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The Impact of the Farmer-Owned Reserve on Market Structure: The Case of Wheat

by

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Abstract

The farmer-owned reserve is modeled as an endogenous variable in an econometric wheat model, and reduced-form impacts are obtained. The reserve equations, which are price elastic, add substantially to the elasticity of total market demand and significantly alter the impacts of exogenous shocks on price and other endogenous variables.

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It is nearly four years since the farmer-owned reserve program was initiated. The response of producers and consumers interests to this reserve concept has generally been positive, and there is every indication that it will continue to be a central instrument of grain policy in the 1980's.

There are many aspects of the reserve that have not been fully examined. One important aspect studied in this paper is the impact of the reserve on the structure and behavior of grain markets.

Clearly reserve placements and redemptions are influenced by commodity prices and that reserve activity also influences price levels (Meyers and Ryan). Thus reserve quantities are endogenous in commodity markets and should be modeled as a simultaneous component in commodity models. The level of the reserve and its price elasticity of response will affect the total elasticity of demand for the commodity and thereby alter the market impacts of all exogenous shocks. In addition, an increase in the reserve level is expected to reduce the demand for private inventories (Gardner), which moderates the price stabilizing effects of reserve changes.

Our purpose is to endogenize reserve quantities in an annual model of the wheat market and examine the altered structure of the market. We first summarize our methodology. In the second section we present the wheat model and discuss the commercial inventory function and the reserve relationship developed for this analysis. Finally we present the impact analysis and discuss the implications of the analysis.

Methodology

The essential features of the methodology can be illustrated with the simple model

1.1 $QD = D(P,X,R) + R(P)$

1.2 $QD = QS$

where

D is total disappearance excluding the reserve

P is market price

QD is total disappearance

QS is total supply (predetermined)

R is total reserve

X is vector of exogenous demand variables.

From 1.1 the price elasticity of total demand (e_{QD}) is a weighted average of its components:

1.3 $$e_{QD} = e_D \frac{D}{QD} + (D_3 + 1)e_R \frac{R}{QD}$$

where $D_3 = \partial D/\partial R$ $\quad -1 \leq D_3 \leq 0$

e is an own price elasticity

The elasticity of total demand will increase in absolute value as the level of reserves (R) and the absolute value of the reserve elasticity (e_R) increase. These effects are reduced as the substitution effect of reserve stocks on free stocks (D_3) approaches -1.

From 1.1 and 1.2 the reduced-form price equation is

$$1.4 \qquad dP = \frac{1}{D_1 + (D_3 + 1)R_1} (dQS - D_2 dX)$$

where

$D_1 = \partial D/\partial P < 0$

$D_2 = \partial D/\partial X$

$R_1 = \partial R/\partial P < 0$

The impact on price of changes in supply (dQS) or in exogenous demand factors (dX) will be reduced if the reserve is price responsive ($R_1 = 0$) and $D_3 > -1$. All other endogenous variables related to price will be similarily influenced.

Clearly the magnitude of the price response of reserves (R_1) and the substitution effect (D_3) are crucial in determining to what extent the reserve program alters market structure and behavior. We quantify these magnitudes and use an econometric model of the wheat sector to evaluate their effects. We specify and estimate a commercial inventory equation to include a reserve quantity variable, and add an equation in the model to endogenize reserve stocks. We then obtain the reduced-form impacts for changes in several key variables in 1977/78 and 1979/80. These impacts are compared with those obtained without a price responsive reserve component.

Analytical Model

The wheat sector model includes equations for feed, seed, food, commercial export and commercial stock demands as well as an acreage response function wheat plantings. The model specification is based on previous work by Gallagher et al. Here we will summarize the model structure and then focus on the revised inventory demand function and the new FOR function.

Important interactions in the model are highlighted in the simplified version below:

2.1 $QD = D(PW, D^*)$ Domestic demand

2.2 $QX = X(PW, XG^*, X^*) + XCPE^* + XG^*$ Export demand

2.3 $QS = S(PWD, QR, QP_{+1}, QG^*, QP, QS_{-1})$ Commercial ending stocks

2.4 $QR = R(PW, R^*)$ FOR ending stocks

2.5 $QP_{+1} = YLD^*_{+1} \quad A(PW, A^*)$ Production response

2.6 $QP + QS_{-1} + QG_{-1} + QR_{-1} = QD + QX + QS + QR + QG^*$ Identity

where

A^* = vector of acreage response shifters

D^* = vector of domestic demand shifters

PW = average farm price of wheat

PWD = average farm price of wheat deflated by wholesale price index

QG^* = CCC ending stocks

QP_{+1} = wheat production expected next year

R^* = vector of FOR stock shifters

X^* = vector of commercial export demand shifters

$XCPE^*$ = export to central planned economies

XG^* = wheat exports under PL480 and AID

YLD^*_{+1} = wheat yield per planted acre expected next year

The variables marked with * are exogenous to the model, and current production (QP) as well as beginning stocks (QS_{-1}, QR_{-1}, QG_{-1}) are predetermined. The addition of an FOR relationship not only adds a new demand component to the system but also a new endogenous element to the commercial stock equation.

Commercial stock equation Commercial inventory behavior is primarily motivated by transactions demand and speculation. Transactions demand is expected to increase with the level of market activity, so current production (QP) is used to measure that component. Speculative demand is associated with differences between current price and expected prices in the future. Current price (PWD) is endogenous in the model, but the future price is unknown. We hypothesize that speculators rely upon information about next year's production (QP_{+1}) and the level of reserves held by farmers (QR) or the government (QG) to form price expectations for the next year. The coefficients on these variables are expected to be in the interval (0,-1), reflecting the depressing effect of future supplies on future price expectations. The lagged dependent variable (QS_{-1}) derives from a partial adjustment model of inventory behavior, and its coefficient must be in the interval (0,1).

The equation was estimated over the period 1952/53 to 1979/80, and the coefficients on farmer-owned and government-owned stocks were constrained to be equal. The result is (t-statistic in parentheses):

$$2.7 \quad QS_t = 417.0 - 144.2\ PWD_t - .287\ QP_{t+1} - .203\ (QG_t + QR_t)$$

(2.60) (-3.07) (-2.71) (-3.05)

$$0.507\ QP_t + 0.157\ QS_{t-1}$$

(4.31) (1.32)

$R^2 = .86$ Standard error = 99.1

The influence of reserve stocks on commercial inventories is smaller in magnitude than that of next year's production. This is reasonable, because the reserves are not fully available to the market. The coefficient of -.203 means that total stocks are increased by 0.8 bushels when the reserves increase by 1 bushel. This is slightly smaller than the coefficient of 0.86 estimated by Sharples and Holland in a previous study.

FOR Model Aggregate placement and redemption functions have been conceptualized by Meyers and Jolly based on an analysis of firm-level behavior. Such relationships are most appropriate for relatively short time periods during which farmers are responding to current program provisions and market conditions in making decisions. In this paper we postulate an analogous relationship for net annual placements using an end-year carryover concept like that used to model ending stocks. If there are placements and redemptions during the year, the end-year reserve stock is the net change in reserves plus the beginning stock level. A hypothetical model of ending FOR stocks is illustrated in Figure 1. As with the placement and redemption functions, this relationship will change from year to year because of changes in program provisions and price expectations. The function will also shift with the level of beginning reserve stocks (QR_{t-1}).

The short series on annual FOR data precludes estimation of these function by econometric methods. However, relationships can be approximated for each year by assuming that the net change in reserves is zero when the annual price equals the release level (PR). The point so defined and the point of equilibrium price (P) and quantity (QR) determine a linear function or any function with two parameters. Linear and log-linear coefficients are computed for each year for the function $QR_t = f(P_t)$. The data and equations are given in Table 1 and the linear results are illustrated in Figure 2. The functions for 1977/78 and 1978/79 are "placement" functions while that for 1979/80 is a "redemption" function. There are substantial differences among them, which reflect the affects of the implicit shift variables (R*).

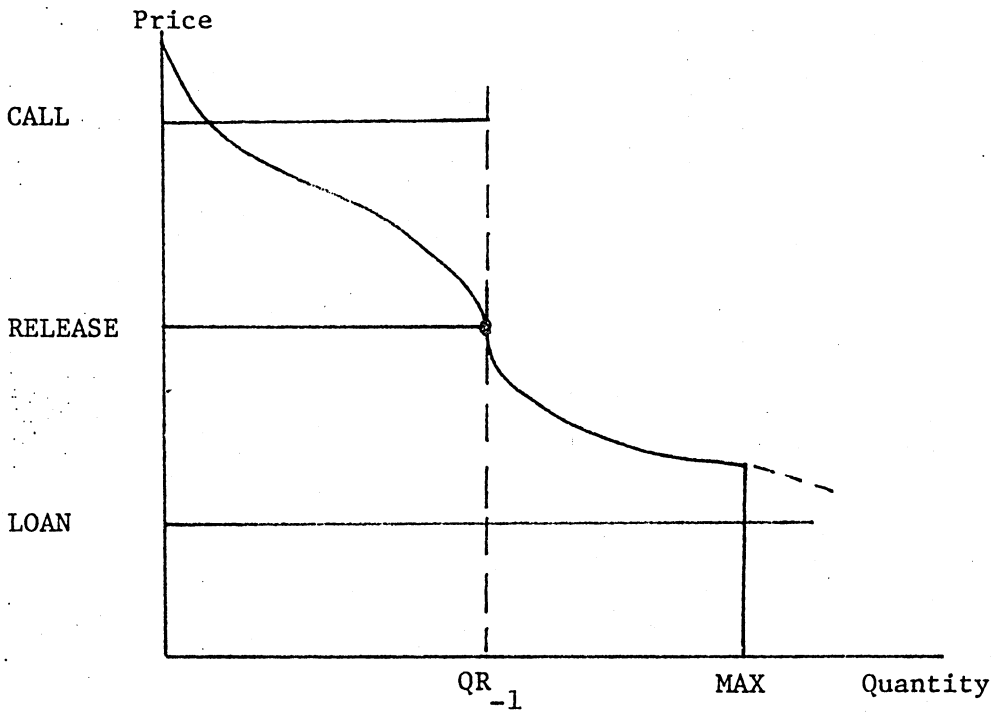

Figure 1. Model of ending FOR stocks. MAX = government constraint on FOR size. QR_{-1} = Beginning FOR stocks

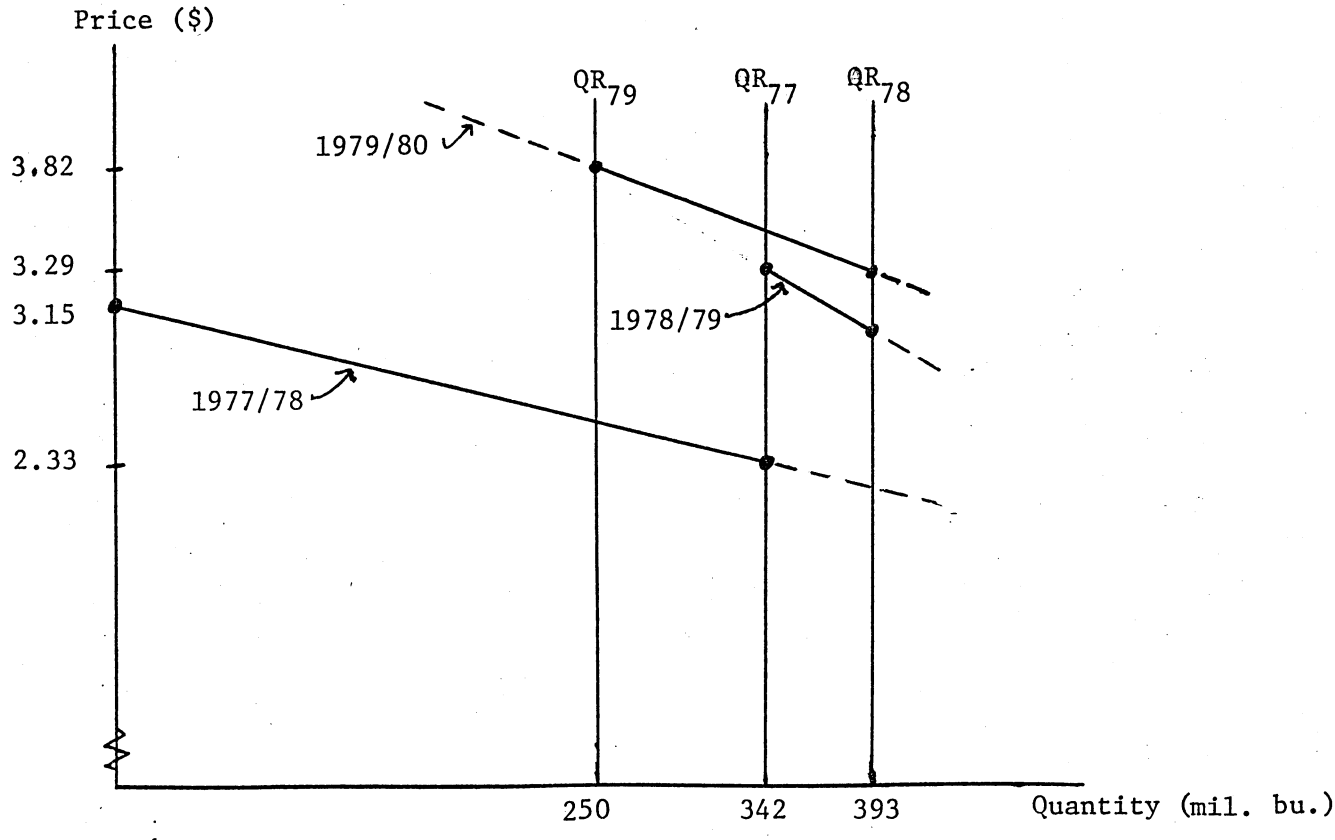

Figure 2. Linear FOR response functions computed for 1977/78 through 1979/80.

Table 1. Data and coefficients for FOR functions

	1977/78	1978/79	1979/80
(PR_t, QR_{t-1})	(3.15, 0)	(3.29, 342)	(3.29, 393)[1/]
(P_t, QR_t)	(2.33, 342)	(2.98, 393)	(3.82, 250)
$QR_t = \alpha + \beta P_t$			
Intercept	1313.8	883.3	1284.7
Slope	-417.1	-164.5	-269.8
Elasticity[2/]	-2.84	-1.25	-4.12
$\ln(QR_t) = \alpha + \beta \ln(P_t)$			
Intercept	[3/]	7.50	9.58
Slope (elasticity)	[3/]	-1.40	-3.03

[1/] This release price prevailed during most of the wheat release, although it was raised in January 1980.

[2/] Computed at equilibrium point (P_t, QR_t).

[3/] Not defined because $QR_{t-1} = 0$.

The FOR response elasticities computed at the equilibrium price and quantity levels are -2.84, -1.25 and -4.12 for 1977/78, 1978/79 and 1979/80, respectively. These results and the relatively small substitution effect (-.20) estimated in equation 2.7 imply the FOR has a significant affect on market structure. Using equation 1.3, the changes in the price elasticity of total demand implied by these results are -.25, -.13 and -.27 for 1977/78, 1978/79 and 1979/80, respectively. Given the inelastic market demand for wheat, these increments are relatively large. To evaluate the effect of these changes on the variability of price and utilization levels, we turn to a reduced-form impact analysis.

Impact Analysis

The change in market behavior resulting from the FOR is evaluated by comparing reduced-form impacts of the model obtained when reserves are fixed and when they are endogenous. These impacts are obtained by shocking the equilibrium solution with changes in predetermined variables.

The "fixed reserves" case represents several situations, including:

1. There is no reserve program.
2. There is a government-owned reserve under which purchases and sales are made at specific trigger prices; but within the price band, reserve levels are not influenced by price.
3. The farmer-owned reserve is full and closed to new placements if supply increases or demand drops.
4. The farmer-owned reserve is empty and provides no cushion if demand increases or supply falls.

The last two are the specific cases evaluated below.

Two exogenous shocks are used for this comparison. One on the supply side -- production --, and one on the demand side -- exports to the USSR.

In the past both of these factors have contributed to the uncertainty and variability of wheat prices. The shocks are evaluated for 1977/78, the year in which most placements occurred, and 1979/80, when most redemptions occurred.

A production increase of 100 million bushels was imposed on the equilibrium solution for 1977/78. If the reserve is closed (fixed), price falls by about $.17 bu. and about 70 mil. bu. of the increase is absorbed in ending shocks (Table 1). When reserves are endogenous, about 1/3 of the increased production is absorbed by reserve placements total stocks increase by 86 mil. bu. and the impact on price (-.08) is 50 percent smaller. The impacts on demand and next year's production are proportionately smaller when the reserve is operating.

The 1977/78 solution was also shocked with a decrease of 100 mil. bu. in exports to the USSR. With reserves fixed, price decreases by about $.34/bu. and 60 mil. bu. of this wheat goes into domestic consumption and commercial exports. When the reserve is in operation, 67 mil. bu. is added to the reserve and the impacts on other uses and on price are sharply reduced.

For 1979/80, when the reserve was in release status, the impacts are evaluated by alternately reducing production and increasing exports by 100 mil. bushels. The results are similar in magnitude and opposite in direction to that obtained for 1977/78. If the reserve is empty (fixed), the impact of these shocks on price and utilization levels is substantially greater. The effect of an increased release price was also evaluated for 1979/80 by assuming a parallel upward shift of the reserve function by $.20

Table 2. Reduced-form Impacts of Changes in Wheat Production, Exports to the USSR and the Release Level Under Alternative Reserve Assumptions.

Change in	Reserve Status	Farm Price	Domestic demand	Exports		Ending Stocks			Production next year
				Commercial	Total	FOR	Free	Total	
1977/78		($/bu.)	- - - - - - - - - - - - million bushels - - - - - - - - - - - -						
Production (+100 mil. bu.)	fixed	-.166	13	16	16	0	71	71	-29
	endog.	-.080	7	7	7	32	54	86	-13
Exports to USRR (-100 mil.bu.)	fixed	-.337	28	32	-68	0	41	41	-59
	endog.	-.160	13	15	-85	67	6	73	-28
1979/80									
Production (-100 mil.bu.)	fixed	.172	-14	-17	-17	0	-69	-69	25
	endog.	.100	- 9	-10	-10	-26	-56	-82	14
Exports to USSR (+100 mil.bu.)	fixed	.348	-30	-34	66	0	-37	-37	52
	endog.	.190	-17	-20	80	-53	-10	-63	29
Release level (+.20)	endog.	.086	- 6	- 9	- 9	31	-16	15	13

per bushel. This approximates what might have happened if the release level had been raised to $3.50/bu. at the beginning of the year rather than in January 1980. The model indicates that redemptions would have been reduced by about 30 million bushels in 1979/80 and the average farm price would have been about $.09/bushel higher.

Implications

The analysis clearly shows that the operation of the reserve program moderates price variability and makes the United States a more reliable supplier for both domestic and export markets. When unexpected demand or supply shocks occur, the reserve serves as a shock absorber, provided that it is neither empty nor closed to new placements.

The old forecasting and outlook "rules of thumb" are not operable when reserves are endogenous. Market structure and behavior have changed. Our results provide some evidence on how the impacts are different; but these, too, are subject to change. The FOR response functions change from year to year as we have seen. Any major change in reserve provisions is sure to alter these results. For example, the interest waiver on December 1980, made participation much more attractive and likely shifted the FOR function upward and increased its own price elasticity. Thus there is a need to identify the shift variables R* in the reserve function so the results of program changes can also be evaluated.

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