PREPARED FOR

Report To The Congress

THE U.S. GENERAL ACCOUNTING OFFICE

Farmer-Owned Grain Reserve Program Needs Modification To Improve Effectiveness: Theoretical And Empirical Considerations In Agricultural Buffer Stock Policy Under The Food And Agriculture Act Of 1977

By Dr. Richard E. Just

Volume 3 Of Three Volumes

Dr. Just's analysis indicates that price stabilization in both the grain and livestock markets due to the farmer-owned grain reserve was minor. The benefits from short-term stabilization were not sufficient to outweigh the related economic costs. As a result, the program led to a net economic loss over the 2-year period of the study, considering all affected market groups.

CED-81-70
JUNE 26, 1981

PREFACE

GAO and two agricultural economists have reviewed the farmer owned grain reserve program. This volume, written by Dr. Richard E. Just, analyzes the major theoretical developments of stabilization policy and then uses this information to develop a model to investigate the effects of the reserve program on prices, quantities, and real income for grain and livestock markets.

Volume	Description
1	Farmer-Owned Grain Reserve Program Needs Modification To Improve Effectiveness--includes an introductory section on the reserve program; synopsizes information in the two other volumes; describes reserve grain quality problems; discusses storage payments; and contains our conclusions and recommendations.
2	Consequences of USDA's Farmer-Owned Reserve Program for Grain Stocks and Prices--examines data on stocks and prices of corn and wheat during the program's first 3 years and estimates its effects.

THEORETICAL AND EMPIRICAL CONSIDERATIONS IN AGRICULTURAL BUFFER STOCK POLICY UNDER THE FOOD AND AGRICULTURE ACT OF 1977

By Dr. Richard E. Just

SUMMARY

This study analyzes the major theoretical developments in stabilization policy, most of which have occurred over the past 10 years. These theoretical developments raise serious questions about most previous empirical work on stabilization policy. Based on generalizations implied by these theoretical studies, a 34-equation, nonlinear simultaneous equation model of the wheat/feed-grain/livestock economy is specified and estimated in this study. The estimated model is then used to investigate the effects of the farmer-owned reserve program on prices, quantities, and real income for grain and livestock markets.

FALSE PRICE SIGNALS RESULTED IN MALADJUSTMENT IN LIVESTOCK INDUSTRY

The empirical results suggest that the program has not benefited grain producers, except for minor benefits in its first year. One reason why the program had few benefits for producers is that large farmer-owned reserves, once accumulated, tended to depress prices because demand for private stocks fell substantially. But this effect may be minor. A more serious drawback is that it gave false price signals to the livestock industry, causing maladjustment. During the program's first year, the relative shortage of grain in the commercial market (compared with what would have been the case without a farmer-owned reserve--not compared with previous years) caused a tendency to higher feed prices and thus contraction in the livestock industry (breeding stock as well a animals on feed) as compared with what would have occurred without a farmer-owned reserve. Later, as the reserve was filled and the grain market could have returned to normal levels, the demand for feed was lower because the livestock industry had held back on production, and thus grain prices tended downward. This grain price effect continued for some time because of the long timelag required to adjust herd sizes and produce feeder animals. These results suggest that substantial economic imbalances can result from frequent policy changes for which the effects cannot be well anticipated.

Results imply that over the first 2 years of the farmer-owned reserve program as a whole, grain consumers and livestock producers generally benefited while meat consumers and grain producers did not. Grain market gains generally exceeded meat market losses for consumers. More importantly, grain producers' losses outweighed the gains of all groups combined. Most of this loss apparently was due to indirect effects of maladjustments caused by temporary false price signals early in the program.

These results suggest that frequent changes in agricultural policy are costly. An agricultural policy should be able to adjust automatically over the long term to changing economic conditions without causing unexpected changes in loan rates, set-aside requirements, etc. This study suggests an alternative policy that may meet these needs.

PROGRAM APPEARS TO HAVE STABILIZED SHORT-TERM GRAIN PRICES

Results indicate that the program helped to stabilize prices in both grain and livestock markets. This conclusion is also supported by an analysis of the effect of an unexpected market development--the Russian grain embargo.

However, the results indicate that the benefits from reducing short-term instability (unanticipated price variations one quarter ahead) are minor compared with the overall losses discussed above. Furthermore, the econometric analysis shows that economic benefits of stability may not be large because producers do not have a strong preference for stable incomes in the short run (one quarter ahead). On the other hand, longer term price stability can prevent the kind of industry maladjustment that occurred as a result of the reserve program. Therefore, long-term stability has much greater economic benefits. But this type of stability cannot be attained with frequent revisions of policy and, in fact, long-term stability does not appear to have been an important objective of U.S. agricultural policy.

GOVERNMENT OWNERSHIP APPEARS TO BE MORE EFFECTIVE THAN FARMER OWNERSHIP

The results of this study strongly favor Government (Commodity Credit Corporation--CCC) ownership over farmer ownership of the grain reserve to the extent that a purpose of the reserve is to meet emergency needs. Apparently, private market concerns regard the farmer-owned reserve as a close substitute for private stocks. Because the reserve is farmer controlled, it can be more responsive to market developments than a CCC-owned stock. Also, farmer-owned reserves will more likely reenter market channels than CCC stocks, which are often used for foreign assistance outside commercial channels. Finally, farmer-owned reserves are more likely held by the same individuals who would otherwise hold market stocks. As a result, the Government pays storage costs on a large part of the reserve that would otherwise be stored by private concerns. Estimates show that over 80 percent of the farmer-held reserve for wheat and over 50 percent for corn would be held in absence of Government payments for storage.

If the Government held the reserve stock, its costs could be cut almost 80 percent for wheat and 50 percent for corn for the same level of protection afforded by the farmer-held reserve program. This result further suggests that the large farmer-owned reserve levels may be providing a false sense of security for policymakers. If much of the farmer-owned reserve is regarded as a substitute for market stocks by those who control sales decisions, then the amount actually available for emergency purposes is far less (about 80 percent less for wheat) than if a similar level of stocks were held by CCC. The reason for this conclusion is that estimates show CCC stocks are not regarded as a close substitute for market stocks; hence, when Government stocks are held by CCC, market stocks are not reduced by a corresponding amount and thus more grain is available for emergency purposes.

In summary, the results of this study suggest that the stabilizing effect of the program has been minor, that major economic inefficiencies resulted from temporary price effects at program inception, and that the particular mechanism of reserve accumulation--the farmer-owned reserve--uses Government funds inefficiently. If a stabilization program is used at all, it should apparently be based on CCC storage and have a built-in mechanism to ease the transition at program inception and should allow producers to better anticipate policy adjustment to market developments and thus make better investment decisions.

While these results are subject to errors of estimation and specification (as in any econometric study)--particularly since only 2 years of data were available in the farmer-owned reserve period--the results at least suggest skepticism regarding net benefits because a reasonably specified model with plausible estimates indicated large negative effects. Furthermore, some experimentation with model specification has suggested that most of the results of this study are quite robust unless specifications are constrained to follow traditional, nonflexible functional forms.

Contents

SECTION 1

INTRODUCTION

The purpose of this study is to review and evaluate theoretical concepts relating to buffer stock policy in the agricultural economy and to consider implications for empirical evaluation of the reserve policy under the Food and Agriculture Act of 1977 on the various major agricultural sectors in view of these theoretical results. The latter analysis focuses specifically on producers of wheat, feed grains, beef, hogs, and poultry and on consumers.

The effects of the policy are evaluated using the concept of economic surplus. Economic surplus is defined as the real income or net benefit derived by producers or consumers from participating in a particular market. With simple concepts of supply and demand, one can readily estimate the effects of a policy on prices and market quantities, but some additional measure of economic welfare is needed to determine whether such changes are beneficial or not (and by how much) for each group of producers and consumers. For example, the amount of a price increase multiplied by the quantity a consumer was consuming before the price increase generally overestimates the change in his real income; he may be better off by consuming less and diverting some expenditure to goods which were almost preferred before the change. The concept of economic surplus accounts for these possibilities in the case of both producers and consumers. In this sense, this study may be regarded as a cost-benefit analysis of the reserve policy enacted by the Food and Agriculture Act of 1977 (although administrative costs are not considered).

Changes in economic surpluses measure changes in real income for market participants. The theory of economic welfare has shown that economic surplus or real income changes can be calculated using consumer demand and producer supply curves. 1/ One can view a demand curve as specifying the maximum amount that a consumer is willing to pay for each additional unit of a product. For example, in figure 1, p2 is the maximum price that a consumer would pay for an additional unit of consumption if he were already consuming q2. Thus, if a consumer actually pays price p1 for every unit of the product, then he has an excess

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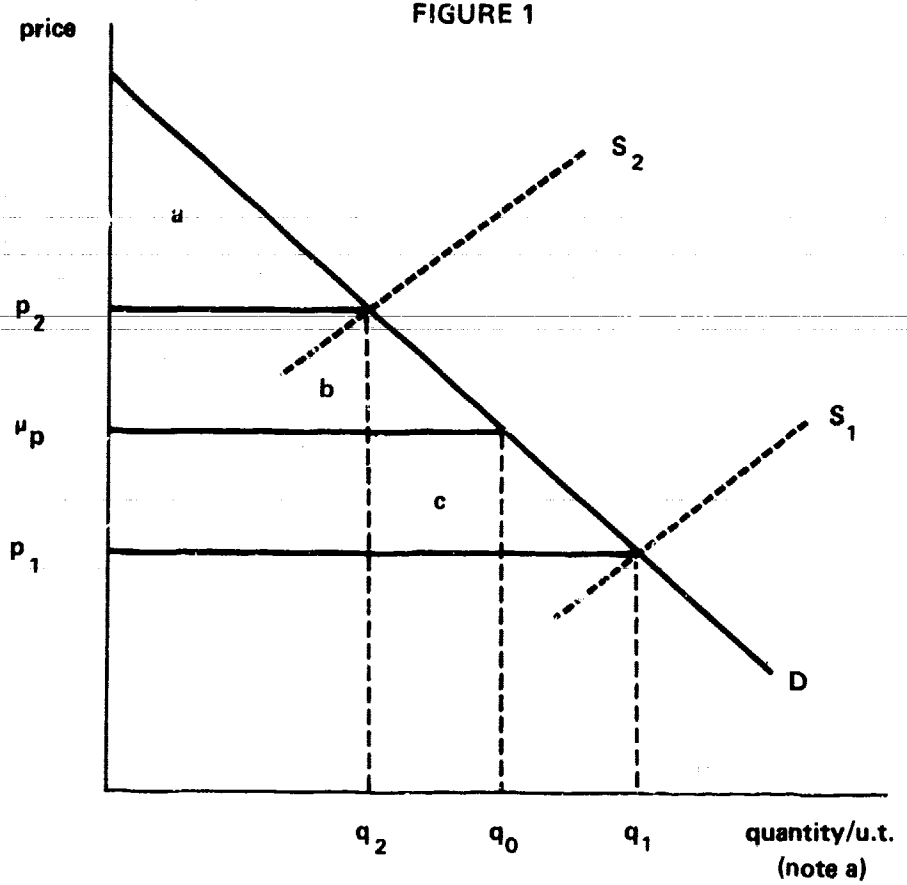
1/M. Currie, J. Murphy, and A. Schmitz, "The Concept of Economic Surplus and Its Use in Economic Analysis," Economic Journal, Vol. 81 (1971), pp. 741-799.

FIGURE 1



a/Quantity per unit of time.

willingness to pay given by the vertical distance between p1 and the demand curve for each unit of output to the left of q1. Summing this excess willingness to pay over all units of output purchased at price p1 (i.e., between zero and q1) obtains the area a as a measure of the consumer's benefits or real income associated with consuming quantity q1 at price p1. Therefore, the change in area below a demand curve and above price measures the change in real income that a consumer derives from participating in a market. 1/ The significance of this area, sometimes called consumer surplus, readily extends from the individual consumer level to the market level.

Parallel developments on the supply side have also shown that a supply curve measures willingness to sell. Hence, the area above a supply curve and below price measures producers' excess willingness or real income. The change in this area, sometimes called a producer surplus change, has been shown to measure change in short-run profits for producers. 2/ Furthermore, the change in area below a producer's derived demand curve and above price measures changes in short-run profits for the associated producer.

The major weakness of the economic surplus approach is the partial nature of its application in practice; that is, it has tended to be applied in single markets without due consideration of effects in other markets. However, a number of recent generalizations have increased the possibilities for more general application where related economic welfare implications in other sectors are also considered. 3/ The principles of these developments

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1/Technically, this relationship holds only for a compensated demand curve, but R.D. Willig has shown that the same result holds with a high degree of approximation under a wide range of conditions for an ordinary demand curve such as is estimated from market data. See R.D. Willig, "Consumer's Surplus Without Apology," American Economic Review, Vol. 66 (1976), pp. 589-597.

2/E.J. Mishan, "What is Producer's Surplus?," American Economic Review, Vol. 58 (1968), p. 1279. Note that the term "short-run profits" is technically called "quasirents."

3/R.E. Just and D.L. Hueth, "Welfare Measurement in a Multimarket Framework," American Economic Review, Vol. 69 (1979), pp. 947-954, or at a more comprehensive level, R.E. Just, D.L. Hueth, and A. Schmitz, Applied Welfare Economics and Public Policy, New York: Prentice Hall, 1981.

are followed in the applied portion of this study by considering extended effects of grain market policy specifically in livestock markets for cattle, hogs, and poultry at both the farm and retail levels. In addition, the welfare effects on farm input suppliers are also considered implicitly to the extent that estimated farm supply curves take into account correlated input price variations. 1/

With these concepts in mind, the following discussion focuses on the effects of reserve policy not only on market prices and quantities, but also on the real income of agricultural producers and consumers. The following section begins by evaluating the theoretical case for reserve policy. Are economic gains from reserve policy conceivable and which economic groups are made better off as a result? A basic model is first expounded. Then a number of recent theoretical considerations which lead to major revisions of these results based on particular market characteristics are discussed in sections 3 through 7.

This survey of theoretical considerations concludes that even though overall gains may be possible, economic theory alone cannot determine whether or not any particular sector of the agricultural economy other than Government will gain or lose as a result of a reserve policy. (See sec. 8.) However, these theoretical results point out some crucial generalities which must be considered in evaluating reserve policy. Since nearly all previous empirical evaluations of reserve policy have not considered these generalities, their results are not reliable. The imposed empirical specifications are so rigid that the data is not allowed to suggest some plausible outcomes of even the qualitative distribution of benefits (that is, outcomes suggesting which sectors of the agricultural economy gain and which lose with reserve policy).

Based on necessary generalities suggested by theoretical considerations, section 9 develops and estimates a model of the wheat/feed-grain/livestock economy which can be used in investigating effects of the reserve policy. Because the generality required for evaluating reserve policy in view of the theoretical considerations of this study surpasses that used in almost all previous studies, no previous estimates exist for some of the parameters. Thus, the econometric model developed here is a departure from previous precedent in terms of functional form. But as

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1/ This result is proven in Just and Rueth, op. cit.

shown by the theoretical results, this additional generality is necessary before results can be considered valid.

Section 10 uses this model to evaluate the effects of the reserve policy of the Food and Agriculture Act of 1977 on the various sectors of the agricultural economy. Section 11 further evaluates the ability of the farmer-owned reserve to smooth unexpected market shocks in the case of the Soviet grain sales embargo of 1980 as a case in point. Section 12 summarizes conclusions about how effectively the farmer-owned reserve has met the goals and objectives of the policy. Finally, section 13 examines implications of the results for future agricultural policy design.

SECTION 2

THE CASE FOR RESERVE POLICY AND BUFFER STOCK HOLDINGS

The welfare effects of price instability were first studied by Frederick V. Waugh in 1944. 1/ He concluded that contrary to popular opinion, consumers should prefer price instability. His results are developed in figure 1 where D represents demand and consumers face prices p1 and p2, each of which occurs half the time, i.e., with probability 0.5. These price variations may be caused by random fluctuations in supply between S1 and S2. When price is p1, consumers buy q1 so that consumer real income (surplus) is represented by area a + b + c. When price is p2, consumers buy q2 so that consumer real income is represented by area a. On the other hand, if prices are stabilized by a Government policy at the average price level, $\mu p = (p1 + p2)/2$, then consumption takes place at q0 with consumer real income represented by area a + b.

To investigate the welfare effects of price stabilization, note that half the time consumers gain area b as price is lowered from p2 to μp, but the other half of the time consumers lose area c as price is raised from p1 to μp. Since $p2 - \mu p = \mu p - p1$, the loss obviously outweighs the gain; the average loss is 1/2 (area c - area b). This result implies that consumers prefer price instability if they can take advantage of it by buying more at low prices and less at high prices.

The effect of stochastic output price on producers was first examined in 1961 by Oi. 2/ Assuming a fixed supply curve, he concluded that producers also prefer price instability when they can adjust instantaneously to price changes. To understand his results, consider figure 2 where supply is represented by S and producers are confronted with two prices, p1 and p2, each of which occurs with probability 0.5. These price variations may be caused by random variation in demand between D1 and D2. When

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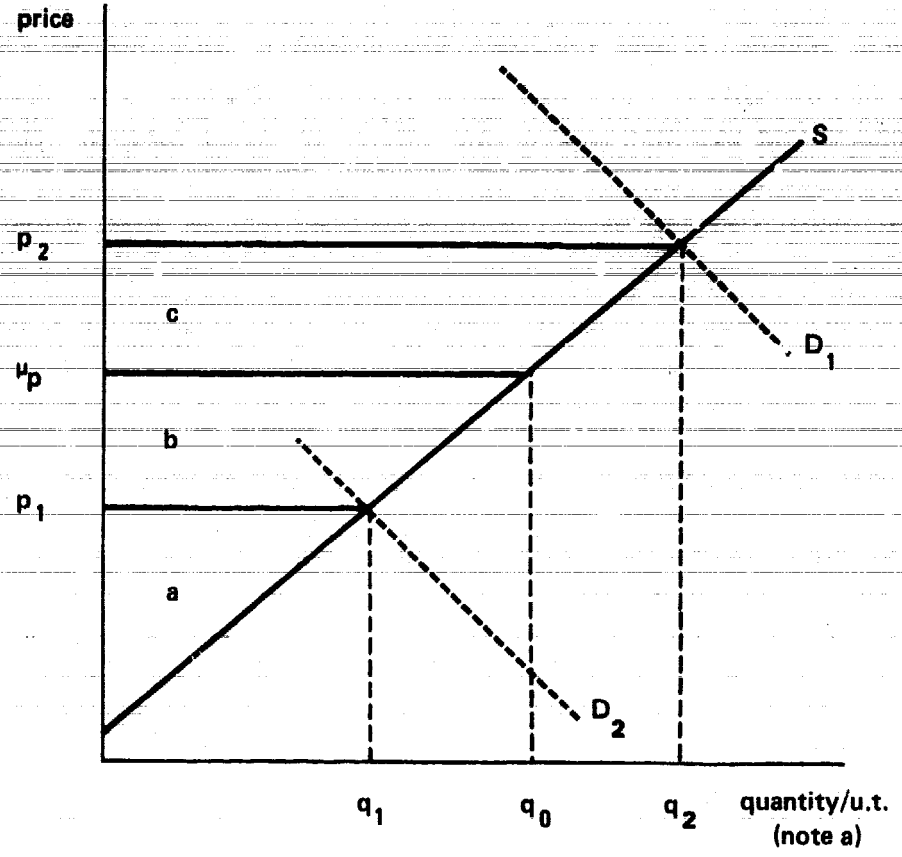
1/Frederick V. Waugh, "Does the Consumer Benefit from Price Instability?," Quarterly Journal of Economics, Vol. 58 (1944), pp. 602-614.

2/W.Y. Oi, "The Desirability of Price Instability Under Perfect Competition," Econometrica, Vol. 27 (1961), pp. 58-64.

FIGURE 2



a/Quantity per unit of time.

price is p1, producers sell q1 so that producer real income (surplus) is represented by area a. When price is p2, producers sell q2 so that real income is represented by area a + b + c. On the other hand, if prices are stabilized by some means such as Government policy at the average price level $\mu p = (p1 - p2)/2$, then production is q0 and producer welfare is represented by area a + b. Where price would otherwise be p1, producers gain area b and where price would otherwise be p2, producers lose area c with stabilization. Since $p2 - \mu p = \mu p - p1$, the latter loss is larger than the former gain; and since each occurs half the time, producers lose on average from price stabilization (unless supply is completely inelastic).

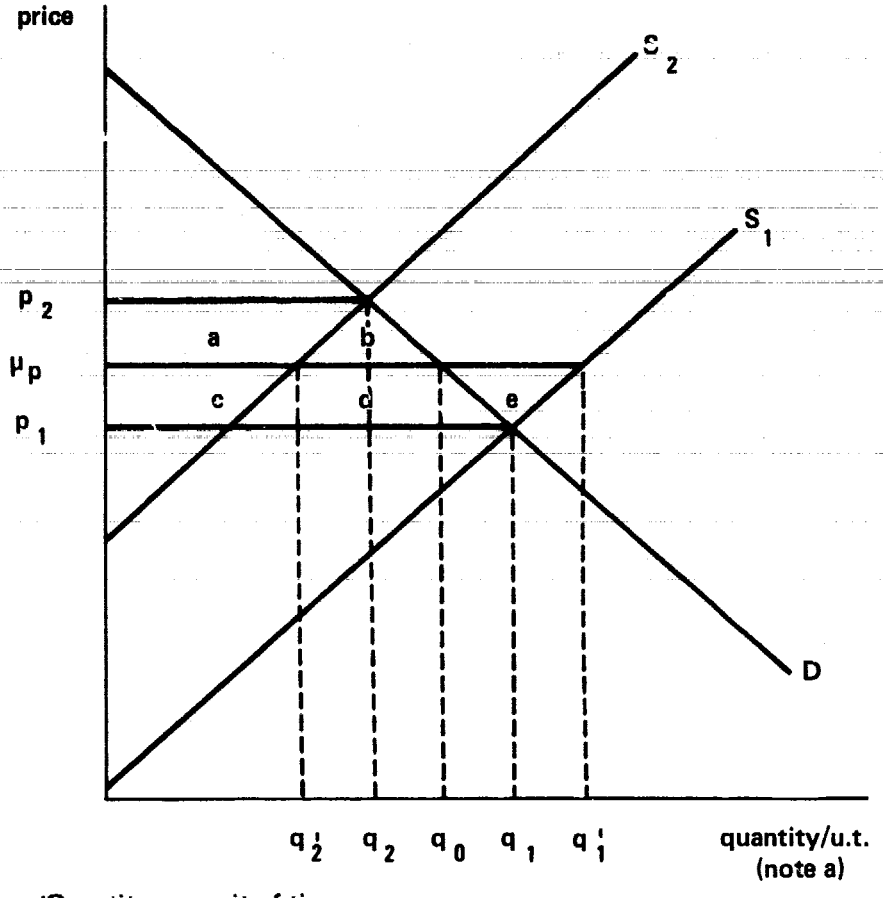
These two counterintuitive results (that an unstable economy is preferable) led economists to consider the issue of price stabilization more closely. Professor Samuelson argued that in fact, an economy cannot "pull itself up by the bootstraps" by simply generating instability. 1/ Both Samuelson and Massell 2/ showed that these two results cannot be simultaneously applicable and that when effects on both sides of the market are considered, there is a net gain from stabilization.

Considering the Massell approach, suppose that in figure 3 consumer demand is represented by D and that stochastic supply is represented by S1 and S2, each of which occurs in alternating periods. Thus, equilibrium prices are p1 and p2, respectively, in alternating periods. Now suppose prices are stabilized at μp, say, by means of a buffer stock policy which buys excess supply, $q1' - q0$, when S1 occurs and sells excess demand, $q0 - q2'$, when S2 occurs. In the event of S1, consumers thus lose area c + d while producers gain area c + d + e for a net gain of area e. In the event of S2, producers lose area a but consumers gain a + b for a net gain of area b. The average overall effect of price stabilization with such a reserve policy is thus a gain of 1/2 (area b + area e). This result implies that the loss from stabilization for consumers offsets some of the gain for producers who are benefited by stability. Furthermore, the gain for producers more than offsets the consumer loss.

1/ Paul A. Samuelson, "The Consumer Does Benefit from Feasible Price Stability," Quarterly Journal of Economics, Vol. 86, No. 3 (1972), pp. 476-493.

2/ B.F. Massell, "Price Stabilization and Welfare," Quarterly Journal of Economics, Vol. 83 (1969), pp. 285-297.

FIGURE 3



a/Quantity per unit of time.

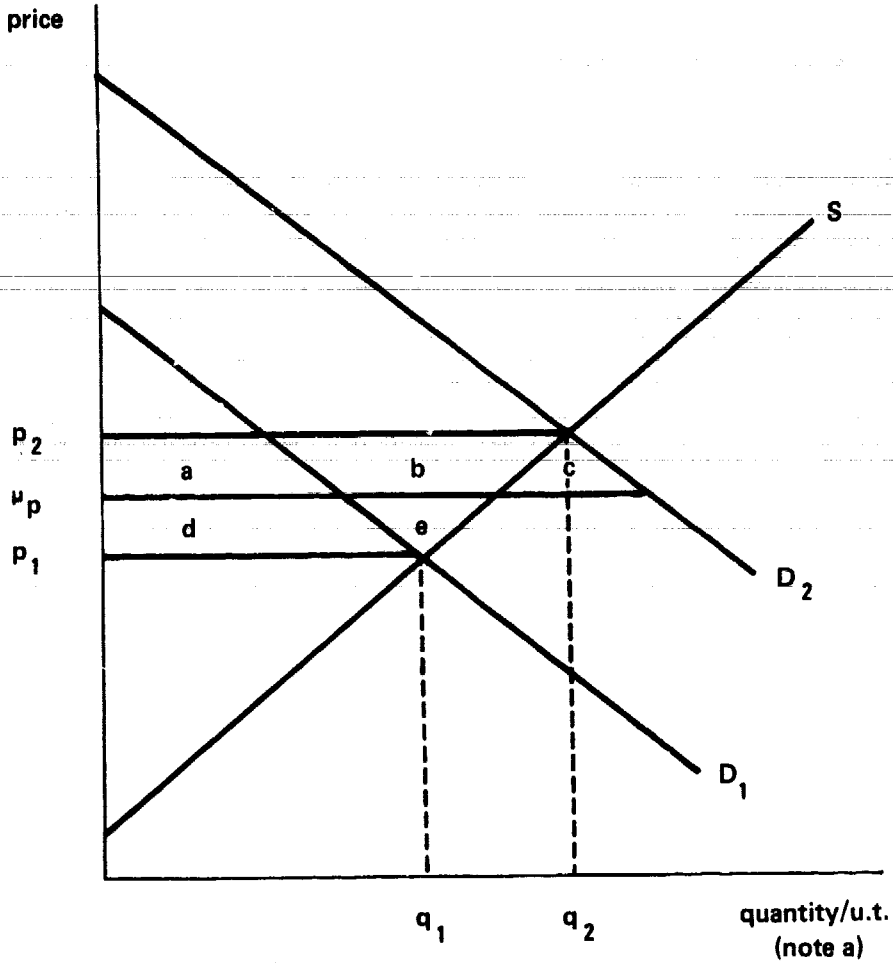
Similar considerations apply to the results in figure 2 as demonstrated in figure 4. With instability represented by demand and price varying between D1 and p1 and D2 and p2, respectively, price stabilization at μp via a buffer stock leads to a gain of area e if D1 occurs or of area c if D2 occurs. On average, the producer loss of 1/2 [area (a + b) - area (d + e)] is more than offset by a consumer gain of 1/2 [area (a + b + c) - area d].

The results of this section suggest that both producers and consumers can benefit by stabilizing prices of storable commodities through a reserve policy if storage costs are not excessive. That is, if one group gains more than the other loses, then a compensation scheme must exist so that both are better off under stabilization.

Massell has further shown that these results can be readily extended to the case with positive storage costs. Consider, for example, figure 5 where supplies S1 and S2 occur in alternative years and where demand is given by D. Corresponding free market prices are thus p1 and p2. Now suppose a reserve policy is instituted such that the buffer stock is increased by q4 - q3 when S1 occurs and is reduced by q2 - q1 when S2 occurs (where q4 - q3 = q2 - q1). The prices p1' and p2' thus correspond to supplies S1 and S2, respectively. Now suppose q4 - q3 and q2 - q1 are chosen such that p2' - p1' is the unit cost of storage. The storage costs are just covered by the buffer stock carriers who buy at price p1' and sell at price p2'. In years of high supply, producers gain area c + d + e over the free market case while consumers lose area c + d; this implies a net gain of area e. In years of low supply, producers lose area a while consumers gain area a + b over the case with no buffer stock; the net gain is area b. As one can see, this analysis and its conclusions are not substantively different than suggested by figure 3. Similar arguments apply to the case of figure 4.

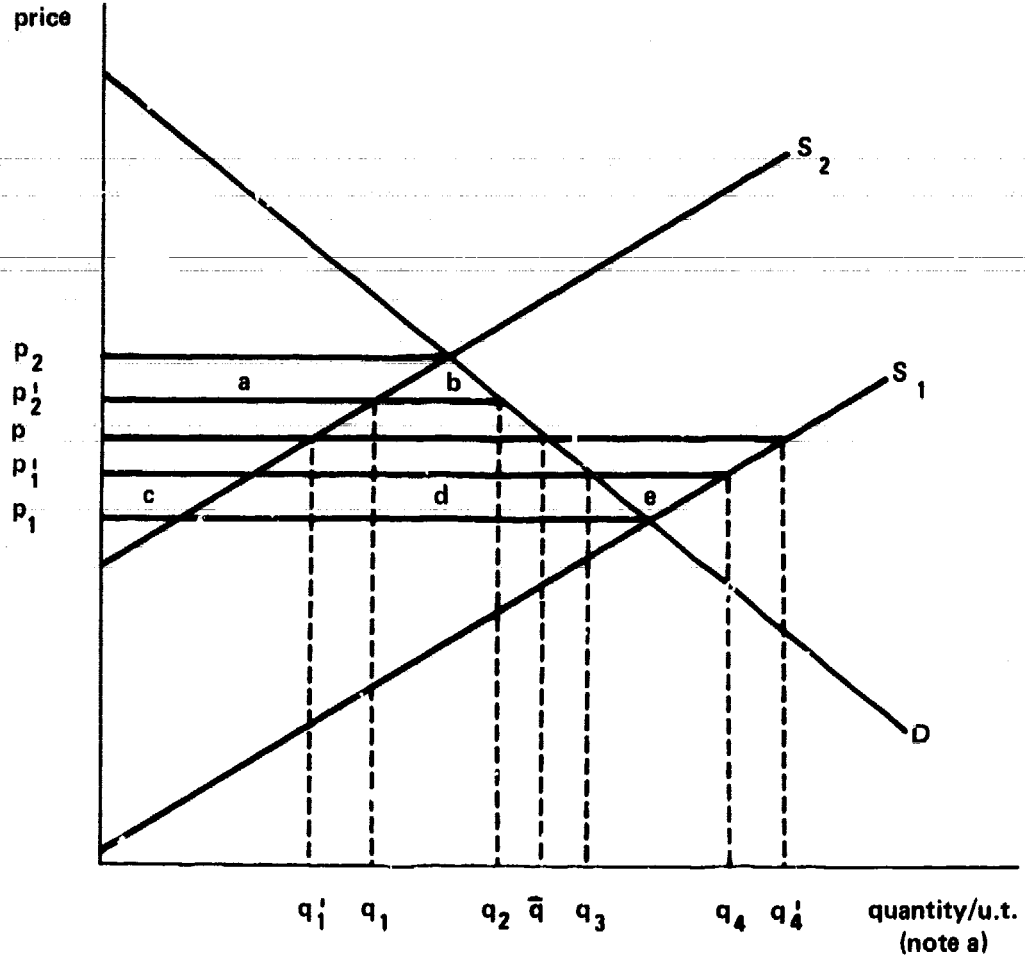
The reserve policy depicted in figure 5 is sometimes called a price band policy because it has lower and upper trigger points which tend to keep prices within the price band defined by p1' and p2'. It is interesting to note some important similarities between price band policy and the current reserve policy. The loan rate at which prices are supported for producers roughly corresponds to p1' since it represents a point at which Government (the buffer stock authority), in effect, will buy all new production (from eligible producers). As excess supply at that price goes into storage under Government control, prices supposedly will not fall below the loan rate.

FIGURE 4



a/Quantity per unit of time.

FIGURE 5



a/Quantity per unit of time.

Then if supplies fall and demand increases, prices may increase. Producers do not dump stocks under Government loan until price reaches the release level. The Government then forcibly divests itself of stock interests if price rises above the call level. Although producers may still hold grain above call level prices, they must do so at their own expense and risk and therefore the free market supposedly prevails. Thus, both the release and call levels correspond in a way to the upper bound of the price band, p2' in figure 5, depending on whether producers tend to unload stocks at their first opportunity (the release level) or whether they tend to hold stocks until the Government forces repayment of loans (the call level).

The Massell analysis suggests that the current reserve policy could improve overall economic welfare. (The spread between loan rate and release levels seems sufficient to cover storage costs.) But whether or not consumers or producers gain from the reserve policy depends on whether demand is more variable than supply. If supply (and factors affecting supply for consumption, such as export demand) is more variable, then consumers tend to be worse off (in figure 3 consumers' loss of area c + d exceeds their gain of area a + b while in figure 4 their gain of area a + b + c exceeds their loss of area d). Also, since the buffer stock authority (the Government) bears the cost of storage without benefiting by selling stocks at a higher price than at which they are accumulated, the taxpayers lose an amount corresponding to storage costs (including the cost of capital tied up in stocks) plus administrative costs. Producers, who receive storage costs as a subsidy plus the additional benefits suggested by figure 5 when supply is relatively more variable than demand, appear to be the beneficiaries of the reserve policy. 1/

The Massell analysis may be interpreted in yet another way considering the importance of international markets for U.S. grain. This interpretation, suggested by Hueth and Schmitz, views the exporting country as the supplier and

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1/Note that the present arguments assume for purposes of discussion that the stochastic distribution of prices is symmetrical and centered around the effective price bands. This assumption will be relaxed for the empirical analysis.

the importing country as the demander. 1/ In this case, the demand may be considered more variable than supply in light of events in the 1970s. If so, then it could be that the major beneficiaries of U.S. reserve policy are importers of U.S. grain. U.S. producers may still benefit to some degree, but this benefit may be solely or completely at the expense of U.S. taxpayers and consumers. In the latter case, an alternative transfer program between domestic producers and consumers that does not also transfer real income to U.S. grain importers may be more beneficial.

The results discussed in this section represent the state of the art that prevailed in theoretical analysis of stabilization policy until about 1976. Ensuing literature, however, has shown that the above conclusions about who gains and who loses from price stabilization are highly sensitive to shape, movement, and other aspects of specification regarding demand and supply. Some of the more important considerations have to do with (1) nonlinearity, (2) the form of random disturbance, (3) private storage response to public intervention, (4) risk aversion and risk response, and (5) extended market effects. For purposes of discussion, each of these aspects will be considered in the context of figures 3 and 4 where storage costs are ignored. However, the arguments have a straightforward generalization in the context of figure 5.

1/Darrell Hueth and Andrew Schmitz, "International Trade in Intermediate and Final Goods: Some Welfare Implications of Destabilized Prices," Quarterly Journal of Economics, Vol. 86 (1972), pp. 351-365.

SECTION 3

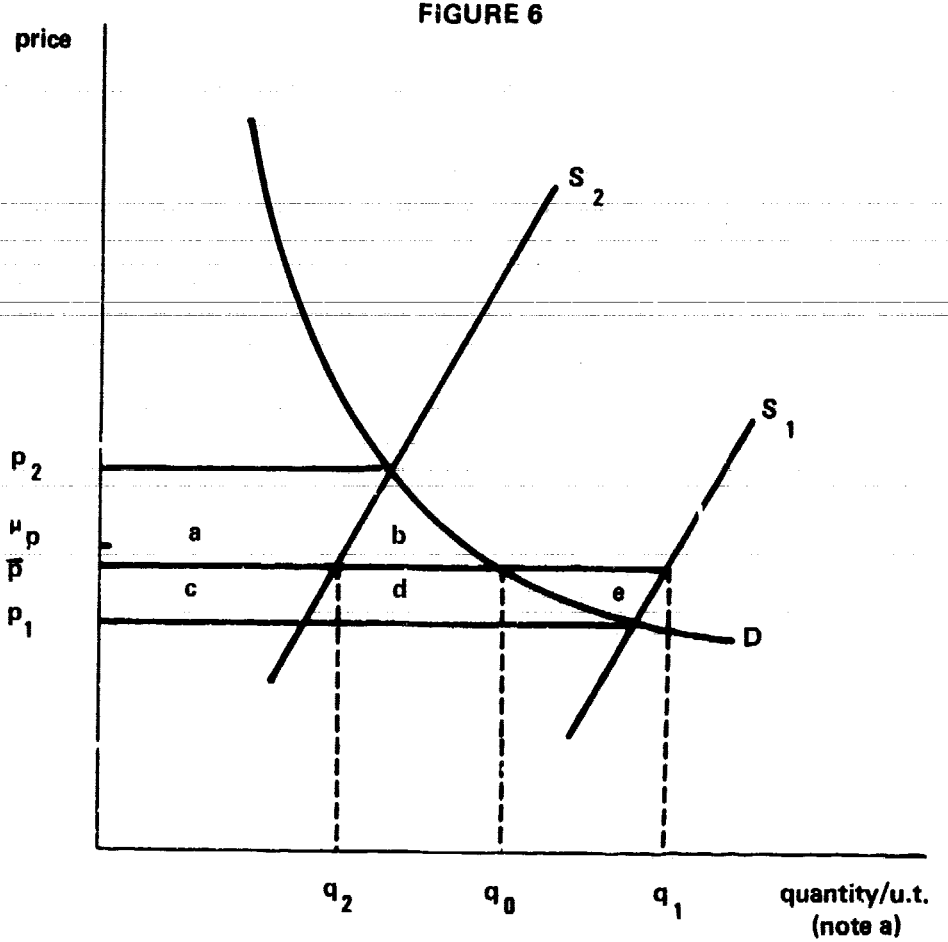
NONLINEARITY: IMPLICATIONS OF THE SHAPE OF SUPPLY AND DEMAND

The simple framework of section 2 is based on an assumption of linearity in supply and demand. To see the implications of nonlinearity, consider figure 6 where the demand curve D is nonlinear and supply alternates between S1 and S2. Now suppose price is stabilized by a buffer stock which purchases some production when supply is high and sells from buffer stocks when supply is low. For such a buffer stock to operate for a long period of time, the increase in stocks when supply is high must be the same as the decrease in stocks when supply is low. Otherwise, the buffer stock would either tend to accumulate until some of the stock would require disposal or stocks would tend to run out so that the stable price could not be enforced. With this requirement, excess supply, q1 - q0, at S1 is equal to excess demand, q0 - q2, at S2 so the buffer stock's sales in a short supply period are the same as its purchases in a long supply period; thus, its net welfare effect is zero on average with complete price stabilization (excluding storage and transactions costs). 1/

With this in mind, the stable price $\bar{p}$ in figure 6 must be chosen so that the horizontal distance between S1 and D is the same as between S2 and D. Hence, if demand is upward bending (convex) as in figure 6, then the stabilized price is lower than the average destabilized price; if demand is downward bending (concave), then stabilized price is above the average destabilized price. The welfare gains and losses for producers and consumers in terms of areas a, b, c, d, and e in figure 6 are exactly the same as in figure 3, except that areas a and b are now relatively large and areas c, d, and e are relatively small. As a result, an average net gain of 1/2 (area b + area e) is still possible, but now the average consumer effect of 1/2 [area (a + b) - area (c + d)] may be positive rather than negative (with sufficient nonlinearity) because the stabilized price is lower than the average destabilized price. Also, the average producer effect of 1/2 [area (c + d + e) - area a] can possibly become negative, thus obtaining exactly the opposite qualitative impacts on producers and consumers as suggested by figure 3.

1/ It may also be noted that this requirement is satisfied by the analysis in figures 3 and 4 under linearity where shifts in supply or demand curves are parallel.

FIGURE 6



a/ Quantity per unit of time.

A similar generalization of the analysis in figure 4 for the case of upward-bending (convex) supply also shows that sufficient nonlinearity in supply can reverse the qualitative effects of price stabilization when instability is due to fluctuations in demand.

These issues have been examined more generally in the theoretical literature by Turnovsky 1/ and Just, Lutz, Schmitz, and Turnovsky. 2/ Using special cases of assumptions similar to those used under linearity by Massell, 3/ Turnovsky has pioneered a methodology for examining the role of nonlinearity in determining the gains and distribution of gains from price stabilization. Further paralleling the work under linearity by Hueth and Schmitz, 4/ the Just et al. paper extends Turnovsky's methodology into a framework of international trade.

The framework of these papers is quite restrictive in that instability can only be assumed to arise from one sector at a time. Nevertheless, the results of the work carry considerable implications for empirical research. Contrary to the earlier work under linearity, Turnovsky concludes that, for a closed economy:

> "* * *the desirability of price stabilization for either producers or consumers does not depend upon the source of the price instability, but only upon the shapes of the deterministic components of the demand and supply curves." [5/]

Similar results developed by Just et al. with respect to importing and exporting countries also demonstrate that

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1/Stephen J. Turnovsky, "The Welfare Gains from Price Stabilization: A Nonlinear Analysis," Australian National University, 1974.

2/Richard E. Just, Ernst Lutz, Andrew Schmitz, and Stephen Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: An International Perspective," Journal of International Economics, Vol. 8, No. 4 (Nov. 1978), pp. 551-563.

3/Massell, op. cit.

4/Hueth and Schmitz, op. cit.

5/Turnovsky, op. cit., p. 24.

shapes of supply and demand curves are critical in determining qualitative effects of stabilization.

Just et al. 1/ further demonstrate that an excessive degree of nonlinearity is not necessary to obtain a reversal in who gains and who loses over the case of linearity. Specifically, they show that, for the range of elasticity estimates forthcoming from most econometric studies of coarse grain supply and demand, a switch in specifications from linearity to log linearity can be sufficient for such a reversal depending on the source of instability. Just and Hallam have argued on this basis that any investigation of the effects of a policy which affects price stability should be undertaken only after econometric estimation of the degree of curvature in supply and demand. 2/

1/Richard E. Just, Ernst Lutz, Andrew Schmitz, and Stephen Turnovsky, "The Distribution of Welfare Gains From International Price Stabilization Under Distortions," American Journal of Agricultural Economics, Vol. 59 (1977), pp. 652-661.

2/Richard E. Just and J. Arne Hallam, "Functional Flexibility in Analysis of Commodity Price Stabilization Policy," Proceedings, Journal of the American Statistical Association, 1978, pp. 177-186.

SECTION 4

THE FORM OF DISTURBANCES: DIFFERENCES IN VARIATION OF QUANTITIES SUPPLIED AND DEMANDED AT HIGH PRICES VERSUS LOW PRICES

Another important issue in analyzing policies which affect price stability is the form of disturbance in the fluctuating supply or demand. In figures 3 through 6, the random fluctuations take place in a parallel or additive fashion. The form of the disturbances is additive in the sense that if supply or demand is written with quantity q as a function of price p, say f(p), then the actual demand or supply curves correspond to $q = f(p) + \varepsilon$ where ε is a random disturbance with the same variance regardless of price level, $E(\varepsilon) = 0$. One alternative form of disturbance defended, for example, by Turnovsky is the multiplicative specification $q = f(p)\varepsilon$, $E(\varepsilon) = 1$. 1/ Although these two alternative stochastic assumptions are admittedly simple, the theoretical literature has been able to argue on the basis of the results that "the [welfare] distributional conclusions are highly sensitive to the form of stochastic disturbance assumed." 2/ For example, one can compare the Just, Lutz, Schmitz, and Turnovsky 3/ results corresponding to linearity with those of Hueth and Schmitz. 4/ Using multiplicative disturbances, Just et al. show that, if domestic supply is sufficiently elastic compared with demand, then domestic consumers gain from stabilization of domestic supply disturbances (even with linearity) which is contrary to results obtained by Hueth and Schmitz with additive disturbances.

1/Stephen J. Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances," International Economic Review, Vol. 17 (1976), pp. 133-148.

2/Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances," op. cit.

3/Just, Lutz, Schmitz, and Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: An International Perspective," op. cit.

4/Hueth and Schmitz, op. cit.

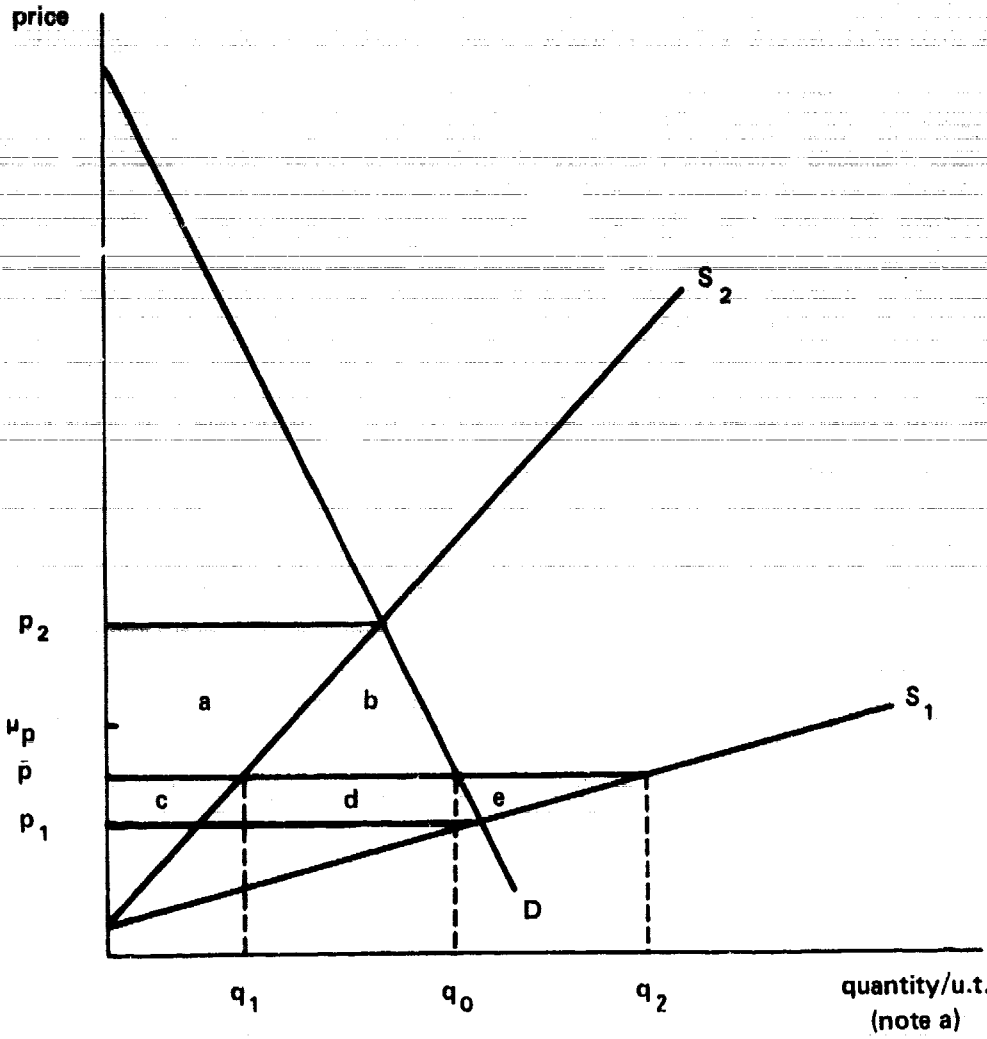
To demonstrate the comparative implications of these two specifications simply and graphically, suppose demand is stable at D as in figure 7 but that supply is unstable with multiplicative variation represented by fluctuations between S1 and S2 in alternating periods. By comparison, additive variation in supply is represented in figure 3. For buffer stocks to be self-liquidating, prices must be stabilized at p' where q2 - q0 = q0 - q1 rather than at the average destabilized price, $\mu p = (p1 + p2)/2$. Again, the welfare effects in figure 7 are the same as in figure 3 in terms of areas a, b, c, d, and e; but, again, as with nonlinearity, areas c, d, and e are smaller than areas a and b. As supplies S1 and S2 diverge (as the slope of S1 falls), these results are accentuated till area c + d + e = 0. Hence, with sufficiently strong multiplicative disturbances, net overall gains of 1/2 (area b + e) are still possible; but, again, even the qualitative implications for individuals or groups may switch. Producers may lose [if area (c + d + e) - area a < 0] and consumers may gain [if area (a + b) - area (c + d) > 0].

Results similar to those in figure 7 can also be developed for the case of multiplicative disturbances in demand in which case the qualitative implications can possibly be just opposite of those in figure 4 where demand disturbances are additive. 1/ Again, Just and Hallam have argued that the welfare effects of price stabilization policy cannot be adequately evaluated empirically without sufficient econometric estimation of the form of disturbances and, in fact, propose a procedure for doing so. 2/

1/The literature also implies that these conclusions carry over into models of general stochastic distributions. This is evident by comparing the results of Massell and of Hueth and Schmitz under additivity and linearity with those which pertain to the case of nonlinearity of Turnovsky and of Just, Lutz, Schmitz, and Turnovsky (where multiplicity is assumed). See Massell, op. cit.; Hueth and Schmitz, op. cit.; Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances," op. cit; and R.E. Just, E. Lutz, A. Schmitz, and S. Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: An International Perspective," op. cit.

2/Just and Hallam, op. cit.

FIGURE 7



a/Quantity per unit of time.

SECTION 5

RESPONSE OF PRIVATE STORAGE TO PUBLIC INTERVENTION: TO WHAT EXTENT ARE PRIVATE STOCKS REDUCED WHEN GOVERNMENT-CONTROLLED STOCKS ACCUMULATE?

Another issue which must be considered with any potential Government policy is that economic stability may not be affected only directly but also indirectly because of private decisionmakers' reactions to the direct effects of the policy. For example, when a large Government buffer stock is established to stabilize prices, the demand for private inventories will likely change because future supplies are more certain. That is, if some private stocks--in addition to working stocks--are held for speculation (the hope that future price will be higher than present price plus storage costs), then the purpose of holding speculative stocks would be negated by a Government policy of price stabilization at some announced price. But this system leads to a greater reliance of private concerns on public stocks. In fact, this consideration raises the question of whether or not private stocks may be held in optimal amounts in the absence of a reserve policy so that no public stocks are needed.

Consider, for example, the diagrammatic analysis of figure 3. If storage costs are negligible and producers gain from price stabilization, then the same gains can be assured if producers undertake stock operations on their own. They simply need to carry stocks of q1 - q0 from high supply years over to periods of low supply. Alternatively, other private decisionmakers would be induced to enter the private storage industry if they were assured of receiving a sales price higher than their purchase price, as in figure 3.

On the other hand, if storage costs are considerable, private storage would not be induced to such a great extent. For example, consider figure 5 where storage costs are p2' - p1' per unit. Then, if price with S1 is less than p1' and price with S2 is greater than p2', profits could be made by private firms by purchasing at the low price, storing, and selling at the high price. Private storage would increase until price at S1 is p1' and price at S2 is p2' where the stock purchased with S1 is q4 - q3 and is equal to the amount sold from stocks, q2 - q1, with short supply S2. In this case, the welfare areas a, b, c, d, and e measure the benefits just as in the case where the Government holds stocks in section 2. The sales from stocks are at a price

just high enough to exactly cover purchase and storage costs, and if less stocks are held, there is a profit incentive to hold more private stocks.

Now suppose in this framework that a public storage program is undertaken to further stabilize prices. If the Government attempts to increase total stock purchases to q4' - $\bar{q}$ when S1 occurs by purchasing public stocks of (q4' - $\bar{q}$) - (q4 - q3) and selling an equal amount in periods of low supply, then private storers of the commodity can no longer cover their storage costs and will reduce private inventories until prices again vary between p1' and p2' or until private storage ceases. It should be further noted, however, that any public storage beyond q4 - q3 would lead to reduced overall benefits for consumers, producers, and Government jointly because the increase in storage cost would be greater than net consumer plus producer gains.

The framework used in this section to demonstrate the reaction of private concerns to price-stabilizing effects of public reserve policy is admittedly quite simple and serves only as an illustration. A number of other issues must also be considered, such as differences in private and public storage costs, time preference discounting, the length of time in storage, credit availability, risk preferences, etc. With these considerations, private stocks may not be optimal. 1/ For example, because of lack of credit, private storage may not be able to respond to expectations of future shortage. Or because of high risk aversion, a farmer may be less inclined to store grain rather than sell at a certain current price.

1/Richard E. Just and Andrew Schmitz, "The Instability-Storage-Cost-Trade-Off and Nonoptimality of Price Bands in Stabilization Policy," Giannini Foundation Working Paper, Department of Agricultural and Resource Economics, University of California, Berkeley, 1979.

SECTION 6

RISK PREFERENCES AND DISCOUNTING OF PROFITS ASSOCIATED WITH INSTABILITY

Thus far, any preferences for stable or unstable prices have been discussed solely in terms of gain in expected economic surpluses, which essentially reflect expected economic profits. For individuals who neither like nor dislike random outcomes--that is, for risk-neutral individuals--these results are appropriate. A risk-neutral individual is one who is indifferent to randomness in, say, income as long as expected income is unaltered. Some individuals, however, may have a great aversion to risk. For example, a producer may prefer earning profits of $20,000 year after year to earning profits of $10,000 or $40,000 each with probability 0.5. This preference may be due to economic reasons, such as more efficient planning possibilities, as well as to purely psychological factors, such as emotional trauma. To reflect these kinds of preferences, the economic surplus concepts used above must be further modified.

Of course, as price stability is attained, risk can be greatly reduced. And as risk is reduced, risk-responsive producers may increase supply; as a result, both producer and consumer welfare may increase by more than the standard Massell-Turnovsky risk-neutrality assumptions would indicate. Furthermore, any public buffer stock could accumulate indefinitely at stabilized prices that would otherwise be reasonable. 1/ Again, the theoretical results are disturbing and imply that estimates of gains from stabilization may be seriously biased and any efforts to determine an optimal stabilization policy--for example a normal price about which to stabilize--may be in vain when risk preferences and responses are not considered. Of course, the possibility of forward contracting may render risk an unimportant factor in decisionmaking in which case these considerations may be unnecessary; however, transactions costs of using forward contracting markets may be prohibitive especially for small farmers. Thus, the importance of risk is an empirical question which must be answered by the data.

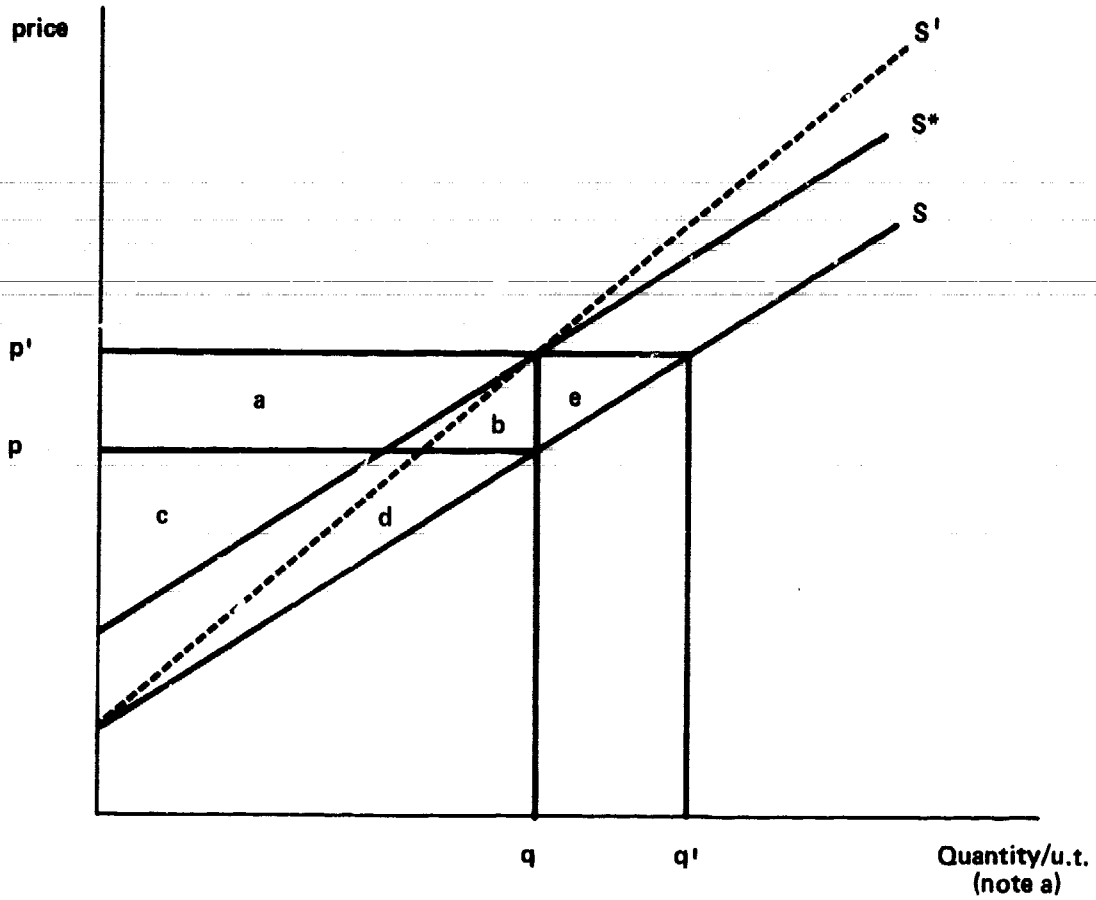
1/This complication is discussed by Richard E. Just, "Risk Response Models and Their Use in Agricultural Policy Evaluation," American Journal of Agricultural Economics, Vol. 57 (1975), pp. 836-843.

The topic of welfare measurement for producers operating with risk has been addressed in the context of stabilization policy by Just and Hallam. 1/ They find that again changes in welfare are adequately reflected by changes in the area above the supply curve and below price if a producer's economic welfare depends linearly on expected profits and the variance of profits. With risk, however, the relevant supply curve depends on expected price (possibly a function of lagged prices) and the subjective variance of price (also possibly determined by previous experience). 2/ Specifically, consider the risk-neutral supply curve or certainty supply curve S in figure 8. Now suppose that the introduction of a given amount of price risk causes the producer to contract production sc that supply shifts to S*. The results by Just and Hallam show that the appropriate curve to use in measuring economic welfare effects for the producer is the curve S* which holds the amount of risk constant. Thus, the surplus area which reflects economic welfare under risk is is area a + c at expected price p'. Under risk neutrality or certainty at p', the supply curve S would imply real income of area a + b + c + d + e so the real income loss associated with price uncertainty is area b + d + e. Of course, if the risk response from q to q' associated with price stabilization is ignored, then the associated real income benefits of area b + d + e would be ignored. Thus, the identification of significant risk preferences as evidenced by risk-responsive decisions may be crucial in justifying a price-stabilization policy.

1/R.E. Just and J.A. Hallam, "New Developments in Econometric Evaluation of Price Stabilizing and Destabilizing Policies," in New Directions in Econometric Modelling and Forecasting in U S. Agriculture, ed. Gordon C. Rausser (Amsterdam: North-Holland), 1981.

2/Or, alternatively in the case of grain supply, acreage can be specified as depending on the subjective mean and variance of returns per acre. Such a specification automatically corrects for any correlation between prices and yields which may otherwise have differing implications for income stability when price is stabilized. That is, due to negative correlation between price and average yield, price stability may actually destabilize income; if so, this would be appropriately reflected by returns per acre.

FIGURE 8



a/Quantity per unit of time.

SECTION 7

EXTENDED MARKET EFFECTS OF STABILIZATION

Another issue which has been considered to a limited extent in the theoretical literature is effects of stabilization on related markets. For example, if the grain market price is stabilized, there may be some implications for the cattle market which impact on consumer meat price stability. Assurance of stable feed grain prices may cause increased beef production or greater cattle market price stability. These considerations thus relate to relaxing the partiality of welfare measurements--an aspect of economic welfare measurement which has received heavy criticism over the years.

Just and Salkin show that these considerations depend crucially on the stochastic nature of production at various market levels. 1/ Their results show that intermediate industries gain from price stabilization of any related market if their production processes are stochastic but they are unaffected if their production processes are nonstochastic. Thus, for example, if corn price is stabilized, corn producers should gain since their production is stochastic; feed processing industries should be unaffected if their production process is nonstochastic; and cattle feeders would gain to the extent that feed gains and death losses are stochastic.

Perhaps a more serious result obtained in their work, however, relates to whether input supplies (say, of fertilizer, seed, fuel, etc.) and final consumption demand for meat and grain products are stochastic. If these components are nonstochastic, then the gains for intermediate producing industries (grain and livestock farmers) come only at the expense of input suppliers and final consumers. In the case of grain markets, it seems reasonable that some input supplies are stable while others are less stable. On the demand side, domestic meat and grain demand would seem to be fairly stable although export demand may be less stable. Thus, some overall gains seem to be possible but the extent of gains from stabilized grain prices may be considerably less than economic analysis of the grain market alone would indicate.

1/R.E. Just and M.S. Salkin, "Welfare Effects of Stabilization in a Vertical Market Chain," Southern Economic Journal, Vol. 42 (1976), pp. 633-643.

In view of these results, unstable prices do not necessarily imply that possibilities exist for improving economic welfare through price stabilization, even in net terms or after compensation. Although these results were derived in a linearized model, they clearly imply that consideration of the extended market situation is necessary in evaluating the effects of any price-stabilization policy.

SECTION 8

THE IMPLICATIONS OF THEORETICAL WORK FOR EVALUATION OF RESERVE POLICY UNDER THE FOOD AND AGRICULTURE ACT OF 1977

The reserve policy instituted with the Food and Agriculture Act of 1977 represented an important departure from previous agricultural policy. Before 1977 U.S. grain policy relied mainly on price supports sometimes augmented by marketing quotas for the purpose of protecting farm incomes from down side risk. When huge grain stocks began to accumulate, however, officials quickly realized that any rule for accumulating stocks (e.g., a loan rate program) must be accompanied by an orderly rule for liquidating those stocks. When stock liquidation was undertaken as prices exceeded loan rates, the huge grain stocks caused the loan rate to act somewhat like a price ceiling as well as a price floor. In this context, the spread between loan rate and release levels in the current policy provides a margin which makes ' vernment storage or Government-financed storage seem more worthwhile according to the comparative analysis of figures 3 and 5.

More importantly, in light of the extreme price instability of the early 1970s and the observed price-depressing effect of stock liquidation a decade or so earlier, the current reserve policy represents an effort to bound price variation both above and below. Under the current reserve policy, excess supply from bumper crops can be placed in storage to prevent excessively low prices; then in years of shortage these stocks can be liquidated to mitigate excessively large price increases which would otherwise destabilize the industry.

The imposition of a price support alone (at least initially) tends to truncate the lower side of the price distribution and thus raises expected price. The current reserve policy, on the other hand, tends to truncate both sides of the price distribution and thus may neither raise nor lower the long-run expected price while reducing the variance of price. Thus, by definition, the effects of most earlier policies were of first order. That is, imposed changes involved shifts in mean prices, the effects of which could be investigated using first order approximations of supply and demand curves.

The current policy, however, may involve only second order impacts. That is, mean prices may be unaffected while the variance of price may be reduced substantially. As shown by the various theoretical studies surveyed above, an evaluation of the distributional economic impacts of a reserve policy which shrinks the price distribution by means of a self-liquidating buffer stock rule is necessarily sensitive to second order considerations, such as curvature of supply and demand, the form of disturbances, risk response, etc.

The results surveyed above show that almost nothing can be determined on the basis of economic theory alone about which groups gain and which lose from price stabilization with such a reserve policy. If demand and supply are linear, producers may gain and consumers lose, while if demand and supply are nonlinear (with the same price elasticities at current price levels), consumers may gain while producers lose. The same difference may apply if disturbances in supply and demand are multiplicative rather than additive. In other words, theory cannot determine whether producers benefit from a reserve policy that stabilizes prices. Nor can theory alone determine whether consumers benefit from a reserve policy. The only obvious distributional conclusion is that taxpayers lose because the Government pays storage costs without receiving the benefits of selling accumulated stocks at higher prices than at which they were purchased or accumulated. Similarly, the aggregate effects are also unclear. For example, with sufficient response of private storage to public storage decisions, a program can be completely ineffective in the aggregate. Since theory cannot determine even the qualitative impacts of reserve policy on producers and consumers, any specific analysis of the current release and call levels in absence of specific empirical information is, of course, futile.

The theoretical results outlined above, however, indicate some important generalities which must be considered in an empirical analysis of the current reserve policy. Consider, for example, the implications of the results relating to nonlinearity in section 3 for empirical and simulation studies of stabilization. The theory implies that any empirical study which does not adequately investigate at least second order functional form may, in fact, be determining results through arbitrary specifications and assumptions. First order approximation in the range of relevancy is not sufficient as in most econometric problems (e.g., price forecasting), since standard welfare measures depend on the shape as well as the position of supply and demand curves.

Unfortunately these considerations have generally not been made in empirical stabilization studies. Nonlinearity, of course, is a problem that has often plagued econometricians. The usual empirical or simulation approach, which has been continued in stabilization studies, has been simply to specify a linear or log linear form. Hence, simplistic as the theoretical studies may be, they invalidate the use of such empirical work on distributional aspects of economic welfare analysis. These conclusions are supported by the empirical work of Reutlinger who, in using crude, piecewise linear demand curves, concluded that "the storage impact on gains and losses by consumers and producers is particularly sensitive to the assumed shape of the demand function." 1/

Similarly, with respect to the form of disturbances, one must conclude that an empirical study which specifies the form of disturbance a priori may be influencing not only the quantitative but also the qualitative nature of the distributional results obtained. As Turnovsky concludes, "unless the policy maker has reliable information on this question, any stabilization policy may have undesirable effects on the group it is intended to assist." 2/

To what extent have these considerations been made in empirical studies of stabilization? Unfortunately, very little if at all. Most studies assume either additive or multiplicative disturbances depending on whether or not linearity or log linearity is assumed. Again, as with nonlinearity, it must be concluded that little confidence can be placed in empirical and simulation studies until the form of random disturbances is adequately investigated.

Similarly, examination of the empirical stabilization literature reveals that risk response has been considered only rarely even though consideration in applied econometrics is becoming common. The traditional stabilization studies which have used econometric estimates of supply and demand have almost universally ignored risk response. Hazell and Scandizzo, however, have been able to treat risk response by

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1/Shlomo Reutlinger, "A Simulation Model for Evaluating Worldwide Buffer Stocks of Wheat," American Journal of Agricultural Economics, Vol. 58 (1976), pp. 1-12.

2/Turnovsky, "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances," op. cit., p. 145.

using a mean-variance programing approach to agricultural supply. 1/ Although their programing model is more restrictive in behavioral assumptions than econometric studies of stabilization, their results are consistent with those of the theoretical implications cited above and raise further doubts about empirical work which ignores risk response. In fact, they conclude that "the potential welfare gains to be had from optimal intervention policies are surprisingly large, in fact far greater than might be anticipated" in the case where risk response is considered. 2/

Likewise, another area in which empirical work has apparently been weak relates to the role of private storage. For example, the empirical work of Cochrane and Danin, 3/ Reutlinger, 4/ and Sharples et al. 5/ has been heavily criticized by Helmberger and Weaver 6/ because it ignores the stabilizing effect of private storage as well as the reaction of private storage supply to the imposition of a public storage program. As Helmberger and Weaver show, the distribution of welfare gains from price stabilization may be much different when these reactions are adequately considered. As shown above, if the Government institutes a storage program, then private concerns can tend to carry fewer stocks because there is less chance of shortage.

1/P.B.R. Hazell and P.L. Scandizzo, "Optimal Price Intervention Policies When Production is Risky," presented at the Agricultural Development Council Conference on Risk and Uncertainty in Agricultural Development, CIMMYT, Mexico, 1976.

2/Hazell and Scandizzo, op. cit., p. 18.

3/Willard W. Cochrane and Yigal Danin, Reserve Stock Grain Models, the World and United States, 1975-1985, Minnesota Agricultural Experiment Station Technical Bulletin No. 305, 1976.

4/Reutlinger, op. cit.

5/J.A. Sharples, R.L. Walker, and R.W. Slaughter, Jr., "Buffer Stock Management for Wheat Price Stabilization," Commodity Economics Division, Economic Research Service, United States Department of Agriculture, Washington, D.C., 1976.

6/Peter Helmberger and Rob Weaver, "Welfare Implications of Commodity Storage Under Uncertainty," American Journal of Agricultural Economics, Vol. 59 (1977), pp. 639-651.

Hence, some welfare effects from price stabilization are felt by private holders of stocks in addition to those experienced by producers and consumers. Furthermore, if private storage increases when Government storage is decreased, then prices are probably not destabilized as much as if private storage did not respond. Given the empirical research which verifies private storage supply response, 1/ one must view most empirical work on stabilization policy with yet a further degree of skepticism.

Finally, in the case of considering extended market effects of stabilization, it appears that empirical work is almost nonexistent. Empirical studies of stabilization policy have almost universally been considered only for the specific market in which controls are introduced.

In view of these considerations, it appears that the vast majority of empirical work is not general enough to be reliable for reserve policy analysis. One study conducted thus far which considers much of the empirical generality suggested by the above arguments is that of Just and Hallam, but it relates only to the wheat market and is developed only for illustrative purposes. 2/ However, they conclude that while the wide range of theoretical implications suggests that almost nothing can be determined *a priori* (even in qualitative terms), a fairly high degree of confidence may be empirically possible when the same set of flexibilities is considered. In point of fact their results suggest that many of the theoretical ambiguities discussed above can be resolved empirically with a reasonable level of confidence. In other words, meaningful empirical work may be possible but only after examining a considerable level of generality in demands, supplies, and extended market relationships.

1/See, for example, Ernst Lutz, "Grain Reserves and International Price Stabilization," unpublished Ph.D. thesis, Department of Agricultural and Resource Economics, University of California, Berkeley, 1977.

2/Just and Hallam, *op. cit.*

SECTION 9

SPECIFICATION OF A MODEL FOR ECONOMIC ANALYSIS OF RESERVE POLICY

The discussion thus far suggests several important features which should be considered in developing any empirical model for investigating price stabilization policy. First, flexibility with regard to nonlinearity seems crucial. Several possibilities allow simple econometric tractability. One could simply consider a second order, Taylor-series approximation of appropriate functions--i.e., use quadratic equations in price rather than follow the usual first order econometric approach of linearity. Another possibility is suggested by the translog function which has become popular in production studies and is now finding use in demand analysis--i.e., use of double-log functions which are quadratic in the logarithm of price (rather than linear in logs as in the Cobb-Douglas case). Other possibilities, such as generalized Leontief functional forms provide flexibility with respect to nonlinearity.

For the purposes of this study, none of these possibilities provide a suitable alternative. That is, the popular demand functions which allow flexible curvature admit U shapes convex to the origin, in which case curves may not cross the price axis (if quantity is the dependent variable) or the quantity axis (if price is the dependent variable). In the former case, the economic surplus concept which measures real income for consumers does not exist, and even changes in this measure of real income are not well defined if demand determinants change. In the latter case some policies may lead to use of the upward sloping part of the estimated demand curve and, in fact, estimates can often suggest upward sloping demand even within the limits of observed data.

An alternative specification suggested for this type of work by Just and Hallam is

$$q_t = a_0 + a_1 (P_2)^{\alpha} + a_2 Z_t + \varepsilon_t \qquad (1)$$

where q_t is quantity demanded, P_t is price, Z_t represents relevant determinants of demand, and ε_t is a random

disturbance, $E(\varepsilon_t) = 0$. 1/ With this specification, complete freedom in fitting first and second derivatives is maintained for arbitrary price-quantity combinations. That is, values of a_1 and α can be chosen to satisfy any arbitrary values of the first and second derivatives for any given price P_t or quantity q_t. Furthermore, the demand function in (1) not only provides at least a second order local approximation of any demand curve but also does so without admitting a troublesome U shape. In fact, if the law of demand is satisfied anywhere, then it will be satisfied all along the demand curve (in which case $a_1 \alpha < 0$). If the demand curve is also concave to the origin (downward bending), then it clearly intersects both the price and quantity axes. If the demand curve is convex, on the other hand, then it may become vertical at some positive quantity and thus not cross the price axis. Even this problem is simply avoidable by imposing the constraint $a_0 + a_2 z_t + \varepsilon_t < 0$ in estimation of a_0 and a_2 so that a well-defined consumer welfare measure always exists under the usual properties of demand. But, of course, some of the flexibility discussed above is lost in so doing.

Turning to the form of disturbance, the functional form in (1) carries additional empirical convenience. That is, even if a multiplicative disturbance δ_t is appropriate, $q_t = (a_0 + a_1 (P_t)^{\alpha} + a_2 z_t) \delta_t$, $E(\delta_t) = 1$, $V(\delta_t) = \sigma_\delta$, the representation in equation (1) can be used by simply defining $\varepsilon_t = [a_0 + a_1 (P_t)^{\alpha} + a_2 z_t] \times (\delta_t - 1)$. Even with heteroscedastic disturbances, ordinary estimation procedures lead to consistent estimators under reasonable circumstances (uniformly bounded variances, etc.). Hence, the investigation of the form of disturbances need not confound estimation of supply and demand but may be investigated subsequently on the basis of estimated disturbances as suggested by the estimation procedures proposed in other contexts by Hildreth and Houck 1/ or, in a more closely related paper, by Just and Pope. 2/ The possibility that the

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1/ Clifford Hildreth and James P. Houck, "Some Estimators for a Linear Model with Random Coefficients," Journal of the American Statistical Association, Vol. 63 (1968), pp. 584-595.

2/ Richard E. Just and Rulon D. Pope, "Stochastic Specification of Production Functions and Economic Implications," Journal of Econometrics, Vol. 7 (1978), pp. 67-86.

variances of ε_t at different prices along the curves are proportional to the square of expected quantities at those respective prices can be investigated separately using a regression equation of the form,

$$\hat{\varepsilon}_t^2 = \gamma_0 + \gamma_1 \hat{q}_t^2 + e_t, \qquad E(e_t) = 0, \qquad (2)$$

where $\hat{q}_t$ is the estimated nonstochastic component of (1) and $\gamma_0 = 0$, $\gamma_1 \neq 0$ suggests multiplicative disturbances and $\gamma_0 \neq 0$, $\gamma_1 = 0$ suggests additive (homoscedastic) disturbances or, for the purposes of this study, both extremes can be investigated empirically. 1/

To consider the possibility of risk response in supply econometrically, a modification of the adaptive risk-response model proposed and used by Just provides an intuitive possibility. 2/ In this model, which presupposes lags in supply response, the quantity supplied q_t depends on the subjective mean of prices μ_t and the subjective variance of the same, σ_t^*, as well as other determinants X_t, e.g.,

$$q_t = b_0 + b_1\mu_t + b_2\sigma_t^* + b_3X_t + V_t, \qquad E(V_t) = 0. \qquad (3)$$

Where $q_t = b_0 + b_1\mu_t + b_3X_t + V_t$ is a risk-neutral supply curve, the linear term $b_2\sigma_2^*$ is added to represent the shift from S to S* in figure 8. Such a supply response model is neatly

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1/Note that a further modification of this approach is required when P and q are determined simultaneously. One alternative is to use instrumental variables methods in which the instruments are developed by regressing q on the determinants underlying supply and demand. See Just and Hallam, op. cit., for further details.

2/Richard E. Just, Econometric Analysis of Production Decisions with Government Intervention: The Case of the California Field Crops, Giannini Foundation Monograph No. 33, University of California, Berkeley, 1974, and "Estimation of an Adaptive Expectations Model," International Economic Review, Vol. 18 (1977), pp. 629-644.

applicable in measuring the welfare effects of changing risk, as discussed above, since it conditions the supply curve on a given level of the variance associated with a given subjective returns situation. One possibility is to specify subjective parameters following an adaptive expectations model,

$$\mu_t = \sum_{k=0}^{\infty} \theta^k \, r_{t-k-1} \qquad (4)$$

$$\sigma_t^{*2} = \sum_{k=0}^{\infty} \theta^k \, (r_{t-k-1} - \mu_{t-k-1})^2, \qquad (5)$$

where r_t represents returns per acre in time period t.

The additional consideration suggested by the earlier discussion relates to the impact of public stocks on private inventories. As suggested by other recent work, 1/ this possibility can be considered simply by including Government stocks or farmer-owned reserves under Government programs as an additional determinant of private inventory demand.

Consider now the specification of a model of the U.S. agricultural economy for investigation of U.S. grain reserve policy. As suggested by earlier studies such as Cromarty 2/ and Mo, 3/ more precise estimation of demand is possible by breaking total private grain demand into components such as food, feed, inventory, and export. With this in mind, grain demands are broken into consumption, stock, and export demands for purposes of estimation. Consumption is assumed to be influenced by consumer income, grain consuming livestock numbers, and seasonal factors in addition to grain

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1/See, e.g., Helmberger and Weaver, op. cit., and Lutz, op. cit.

2/William A. Cromarty, "An Econometric Model for United States Agriculture," Journal of the American Statistical Association, Vol. 54 (1954), pp. 556-574.

3/M.Y. Mo, "An Econometric Analysis of the Dynamics of the U.S. Wheat Sector," USDA Technical Bulletin No. 1395, Washington, D.C., 1968.

price. 1/ Market demand for grain stocks is assumed to depend on price, production, carryin market stocks, carryin Government stocks, and seasonal factors. Export demand depends on price, the terms of trade or exchange rate between the United States and other countries, carryin of stocks outside the United States, and seasonal factors. On the other side of the market, production depends on subjective assessments of market price possibilities (both mean and risk) and diversion or set-aside requirements under Government programs. 2/ Subjective assessments for market price are assumed to follow an adaptive expectations mechanism such as in (4) and (5).

Since a major purpose of this study is to determine the effect of the farmer-owned reserve program on the livestock sector, a model of the livestock sector and the grain-livestock linkage is needed. For this purpose, demands for beef, pork, and poultry are assumed to depend on prices of the alternative meats (e.g., beef demand depends on pork and poultry prices), consumer income, and seasonal factors. Beef and pork supply depends on cattle placed on feed or hogs kept for market with appropriate lags and seasonal

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1/Although one might suspect that livestock producers may change the quantity of feed per animal and thus change feed demand more than reflected by livestock numbers on feed when livestock prices change, this is apparently not the case to any significant degree since implausible results were obtained when both livestock prices and grain consuming livestock numbers were included in estimating grain consumption. This has apparently been the case in other studies as well since the structure used here is similar to that resulting in other econometric studies of the livestock sector.

2/While this supply specification may appear somewhat simplistic compared with annual studies which use 2 or 3 decades of data, one must bear in mind that supply is estimated here in a quarterly model using only 13 years of data from a policy period which is much more comparable with current supply. As evidenced by the estimates below, this simple specification fits the 13 years quite well.

factors. 1/ Beef cattle placed on feed depends on cattle prices, feed prices, beef cow inventories with an appropriate lag, and seasonal factors. Similarly, hogs kept for market depends on hog prices, feed prices, breeding hog inventories with an appropriate lag, and seasonal factors. Likewise, beef cow inventories respond to cattle prices and other seasonal factors and breeding hog inventories respond to hog prices, feed prices, and other seasonal factors. Poultry supply depends on poultry prices, feed prices, and seasonal factors.

The general structure of the livestock sector follows along lines used previously by Arzac and Wilkinson, 2/ Crom, 3/ Fox, 4/ Freebairn and Rausser, 5/ and others. However, livestock demand coefficients are constrained to satisfy symmetry conditions so that cross welfare effects (e.g., the effects of grain policy on livestock producers) are theoretically sensible.

In all cases except the grain production equations, estimates were developed by truncated two-stage least

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1/Although it may seem desirable to include price as well as livestock numbers on feed in estimating short-run beef and pork supply, the traditional problem of a negative price effect was encountered. This result reflects the fact that livestock producers tend to hold back more stock for breeding when prices are rising. However, this effect is extremely small and greatly complicates the welfare analysis below. Thus, the current quarterly price is not included in estimating beef and pork supply (for the same reasons it has not been included in many other econometric studies of the livestock industry).

2/E.R. Arzac and M. Wilkinson, "A Quarterly Econometric Model of United States Livestock and Feed Grain Markets and Some of the Policy Implications," American Journal of Agricultural Economics, Vol. 61 (1979), pp. 297-308.

3/R.J. Crom, "A Dynamic Price-Output Model of the Beef and Pork Sectors," USDA ERS Technical Bulletin No. 1426, 1970.

4/K.A. Fox, "A Submodel of the Agricultural Sector," The Brookings Quarterly Econometric Model of the United States ed. J.S. Duesenberry, G. Fromm, L.R. Klein, and E. Kuh (Amsterdam: North-Holland Publishing Co.), 1965.

5/J.W. Freebairn and G.C. Rausser, "Effects of Changes in the Level of U.S. Beef Imports," American Journal of Agricultural Economics, Vol. 57 (1975), pp. 676-688.

squares, except for the nonlinear parameters which were estimated by search techniques. To make the model fully quarterly in specification (which is important for the economic welfare analysis), a few variables--namely, livestock inventories--had to be interpolated from annual or semiannual data and grain production had to be attributed to a specific quarter of the year. Also, since appropriate software was not available in the context of this project, the equations could not be estimated directly by nonlinear means. As a result and because of the number of nonlinear parameters, the nonlinear parameters were only computed to an accuracy of 0.125 and therefore standard errors of estimates can only be reported subject to these nonlinear parameter estimates. 1/

The estimated model, along with variable definitions and sample periods for each equation, appears in table 1. Functional forms for demand follow equation (1) in every case, while grain supply follows the functional specification in equation (3). Nonlinearity was not investigated in supply of either grains or livestock because supplies are essentially inelastic and determined by lagged phenomena. (Nonlinearity of supply with respect to current price becomes a trivial issue when supply is perfectly inelastic.) In the context of the earlier discussion, however, the responsiveness to risk in supply is of crucial interest.

Responsiveness to risk was investigated for producers of wheat, corn, cattle, and hogs. 2/ For livestock producers, risk was considered for both livestock prices and feed (corn) prices. Results generally did not show a significant response to risk. Only in the case of hog producers did risk appear to play an important role; the significant response is in the stock of pigs held for breeding. Several alternative explanations may be given for the lack of significant empirical risk response. First, risk may simply not have changed very much over the sample period so that there is no differential response to

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1/In addition, the nonlinear parameters were selected subject to constraints of economic surplus existence (i.e., that the demand curves cross the price axis for sufficiently large prices). These constraints were effective for grain disappearance and beef demand.

2/Due to limited space, these results and a number of others that are not central to the specific results below will be discussed without presentation.

pick up. Second, risk may be important only over longer planning horizons than are of interest in the quarterly model developed here. Indeed, for hogs the significant response occurs only in the equation related to the longest planning horizon. Third, the expectation and risk terms may be so collinear that identification of differential effects is not possible. Finally, decisionmakers may actually be risk-neutral. Examination of the data suggests that risk has changed fairly substantially from the 1960s to the 1970s even over short planning horizons. However, the expectation and risk terms are highly correlated; both price levels and risk increased simultaneously with the commodity boom of the early 1970s. To the extent that this correlation continues, the model estimated in table 1 would be valid for investigating stabilization policy regardless of the importance of risk in reality. This would generally not be the case for all types of stabilization policy but appears to be a reasonable assumption for the particular investigations presented below. 1/

1/It may be further noted that, in those cases where risk coefficients did not turn out to be important, the welfare calculations reduce to the same as those discussed in earlier sections for the non-risk-responsive cases. This occurs on the supply side because lags make supplies inelastic with respect to current price.

TABLE 1

ESTIMATED GRAIN-LIVESTOCK MODEL (note a)

Wheat Market Behavioral Equations

$$QDWHT = \underset{(136.9)}{185.8} - \underset{(.1069)}{0.1568}\ QDWHT_{t-1} - \underset{(235.1)}{546.6}\ (PWHT/WPI)^{.375}$$

$$+ \underset{(0.03461)}{0.09584}\ DI_{72} + \underset{(2.899)}{1.642}\ GCAU - \underset{(11.15)}{70.84}\ Q2 + \underset{(13.54)}{68.71}\ Q3 + \underset{(14.445)}{4.494}\ Q4$$

$R^2 = .73$ $\bar{R}^2 = .71$ DW = 2.10 σ = 36.16 PRMSE = 20.5 1957 IV/1979 III

$$STWHT = \underset{(130.9)}{161.8} + \underset{(0.0629)}{0.7708}\ STWHT_{t-1} - \underset{(.4527)}{2.2610}\ (PWHT/WPI)^{1.125} + \underset{(.0850)}{0.8317}\ PWPR$$

$$- \underset{(.08996)}{.04358}\ GOVWHT - \underset{(.1953)}{0.8095}\ FORWHT + \underset{(40.30)}{50.44}\ Q2 - \underset{(150.1)}{116.5}\ Q3 + \underset{(40.87)}{82.77}\ Q4$$

$R^2 = .99$ $\bar{R}^2 = .98$ DW = 2.00 σ = 63.14 PRMSE = 5.0 1969 I/1978 II

$$EXWHT = \underset{(206.7)}{521.8} + \underset{(.1948)}{.3369}\ EXWHT_{t-1} - \underset{(2.776 \times 10^{15})}{2.782 \times 10^{15}}\ (PWHT/WPI)^{9.125} - \underset{(252.4)}{266.2}\ SDR$$

$$- \underset{(2.333)}{3.451}\ WSTOCKW - \underset{(27.57)}{60.27}\ Q2 + \underset{(49.6)}{101.1}\ Q3 + \underset{(31.43)}{12.98}\ Q4$$

$R^2 = .79$ $\bar{R}^2 = .73$ DW = 1.86 σ = 53.48 PRMSE = 23.8 1969 I/1977 II

$$PWPR = \underset{(139.0)}{(965.1} + \underset{(226)}{1392}\ MNWHT - \underset{(5.571)}{5.375}\ DIVWHT)\ Q3$$

$R^2 = .98$ $\bar{R}^2 = .98$ DW = 2.00 σ = 92.15 PRMSE = 22.70 1964 I/1977 IV

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a/Terms defined at end of this table.

TABLE 1
(continued)

Corn Market Behavioral Equations

$$QDCRN = \underset{(416.88)}{-53.85} - \underset{(.10733)}{0.0167}\ QDCRN_{t-1} - \underset{(6267)}{3288}\ (PCRN/WPI)^{\underset{(.1431)}{.875}} + .4412\ DI_{72}$$

$$+ \underset{(10.63)}{21.40}\ GCAU - \underset{(45.4)}{375.1}\ Q2 - \underset{(71.3)}{126.3}\ Q3 + \underset{(53.9)}{158.3}\ Q4$$

$R^2 = .73$ $\bar{R}^2 = .71$ DW = 1.95 $\sigma = 140.38$ PRMSE = 14.5 1957 IV/1979 III

$$STCRN = \underset{(317.4)}{404.8} + \underset{(.0559)}{.6898}\ STCRN_{t-1} - \underset{(14589)}{67460}\ (PCRN/WPI)^{\underset{(.0488)}{1.125}} + 0.7701\ PCPR$$

$$- \underset{(.4655)}{.5174}\ FORCRN + \underset{(93.5)}{204.2}\ Q2 - \underset{(135.0)}{643.2}\ Q3 - \underset{(318.6)}{128.8}\ Q4$$

$R^2 = .996$ $\bar{R}^2 = .995$ DW = 1.25 $\sigma = 104.47$ PRMSE = 3.9 1969 I/1978 II

$$EXCRN = \underset{(398)}{1412} + \underset{(.1545)}{.3408}\ EXCRN_{t-1} - \underset{(1.821 \times 10^{18})}{3.666 \times 10^{18}}\ (PCRN/WPI)^{\underset{(344)}{9.5}} - 1269\ SDR$$

$$- \underset{(7.513)}{7.974}\ WSTOCKC - \underset{(45.5)}{119.6}\ Q2 + \underset{(54.7)}{181.7}\ Q3 + \underset{(33.73)}{32.61}\ Q4$$

$R^2 = .83$ $\bar{R}^2 = .79$ DW = 2.31 $\sigma = 60.14$ PRMSE = 23.1 1969 I/1977 II

$$PCPR = (\underset{(950)}{3279} + \underset{(800)}{2194}\ MNCRN - \underset{(14.75)}{23.70}\ DIVCRN)\ Q4$$

$R^2 = .98$ $\bar{R}^2 = .98$ DW = 1.95 $\sigma = 304.51$ PRMSE = 24.5 1964 I/1977 IV

TABLE 1
(continued)

Cattle Market Behavioral Equations

$$QDCOW = \underset{(32.4)}{(141.4} - \underset{(32.99)}{96.84}\left(\frac{RCOW}{WPI}\right)^{.125} + \underset{}{12.85}\ \frac{RHOG}{WPI} \quad \underset{}{6.645}\ \frac{RBRL}{WPI}$$

$$- \underset{(.8215)}{.3276}\ Q2 + \underset{(.8207)}{.8769}\ Q3 + \underset{(.8165)}{.9306}\ Q4)\ DI_{72}^{.7}$$

$R^2 = .90$ $\bar{R}^2 = .89$ DW = .42 σ = 271.67 PRMSE = 6.28 1954 I/1978 IV

$$QSCOW = \underset{(259)}{2609} + \underset{(44.6)}{504.0}\ BFFEED_{t-2} - \underset{(188)}{1200}\ Q2 + \underset{(156.2)}{333.7}\ Q3 + \underset{(160.5)}{515.5}\ Q4$$

$R^2 = .64$ $\bar{R}^2 = .62$ DW = .51 σ = 481.80 PRMSE = 9.9 1960 III/1979 III

$$BFFEED = \underset{(1.277)}{-\ 4.763} + \underset{(2.729)}{3.632}\ \frac{PCOW}{WPI} - \underset{(56.7)}{108.5}\ \frac{PCRN}{WPI} + \underset{(.0333)}{.1077}\ BFINV_{t-3}$$

$$+ \underset{(.0935)}{.6244}\ BFFEED_{t-1} + \underset{(.328)}{1.501}\ Q2 + \underset{(.346)}{2.448}\ Q3 + \underset{(.291)}{4.225}\ Q4$$

$R^2 = .90$ $\bar{R}^2 = .89$ DW = 2.35 σ = .575 PRMSE = 10.40 1960 II/1978 IV

$$BFINV = \underset{(.2347)}{-\ .6610} + \underset{(1.097)}{6.743}\ \frac{PCOW}{WPI} + \underset{(.0047)}{.9803}\ BFINV_{t-1} - \underset{(.08532)}{.08206}\ Q2$$

$$- \underset{(.08495)}{.05246}\ Q3 - \underset{(.08514)}{.02085}\ Q4$$

$R^2 = .998$ $\bar{R}^2 = .998$ DW = .35 σ = .297 PRMSE = .89 1954 II/1978 IV

TABLE 1
(continued)

Hog Market Behavioral Equations

$$QDHOG = \underset{(7.83)}{(-83.01} + \underset{(5.74)}{69.98}\left(\frac{RHOG}{WPI}\right)^{-.75} \quad 2.85\,\frac{RCOW}{WPI} + 35.68\,\frac{RBRL}{WPI}$$

$$\underset{(1.164)}{- 3.985\ Q2} \quad \underset{(1.1\ )}{- 3.120\ Q3} + \underset{(1.157)}{2.663\ Q4)}\ DI_{72}^{.7}$$

$R^2 = .59$ $\bar{R}^2 = .57$ DW = .86 σ = 385.01 PPMSE = 11.4 1954 I/1978 IV

$$QSHOG = \underset{(432)}{1673} - \underset{(16227)}{56656}\,\frac{PCRN}{WPI} + \underset{(6.40)}{51.42}\ STPIGM_{t-1} \quad \underset{(67.7)}{- 176.9\ Q2}$$

$$\underset{(67.7)}{- 348.7\ Q3} + \underset{(69.3)}{203.3\ Q4}$$

$R^2 = .79$ $\bar{R}^2 = .77$ DW = .98 σ = 182.05 PRMSE 5.30 1964 II/1978 IV

$$STPIGM = \underset{(4.824)}{- 3.644} + \underset{(11.47)}{22.25}\,\frac{PHOG}{WPI} \quad \underset{(183.5)}{- 144.6}\,\frac{PCRN}{WPI} + \underset{(.637)}{3.659}\ STPIGB_{t-2}$$

$$\underset{(40281)}{- 16400\ SIGCRN} + \underset{(.0969)}{.3458}\ STPIGM_{t-1} + \underset{(.5770)}{.1133\ Q2} + \underset{(.604)}{1.038\ Q3} + \underset{(.629)}{1.384\ Q4}$$

$R^2 = .87$ $\bar{R}^2 = .85$ DW = 1.11 σ = 1.524 PRMSE = 3.11 1964 III/1978 IV

$$STPIGB = \underset{(1.109)}{3.265} + \underset{(2.490)}{3.862}\,\frac{PHOG}{WPI} \quad \underset{(42.2)}{- 115.6}\,\frac{PCRN}{WPI} \quad \underset{(9147)}{- 18406\ SIGCRN}$$

$$\underset{(.0911)}{+ .6733\ STPIGB_{t-1}} + \underset{(.1303)}{.262\ Q2} + \underset{(.1308)}{.5485\ Q3} + \underset{(.1299)}{.2977\ Q4}$$

$R^2 = .80$ $\bar{R}^2 = .77$ DW = 1.91 σ = .340 PRMSE = 3.87 1964 II/1974 IV

TABLE 1
(Continued)

Poultry Market Behavioral Equations

$$QDBRL = \underset{(.752)}{(4.754} - \underset{(4.31)}{44.64}\left(\frac{RBRL}{WPI}\right)^{1.875} - 6.645\ \frac{RCOW}{WPI} + 35.68\ \frac{RHOG}{WPI}$$

$$+ \underset{(.369)}{1.930}\ Q2 + \underset{(.368)}{1.255}\ Q3 - \underset{(.3734)}{.2258}\ Q4)\ DI_{72}^{.7}$$

$R^2 = .63$ $\bar{R}^2 = .61$ DW = .43 $\sigma = 113.37$ PRMSE = 6.9 1960 I/1978 IV

$$QSBRL = \underset{(118)}{-2860} - \underset{(5666)}{3603}\ \frac{PCRN}{WPI} + \underset{(44)}{2231}\ PTPLT + \underset{(423.1)}{383.6}\left(\frac{PRRL}{WPI}\right)_{t-1}$$

$$- \underset{(3760)}{17695}\left(\frac{PCRN}{WPI}\right)_{t-1} + \underset{(19.5)}{182.4}\ Q2 + \underset{(19.3)}{191.4}\ Q3 + \underset{(20.56)}{25.26}\ Q4$$

$R^2 = .99$ $\bar{R}^2 = .98$ DW = .86 $\sigma = 58.10$ PRMSE = 3.54 1960 I/1978 IV

Livestock-Feed Demand Relationship

$$GCAU = \underset{(.1624)}{.3904}\ (BFFEED_{t-1} + BFFEED_{t-2}) + \underset{(.0263)}{.6009}\ (STPIGB_{t-1} + STPIGM_{t-1})$$

$$+ \underset{(.00086)}{.00141}\ QSBRL$$

$= .37$ $\sigma = 2.368$ PRMSE = 5.6 1964 II/1979 III

TABLE 1
(Continued)

Livestock Marketing Margin Relationships

$$MARCOW = \underset{(.0509)}{.1662} + \underset{(.00001265)}{.00007366}\ QSCOW + \underset{(.0795)}{.4209}\ \frac{RCOW}{WPI} + 12.98\ \frac{ULCP}{WPI} - \underset{(.00001200)}{.00006268}\ QSCOW_{t-1}$$

$R^2 = .68$ $\bar{R}^2 = .66$ DW = .86 $\sigma = .0284$ PRMSE = 4.47 1954 I/1978 IV

$$MARHOG = \underset{(.04603)}{.09601} + \underset{(.000006503)}{.000006093}\ QSHOG + \underset{(.0490)}{.3714}\ \frac{RHOG}{WPI} + \underset{(11.43)}{44.34}\ \frac{ULCP}{WPI} - \underset{(.00000475)}{.00002671}\ QSHOG_{t-1}$$

$R^2 = .61$ $\bar{R}^2 = .59$ DW = .85 $\sigma = .0211$ PRMSE = 4.56 1954 II/1978 IV

$$MARBRL = \underset{(.04810)}{.02898} + .3417\ \frac{RBRL}{WPI} + \underset{(6.85)}{27.77}\ \frac{ULCP}{WPI} - \underset{(.00000656)}{.00002450}\ QSBRL_{t-1}$$

$R^2 = .74$ $\bar{R}^2 = .73$ DW = 1.40 $\sigma = .0145$ PRMSE = 6.07 1960 II/1978 IV

TABLE 1
(continued)

Identities

$$QDWHT + STWHT + EXWHT + GOVWHT + FORWHT = PWPR + STWHT_{t-1} + GOVWHT_{t-1} + FORWHT_{t-1}$$

$$QDCRN + STCRN + EXCRN + GOVCRN + FORCRN = PCPR + STCRN_{t-1} + GOVCRN_{t-1} + FORCRN_{t-1}$$

$$QDCOW = QSCOW$$

$$QDHOG = QSHOG$$

$$QDBRL = QSBRL$$

$$MNWHT = MAX \left[1/3 \sum_{k=1}^{3} \left(\frac{PWHT}{WPI}\right)_{t-4k} YWHT_{t-4k}, \frac{LRWHT}{WPI} 1/3 \sum_{k=1}^{3} YWHT_{t-4k} \right]$$

$$MNCRN = MAX \left[1/3 \sum_{k=1}^{3} \left(\frac{PCRN}{WPI}\right)_{t-4k} YCRN_{t-4k}, \frac{LRCRN}{WPI} \sum_{k=1}^{3} YWHT_{t-4k} \right]$$

$$SIGRN = 1/12 \sum_{k=1}^{12} \left(\frac{PCRN}{WPI}\right)_{t-k} - MNC$$

$$MNC = 1/12 \sum_{k=1}^{12} \left(\frac{PCRN}{WPI}\right)_{t-k}$$

$$MARCOW = \frac{RCOW}{WPI} \quad \frac{PCOW}{WPI}$$

$$MARHOG = \frac{RHOG}{WPI} \quad \frac{PHOG}{WPI}$$

$$MARBRL = \frac{RBRL}{WPI} \quad \frac{PBRL}{WPI}$$

TABLE 1
(continued)

a/Note that numbers in parentheses are standard errors estimated subject to nonlinear parameter estimates. Definitions of endogenous variables are as follows:

QDWHT = Domestic disappearance of wheat, mil. bu. (WS)
STWHT = Market stock of wheat, mil. bu. (WS)
EXWHT = Exports of wheat, mil. bu. (WS)
PWPR = Domestic production of wheat, mil. bu. (WS)
PWHT = Price of wheat, $/bu., farm level (AGP)
QDCRN = Domestic disappearance of corn, mil. bu. (FDS)
STCRN = Market stock of corn, mil. bu. (FDS)
EXCRN = Exports of corn, mil. bu. (FDS)
PCPR = Domestic production of corn, mil. bu. (CRP)
PCRN = Price of corn, $/bu., farm level (AGP)
QSCOW = Quantity supplied of beef and veal, mil. lbs. (LMS)
QDCOW = Quantity demanded of beef and veal, mil. lbs. (Identity)
BFFEED = Cattle placed on feed, 23 States, mil. hd. (COF)
BFINV = Stock of beef cows, mil. hd., interpolated from January 1 data (CTL)
PCOW = Price of all beef cattle, $/cwt., farm level (AGP)
RCOW = Retail price of beef, $/cwt. (BLS)
MARCOW = Beef retail/farm level marketing margin, $/cwt. (Identity)
QSHOG = Quantity supplied of pork, mil. lbs. (LMS)
QDHOG = Quantity demanded of pork, mil. lbs. (Identity)
STPIGM = Stock of pigs kept for market, mil. hd. (CEA)
STPIGB = Stock of pigs kept for breeding, mil. hd. (CEA)
PHOG = Price of hogs, $/cwt., farm level (AGP)
RHOG = Retail price of pork, $/cwt. (BLS)
MARHOG = Pork retail/farm level marketing margin, $/cwt. (Identity)
QSBRL = Federally inspected broiler production or quantity supplied, mil. lbs., R-T-C weights (PES)
QDBRL = Quantity demanded of broiler production, mil. lbs. (Identity)
PBRL = Price of broilers, $/cwt., farm level (AGP)
RBRL = Price of frying chicken, $/cwt., retail level (BLS)
MARBRL = Poultry retail/farm level marketing margin, $/cwt. (Identity)
GCAU = Grain consuming animal units (CEA)
MNWHT = Subjective returns per acre for wheat adjusted rationally to changes in loan rate (Identity)

TABLE 1
(continued)

MNCRN = Subjective returns per acre for corn adjusted rationally to changes in loan rate (Identity)
SIGCRN = Subjective variance of corn price for use in livestock feed (Identity)
MNC = Subjective mean of corn price used in determining SIGCRN (Identity)

Definitions of exogenous variables are as follows:

DI_{72} = Disposable income in 1972 dollars (BLS)

WPI = Wholesale price index, 1967 = 100 (BLS)

SDR = Special drawing rights per dollar exchange rate (IMF)

PTPLT = Productivity trend for poultry (CEA)

ULCP = Private unit labor costs (BLS)

GOVWHT = Beginning Government-owned stocks of wheat, mil. bu. (USDA)

GOVCRN = Beginning Government-owned stocks of corn, mil. bu. (USDA)

FORWHT = Beginning farmer-owned reserves of wheat under the Food and Agriculture Act of 1977, mil. bu. (GAO)

FORCRN = Beginning farmer-owned reserves of corn under the Food and Agriculture Act of 1977, mil. bu. (GAO)

WSTOCKW = Beginning stocks of wheat in non-U.S. wheat exporting countries at beginning of quarter (GB)

WSTOCKC = Beginning stocks of corn in non-U.S. corn exporting countries at beginning of quarter (GB)

LRWHT = Wheat loan rate, $/bu. (WS)

LRCRN = Corn loan rate, $/bu. (FDS)

DIVWHT = Wheat acreage diverted or set aside under Government programs, mil. a. (CEA)

DIVCRN = Corn acreage diverted or set aside under Government programs, mil. a. (CEA)

Q2 = Second quarter indicator variable

TABLE 1
(continued)

Q3 = Third quarter indicator variable
Q4 = Fourth quarter indicator variable

Sources of data indicated in parentheses above are defined as follows:

(WS) - Wheat Situation, Economic Research Service, USDA.
(AGP) - Agricultural Prices, Statistical Reporting Service, USDA.
(FDS) - Feed Situation, Economic Research Service, USDA.
(CRP) - Crop Production, Statistical Reporting Service, USDA.
(LMS) - Livestock and Meat Situation, Economic Research Service, USDA.
(COF) - Cattle on Feed, Statistical Reporting Service, USDA.
(CTL) - Cattle, Statistical Reporting Service, USDA.
(BLS) - Consumer Price Index, Bureau of Labor Statistics, USDL.
(CEA) - Chase Econometrics Associates, Inc.
(PES) - Poultry and Egg Situation, Economic Research Service, USDA.
(IMF) - International Financial Statistics, International Monetary Fund.
(USDA) - Unpublished data obtained from USDA.
(GAO) - Available through GAO as part of this project.
(GB) - Grain Bulletin, Great Britain Commonwealth Secretariat, Commodities Division.

Turning to the demand side of the model, the estimates in tabl 1 suggest some interesting characteristics of grain demand in the context of nonlinearity. First of all, the grain export equations are highly nonlinear and, perhaps surprisingly, turn down at larger quantities. In fact, export demand becomes almost perfectly inelastic at lc prices but is much more responsive at high prices. The important implication of this result for stabilization policy in contrast to linear models is that stock accumulation can very quickly depress prices to support levels when the reserve becomes too large.

The results relating to nonlinearity of the private stock demand equations are also somewhat surprising. A common belief in the literature is that the relationship between stocks and prices is highly nonlinear but with an upward curvature so that prices do not fall much at large stock levels but rise sharply when stocks are low. 1/ The results here, however, suggest a downward curvature in which large stocks cause sharp declines in prices; large stocks apparently tend to cause buyers to regard the market as glutted. Actually, when the private stock relationships were estimated without considering response of private storage to public stocks and farmer-owned reserve levels in this study, both the corn and wheat stock equations took on the usual upward curving shape. The estimated exponents for price were .625 for wheat stocks and -.125 for corn stocks. With Government and farmer-owned reserve levels in the equations, however, the estimated exponents became 1.125 in each case. 2/ The curvature is downward

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1/See T.N. Barr, "Demand and Price Relationships for the U.S. Wheat Economy," Wheat Situation WS-226 (1973), pp. 15-25.

2/The initial estimate for the wheat stock equation exponent was even higher, 2.25, but this estimate had to be adjusted downward for purposes of obtaining sufficient market stability for the following analyses. That is, in the process of model validation (not discussed in detail here), it became clear that the version of the model based on the coefficient of 2.25 was rather unstable. Furthermore, the likelihood function for this equation was almost insensitive to changes in the nonlinear wheat stock price parameter between 1.125 and 2.25. Hence, the estimates in table 1 are conditioned on the parameter estimate 1.125 which leads to greater stability of the system. Such an adjustment was not made for any other parameter estimate.

bending if the exponent is greater than 1 and upward bending if the exponent is less than 1. 1/

The fact that including response of private storage to public stock policy causes this switch in curvature suggests that Government programs have been primarily responsible for price support at large stock levels. Private concerns may not keep prices from falling quite as low in the absence of Government price support when stock levels are large. Thus, the estimated stock equations, like the estimated export equations, suggest that stock accumulation in the U.S. grain economy may carry a high risk of either price depression or high Government costs in avoiding price depression.

The magnitudes of the estimated coefficients of the farmer-owned reserve are of further interest in examining the effectiveness of the farmer-owned reserve program. In particular, the coefficient of -.8095 on the wheat farmer-owned reserve indicates that other private stocks are reduced by nearly 81 percent of any increase in farmer-owned reserve. This is in sharp contrast to the coefficient of -.04358 for Government-owned stocks; that is, private stocks are reduced by only a little over 4 percent of any increase in CCC holdings. Furthermore, these differences are quite significant as evidenced by the small standard errors of coefficients.

If one goal of the agricultural policy is to maintain an effective emergency food reserve, then these results imply that the farmer-owned reserve is a very inefficient means of doing so. 2/ According to these estimates, the Government must pay storage costs on 5.51 bushels to actually increase total stock holdings by 1 bushel. On the other hand, Government-owned stocks must only be increased by 1.05 bushels to increase total stock holdings

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1/This may be simply verified by computing second derivatives of the demand equations with respect to price.

2/As pointed out by Daniel Sumner in his review of this report, these results may not be so critical of the farmer-owned reserve as they are of the way it was managed. If rules governing the farmer-owned reserve could be determined so that it would behave as the CCC would have behaved, then it would be no better or worse. However, this study is based on historical data and thus compares operations of the farmer-owned reserve with those of the CCC as stocks were actually managed in each case historically.

by 1 bushel. Thus, to establish a given emergency food stock in addition to usual levels of market stocks costs the Government more than five times as much in storage costs as if stocks are held instead by the CCC. The reason for this great difference is apparently that market participants regard farmer-owned reserves as a very close substitute for market stocks in meeting unexpected short-term needs, whereas CCC stocks are regarded as much less accessible and thus as less of a substitute. For example, CCC stocks may be depleted through Public Law 480 shipments or other Government food aid projects which are not anticipated at harvest time. Perhaps, since decisions regarding release of the farmer-owned reserve are in the hands of farmers rather than Government, grain buyers view those stocks as responding faster to unanticipated market developments. Perhaps also there is more displacement under the farmer-owned reserve since the farmers holding the reserve are more likely to be the ones holding market stocks in the absence of a farmer-owned reserve.

Estimates for the corn farmer-owned reserve have similar qualitative implications but the magnitudes are much less certain. The coefficient of -.5174 implies that only about 2 bushels of stocks must be held in the farmer-owned reserve to increase total stocks by 1 bushel. But the standard error in this case is quite large. Furthermore, Government-owned stocks when included in the equation had an implausible (but insignificant) positive sign. But neither of these results are statistically inconsistent with the rather precise results obtained for wheat.

Turning to the livestock model, the crucial aspects for this study have to do with the grain-livestock market linkages. Corn price is used as a proxy for feed price in the livestock supply models, while the number of grain consuming animal units is used as the determinant of grain demand for feed. Since wheat feed use often constitutes only a residual part of feed supply, wheat price is not used as a determinant in the livestock supply equations even though livestock numbers affect wheat demand for feed substantially.

Corn price appears to play a strong role in decisions to place beef cattle on feed, to change the stock of pigs held for breeding, and to raise broilers (the latter is represented by a lagged corn price in the broiler supply equation). Likewise, the number of livestock on feed (represented by grain consuming animal units) appears to play a strong role in determining corn demand. The much weaker role of livestock numbers in wheat demand is presumably due to wheat's relative unimportance as a feed as well as its somewhat intermittent use for that purpose.

The nonlinear estimates of meat demand are also interesting. 1/ First of all, the poultry-meat demand equation has a downward curvature. Thus, as poultry prices become high (relative to beef and pork), consumers increasingly substitute other commodities--presumably beef and pork. On the other hand, as poultry prices get low, consumers tend to reach saturation and demand becomes sharply inelastic. With beef and pork, on the other hand, demand turns upward so that consumers are reluctant to give up all beef and pork consumption at high prices while quantities increase sharply at low prices. While not directly obvious from the esti-

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1/The specification of meat demand is based on a consumer indirect utility function of the form

$$V = \alpha_1 P_b^{\delta_1} + \alpha_2 P_h^{\delta_2} + \alpha_3 P_p^{\delta_3} + \alpha_4 m^{\delta_4} + \alpha_5 P_b P_h + \alpha_6 P_b P_p + \alpha_7 P_h P_p$$

where P_b, P_h, and P_p are prices of beef, pork, and poultry, respectively, deflated by a basket price, and m is consumer income relative to the basket price. The demand equation specifications follow through explication of Roy's identity in which demand for, say, beef is given by

$$X = - \frac{\partial V / \partial P_b}{\partial V / \partial m}$$

The reader may note similar justification can be used for the grain demand equations as well where indirect utilities are of the form

$$V = \alpha_1 p^{\delta_1} + \alpha_2 X_p + m^{\delta_2}$$

for grain disappearance and

$$V = \alpha_1 p^{\delta_1} + \alpha_2 X_p + \alpha_2 mp, \quad m=0$$

for grain stocks and exports with X representing the role of an exogenous variable. With these specifications, the exact compensating variations can be estimated for purposes of welfare analysis; thus, the results do not rely on the usual arguments of approximation of ordinary consumer surplus for compensating variation. Note, however, that the grain disappearance demands were linearized with respect to income for purposes of estimation.

mates, substitution of actual price levels reveals that the upward curvature for beef is about four times that of pork (as measured by second derivatives). Thus, as one would expect, beef appears to be a more preferred good (followed by pork and then poultry) in the sense that its consumption ultimately increases more at low prices (or high incomes). Again, these results suggest the importance of adequate consideration of nonlinearity in reflecting realistic relationships which, as shown earlier, have a bearing on the effects of price stabilization.

One final note is needed before proceeding to the analysis of the farmer-owned reserve policy. To examine the issue of disturbance form in the context of the earlier discussion, the residuals from estimated relationships were computed. The squares of these were then regressed on squares of predicted dependent variables following equation (2). As in previous work, this exercise did not conclusively support either additive or multiplicative disturbances. As a result, the analyses in this study were carried out under both specifications. Because of the magnitudes of changes involved, this change in specification had only negligible effects on results. Since results are almost the same for the two specifications, only those associated with additive disturbances are presented below.

Aside from these considerations, the statistical fit in table 1 is generally good and standard errors of most economic variables are small relative to estimated coefficients. The fit on the crucial production and stock equations for the grains is particularly good in terms of R^2; the high percentage-root-mean-squared errors (PRMSE) for production are due to the very risky nature of agricultural crop yields. The Durbin-Watson statistics (which may be biased for this application) are all in a satisfactory range for the grain sector and are low, suggesting serial correlation in the livestock sector essentially only in equations with very low PRMSEs where the consequences are less important.

While the necessity for brevity in this report prevents reporting the model validation work which was undertaken in examining properties of the estimated model, the PRMSEs provide useful evidence in the context of the sample period and are comparable with those obtained in other econometric studies of these agricultural sectors. In addition, a number of simulations beyond the sample period were performed. The simulations that involved actual and forecasted post-sample data for the exogenous variables generally indicated that the model behaved in a reasonable and stable manner over near time horizons. When these simulations were performed

with widely different values for some of the exogenous variables, however, somewhat peculiar results were obtained beyond 6 to 10 quarters. Such results are not uncommon for models with so many dynamic relationships as this one. But upon comparison with other models in the literature, these model validation results have further interesting implications.

That is, the model estimated here follows the same essential structure as in previous studies aside from the generality of functional forms considered here. Consider, for example, the beef market. The meat demand equations involve the same variables as used by Arzac and Wilkinson. 1/ Furthermore, the income elasticity was chosen to correspond roughly to their results. The difference lies in the curvature allowed in the functional forms used here, whereas linearity is arbitrarily imposed by Arzac and Wilkinson. The margin equations used here also follow the same essential specification used by Arzac and Wilkinson except that a quantity variable is added to allow some response elasticity by the processing sector (i.e., the possibility of a non-constant margin). The beef meat supply equation follows Arzac and Wilkinson except that insignificant variables are not included. The cattle-placed-on-feed equation follows Arzac and Wilkinson except that a different variable is used to represent calves available. The beef cattle inventory equation follows Arzac and Wilkinson except that a single price rather than a lag distribution of prices is used to represent cattle price effects. Other equations in the livestock sector are specified with variables similar to those used by Arzac and Wilkinson to the extent that data were available within the context of this study. Similarly, the specifications of the wheat and corn markets are essentially the same as used by Chambers and Just 2/ except that farmer-owned reserve variables are added and functional forms have been generalized with respect to nonlinearity.

1/Arzac and Wilkinson, op. cit. Because the econometric work in this study had to be completed in a very short time (on the order of weeks) to allow time for the rest of the study, a decision was made to follow the structure of existing models (aside from functional flexibility) as much as possible after considering data availability in the Chase Econometrics system (which was the system made available for the empirical work).

2/Robert G. Chambers and Richard E. Just, "A Dynamic Analysis of Effects of Exchange Rate Changes on U.S. Agriculture," American Journal of Agricultural Economics, Vol. 63 (1981), forthcoming.

With the similarity in variables used here and elsewhere, one must conclude that unusual behavior in this model--if it occurs--is due to the functional generalities. That is, since functional specificity is imposed by other studies arbitrarily, one must consider that the conservative behavior of other models may be misleading, that other functional specificities may also lead to plausible but different results, and that the precision in a functionally more general model such as this one may be more representative of what is known about market behavior. For example, perhaps very little is known about whether grain demand would become more or less elastic at low prices in absence of Government controls since Government price supports have prevented observation of such a situation for several decades. With this in mind, somewhat noisy predictions should be expected and would, in fact, be the reasonable result in simulating low price situations in absence of price supports; by contrast, usual formulations which assume constant elasticities or constant slopes would give a false sense of security in model simulations. This must be borne in mind in examining the results below because the effects of the farmer-owned reserve are derived by comparing with the case of no Government-connected reserves and thus no price supports.

SECTION 10

AN EVALUATION OF THE EFFECTS OF THE FARMER-OWNED RESERVE PROGRAM UNDER THE FOOD AND AGRICULTURE ACT OF 1977

Based on the econometric model developed in table 1, this section turns to use of the model in gaining insight into effects, both direct and indirect, of the farmer-owned reserve program. The analysis in this section is based on the actual exogenous and random forces which influenced the grain-livestock sector during the program. Since this type of analysis necessarily requires actual data, it can cover only the period for which data have come available since the program's inception. This period basically covers the 1977-78 and 1978-79 seasons. Much of the data for the 1979-80 season were unavailable at the time of this study.

To estimate the actual impact of the program, the estimated model in table 1 was fitted to actual data for the eight quarters from 1977 III to 1979 II. 1/ That is, residuals were determined that would make the model generate the exact grain-livestock prices and quantities observed in 1977 III to 1979 II. Then, using these residuals, the model was simulated in absence of the farmer-owned reserve program (and accompanying loan rates) using the estimated coefficients in table 1 to determine the associated responses. 2/ Because of the interrelated nature of the three livestock and two grain markets, these adjustments had impacts throughout the system. The effects could only be determined by solving the 34-equation nonlinear model simultaneously in each of the eight one-quarter periods. Because of the recursive nature of parts of the model, however, only 11 nonlinear equations required simultaneous solution in each period; other equations could be used recursively.

Using this approach, the estimated impacts of the farmer-owned reserve program on market prices and quantities of both grain and livestock in table 2 were derived. As might be expected, the effects of the program are small in the early part of the program when the reserve was small.

1/Note that time periods are referenced quarterly with respect to calendar year so, for example, 1977 I represents January through March of 1977.

2/Thus, for purposes of performing the simulations below, the remaining errors relative to the observed real world situation are all zero.

TABLE 2

ESTIMATED PRICE AND QUANTITY EFFECTS OF THE FARMER-OWNED RESERVE, 1977 III - 1979 II (note a)

	Effect	1977 III	1977 IV	1978 I	1978 II	1978 III	1978 IV	1979 I	1979 II
	WHEAT								
1.	Price ($/bu.)	+.16	+.44	+1.10	-.08	-1.57	-2.57	-2.88	-2.71
2.	Disappearance (mil. bu.)	-3	-7	-20	-3	+17	+13	+15	+14
3.	Private stocks (mil. bu.)	-12	-54	-171	-289	-352	-395	-429	-459
4.	Exports (mil. bu.)	—	—	—	—	—	+10	+13	+24
5.	Production (mil. bu.)	—	—	—	—	+16	—	—	—
6.	F.O.R. (mil. bu.)	+15	+64	+201	+317	+382	+400	+405	+403
7.	Total stocks (mil. bu.)	+3	+10	+30	+28	+30	+15	-24	-56
	CORN								
8.	Price ($/bu.)	—	+.03	+.16	+.66	+1.02	-.99	-1.64	-1.86
9.	Disappearance (mil. bu.)	—	+2	-17	-49	-100	-122	-149	-193
10.	Private stocks (mil. bu.)	—	-7	-42	-191	-463	-437	-354	-232
11.	Exports (mil. bu.)	—	—	—	-1	—	+9	+60	+252
12.	Production (mil. bu.)	—	—	—	—	—	+11	—	—
13.	F.O.R. (mil. bu.)	—	+5	+57	+257	+629	+728	+733	+552
14.	Total stocks (mil. bu.)	—	-2	+15	+66	+166	+291	+379	+320
	CATTLE								
15.	Price ($/cwt.)	—	+.02	+.36	+2.09	+5.61	+16.97	+32.94	-23.42
16.	Marketing (mil. lb.)	—	—	+1	-9	-39	-177	-330	+188
17.	Placed on feed (mil. hd.)	—	—	-.1	-.4	-.7	+.4	+1.6	+1.5
18.	Cattle on farms (mil. hd.)	—	—	—	+.1	+.3	+.8	+1.8	+1.0
	HOGS								
19.	Price ($/cwt.)	—	+.17	+1.36	+4.36	+7.92	+1.64	+2.96	+1.16
20.	Marketing (mil. lb.)	—	-10	-70	-226	-433	-113	-150	-344
21.	Kept for market (mil hd.)	—	-.4	-1.0	-3.1	-7.2	-11.1	-16.4	-17.6
22.	Kept for breeding (mil. hd.)	—	-.5	-1.3	-2.1	-3.4	-3.2	-3.2	-2.6
	POULTRY								
23.	Price ($/cwt.)	—	+.23	+1.82	+6.02	+12.35	+2.24	-7.18	+1.93
24.	Marketing (mil. lb.)	—	-1	-5	-22	-51	-34	+107	+149

a/Note that blanks indicate zero or negligible values.

Generally, the early effects during the first year of the program were to increase grain prices, reduce grain consumption, and reduce private grain stock levels. As suggested by the earlier discussion, much of the reduction in private stocks is in direct response to the accumulation of the farmer-owned reserves. However, the ratio of farmer-owned reserve to change in total stock level is somewhat larger in table 2 than implied by the structural coefficients in table 1. Apparently considering price adjustments and adjustments in other demands and other markets, the farmer-owned wheat reserve actually had to increase by far more than the 5.25 bushels suggested by the impact effect discussed above in order to increase total wheat stocks by 1 bushel (compare rows 6 and 7 in table 2). In fact, this ratio gets much higher in 1979. For corn, this ratio also varies generally above that which is suggested by the structural estimates. These differences result from considering extended market effects as well as price adjustment in response to increased demand for stocks.

The most interesting aspect of the results in table 2 is that the grain price supporting effects of the reserve during the first year of the program quickly turn into price depressing effects. These effects are hard to explain in the context of the wheat and corn markets alone. One would think that the high farmer-owned reserve level tends to depress price in the second year but these effects are largely offset by lower private stocks. The explanation lies in the related markets. The higher prices in the first year and through 1978 III, particularly for corn, led to a reduction in cattle placed on feed and in numbers of hogs kept for both marketing and breeding compared with a free market case without a farmer-owned reserve. These reductions caused a tendency toward higher livestock prices. Then these upward livestock price pressures along with reduced corn price tendencies eventually caused cattle numbers to increase above free market levels and the negative effects on hog numbers kept for breeding to reverse. But these effects follow long delays required to raise breeding stock to maturity in the livestock industry. In the meantime, the earlier decisions to reduce livestock numbers compared with free market levels reduce the availability of feeder cattle and pigs for market. Thus, grain consuming animal units are reduced below free market levels for a fairly long period of time. This sustained reduction explains the lower demand for grain and thus lower prices resulting in the second year of the program as compared with the free market case. This is the case for wheat as well as corn.

Although wheat price does not play an important role in determining livestock production decisions, the residual

market for wheat as feed is important in keeping wheat prices in line with corn prices. In fact, the relative effect of grain consuming animal units on wheat demand estimated in table 1 is almost as great as for corn. An additional factor which tends to make wheat prices respond to the farmer-owned reserve more than corn prices is the relatively greater estimated sensitivity of private wheat stocks to the quantity held in the farmer-owned reserve.

While the results in table 2 indicate directional impacts of the farmer-owned reserve program which after careful analysis are plausible, they give limited information about whether the program objectives of stabilizing prices, providing reasonable prices for consumers, combating inflation, etc., are achieved. 1/ To examine the stabilizing influence of the program, table 3 is constructed using the actual prices under the farmer-owned reserve and the estimated prices under the free market case associated with table 2. These results show that while the program had the somewhat unexpected effect of depressing grain prices, it also served to increase livestock prices and to stabilize prices in both grain and livestock markets (except for the hog market where instability changed negligibly). Thus, the objective of stabilization was apparently achieved during the first 2 years of the program. The effects on consumer prices, however, are conflicting. Grain prices were lowered but livestock prices increased.

The above results indicate impacts on prices and quantities associated with the farmer-owned reserve. But the more important impacts on real income of producers and consumers are not clear without further analysis. For example, a high grain price is not of as much benefit if a farmer has less of

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1/While the directional impacts are plausible, the large magnitude of change for prices in the last 3 quarters of the 2-year period covered by table 2 are somewhat questionable. It should be noted, however, that experimentation with several alternative specifications of the model admitting the necessary flexibilities discussed in sections 3 to 7 led to the same directional impacts with equally large or larger magnitudes. It should also be noted that the model validation work discussed above appropriately raises reservations regarding results beyond 6 quarters (1978 IV) for some equations. While the less stable forecasts generated from the flexible type of model used here may overstate program effects at least in later periods, the theoretical results above imply that a traditional linear or log-linear model can understate effects.

TABLE 3

COMPARISON OF PRICE LEVELS AND STABILITY

WITH AND WITHOUT THE FARMER-OWNED RESERVE

1977 III - 1979 II (note a)

Market	Actual With the Farmer-Owned Reserve	Estimated Without the Farmer-Owned Reserve
Wheat ($/bu.)	2.76 (.35)	3.78 (1.79)
Corn ($/bu.)	2.06 (.20)	2.39 (1.08)
Cattle ($/cwt.)	49.74 (12.18)	45.42 (18.92)
Hogs ($/cwt.)	47.68 (3.48)	45.23 (3.10)
Poultry ($/cwt.)	25.98 (2.46)	23.93 (5.24)

a/Numbers in parentheses are standard errors.

a crop to sell. Furthermore, a high price in the current period may induce expanded output next period just when low prices occur. In the latter case, a high price this period may have a detrimental overall impact on the producer's economic welfare when the overall impact is realized. Detrimental effects would tend to be realized when temporarily high or low prices provide false signals for producers.

The short-run real income effects on consumers and producers of the farmer-owned reserve can be estimated following the economic surplus methodology discussed earlier. In addition, changes in investment resulting from the implementation of the farmer-owned reserve program over time can be evaluated following the methodology outlined in Just, Hueth, and Schmitz. 1/ That is, where the role of lags in supply is clearly due to timelags required in production, the lag

1/R.E. Just, D.L. Hueth, and A. Schmitz, op. cit., Appendix C.

coefficients can be used together with market information to estimate the amount of investment made in each lag period which first contributes to production in a current period. In evaluating the economic welfare effects of the program, one must consider not only the change in (short-run or current-period) revenues associated with changes in prices and quantities, but also the difference in investment costs resulting from implementation of the program. Considering both the short-run changes in costs and benefits as well as the changes in investment costs incurred over time, the effects associated with the changes in table 2 are estimated in table 4. The results are again somewhat surprising but consistent with the results in table 2.

Because the program acted as a price support in its first year as farmer-owned stocks were accumulated under loan, the impact (initial) effect on grain producers was an increase in real income. Wheat farmers' profits were $333 million higher and corn farmers' profits were $205 million higher than in the absence of the farmer-owned reserve (including absence of any effective loan rate). However, the higher prices supported by the farmer-owned reserve program as stocks were accumulating led to a false signal to expand grain production which would not be sustained. As a result, wheat farmers undertook an additional $75 million investment and corn farmers an additional $59 million investment to expand output for the 1978 crop year above what they would have in absence of the farmer-owned reserve. This expanded output together with grain stock levels which were higher and livestock numbers on feed which were lower than in absence of the farmer-owned reserve then led to lower prices than would have been realized in absence of the reserve. These two effects led to a substantial decline in short-run profits of $2.7 billion for wheat farmers and $7.0 billion for corn farmers in 1978 from the case with no farmer reserve. Thus, the farmer-owned reserve seems to be a case where the stock accumulation period caused false price signals for livestock industry contraction and grain market expansion so that the higher initial prices eventually worked against the grain farmers who were the intended beneficiaries.

Turning to the effects on other market groups, grain demanders are obviously adversely affected by the initial price increases but then beneficially affected by the late price declines compared with the case with no farmer-owned reserve. Estimates suggest that these early adverse effects during the 1977 crop year were more than outweighed by beneficial effects in the 1978 crop year for all grain demanders--consumers, stockholders, and foreign importers. Among these groups, the effects on foreign importers appear to be relatively small because prices were relatively low,

TABLE 4

ESTIMATED REAL INCOME EFFECTS OF THE FARMER-OWNED RESERVE, 1977 III - 1979 II (note a)

Effect		1977 III	1977 IV	1978 I	1978 II	1978 III	1978 IV	1979 I	1979 II	Total
		million dollars								
WHEAT	Source									
Consumers	TOTAL	-2	-23	-39	+78	+24	+231	+369	+3881	+4519
Stockholders	TOTAL	-2	-4	-5	+2	+23	+32	+29	+23	+98
Foreign Concerns	TOTAL	---	---	-2	---	+4	+5	+4	+3	+14
Producers	SR	+333	---	---	---	-2742	---	---	---	-2409
	AC	---	---	---	---	-75	---	---	---	-75
	FOR	-32	-118	-356	-327	-187	-54	-15	+7	-1082
Government Costs	TOTAL	---	-4	-13	-20	-24	-25	-25	-25	-136
CORN										
Consumers	TOTAL	---	-2	-9	-99	-65	+61	+110	+329	+325
Stockholders	TOTAL	---	-1	-3	-7	-3	+37	+45	+38	+106
Foreign Concerns	TOTAL	---	---	---	-1	-2	+5	+4	+6	+12
Producers	SR	---	+205	---	---	---	-6988	---	---	-6783
	AC	---	---	---	---	---	-59	---	---	-59
	FOR	---	-9	-107	-454	-763	-201	-11	+427	-1118
Government Costs	TOTAL	---	---	-4	-16	-39	-46	-46	-35	-186
LIVESTOCK										
Meat Consumers	TOTAL	---	---	-2	-15	-16	-437	-2148	+10	-2608
Cattle Producers	SR	---	+1	+23	+123	+320	+982	+1376	-1034	+1791
	AC	---	---	---	---	-2	-9	+353	-82	+260
Hog Producers	SR	---	+2	+12	+41	+71	+2	+24	-107	+45
	AC	---	---	-1	-4	-13	-27	-24	-34	-163
Poultry Producers	SR	---	+5	+41	+148	+307	+44	-144	+67	+468
	AC	---	---	---	---	-3	-5	---	+3	-5
Total Grains	TOTAL	+297	+44	-538	-844	-3849	-7002	+464	+4654	-6774
Total Livestock	TOTAL	---	+8	+73	+293	+664	+550	-563	-1177	-152
Overall Net Effect b/	TOTAL	+297	+52	-465	-551	-3185	-6452	-99	+3477	-6926

a/Blanks represent zero or negligible figures. Note that Government storage costs are computed at $.25 per bushel per year on the amount in the farmer-owned reserve prorated quarterly. The source codes are defined as follows: SR = short-run profits, AC = change in investment costs (herd expansion, etc.) incurred in earlier periods which become productive (contributes to sales) in the relevant quarter (represented as a negative benefit), and FOR = dollar value of grain leaving the farmer-owned reserve (negative if entering).

b/Before correcting for the value of grain still held in the farmer-owned reserve.

particularly in real terms, so that world markets were fairly saturated and thus unresponsive to the price differentials. Stockholders were affected to a larger extent, while consumers were affected to the greatest extent.

In view of these effects, one may consider whether the farmer-owned reserve program benefited grain market participants as a whole. Aggregating the effects over all grain market participants reveals a positive net impact in the last half of 1977 and first half of 1979 but a negative effect during 1978. (See the Total Grains line in table 4.) Basically, producers' gains dominate the last two quarters in 1977 while demanding groups' gains dominate the first two quarters of 1979. However, the negative effects in 1978 more than outweigh the positive impacts in the remainder of the 2-year period. All grain market participants considered jointly suffered a loss of over $6.8 billion over the 2-year period.

In evaluating these overall effects on grain, though, one must bear in mind that farmer-owned reserve accumulation is regarded as a liability in the above calculators corresponding to the value of grain placed in reserve. The corresponding benefits are not realized until the grain is sold. But at the end of 1979 II, 250 million bushels of wheat and 586 million bushels of corn were still in the reserve. At market prices for 1979 II (which could not have been sustained in the event of a sale), these stocks were valued at $2.5 billion. Adjusting the overall grain market loss by this amount suggests a net loss of $4.3 billion over the 2-year period instead of the $6.8 billion figure above. Nevertheless, the net loss is substantial (on the order of a quarter dollar per bushel over the 2-year period). One might also note, however, that if these stocks were carried over to some later period of substantial shortage, they may be worth considerably more than $2.5 billion and thus the negative overall effect of the program could be less.

Next, consider the real income effects on livestock market participants. The directional impacts on meat consumers are fairly evident from table 2 since meat prices were affected relatively little in the earlier quarters and then were substantially higher with the farmer-owned reserve than without it with a few negative effects appearing near the end of the 2-year period. In terms of magnitudes, however, the only large effects were losses in 1978 IV and 1979 I where the differential effect of the reserve on beef prices reached its maximum. The estimated net loss in real income

for meat consumers over the 2-year period amounts to $2.6 billion. 1/

These losses for meat consumers are generally due to the relative slackening of meat supply under the reserve. And, of course, the relative slackening of meat supply occurring during 1978 and early 1979 is a result again of false corn price signals in 1977 generated by accumulation of the farmer-owned reserve. That is, the initial upward pressure on corn prices, caused by taking grain off the market and putting it into the reserve, gave the livestock industry a false signal to contract because expectations of corn prices were higher than if the farmer-owned reserve had not been accumulated. 2/ To some extent the upward pressure on corn prices was counteracted by an associated upward pressure on livestock prices. Nevertheless, the effect on corn prices in the first three quarters of 1978 caused a reduction in investments (in herd expansion and cattle placed on feed) as compared with the free market case that would affect beef supply in 1979 I by $353 million over and above any increase in investment due to higher cattle prices. This effect explains the net reduction in investment in the beef sector of $260 million over the 2 years examined in table 4 compared with the case with no farmer-owned reserve. Similar effects of the differential corn price under the reserve program were also felt in the hog and poultry markets. But

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1/One should bear in mind, however, that $2.1 billion of this loss occurs in 1979 I which is beyond the 6 quarter simulation horizon in which the model validation work indicated reasonable and stable results.

2/Of course, one must bear in mind that these conclusions are based on the particular price expectation mechanisms in the estimated econometric model. Other mechanisms could conceivably generate different results but the directional impacts discussed here seem reasonable. On the other hand, if livestock producers were alert and informed enough to correctly perceive the effects of the program on feed prices, then there may have been little or no livestock industry maladjustment. Reality is likely somewhere in between this extreme and that assumed in the model of this paper where livestock producers do not perceive the short-run nature of the initial effects. In this sense, the effects estimated in tables 2 and 4 may be taken as upper bound estimates. The assumption of fully informed livestock producers seems questionable, however, when studies such as this are required to estimate the price effects that livestock producers would be assumed to know 3 years earlier.

these effects were outweighed by expanded investment associated with livestock prices that were higher with the farmer-owned reserve than without it and which were in turn partially due to the above developments in the beef market.

Short-run profits were generally higher for each of the livestock industries because livestock prices were higher with the reserve than they would have been without it. This is reasonable even though smaller quantities of livestock were sold because of the inelastic nature of demand: as quantity declines, total revenue increases. The increase in short-run profits was generally larger for cattle producers and smaller for hog producers. In fact, because of the shorter term involved for supply response in the hog industry, the higher prices under the reserve program led to increases in investments which more than outweighed the increase in short-run profits. Supply response in the poultry industry, on the other hand, is much faster; investments are relatively small with quick payoffs. Thus, the increased short-run profits easily dominate the higher investments under the reserve.

In evaluating the net effects on the livestock sector, the higher livestock prices caused shortly after the introduction of the reserve program seem to have led to increased producer short-run profits which dominated all other effects until early 1979. Substantial adverse effects on meat consumers caused by the higher prices, however, caused net effects to turn negative in 1979 I. Finally, as greater supplies hit the market in response to higher 1978 prices, the beef and pork prices began to fall; the lower producer profits thus dominated other effects in 1979 II. As one might expect, however, the net effects on the livestock sector, which are indirect effects, are secondary in importance as compared with the grain market effects. Nevertheless, it is worth noting that the net livestock sector effect over the first eight quarters of the farmer-owned reserve program was a loss of $152 million.

The overall estimated effect over the first eight quarters of the program is a loss of $6.9 billion. Reducing this loss by the value of grain still held in the reserve ($2.5 billion) thus results in an overall net loss of $4.4 billion. This result implies that some system of transfers must have existed so that all market participants would have been better off without the farmer-owned reserve program in the first 2 years. For example, meat consumers would have been better off to have compensated cattle producers and poultry producers for their losses incurred in foregoing the program so that everyone in the livestock

sector would have preferred no reserve program. Therefore, the farmer-owned reserve program appears to be unjustifiable on the basis of economic performance in the first 2 years alone. It should also be noted that some experimentation with model specification has suggested that these results are quite robust at least when flexible functional forms are used for the analysis.

One must bear in mind, however, that these are effects only over the first 2 years of the program. As far as overall effects of the program are concerned, the results of this simulation imply that a steady state adjustment to the new program had not yet been reached by 1979 II and thus the long-run gains could conceivably exceed the costs. 1/ But the $4.4 billion deficit after 2 years seems hard to overcome if future periods are discounted to a very great extent. (Note that the estimates are in nominal terms so the rate of discount should be fairly high.) Thus, the dynamic problems of adjustment because of false price signals in the early periods of the program appear to have serious consequences for the overall benefits of the program.

Finally, a few words concerning the value of the results in this section are in order. This section reports the results of an empirical analysis within the confines of a presumably well-specified model, the parameters of which have been estimated with historical data. The estimated model is then used for purposes of simulating a situation unlike those for which data were available (absence of a farmer-owned reserve program, including absence of the related price supports, etc.). One must bear in mind that the results of such an exercise typically have important properties, some of which may be desirable and some of which may not. Nevertheless, the results from such a simulation can be very instructive even though they do not match any real world phenomena. For example, the results in tables 2 and 4 suggest a few price and welfare effects in later periods which seem unreasonably large although the basic story suggested by results is plausible and broadly consistent with intuition. In this case, the simulation gives a general explanation of the facts which has serious implications for agricultural policy formulation even if the magnitudes of some of the estimated effects seem too large.

1/While it would be highly desirable to examine the ultimate or steady state adjustment to the farmer-owned reserve program empirically, such an analysis is outside the scope of this study because of time constraints.

Furthermore, one must bear in mind that the farmer-owned reserve program is compared here with the case of no direct price controls of any kind. Such a market situation has not been observable in reality for decades. Thus, actual market data gives little basis for intuition regarding what magnitude of effects is plausible. While this study could have alternatively compared with a policy regime involving, say, price supports or loan rates along with set-aside requirements as had operated prior to the farmer-owned reserve program, the basis for determining the loan rates and set-aside levels that would have been adopted under such a regime is lacking. For example, one possibility is that they would have been the same as used with the farmer-owned reserve. But this would have been the case only if Government would have been willing to accumulate stocks rapidly during the 1977-78 crop year. And if this had been the case, then the the effects under the farmer-owned reserve would have been very much like those that would have existed otherwise because the distinguishing feature of the farmer-owned reserve program--the release and call levels--did not play a role until 1979.

SECTION 11

THE SOVIET GRAIN SALES EMBARGO: A CASE IN POINT

One of the major objectives of a grain reserve is market stabilization. The reserve's stabilizing ability can be tested by examining its ability to deal with unexpected market developments. Perhaps the greatest source of grain market instability for the United States has been its export market, and one of the most unpredictable components of export demand has been grain trade with the Soviet Union. (See table 5.) A substantial shock to grain trade with the Soviet Union occurred January 4, 1980, when President Carter suspended delivery to the Soviet Union of any U.S. grain exceeding 8 million metric tons--an amount already committed under an earlier grain trade agreement which went into effect on October 1, 1976.

At the time the President ordered the suspension of grain sales to the Soviet Union, it had contracts for delivery of U.S. grain from private exporters totalling 21.8 million metric tons--6.7 million tons of wheat and 15.1 million tons of corn--of which 5.5 million metric tons had already been shipped. 1/ In accordance with article II of the 5-year U.S.-U.S.S.R. Grain Agreement, the U.S.S.R. could import only 2.5 million tons of additional grain. As a result, the suspension of sales reduced U.S. exports to the Soviet Union by at least 13.8 million metric tons. In this section, an analysis is made of the impact of the Soviet grain embargo on the farmer-owned reserve and the reserve's ability to deal with such a massive shock.

To examine the implications of this change, suppose the reductions of wheat and corn exports occur in equal proportions. Thus, the actual exports of wheat during the 1980 fiscal year would be the 6.7 million metric tons originally contracted, reduced by the proportion of original contracts that cannot be shipped under the embargo, 13.8/21.8; i.e., $4.24 = 6.7 \times (13.8/21.8)$. A similar assumption for corn would suggest corn export reductions due to the embargo of 9.55 million metric tons; i.e., $9.55 = 15.1 \times (13.8/21.8)$. Equivalently, this amounts to reductions of 154 million bushels and 376 million bushels for wheat and corn exports, respectively. Assuming these reductions would be spread evenly over the three quarters of the fiscal or trade year

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1/D.E. Hathaway, statement made to the Subcommittee on International Finance, Committee on Banking, Housing and Urban Affairs, U.S. Senate, Jan. 22, 1980.

TABLE 5

U.S. AND SOVIET GRAIN PRODUCTION AND TRADE

Marketing Year	U.S. Prod.	Total U.S. Exports	U.S. Exports to USSR	USSR Prod.	Total USSR Imports a/	U.S. Avg. Annual Price b/
	million metric tons					$ bu.
1970/71						
Wheat	36.8	19.9	0	99.7	0.5	1.33
Coarse Grains	145.2	18.9	0	76.9	0.3	1.33
1971/72						
Wheat	44.1	16.8	0	98.8	3.5	1.34
Coarse Grains	188.3	24.5	2.9	72.6	4.3	1.08
1972/73						
Wheat	42.1	31.8	9.5	86.0	15.6	1.76
Coarse Grains	181.3	39.1	4.2	72.5	6.9	1.57
1973/74						
Wheat	46.6	32.9	2.7	109.8	4.5	3.95
Coarse Grains	186.1	49.4	5.2	101.0	6.4	2.55
1974/75						
Wheat	48.4	27.4	1.0	83.9	2.5	4.09
Coarse Grains	150.4	35.7	1.3	99.7	22.7	3.03
1975/76						
Wheat	57.8	31.7	4.0	66.2	10.1	3.56
Coarse Grains	184.7	50.0	9.9	65.8	15.6	2.54
1976/77						
Wheat	58.2	25.5	2.9	96.9	4.6	2.73
Coarse Grains	193.5	50.6	4.5	115.0	5.7	2.15
1977/78						
Wheat	55.4	30.6	3.3	92.2	6.7	2.33
Coarse Grains	203.4	56.3	9.2	92.6	11.7	2.02
1978/79						
Wheat	48.9	32.5	2.9	120.8	5.1	2.94
Coarse Grains	217.4	60.2	8.3	105.3	10.0	2.20
1979/80 c/						
Wheat	58.3	36.1	(d)	86.0	9.8	3.60-3.90
Coarse Grains	233.9	62.7	(d)	84.0	14.9	2.25-2.45

SOURCE: Statement by Honorable Bob Bergland, Secretary of Agriculture, to the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, January 22, 1980.

a/July-June year.

b/Coarse grain price is for corn only.

c/Forecast.

d/The U.S.S.R. may purchase up to 8 million metric tons of U.S. grain in the fourth agreement year (Oct. 1979 - Sept. 1980).

following President Carter's announcement, the quarterly reductions in exports are 52 million bushels for wheat and 125 million bushels for corn.

The effects of such an unexpected shock on the U.S. grain economy can be analyzed using the econometric model in table 1. Although actual data was not yet available for the embargo period at the time of this study, the Chase Econometric Associates, Inc., forecasts for the variables in the econometric model can be used as a basis to evaluate departures due to the embargo. However, because these forecasts tend to be more in error for longer forecast horizons, only data from the first quarter of the embargo is analyzed below. The first quarter of 1980 was history at the time of this study, even though the data were not yet available in published form. Thus, the forecast data should be fairly accurate and no unexpected large changes should occur to invalidate the analysis presented here. The April 1980 Chase forecast was used for the analysis.

The estimated effects of the embargo on grain market prices and quantities are presented in table 6. Again, as in table 3, these effects were developed by fitting the model in table 1 to actual (forecast) data. That is, disturbances were determined for each equation so that the model perfectly fits 1980 I data. Then these disturbances were used in estimating the effects of altering policy. Impacts on the livestock market of these changes are not included since the short-run effects are negligible. Substantial effects may be realized by the livestock industry over time, but these effects begin to occur only after livestock supply has sufficient time to respond to new grain prices. These latter effects could also be estimated using the model in table 1 but only with considerably more computational expense and estimation error (because less is known about future prices and quantities). 1/

The estimates in table 6 compare the effects of the Russian embargo with and without the farmer-owned reserve program in effect in the United States. Thus, four policy alternatives can be considered, depending on imposition of the embargo and operation of the reserve. All of the

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1/Even forecasts from the major econometric firms such as Chase Econometrics Associates, Inc., generally entail 10- to 20-percent errors over forecast horizons long enough to capture the major part of livestock industry response. Errors of this magnitude in price and quantity estimates can lead to much greater relative errors in estimates of real income effects.

TABLE 6

GRAIN MARKET IMPACTS OF THE SOVIET GRAIN EMBARGO, 1980 I

Case	Price	Disappearance	Private Stocks	Exports	FOR a/
	($/bu.)	million bushels			
WHEAT					
Actual:					
with embargo and FOR	3.71	209	886	390	230
Estimated:					
no embargo, with FOR					
-FOR cleared at release levels b/	3.29	214	913	442	145
-FOR cleared at observed prices	3.71	209	885	442	178
-FOR cleared at call levels	4.11	205	859	442	209
Estimated:					
with embargo, no FOR	5.00	186	917	381	0
Estimated:					
no embargo, no FOR	6.53	182	880	422	0

TABLE 6
(Continued)

CORN					
Actual:					
with embargo and FOR	2.38	1411	3874	807	586
Estimated:					
no embargo, with FOR					
-FOR cleared at release levels	2.50	1415	3852	932	480
-FOR cleared at observed prices b/	2.38	1418	3852	932	455
-FOR cleared at call levels	2.80	1408	3796	930	544
Estimated:					
with embargo, no FOR	3.70	1388	3927	777	0
Estimated:					
no embargo, no FOR	4.07	1381	3855	857	0

a/Farmer-owned reserve.

b/These scenarios are less reasonable according to arguments in the text.

effects of the four alternatives can be estimated using table 1, except the case with no embargo where the farmer-owned reserve is in operation. To deal with the latter case requires information about how high prices must rise before the farmer-owned reserve enters market channels. The mechanics of the program suggest that the reserve would not be sold until prices reach at least the release levels and that they would be cleared before prices rise above call levels. But whether most of the reserve stocks will be sold near release levels or near call levels is not clear.

Since the program imposes only a single lower bound on price (i.e., the loan rate), the theoretical nature of behavior in cases of low price is unambiguous. However, the dual nature of upper price bounds makes the theoretical behavior of the market somewhat ambiguous for high price cases. Thus far, only limited observation of the program has been possible for high price cases. Corn prices reached the release price only for a little over a month on two occasions in the summer and fall of 1979. Wheat prices rose to the release price for the first time in May of 1979. In each case, storage payments were not discontinued until sometime after release status was entered. In the case of corn, no quarterly observations were yet available where the release provisions of the program were in operation. Of course, in neither case were call levels reached, so no data pertaining even partially to that case has been generated.

Because the operation of the farmer-owned reserve is somewhat unclear at high prices, the associated results for the estimated case with the farmer-owned reserve in table 6 are developed under three scenarios. The first assumes that if the embargo had not been imposed, the reserves would have been sold at release levels. This was clearly not the case for wheat for the case where the embargo was imposed (which is represented by actual data). Nevertheless, it represents a lower bound on the set of prices where reserves would be sold. The second scenario assumes that reserves would be sold at the same price in the event of no embargo as with the embargo or, more specifically, at the actual prices which occurred under the embargo case. This is probably inappropriate for corn since the quarterly price was actually below the release price. This case seems reasonable for wheat, however. The third scenario assumes that reserves would not have been sold until prices reached call levels if the embargo had not been imposed. This case would have been likely if higher prices would have been anticipated by farmers through a rising market as Soviet exports imposed increasing upward price pressures.

The release and call levels used for this policy case are the ones that existed prior to the embargo. This seems to be the most likely policy alternative because the higher loan rates, release levels, and call levels were instituted in 1980 as a measure to ease the adverse effects of the embargo on producers. 1/

Finally, before proceeding with the analysis, it should be noted that actual data on levels of farmer-owned reserves were not yet available during 1980 at the time of this study, so the latest data available was used.

The results in table 6 imply that the embargo may have had significant effects on U.S. grain markets under the farmer-owned reserve program. 2/ Farmer-owned reserves may have been falling as much as 52 million bushels per quarter for wheat and 106 million bushels per quarter for corn compared with the case with no embargo (ignoring the less reasonable cases indicated above). If this rate had persisted, the reserves would have been exhausted in four to six quarters. Of course, however, the unusually large Soviet demand may not have persisted beyond contracts already existing for the trade year ending with 1980 III. Furthermore, if reserves were held until call levels were reached, then the reserve would have dropped only 11 million bushels per quarter for

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1/According to a statement by Secretary Bob Bergland to the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, Jan. 22, 1980, provisions of the farm program designed to reduce adverse effects of the embargo on producers included raising loan rates from $2.35 to $2.50 for wheat and from $2.00 to $2.10 for corn. Furthermore, the release price for wheat was raised from 140 to 150 percent of loan rate and the call price was raised from 175 to 185 percent of loan rate. For corn, the release price continued to be 125 percent of loan rate, but the call level was raised from 140 to 145 percent of loan rate.

2/While the results in table 6 imply rather high prices in the case of no farmer-owned reserve, one must bear in mind that total stocks are substantially lower for those cases (by about the size of the farmer-owned reserve since other private stocks are near the same). Furthermore, exports to the Soviet Union even under the embargo were at about the same level as in the 1973-74 crop season (table 5). Wheat prices in excess of $6.00 may well be plausible where Soviet exports are triple the 1973-74 level, which table 6 indicates they would have been in absence of the embargo.

wheat and 42 million bushels per quarter for corn so the period of adequacy for reserves would have been much longer. On the other hand, one must bear in mind that as reserves decline, private stock demands increase (table 1). This increased demand could have caused the extent of reserve depletion in future quarters to increase as prices were bid up in the absence of an embargo.

Turning to the effects on prices and quantities, the price could have been as much as $0.40 per bushel higher for wheat and $0.52 per bushel higher for corn if the embargo had not occurred under the farmer-owned reserve. On the other hand, if the farmer-owned reserve had not been in operation, then the effect of the embargo would have been a $0.53 per bushel price decline for wheat and a $0.37 per bushel price decline for corn. These price differentials are associated with modest changes in disappearance (although disappearance appears to depend substantially on whether the farmer-owned reserve is implemented). However, private stocks tend to be more responsive in absence of a farmer-owned reserve. The change in stocks for wheat of 37 million bushels in absence of a farmer-owned reserve is larger than for any of the three scenarios with a farmer-owned reserve. For corn, the change in stocks without a farmer-owned reserve is higher than the estimates for the case of a farmer-owned reserve except when reserves are held until prices approach call levels. This responsiveness of stocks is required to accommodate the more responsive nature of exports at the higher prices resulting in absence of an embargo.

Again, the magnitude of benefits associated with these differentials cannot be evaluated directly from price and quantity data because the extent of cost savings or possibilities for substitution are not evident. Quantitative information can be derived using the economic surplus concepts discussed earlier using the estimates in table 1. These results, which correspond to the price and quantity differentials in table 6, are reported in table 7. While producers would not experience a direct effect on economic welfare in 1980 I according to the model in table 1 (because production is only realized in quarters III and IV), an estimate of the average quarterly effect may be obtained as the change in revenue on one-quarter of the crop resulting from the change in price. These figures are reported in table 7 as a standard of comparison for the welfare effects on other market groups.

The estimates in table 7 confirm that effects on economic welfare tend to be higher in absence of the farmer-owned reserve. The gain for wheat consumers from lower prices under the embargo is more than three times

TABLE 7

REAL INCOME EFFECTS OF THE SOVIET GRAIN EMBARGO

WITH AND WITHOUT THE FARMER-OWNED RESERVE (FOR), 1980 I

Case	Market Groups			
	Consumers	Stockholders	Foreign Concerns	Producers a/
WHEAT	million dollars			
No FOR	+66.4	+3.4	+2.7	-283.8
FOR cleared at release level b/	-15.3	-1.5	-0.3	+224.9
FOR cleared at observed prices	+0.3	(c)	+0.4	(c)
FOR cleared at call level	+18.6	+1.6	+1.2	-214.2
CORN				
No FOR	+23.2	+10.0	+3.8	-718.1
FOR cleared at release level	+7.4	+2.0	+11.4	-232.9
FOR cleared at observed price b/	+0.8	(c)	+0.6	(c)
FOR cleared at call level	+24.3	+ 7.6	+2.5	-815.2

a/Estimated on a quarterly basis by allocating the annual impacts equally among quarters assuming the annual differential impact on price is the same as estimated for 1980 I.

b/These scenarios are less reasonable according to arguments in the text.

c/Negligible effects.

greater with no farmer-owned reserve than the scenario with the largest change under a functioning farmer-owned reserve. For wheat stockholders and foreign concerns, the gain is a little more than twice. These gains, however, are more than offset by producer losses which are also higher in absence of a farmer-owned reserve. The net effect of the farmer-owned reserve on wheat market groups as a whole is a reduction in the loss in economic welfare or real income associated with imposition of the embargo in the amount of at least $18.5 million per quarter. Furthermore, the farmer-owned reserve seems to reduce the vulnerability of every individual market group to unexpected developments in the export market. In this respect, one of the apparent objectives of the program is met for wheat.

These results, however, must also be evaluated in the context of results obtained in table 4. Results there imply that real income is reduced on average for many market groups and for all groups taken together. Thus, the lower vulnerability to unexpected market developments with the farmer-owned reserve may be due to the fact that there is less to lose. One way of evaluating these possibilities is to compare the magnitude of the directional effect in table 4 with the degree of vulnerability to unexpected developments suggested by table 6. With this in mind, the net reduction in loss per quarter of $18.5 million estimated above is very small compared with the directional effects estimated in table 4. Thus, unless the likely magnitude of unanticipated changes in the wheat market is larger than for the Soviet embargo (which is doubtful), then the reduced vulnerability is not sufficient to override implications of the analysis of table 4. One may further note that this is true with respect to every individual market group.

Turning to the case of corn, a similar result is found in comparing the case of no farmer-owned reserve with the case of a farmer-owned reserve where reserves are cleared at release levels. If reserves are cleared at call levels, however, then the comparison is reversed for consumers and producers. Thus, for corn, consumers generally gain more and producers lose more than if the embargo were imposed in absence of a farmer-owned reserve. This result suggests that the call level for corn is too high to cause the farmer-owned reserve to absorb shocks in the corn market. Again, however, the net effect is negative. Also, these effects are secondary to those considered in table 4. Thus, while the objectives of the farmer-owned reserve associated with meeting unexpected situations seem to be met to some extent, the value of meeting these objectives for the market

participants is less than the value of giving up the reserve from other respects.

The above analysis suffers from several important simplifications, but the major simplifications lead to biasing the effects upward rather than downward. For example, the change in CCC activity which accompanied the embargo has not been considered. As part of the embargo policy, Secretary Bergland announced that CCC would assume the contractual obligations for grain shipments to the Soviet Union that would be prohibited by the embargo. 1/ If the same amount of grain were taken out of commercial channels as would otherwise have gone to the Soviet Union, then the effects would be approximately the same. For example, the model in table 1 indicates that increased CCC ownership of wheat has a small effect on the commercial market whereas no effect could be found for CCC corn ownership in the corn market. Furthermore, unlike corn, the wheat would have less potential for reentering the commercial market since it was to be used in support of foreign food assistance programs. Thus, these accompanying policies could negate impacts of the embargo on U.S. commercial grain markets.

The above discussion also essentially avoids the issue of response by other major grain exporters; that is, it is not known to what extent Australia, Canada, and Argentina also blocked grain sales to the Soviet Union. These three countries are large wheat exporters to the Soviet Union but export relatively little feed grain. At the extreme, if the U.S.S.R. is able to meet its demands by buying additional grain (wheat) from these three nations, the impact on U.S. wheat prices would be minimal in the United States, since it would export more to those markets (excluding the Soviet Union) where the above three countries now ship. In a sense there would be substitution among markets, although it may not be perfect. However, if the other exporters did not ship to the Soviet Union (even though there would be some illegal shipments to the Soviet Union from importers of grain from the United States, Canada, Australia, and Argentina), the impact on U.S. grain markets would be much greater. However, in this case, the other exporters also experience substantial market impacts.

One might further note in the context of this discussion that the impact on U.S. feed grain prices likely

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1/Statement by Secretary Bob Bergland to the Committee on Agriculture, Nutrition, and Forestry, U.S. Senate, Jan. 22, 1980.

does not depend as critically on the reaction from other exporters as for wheat. This is because the United States is by far both the world's largest feed grain exporter and the largest exporter to the U.S.S.R. (See table 5.) Thus, in the absence of other offsetting policy changes, the United States' livestock sector could be expected to eventually benefit from the embargo due to cheaper internal feed grain prices. This effect could not be greatly offset by sales expansion to the Soviet Union by other exporters because of the U.S. dominance of that market. Again, however, if this is a short-lived development, the false price signals for livestock industry expansion could lead to ultimate losses for the livestock industry as well.

Finally, it is worthwhile to consider the combination of circumstances where CCC assumes contractual obligations at the same time other exporters fill Soviet demands for grain. In this case, substantial amounts of U.S. grain would be leaving commercial channels and, at the same time, demand by importers other than the U.S.S.R. could be unfilled because of other exporters shipping to Soviet markets instead. Thus, the same overall commercial demand for grains could exist as without the embargo as in the case where the embargo is not imposed while a smaller supply of commercial grain could exist to fill it. In this case, the change in CCC policy together with the embargo could actually have strengthened U.S. and world grain markets, in which case U.S. grain consumers would be losers and U.S. grain producers would be gainers. Of course, if these are the realistic assumptions, then the analysis in tables 6 and 7 should be revised and could have as much as roughly opposite implications.

In each case, however, the estimates together with additional considerations imply that benefits from the reserve for encountering stocks in the wheat market are rather small compared with other considerations. These conclusions are apparently consistent with the confidence shown in the farmer-owned reserve policy. That is, if the reserve policy were viewed as capable of handling large shocks in the grain market, then such major revisions in the reserve policy (loan rates, release levels, call levels, storage payments, interest payments, and accompanying CCC policy) would not be required with such developments as the Russian grain embargo.

SECTION 12

CONCLUSIONS REGARDING EFFECTIVENESS OF THE FARMER-OWNED RESERVE

The goal of U.S. agricultural grain stock policy has been to ensure against uncertainties of weather and trade policies of foreign countries that could prevent attainment of the following objectives of U.S. agricultural policy:

1. Maintaining the productive base by stabilizing agricultural prices and supporting farm income.

2. Protecting domestic consumers by providing adequate supplies at reasonable prices.

3. Ensuring availability of exports for commercial and humanitarian needs and to improve U.S. trade balances.

4. Holding down long run Government costs.

5. Combating inflation. 1/

The evidence of this study on the farmer-owned reserve program's ability to meet these objectives is mixed at best.

The program seems to have fostered greater stability of prices and incomes than would have existed in absence of a farmer-owned reserve (table 3). Also, the reserve seems to have a capability of reducing short-run vulnerability to unexpected developments in the world market (table 7). However, these gains in stability have come at considerable expense in terms of average farm income for grain producers (table 4). Furthermore, the econometric results show that short-run stability is not highly valued by producers; risk response did not prove to be important. 2/ Livestock producers, on the other hand, can be major benefactors from both lower grain prices after reserve accumulation (table 2) and greater market stability (table 3). However,

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1/Taken from Harold Jamison and Roy Cozart, "Draft Impact Analysis," USDA-ASCS, Dec. 10, 1979.

2/The results, however, show that long-run stability could have considerable impact because of greater planning ability and the associated economic efficiency in investment.

the livestock industry benefits do not appear to outweigh the costs imposed on grain producers or meat consumers. Thus, the first objective appears to be met in part but the costs of not meeting the second part of the objective may outweigh the benefits of meeting the first part of the objective.

Turning to the second objective, it appears that consumer interests have been well protected in the grain markets but major losses have been suffered in the meat market as a result of the policy. However, the bulk of loss in the meat market is due to problems of adjustment due to false price signals in the livestock industry. These losses should gradually turn into gains as the livestock industry is able to adjust. In fact, the results in table 4 indicate that these gains were beginning to be realized in 1979 II. Again, however, one must note that the net consumer gains resulting from the policy are more than offset by producer losses.

For the third objective, there is no evidence that suggests lack of availability for exports under the program. In fact, because of reduced year-to-year private stock demand and reduced grain prices, the results suggest improved export availability. By the same token, however, the reduced grain prices lead to deteriorated U.S. trade balances; prices are eventually lower under the program and, due to world market saturation at low prices, export quantities are only negligibly higher (table 2). Again, the evidence is mixed; the ultimate evaluation of results relative to the third objective depends on the extent to which humanitarian needs for food at low prices are valued in U.S. policy formulation. Evidently, lower export prices are attained at the expense of U.S. producers and U.S. trade balance deterioration. Furthermore, from the standpoint of maintaining an emergency food reserve for humanitarian reasons, the size of the farmer-owned reserve is deceivingly large; estimates show that over 80 percent of the wheat reserve and over 50 percent of the corn reserve are serving the purpose of commercial reserves for the farmers who actually control sales decisions.

For objective four, the evidence is clearly and strongly negative. The coefficient for response of private stock levels to farmer-owned reserve levels in table 1 is very large relative to the coefficient for CCC or Government-owned stocks. These results imply that a much larger Government-related reserve is required to reach the same level of insurance of adequate emergency supplies under the farmer-owned reserve than with CCC ownership. Storage costs paid by the Government in the case of wheat are more than five times greater with the farmer-owned reserve. In fact,

after considering the interactions with extended markets, the difference in Government costs are even greater. Results suggest that farmer-owned reserves are viewed as close substitutes for private market stocks and, as a result, the Government can suffer the burden of paying storage costs which would normally be assumed by private market concerns.

Finally, the evidence on inflation is also somewhat mixed. 1/ Grain prices are ultimately lower with the reserve program but meat prices are increased substantially in the intermediate run (up to six quarters). Examining the results in table 4 suggests that consumers of food are better off over all. One must also consider the effect on U.S. trade balances, however. As trade balances deteriorate, exchange rates turn against the United States so that foreign goods become more expensive. Thus, foreign goods may become relatively more expensive for consumers. But these latter effects are probably secondary.

The stated objectives of the reserve program are conflicting. Prices cannot be simultaneously lowered for consumers and increased for producers without increasing Government costs. Thus, it is not surprising that the evidence is mixed regarding attainment of program objectives. An ultimate evaluation of the reserve program depends on the importance of each objective. Such issues can only be decided by the lawmakers responsible for policy formulation.

However, one interesting piece of evidence can be compiled by considering market participants' evaluation of the effects. That is, suppose for each group which gains under the reserve policy that one can determine how much they would be willing to pay, at most, to have the reserve policy. Then suppose for each group which loses under the reserve policy that one can determine the least amount of transfer payment that would cause them to prefer the reserve policy if accompanied by the transfer payments. With this information, one can hypothetically consider financing the transfer payments from the gains of those groups for whom economic welfare is improved. If this is possible, then some system of transfer payments exists so that everyone is better off with the reserve policy. If not, then some system of transfer payments exists so that everyone is better off without

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1/ While this type of objective may not make sense for grain stock policy in the context of general theories of inflation, it makes sense if interpreted as an objective of avoiding food price increases. This is the sense in which the objective is evaluated here.

the reserve policy. The estimates in table 4 are, in fact, estimates of these gains and losses and suggest that those who were worse off in the first 2 years of the farmer-owned reserve program could easily have financed necessary transfers to those who gained so that everyone would have been better off without the program.

In reaching these conclusions, however, one must bear in mind that the 2-year period analyzed here was one of relative surplus; expenses are generally incurred in accumulating Government reserves in surplus years. One should also consider the possible benefits of having accumulated such a reserve if a period of shortage were then to ensue. The reserve could be more valuable than current prices during surplus years would suggest, plus it may have the effect of holding prices down substantially on all other grain transacted in shortage periods.

To investigate the possible extent of such effects, one can consider the various cases of no embargo with a farmer-owned reserve program in table 6. The results here imply that drawing down farmer-owned reserve stocks by an extra 31 million bushels per quarter leads to a $0.40 per bushel reduction in wheat price and that a reserve reduction of 64 million bushels reduces wheat price by $0.72 per bushel. In the case of corn, an 89 million bushel reduction in the farmer-owned reserve reduces corn price by $0.42 per bushel and a 64 million bushel decrease reduces corn price by $0.30 per bushel. Thus, price reactions are fairly substantial with total elasticities on the order of unity.

But one must bear in mind that such price reductions involve to a large extent simply transfers from producers to consumers so that the associated net welfare gains are less than the change in value of production. With this in mind, it appears that the net costs of accumulating the farmer-owned reserve may or may not be recovered if a shortage were to develop. Thus, some potential for net gains from the farmer-owned reserve may still be possible even though net losses over the first 2 years have apparently been higher.

SECTION 13

IMPLICATIONS FOR NEW AGRICULTURAL POLICY FORMULATION

The results of this study have important implications for the design of future agricultural policy. First, since market stocks are so much more responsive to farmer-owned reserves than Government-owned reserves, results show that any effort to hold an emergency food reserve should be tied to CCC ownership rather than farmer ownership. 1/ Otherwise, the Government bears the cost of some stocks held for market purposes and the extent of this cost can be substantially greater than otherwise.

Second, the results of this study emphasize that costs of adjustment to new policies can be substantial. Initial price adjustments that differ from long-run equilibrium levels cause false price signals for producers. These false price signals can then cause substantial maladjustment, particularly in the livestock industry because of long lags in production.

The results in table 2 suggest that adjustments in the livestock sector were far from complete even after eight quarters of the new program. During this long period of adjustment, the 1977 changes in policy led to poor investment decisions which contributed to serious economic inefficiency. In view of these results, the recent practice of changing agricultural policy substantially every 4 years seems to impose unnecessary costs on the agricultural sector. With policy changing every 4 years, the livestock industry can be continually in a state of trying to adjust to new policies because of its inability to adjust quickly.

Furthermore, these costs are over and above any risk imposed on the agricultural sector because of uncertainties about what future policies may be. Economic inefficiencies resulting from unrealized anticipations about what new programs may exceed those considered in table 4. The inefficiencies in table 4 relate simply to false investment anticipations about what the effects of a program on price are likely to be given the provisions of the program. These considerations point to the importance of designing policy which is self-adjusting (so changes can be anticipated by

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1/Or, again alternatively, the mechanism governing the farmer-owned reserve should be modified so that other private stocks are less responsive to farmer-owned reserves as they were to CCC stocks in earlier years.

producers) and which causes only smooth, orderly changes in price (so large changes in investment are not induced which cause years of similarly large oscillatory adjustments in related markets).

A further issue along this line relates to the choices of specific levels of loan rates, release levels, call levels, and accompanying set-aside requirements. For corn, release levels have been high enough that they have been rarely reached. For both wheat and corn, the loan rates were high enough that farmer-owned reserves accumulated very rapidly during the 1977 and 1978 crop years. If the unusually large Soviet grain demand had not occurred in the 1979 crop year (and had not been offset by other policies after the embargo), grain prices could have been low again and farmer-owned reserves could have become unmanageably large. Furthermore, these developments were occurring while set-aside requirements were being imposed for the 1978 and 1979 crops.

In fact, the evidence suggests that once the farmer-owned reserves approached goal levels, the policy became essentially one of choosing set-aside controls to avoid further reserve accumulation (excluding the embargo period). As a result, one of the most important policy controls--the set-aside requirement--was determined annually so that producers could not anticipate policy effects even 1 year in advance.

Furthermore, major developments led to more than one major revision in policy during the 4-year period. A depressed grain market led to the Emergency Agricultural Credit Adjustment Act of 1978, which was soon accompanied by higher loan rates, release levels, and call levels for wheat. And, of course, the Soviet embargo was accompanied by major revisions described in section 11. Each of these major revisions was apparently necessary to correct inadequacies in the program. Thus, producers not only suffered from an inability to anticipate set-aside requirements more than a year in advance but also from inability to anticipate other major policy changes during the policy period since 1977. When a grain farmer is considering investments in machinery, etc., but does not know how much grain he will be allowed to plant the following year, he is likely to make a poor decision. As evidenced by the results in table 2, the investment inefficiency in the livestock sector can be even greater because of the long term required for herd expansion and subsequent production of feeder animals.

POSSIBILITIES FOR IMPROVED ADMINISTRATION OF EXISTING CONTROLS

In view of these considerations, strong possibilities appear to exist for improving economic efficiency with agricultural policy design. But what characteristics should agricultural policy have to promote improved economic efficiency? First, the policy should not involve annual all-or-nothing types of decisions about whether or not set-asides should be imposed. More orderly changes, such as the degree to which a control should be applied, would be more appropriate. For example, the policy since 1977 has involved setting a particular level for the loan rate and then, when it appears to be too far out of line, a substantial revision is made.

Experience suggests that this piecemeal approach will always be necessary when specific levels of, say, loan rates are determined only after existing levels appear too far out of line. For example, simulation studies (not reported) with the model in table 1 have indicated that the loan rates were relatively high in 1977 and 1978 but that, after sufficient inflation, the release levels would have become too low. As a result, the policy acted more like a simple price support in early years, in which case economic welfare analysis clearly implies a net loss for society as a whole. On the other hand, after sufficient inflation, the release level would act as a price ceiling in absence of set-asides at least until reserves were depleted. Again, economic welfare analysis clearly implies a net loss for society as a whole.

One would expect that loan rates would eventually be raised to avoid further depletion of reserves in this case. But as a result of this type of policy approach, the program can become a destabilizing influence or, at best, promote economic inefficiency by artificially holding prices up immediately after loan rate revisions and then artificially holding prices down after inflation and just before new revisions. A better approach would be to change loan rates more frequently in smaller amounts in accordance with observed and anticipated changes in equilibrium price levels. Then prices could be stabilized near equilibrium or efficient price levels rather than near distorted price levels.

Moreover, an even better approach would be to specify in advance how the specific controls of the program (loan rates, etc.) will be changed in response to market conditions. In this way, farmers can better anticipate such changes through their own assessments of future market conditions. Thus, better investment decisions should be

possible than when farmers are left to guess about future policy control levels. As evidenced by the results in tables 2 and 4, this approach could lead to substantial improvements in economic welfare for society as a whole.

When considering the observed conditions which influence revisions of controls, the most important ones include farmer income levels, inflation of food prices, the size of Government-related stocks, and Government costs. The loan rates supposedly avoid low farm incomes, while the release and call levels avoid rapid food price inflation. But acceptable levels of farm income and consumer prices change with inflation. So, perhaps, loan rates and release and call levels should be keyed to inflation so that changes in their levels can be anticipated by farmers in planning decisions.

Set-asides are supposedly set to avoid overaccumulation of reserves which lead to high Government costs. So, perhaps the level of set-aside requirements should be keyed to the level of accumulated reserves--in an explicit published way which allows farmer anticipation. Furthermore, to avoid the uncertainty that could occur when reserves are near a level where set-asides would be imposed or not, perhaps the reserve levels of any set-aside requirements should vary continuously. For example, a 1-percent set-aside could be required for every 20 million bushels of wheat in Government reserves. Thus, farmers could anticipate the set-aside requirement often within 1 or 2 percent and therefore face much less uncertainty in planning than when, for instance, either a 20-percent requirement or no requirement is imposed.

Set-asides can be used to avoid overaccumulation of reserves, but price incentives are generally necessary to avoid reserve depletion. Thus, loan rates, for example, must necessarily be increased when reserves become low. But rather than making these revisions in a piecemeal manner which is hard to anticipate, the loan rate could also be explicitly tied to the level of Government reserves as well as to inflation. For example, the loan rate could be increased $0.01 per bushel for every 3 million bushels the Government reserve is below some target level. If farmers could anticipate this adjustment process rather than speculate about it in making investment decisions, agricultural production should attain greater economic efficiency with less risk. In fact, with more efficient investment in the agricultural sector, lower prices may lead to the same levels of income.

IMPROVED POLICY CONTROLS BASED ON GOVERNMENT OWNERSHIP

Another consideration relates to the "all or nothing" applicability of loan rates and release or call levels. A loan rate theoretically plays no role unless price falls to the loan rate; then it theoretically acts as a controlled price below which price levels do not fall regardless of how much grain goes under Government loan at that price. Similar arguments apply to release and call levels for grain sales, although the degree of enforcement is less. In this context, Government policy may offer no benefits when prices are near normal levels and costs of providing some stabilizing influence would be very cheap. On the other hand, a very high level of benefits is provided in a very extreme situation in which the costs may be much greater than benefits. In fact, it is this type of situation that has sometimes caused programs to require unexpected modification.

Unexpected market developments may lead to a large increase in reserve levels; consequently, Government costs can get unbearably high. One way to ease this burden interseasonally is to make the price-control levels explicitly dependent on stock levels, as suggested above. But another way to ease this burden interseasonally is to operate the controls according to a prespecified scale. In other words, rather than the Government offering to take all grain at a loan rate, it could offer to buy, say, 1 million bushels of grain for every $0.01 per bushel the price is below a target level. Similarly, the Government could sell 1 million bushels from stocks for every $0.01 per bushel the price is above the target price. If these transactions were made at market prices, then it would make no difference which farmer's grain was actually purchased by the Government.

In this way, some stabilizing influence is provided when prices are near equilibrium and stability comes at very low cost. On the other hand, the Government does not promise to stick to hard and fast price limits that may have to be revised when Government costs become excessive. Furthermore, with this type of policy, the stabilizing influence can be provided throughout a marketing season. For example, as the price starts to move up, the Government could begin to sell stocks to ease price increases; as price starts downward, the Government could buy stocks to ease price declines. Thus, the announced policy of, for example, 1-million-bushel transactions for a $0.01 change in price would be an equilibrium relationship that could be applied continuously in determining Government stock transactions. In practice, of course, the market price used in governing these transactions should be some type of moving average price so that transactions are not based on day-to-day random market fluctuations but

perhaps on week-to-week or month-to-month fluctuations. But the interval of transactions should not be too long so that prices get too far out of line or cause too much price unsettlement when transactions finally occur.

Finally, to make this stabilization policy operational and self-adjusting interseasonally, a rule should be specified for modification of target price from period to period. One way to make this rule responsive to Government cost considerations is to make it dependent on the level of Government stocks relative to some Government stock goal. That is, suppose the Government determines a long-term stock goal of 400 million bushels of wheat based on a variety of considerations. Then the target price could be increased for each succeeding year by, say, $0.01 for every 3 million bushels the Government wheat stock is below 400 million bushels; similarly, the target price could be lowered $0.01 for every 3 million bushels the Government stock of wheat is above 400 million bushels. This rule for target price modification would automatically adjust to changing inflation rates since high producer costs would cause, in turn, less supply, higher price, lower Government stocks, and finally higher target price.

If this rule for buying and selling Government stocks were announced and known well in advance (e.g., years in advance), then decisionmakers could assess the effects of Government policy in making their investment decisions based on market forces. There would be no policy uncertainty due to decisionmakers guessing with little or no advance notice what the Government would do next. They would simply have to assess a market situation and then consider the Government actions specified for that situation. Similarly, the Government would not be introducing additional uncertainty into the market in the way that specific control levels are modified, since they would be determined on the basis of market phenomena--an uncertainty that farmers already face. Furthermore, the self-adjusting controls would be acting to reduce the market effects of the existing uncertainty.

IMPROVED POLICY CONTROLS BASED ON FARMER OWNERSHIP

Government ownership of grain reserves has come to be viewed with a great deal of skepticism because of the large amount of power it concentrates in the hands of a few individuals in making Government buy/sell decisions. Presumably, the proposed policy discussed above avoids these problems because the Government buy/sell decisions become mechanically controlled by the initial terms of the policy. Nevertheless, for the case where Government ownership is simply viewed

as politically infeasible, it is desirable to consider some alterations in farmer-owned reserve controls which could make it take on some of the smooth self-adjusting characteristics which are important in avoiding economic inefficiency.

First of all, if the farmer-owned reserve operates with release/call levels, decisionmakers will be faced with uncertainty regarding how the market will behave when prices draw near these levels. Rather than operating the program with cut-off points where at one price level farmers get a full storage subsidy and at the next slightly higher price they get no subsidy, the subsidies could be offered on a partial and sliding basis. For example, the Government could pay farmers a storage subsidy of a target amount per bushel, say $0.25 a bushel, plus 10 percent of the difference between a target price and the current price. The latter term would be positive and encourage more storage when current price is low and would be negative encouraging less storage when current price is high. When current price gets very high (e.g., $2.50 a bushel higher than the target price in this case), the storage subsidy would be completely phased out but it would be phased out in a smooth orderly manner rather than in an "all or nothing" manner as with the current release levels.

In addition to this change, the "all or nothing" aspects of the loan rate and call levels could be avoided by simply making the target storage subsidy high enough to compensate for commercial capital costs in borrowing against stored grain. Then, following the general type of storage subsidy rule above, the essential effects of all three current controls (loan rate and release/call levels) could be gradually phased in and out by the single storage subsidy mechanism above as dictated by market developments. If the rules governing storage subsidies were published well in advance, then farmers should be able to better anticipate Government program effects. And if the official current market price effective in determining storage subsidies is revised frequently, say weekly or monthly, then no market discontinuities with their accompanying uncertainties should be experienced within crop years.

Finally, to avoid the need for continual unanticipated year-to-year revisions of the storage subsidy rule, the target subsidy should be specified to depend on the accumulated size of the farmer-owned reserve. For example, the new target subsidy could be determined by subtracting $0.05 per bushel for every million tons the farmer-owned reserve exceeds some goal level for the reserve size (or adding a similar amount if the farmer-owned reserve falls below this goal level). If this revision rule were known well in advance by producers, then the effects of current and expected future market developments could be taken

into account in making effective investment decisions which affect future periods. Thus, the uncertainty associated with unanticipated policy changes could be avoided. Furthermore, with this type of rule, revisions would be assured so that reserves would not begin to accumulate indefinitely leading to excessive Government costs. Nor could reserves continue to be depleted over a period of many years.

The general policy outlined in this section attains much of the desirable nature of the policy outlined on pages 90 and 91 (except that Government storage costs may be higher in this case due to payment of storage costs for grain which might otherwise be held as purely private stocks). Decision-makers would not face policy uncertainty associated with guessing with little or no advance notice what the Government would do next. Again, they would simply have to assess a market situation and then consider the Government actions specified for that situation. Government would not be imposing additional uncertainty on farmers and, in fact, the policy would act to reduce the market effects of existing inherent uncertainty.

CONCLUSIONS

Only recently have economists begun to realize the potential benefits for society of controls that are determined automatically by the severity of market conditions. Both theoretical and empirical studies have been done to analyze the type of policy suggested by the results of this study; i.e., one where Government stock transactions depend continuously on the difference between market price and some target price. In each case, studies have concluded in its favor over the usual approach of loan rates, price bands, etc. 1/ Furthermore, these studies are short-run and do not account for additional benefits of longer-term investment efficiency that are suggested by this study. Thus, the case for a more orderly agricultural policy with built-in self-adjustments that can be well anticipated is strong.

1/For a theoretical study of these issues, see R.E. Just and A. Schmitz, op. cit. For empirical simulation studies, see W.W. Cochrane and Y. Danin, Reserve Stock Grain Models: The World and the United States, 1975-85, Minnesota Agr. Exp. Sta. Tech. Bulletin 305, 1976; Y. Danin, "Grain Reserves and Price Stabilization," Department of Agriculture and Applied Economics Staff Paper, pp. 75-80, University of Minnesota, Dec. 1975; and A.C. Zwart and K.D. Mielke, "Economic Implications of International Wheat Reserves," School of Agriculture, Economics, and Extension Education, Discussion Paper 1, University of Guelph, June 1976.