interpreted as the relative effect of phaseout on the relevant variables, conditioned on the realized macroeconomic environment.

The results as presented in Table 9-4 show that in a benign macroeconomic environment (base and 1975-1979 macroeconomic sets) current levels of the policy instruments contribute only a small measure of distortionary impact on the sector. Since the level of distortion is limited, phased reduction has only a minor impact on short-run prices, production, crop receipts, and government payments. Added to the low level of distortion is the perverse result that phased reduction of all policy instruments actually increases program participation in the short run since the decrease in the opportunity costs of diversion outweighs the effect of a lower target price and loan rate. This rise in participation helps to offset the added acreage coming into production as the diversion rate is lowered and helps to hold up prices.

Table 9-4. Conditional Effects of Phased Reduction of Program Parameters

Macroeconomic Set	Δ Real Price of Wheat	Δ Production	Δ Crop Receipts	Δ Government Payments	Δ Gross Farm Income[a]
	percent				
BASE	-1.4	0.4	-1.1	0	-1.1
1981-1985	-31.4	5.2	-27.7	-57.0	-40.5
1975-1979	-0.6	0.2	-0.4	0	-0.4

[a]Gross farm income is defined as crop receipts plus deficieincy payments.

Note: Δ is the change in the endogenous variable attributed to phased reduction of the program parameters, evaluated in 1995.

Price Effect of Policy Reform

Decrease in the real price of wheat

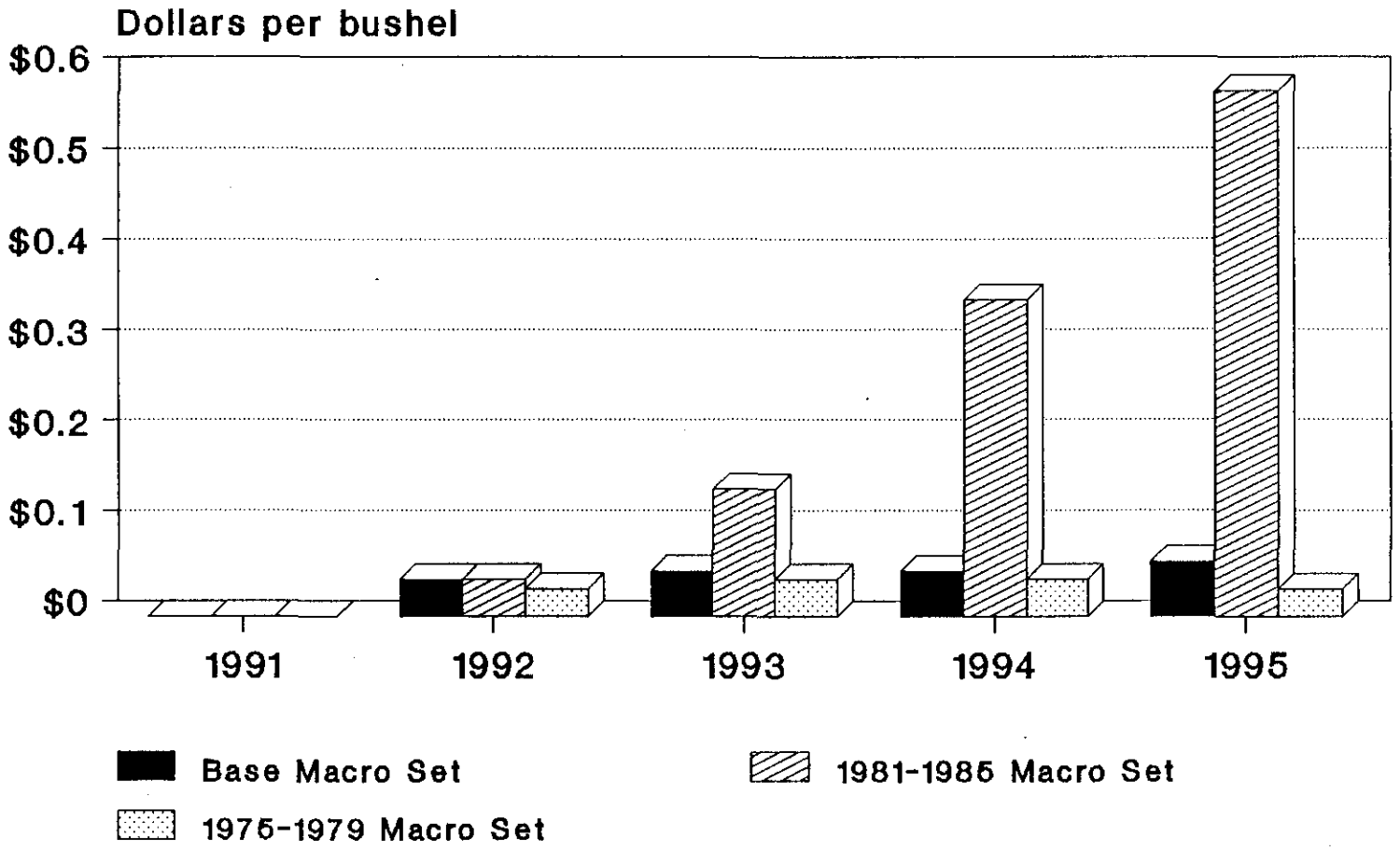

Fig. 4

Policy Reform And Farm Income

Decrease In Farm Income Due To Phase Out

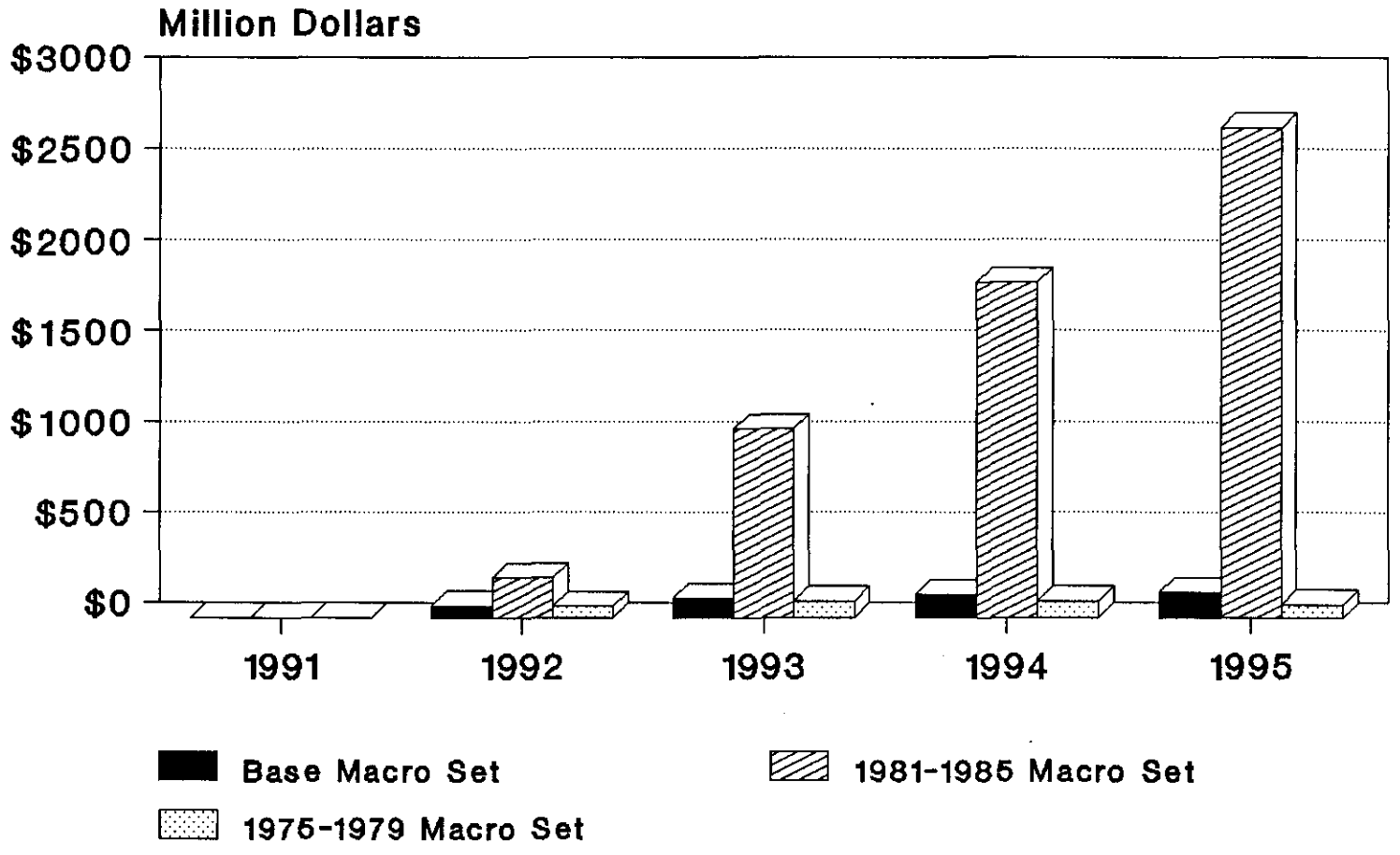

Fig. 5

The converse holds in the case of an adverse macroeconomic environment (1981-1985 macroeconomic set). As prices deteriorate due to the adverse macroeconomic set, the current policy setting becomes very distortionary. We can separate the effects of the macroeconomy on the sector into direct and indirect effects. The direct effect is the more obvious one in which the adverse macroeconomic environment depresses prices, production, and crop receipts and increases government payments. The indirect effect is due to the change in participation and, thus, set-aside acreage and price. Since the opportunity cost of diversion (participation) is much less under the adverse macroeconomic set, the perverse result of increased participation due to phased reduction is not obtained. The perverse result helps to further dampen the already limited effects of phaseout; however, in an adverse macroeconomic environment program, participation and acreage set-aside are less than under a fixed policy scenario. Thus, added pressure on prices occurs as added production is generated, not only by the smaller diversion requirement but also by the endogenous decrease in participation.

6.5 Alternative Design in Phased Reduction of Policy Parameters

Various schemes for reducing the distortionary aspects of U.S. agricultural programs exist. The specific design used in the preceding simulation experiments reduced target price, loan rate, and diversion requirement in equal increments. This particular design is tractable and consistent with the GATT framework.

In order to better understand the relative importance of alternative designs in phased reduction of distortionary policies, a payment acreage scheme was simulated. For these simulation experiments, target price, loan rate, and diversion requirement are held constant; however, the amount of acreage on which a producer is entitled to receive deficiency payments is a declining proportion of his fixed base acreage.

Phased reduction of payment acreage was simulated under the various macroeconomic sets. When the favorable macroeconomic sets (base and 1975-1979) are considered, we find

that this specific form of policy adjustment has no effect on the sector as measured by our model. Operationally, this is due to the deterministic nature of the model. Since producers act as though they have perfect foresight, they attribute no option value to target prices and loan rates when they are below the market price. The base and 1975-1979 macroeconomic sets lead to a market price that is greater than the target price; hence, deficiency payments are zero[10]. A model that admits stochastic optimization would offer different results; however, Gardner (1989) notes that such option value implied by the program is probably relatively small.

Given the adverse 1981-1985 macroeconomic set, a "payment acreage" scheme helps to support price over the simulation period as compared to the phased reduction of the all instruments policy scenario. As the opportunity cost of diversion falls because of the weak equilibrium price, participation and total acreage set-aside (shown in Appendix Table 9-B8) increase by a larger margin as compared to the all instruments scheme (Appendix Table 9-B4). The primary force behind the differential effects is the fact that the diversion requirement is fixed in the payment acreage experiment, where it is gradually reduced in the all instruments experiments. Given the parameters of the system, the endogenously determined set-aside acreage increases market price and crop receipts. That is to say, given phased reduction of payment acreage, price and crop receipts fall by less than under phased reduction of all major program instruments during the period of phaseout.

It is to be stressed that the goal of this research is to examine the short-run effects of phased reduction of the major program instruments. Given that the short run in this particular case is at least 10 years long because of the extended nature of phased reduction, the short run becomes empirically important.

The major results of the experiments dealing with the differential effects of policy design conditioned on the realized macroeconomy are summarized in Table 9-5. Final period (1995) values are compared on the basis of the effect of phase-out design relative to a fixed-policy scenario under the base macroeconomic set and the 1981-1985 macroeconomic set.

The relative effects of two policy designs conditioned on specified macroeconomic environments are shown in Table 9-5. The experiments show that, given phased reduction of all major policy instruments, the preceding results are robust in a qualitative sense, at least over the two phase-out designs considered ,and that the quantitative results are conditioned on the realized macroeconomy. That is to say that, for both policy designs, the macroeconomy matters and the magnitude of the short-run effect of phased reduction is partly determined by the policy design.

Given the base macroeconomic set, the relative effects of program design are negligible. The deterministic nature of this model leads to the result in which reduction of payment acreage has no effect on the sector when market price is above the target price and the diversion rate is held constant. If the option value of program participation was accounted for, we suspect that the two policy designs in the case of the base macroeconomic set would still lead to similar outcomes because the reduced option value of program participation is probably small relative to the opportunity cost of diverting acreage.

For the 1981-1985 macroeconomic set, prices and crop receipts fall as payment acreage is reduced, but not nearly as much as under the reduction of all instruments. Government payments over the simulation period are very different over the two phase-out schemes, as might be expected since the settings of the program instruments are different within each period. The interesting point is that, in order to understand the short-run effects of phased reduction of distortionary policies on equilibrium price, production, and income, one must be explicit about the manner in which those policies are to be phased out.

7. Conclusion

This study has offered a framework for policy analysis in which large shocks to the system can be evaluated. Sufficient attention has been given to the underlying structure of the system such that the parameters of the model are invariant to the class of policy

Table 9-5. Alternative Design in Phased Reduction of Policy Parameters

Macroeconomic Set	Δ Real Price of Wheat	Δ Production	Δ Crop Receipts	Δ Government Payments	Δ Gross Farm Income[a]
	percent				
BASE (All)	-1.4	0.4	-1.1	0	-1.1
BASE (Pay)	0	0	0	0	0
1981-1985 (All)	-31.4	5.2	-27.7	-57.0	-40.5
1981-1985 (Pay)	-8.7	1.3	-7.0	-39.7	-21.3

[a]Gross farm income is defined as crop receipts plus deficiency payments.

Notes: Δ is the change in the endogenous variable attributed to phased reduction of the program parameters, evaluated in 1995.

All = "all instruments" phased out.

Pay = "payment acreage" phased out.

evaluations which we have studied. This framework has been applied to the evaluation of phased reduction of the U.S. wheat program and has led to the following results.

7.1 The macroeconomy has a large influence on U.S. agriculture

Following the results of many of the previous studies cited throughout this paper, we have shown that the macroeconomy can have a severe impact on agriculture prices, production, and income. Our simulations show that, given a macroeconomic environment similar to that observed during the early 1980s, the real price of wheat could fall by as much as 42 percent—even with the wheat program held in place.

7.2 The effect of policy reform is conditioned on the macroeconomy

Given the current macroeconomic environment, policy reform will have little effect on agricultural prices, production, and income. This result is not robust to various realizations of the macroeconomy. Given the adverse environment of the early 1980s, phased reduction of the major program instruments will further decrease real price by 31 percent and total farm revenue by 40 percent (including government payments) as compared to holding the program in place.

7.3. The U.S. farm program can not be modelled as an ad valorem equivalent

Since program participation is voluntary, total acres set aside are endogenous, even when the diversion rate is held constant. Ad valorem equivalents will not be useful in simulating phased reduction or partial policy reform unless further attention is given to the participation decision. Furthermore, ad valorem equivalents as commonly measured are not appropriate for evaluating policy reform in the long run. It is unreasonable to assume that the target price is the rational producer incentive price in the face of pre-announced policy reform. Evaluations based on commonly used measures of ad valorem equivalents overestimate the production incentives of the U.S. farm program and thus underestimate the net effect of

production controls. Contrary to many previous studies on unilateral policy reform, we find that phased reduction of the major policy instruments will lead to decreased market price and crop receipts as land is brought back into production in a market facing inelastic demand.

The normative implications of the above empirical results are simply that subsidy reductions be conditioned upon the macroeconomic environment. In particular, flexible adjustments should be introduced to admit the possibility of some variance in the implementation of reform, depending upon the external economic conditions. Total liberalization by a fixed time, without some conditionality or variance, is a very risky proposition indeed. It threatens government credibility directly and endangers the implementation of reform strategies. To be sure, an inability to implement reform in a few countries can even undermine an externally binding GATT code. Government or political failure in implementing reform in some nations could lead to revisions in a GATT code that would make once-binding constraints totally ineffective.

Footnotes

[1]For a major exception, see Just, Rausser, and Zilberman in this volume.

[2]These studies do not account for the fact that program payments are based on a producers' base acreage—currently defined as a 5-year moving average of acreage planted or considered planted. If the target price is to draw into production acreage which would not have been planted otherwise, the producer must take a short-run (5-year) loss (plant such that marginal cost is greater than price received) in order to gain future program rents. Following the intuition behind the formal treatment of dynamic optimization and the U.S. farm program as shown by de Gorter and Fisher (1989), farmers would increase production only to the extent that the cost of entry to the program is outweighed by the stream of discounted program profits. As such, for a positive discount rate, the first 5 years of the "entry tax" may significantly reduce the distortionary effect of the target price, even in the long run.

[3]Given the fairly limited observations on additional voluntary diversion programs, profits from additional voluntary diversion are only included when anticipated profits from voluntary diversion are greater than anticipated market returns from planting. This simplification is not perfectly correct; however, it should be a very good approximation. In examining the data, we find that the most effective voluntary programs over the 1974-1988 period were the PIK programs of 1983 and 1984 (which are accounted for in this representation). The 0-92 Program is becoming marginly important, but too few observations exist in which to estimate the relevant effects.

[4]The survey work done by Eales, Engel, Hausser, and Thompson (1990) offers empirical evidence that farmers price expectations are not significantly different than the observed futures price.

[5]Notice that, as specified, the real interest rate enters only through the effect on market-held stocks. If interest-rate shocks have an effect on farm production costs as Tweeten

(1980) suggests, the full effect of interest rates may be tempered by the change in endogenous production.

[6]Since the diversion rate is defined as a ratio, interpretation of the reported impact response must be made with care. Notice that a 10 percent change in the diversion rate at its mean value of 13.4 percent is only 1.34 percent. We are not evaluating a change to 23.4 percent required diversion.

[7]This does not imply that the target price was below the market price on average over the sample period.

[8]A dynamic model of intertemporal profit maximization following the model of de Gorter and Fisher (1989) may admit a positive relationship between the target price and production.

[9]For this study, government payments are defined as simply the sum of CCC acquisitions and deficiency payments.

[10]The primary reason the model obtains a 1991 market price grater than the target price is the presupposed low carry-in from the 1990 crop. The realized growing conditions conditions of 1990 greatly diminished the realized market price.

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APPENDIX A
PARAMETER ESTIMATION

PRODUCTION

The production block has been estimated over the sample period of 1974-1987 using the three-stage, least-squares estimator. Given the nonlinearity of real net profit from participation, the variable has been specified as exogenous for estimation purposes. Given this procedure, the three-stage, least-squares estimator is operationally equivalent to the Seemingly Unrelated Regression Estimator since the production system as specified for estimation contains no endogenous right-hand-side variables.[1] Note that for simulation purposes real net profit from participation is endogenous. All estimated coefficients are of the assumed sign, and generally are significant as judged by the asymptotic t-ratio.

Following Sims (1972), the Durbin-Watson statistic presents a low power test for autocorrelation. The low Durbin-Watson statistic for the acreage planted by nonparticipants suggests autocorrelation and biased parameter estimates. The production equations were re-estimated using a standard autocorrelation correction technique. The re-estimated parameters did not vary much from those reported above and indicate that the autocorrelation bias is minimal.

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[1]In the production block, the futures price enters exogenously. Simultaneity bias should be minimal due to the large variance in excess demand as compared to U.S. supply. Notice that, in the demand block, current price is endogenous and instruments are formed for the reduced form relations.

PROGRAM PARTICIPATION RATE

$$PRTR = 0.625 + 0.00824*RNPFP + 0.375*DDVR$$

(9.659) (17.622)

[0.04]

T-ratio ( ), elasticity [ ]

$R^2 = 0.974$ D.W. = 2.05

PRTR = Program participation rate

RNPFP = Real net profit from participation

DDVR = Indicator variable for zero mandatory diversion

YIELD PER PLANTED ACRE

$$YLD = -426.9 + 1.051*RFPW - 0.0163*RVC + 0.065*STASD + 10.506*t - 0.061*tq$$

(2.236) (0.161) (1.110) (2.785) (2.855)

[0.18] [-0.03] [0.02]

T-ratio ( ), elasticity [ ]

$R^2 = 0.86$ D.W. = 2.80

YLD = Yield per planted acre

RFPW = Real futures price of wheat (October quote for September delivery)

RVC = Real variable costs

STASD = Acreage set-aside (mandatory and voluntary programs)

t = Time

tq = Time squared

ACREAGE PLANTED BY NONPARTICIPANTS

APNP = 120 + 0.26*LAPNP + 4.579*RFPW - 1.66*RVC - 1.039*PACP + 26.339*SUB

(1.811)	(1.619)	(2.985)	(8.802)	(1.871)
[0.28]	[0.97]	[-4.11]	[-2.72]	[1.48]

T-ratio ( ), elasticity [ ]

$R^2 = 0.913$ D.W. = 1.122

APNP = Acreage planted by nonparticipants

LAPNP = Lagged acreage planted by nonparticipants

RFPW = Real futures price of wheat

RVC = Real variable costs

PACP = Program acreage considered planted

SUB = Relative price (futures price of wheat divided by futures price of corn)

DEMAND

The demand block has been estimated over the sample period of 1963-1987 using the three-stage, least-squares estimator. The estimated coefficients are of the assumed sign and generally are significant. The distributed lag specification appears to capture much of the underlying dynamics of the demand system. The Durbin-Watson statistics are all close to two, and the estimated parameters proved to be vary robust to alternative autocorrelation specifications.

FOOD

$$FOOD = 74.728 + 0.720*LFOOD - 2.044*RPW + 0.0362*USGNP$$

	(3.881)	(0.900)	(1.948)
	[0.71]	[-0.02]	[0.18]

T-ratio ( ), elasticity [ ]

$R^2 = 0.962$ D.W. = 1.968

FOOD = U.S. wheat used for food

LFOOD = Lagged FOOD

RPW = Real price of wheat (price received by farmers, annual average weighted by marketings)

USGNP = Real U.S. gross national product

FEED

$$FEED = 308.7 + 0.364*LFEED - 26.798*RPW + 0.0723*USGNP - 190.45*SUBF$$

	(2.381)	(2.776)	(2.555)	(2.302)
	[0.35]	[-0.47]	[0.81]	[-0.9]

T-ratio ( ), elasticity [ ]

$R^2 = 0.80$ D.W. = 2.32

FEED = U.S. wheat used for feed and seed

LFEED = Lagged FEED

RPW = Real price of wheat

USGNP = U.S. gross national profit

SUBF = July price of wheat divided by July price of corn

EXPORT DEMAND

$$ED = 1{,}954 + 0.679*LED - 69.845*RPW - 12.155*EX + 0.013*WGNP$$

(3.427)	(1.597)	(3.396)	(0.264)
[0.65]	[-0.29]	[-1.27]	[0.08]

T-ratio ( ), elasticity [ ]

$R^2 = 0.728$ D.W. = 2.11

ED = Export demand

LED = Lagged export demand

RPW = Real price of wheat (U.S. currency)

EX = Rest of world currency per dollar (Federal Reserve Board trade-weighted exchange rate)

WGNP = World gross national profit (O.E.C.D. gross national profit serves as a proxy)

MARKET STOCKS

$$KMARK = 1{,}017 - 95.387*RPW - 56.453*RRATE + 0.533*DKGOV$$

(3.374)	(3.655)	(5.670)
[-0.82]	[-0.14]	[-0.01]

T-ratio ( ), elasticity [ ]

$R^2 = 0.549$ D.W. = 1.74

KMARK = Market held end of crop year carry-over

RPW = Real price of wheat

RRATE = Real rate of return on 6-month T-Bill (ex post)

DKGOV = Net change in government held stocks in period t+1

APPENDIX B

Table 9-B1 Base Macroeconomic Set and Base Policy Set

Year	Real Price of Wheat	Food Demand	Feed Demand	Export Demand	Market Storage	Production
	dollars/bushel	million bushels				
1991	3.50	772	422	1,494	471	2,450
1992	3.88	778	433	1,635	435	2,764
1993	4.02	784	437	1,722	421	2,883
1994	4.14	790	438	1,774	409	2,945
1995	4.24	796	440	1,805	400	2,986

Year	Participation	Nonparticipant Acreage	Total Acreage	Acreage Set-aside	Crop Receipts	Government Payments
	percent	million acres			million dollars	
1991	55	42	79	5.8	8,569	0
1992	54	52	88	5.7	10,713	0
1993	53	56	91	5.6	11,598	0
1994	53	58	93	5.6	12,207	0
1995	52	59	94	5.5	12,662	0

Calculated.

Note: Government payments are the sum of deficiency payments and the cost of Commodity Credit Corporation acquisition.

Table 9-B2 Base Macroeconomic Set and All Instruments Policy Set

Year	Real Price of Wheat	Food Demand	Feed Demand	Export Demand	Market Storage	Production
	dollars/bushel	million bushels				
1991	3.50	772	422	1,494	471	2,450
1992	3.84	778	434	1,637	438	2,770
1993	3.97	784	438	1,727	426	2,891
1994	4.09	790	441	1,782	415	2,956
1995	4.18	796	443	1,814	407	2,999

Year	Participation	Nonparticipant Acreage	Total Acreage	Acreage Set-aside	Crop Receipts	Government Payments
	percent	million acres			million dollars	
1991	55	42	79	5.8	8,569	0
1992	55	51	88	5.2	10,648	0
1993	55	54	91	4.5	11,490	0
1994	56	54	93	3.9	12,080	0
1995	57	54	94	3.3	12,522	0

Calculated.

Note: Government payments are the sum of deficiency payments and the cost of Commodity Credit Corporation acquisition.

Table 9-B3 1981-1985 Macroeconomic Set and Base Policy Set

Year	Real Price of Wheat	Food Demand	Feed Demand	Export Demand	Market Storage	Production
	dollars/bushel	million bushels				
1991	3.20	775	434	1,391	487	2,377
1992	3.12	786	466	1,356	482	2,557
1993	2.74	798	496	1,208	508	2,482
1994	2.33	813	526	968	534	2,288
1995	1.85	828	559	655	567	2,030

Year	Participation	Nonparticipant Acreage	Total Acreage	Acreage Set-aside	Crop Receipts	Government Payments
	percent	million acres			million dollars	
1991	56	40	77	5.6	7,598	40
1992	57	46	83	6.1	7,971	146
1993	65	38	82	6.9	6,794	755
1994	76	25	77	8.1	5,331	1,613
1995	88	8	69	9.4	3,747	2,905

Calculated.

Note: Government payments are the sum of deficiency payments and the cost of Commodity Credit Corporation acquisition.

Table 9-B4 1981-1985 Macroeconomic Set and All Instruments Policy Set

Year	Real Price of Wheat	Food Demand	Feed Demand	Export Demand	Market Storage	Production
	dollars/bushel	million bushels				
1991	3.20	775	434	1,391	487	2,377
1992	3.08	786	467	1,359	486	2,564
1993	2.60	799	500	1,220	519	2,506
1994	1.98	814	537	1,001	567	2,353
1995	1.27	830	578	718	622	2,135

Year	Participation	Nonparticipant Acreage	Total Acreage	Acreage Set-aside	Crop Receipts	Government Payments
	percent	million acres			million dollars	
1991	56	40	77	6.0	7,598	40
1992	57	45	84	5.5	7,898	0
1993	59	42	83	5.0	6,510	0
1994	63	35	80	4.7	4,658	439
1995	75	20	74	4.8	2,708	1,250

Calculated.

Note: Government payments are the sum of deficiency payments and the cost of Commodity Credit Corporation acquisition.

Table 9-B5 1975-1979 Macroeconomic Set and Base Policy Set

Year	Real Price of Wheat	Food Demand	Feed Demand	Export Demand	Market Storage	Production
	dollars/bushel	million bushels				
1991	3.72	775	422	1,513	502	2,502
1992	4.23	785	436	1,689	505	2,867
1993	4.53	798	443	1,822	528	3,041
1994	4.82	812	449	1,925	552	3,163
1995	5.09	826	455	2,008	578	3,269

Year	Participation	Nonparticipant Acreage	Total Acreage	Acreage Set-aside	Crop Receipts	Government Payments
		million acres			million dollars	
1991	54	44	80	5.7	9,298	0
1992	52	55	90	5.5	12,127	0
1993	51	61	94	5.4	13,769	0
1994	50	64	97	5.3	15,242	0
1995	49	68	100	5.2	16,649	0

Calculated.

Note: Government payments are the sum of deficiency payments and the cost of Commodity Credit Corporation acquisition.

Table 9-B6 1975-1979 Macroeconomic Set and All Instruments Policy Set

Year	Real Price of Wheat	Food Demand	Feed Demand	Export Demand	Market Storage	Production
	dollars/bushel	million bushels				
1991	3.72	775	422	1,513	502	2,502
1992	4.20	785	437	1,692	508	2,873
1993	4.49	798	445	1,826	532	3,048
1994	4.78	812	451	1,931	556	3,170
1995	5.06	827	456	2,014	581	3,267

Year	Participation	Nonparticipant Acreage	Total Acreage	Acreage Set-aside	Crop Receipts	Government Payments
	percent	million acres			million dollars	
1991	54	44	80	5.7	9,298	0
1992	54	54	90	5.2	12,065	0
1993	54	58	95	4.6	13,675	0
1994	54	60	98	4.0	15,151	0
1995	55	62	100	3.5	16,576	0

Calculated.

Note: Government payments are the sum of deficiency payments and the cost of Commodity Credit Corporation acquisition.

Table 9-B7 Base Macroeconomic Set and Payment Acreage Policy Set

Year	Real Price of Wheat	Food Demand	Feed Demand	Export Demand	Market Storage	Production
	dollars/bushel	million bushels				
1991	3.50	772	422	1,494	471	2,450
1992	3.88	778	433	1,635	435	2,764
1993	4.02	784	437	1,722	421	2,883
1994	4.14	790	438	1,774	409	2,945
1995	4.24	796	440	1,805	400	2,986

Year	Participation	Nonparticipant Acreage	Total Acreage	Acreage Set-aside	Crop Receipts	Government Payments
	percent	million acres			million dollars	
1991	55	42	79	5.8	8,569	0
1992	54	52	88	5.7	10,713	0
1993	53	56	91	5.6	11,598	0
1994	53	58	93	5.6	12,207	0
1995	52	59	94	5.5	12,662	0

Calculated.

Note: Government payments are the sum of deficiency payments and the cost of Commodity Credit Corporation acquisition.

Table 9-B8 1981-1885 Macroeconomic Set and Payment Acreage Policy Set

Year	Real Price of Wheat	Food Demand	Feed Demand	Export Demand	Market Storage	Production
	dollars/bushel	million bushels				
1991	3.20	775	434	1,391	487	2,377
1992	3.12	786	466	1,356	482	2,557
1993	2.73	798	496	1,209	508	2,484
1994	2.27	813	528	973	539	2,298
1995	1.69	829	563	669	581	2,507

Year	Participation	Nonparticipant Acreage	Total Acreage	Acreage Set-aside	Crop Receipts	Government Payments
	percent	million acres			million dollars	
1991	56	40	77	6.0	7,598	40
1992	57	46	83	6.1	7,971	131
1993	64	39	82	6.8	6,771	607
1994	72	28	77	7.7	5,225	1,140
1995	80	15	70	8.5	34,84	1,751

Calculated.

Note: Government payments are the sum of deficiency payments and the cost of Commodity Credit Corporation acquisition.