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The Uncertainty of Key Behavioral Parameters and Implications for Commodity Analysis

William H. Meyers*

One of the most important pieces of information a farmer needs in making a decision about participation in an announced government program is the likelihood of various market prices occurring in the marketing year following harvest. Likewise, an important consideration in making government decisions about program provisions is the range of possible outcomes and associated costs, given alternative participation rates and weather conditions. Thus, the farmer and the policy maker and the people in between who provide them with advice and information need to go through similar analyses on the likely impacts of alternative outcomes. In many years it is necessary to go through this kind of analysis numerous times. Government analysts need to because of the numerous options that they consider; farmers and extension analysts need to because of the all too frequent changes in government program provisions.

This kind of analysis is a tedious task and is made more so by the uncertainty regarding some of the behavioral parameters that must be used. In particular, there is a good deal of uncertainty about the elasticity of demand for exports. Also the elasticity that one assigns to private inventory demand is likely to vary under differing market conditions. Gardner has suggested that analysts use a range of key parameters when there is substantial uncertainty about their level. Such sensitivity testing makes the analytical task even more laborious.

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The rapid adoption of microcomputers and spread-sheet programs offers analysts a quick and not-so-dirty solution to this problem. The purpose of this paper is to present an approach and a particular model that has been used to test the sensitivity of corn program effects to changes in key parameters. It could easily be adapted to other commodities or to situation and outlook updates.

The approach developed in this paper allows the analyst to provide his or her own demand and supply elasticities and to test the sensitivity of the results to changes in these parameters. A base supply, use and price scenario is required and all impacts are computed from that base. The model permits the analyst to quickly evaluate alternative yield prospects, participation rates and other uncertainties that exist when programs are announced one year before harvest. Consequences for supply, use, prices, program costs, and net returns are generated.

The model is applied to the 1985/86 corn program and compares the results under various yield and participation alternatives. Sensitivity tests are employed to evaluate the importance of key parameters such as demand elasticities and the private and public stock substitution rates. This approach makes it relatively easy for the analyst to determine ranges of outcome based not only on uncertain events but also on uncertain behavioral parameters.

Analytical Model

The model is designed to compute the changes that occur as a result of changes in production. Production may change as a result of changes in the acreage reduction program provisions, the participation rate or crop yield. The analyst must provide the model with initial supply-use levels and with certain price elasticities and other structural parameters. The model then

computes the reduced-form impact multipliers and uses these to adjust the endogenous variables in response to changes in production.

Abstracting from other exogenous variables the structure of the model is given by:

(1) $QFEED = f_1(P)$ Feed demand

(2) $QNFEED = f_2(P)$ Nonfeed demand

(3) $QEXP = f_3(P)$ Export demand

(4) $QFOR = f_4(P)$ FOR stocks

(5) $QFREE = f_5(P, QFOR, QCCC, QPDN)$ Free stocks

(6) $QPDN + QBEGS = QFEED + QNFEED + QEXP + QFREE + QFOR + QCCC$

In addition to the price elasticities for each equation, parameters are needed for the effect of reserve stock (QFOR), CCC stocks (QCCC) and production (QPDN) on free stocks. The level of CCC stock can change according to a specified rule if prices fall below the loan rate, so it is also endogenous.

The total elasticity computed from this model and the reduced-form impacts of a production change are:

(7) $TELAS = (e_1\ QFEED_0 + e_2\ QNFEED_0 + e_3\ QEXP_0 + e_4\ (1 + f_{52})\ QFOR_0 + e_5\ QFREE_0)/(QPDN_0 + QBEGS_0)$

(8) $dP = P_0\ (1-f_{54})/TELAS\ (QPDN_0 + QBEGS_0)$

(9) $dQFEED = e_1\ dP\ QFEED_0/P_0$

(10) $dQNFEED = e_2\ dP\ QNFEED_0/P_0$

(11) $dQEXP = e_3\ dP\ QEXP_0/P_0$

(12) $dQFOR = e_4\ dP\ QFOR_0/P_0$

(13) $dQFREE = 1 - dQFEED - dQNFEED - dQEXP - dQFOR$

A change in supply from the base level (denoted by the subscript "0") is translated into demand and price changes by these multipliers. If price is

forecast to go below a set minimum, additional increases in CCC and FOR stock are triggered by a rule to keep the price at this minimum. This minimum can be set below the loan rate when program participation is low. If price is forecast to go above a set maximum, additional reductions in FOR stock are triggered to keep the price at this maximum. This maximum can be set above or below the release price. When these stock triggers are employed, other demand levels are adjusted accordingly.

When all the price and quantity impacts are computed, the model estimates government costs and farm net return over variable costs. Government costs include payment-in-kind, diversion payments, deficiency payments, reserve storage payment, interest losses on reserve loans and CCC storage and handling costs.

Elasticity and Supply-Use Assumptions

The model was used to evaluate the influence of different elasticity levels on the impacts of alternative participation rates and corn yields for the 1985/86 year. The range of elasticities were obtained by doing a survey of the NCR-134 mailing list for government and university economists. The means and the means plus and minus one standard deviation are reported in Table 1. The range is largest for exports and inventory demand, where there is clearly more uncertainty among analysts as to the appropriate levels of elasticities. The analysis was conducted using the most elastic and least elastic ends of the range to see how the choice would effect the range of the results. Note that the "high elasticity" end of the range gives a total demand elasticity of -0.54 and the "low elasticity" levels give an elasticity of -0.21 for total demand.

The impact multipliers per 100 million bushel change in production are also presented in Table 1. The price impacts and the stock impacts show the largest differences.

The initial levels for supply, use and prices in 1985/86 are given in Table 2, column 1. This is the base off which all the computations are made. The table also shows an example of the impact of yield changes to 95 and 115 bushels per acre, using the mean levels of the elasticities. The resulting ranges of demand quantities and prices are presented in columns 2 and 3.

Impact Analysis

Two types of impacts are evaluated. The first looks at the range of values of endogenous values that result from changing the participation rate from 20 to 60 percent. The second looks at the range of values resulting from a variation in yield from 95 to 115 bushels per acre. The ranges are computed under both the high and low demand elasticities reported in Table 1.

Because the 1985/86 program for corn is only a 10 percent set aside, the change in participation rate from 20 to 60 percent changes production by less than 300 million bushels (Table 3). Thus the quantity ranges differ relatively little between the high and low elasticity levels. The main difference is in the price range which is $.30 per bushel with low elasticities and $.12 under high elasticities. As a result of the larger price range, farm net returns over variable cost also have a larger range under the low elasticity case.

The change in yield from 95 to 115 bushels per acre makes a difference of more than 1500 million bushels in production (Table 4), so the choice of high or low elasticities shows a more dramatic effect. Under high elasticities the range of total use is 931 million bushels compared to 628 under low elasticities, and the range of exports falls from 434 to 243 million bushels. The situation is reversed with stocks, as the larger price movements cause

FOR and CCC stocks and total stocks to vary much more when low elasticities are used.

The price range increases from $.57 per bushel under high elasticities to $.86 under low elasticities. Since both reach the price minimum of $2.50, the low elasticity case leads to a larger accumulation of stocks to protect that minimum price. Under the low elasticity case, the range of nonrecoverable costs is half a billion dollars larger and the range of net loan and forfeiture costs is more than $1 billion larger. The net returns range narrows with the low elasticity case, because larger price changes offset the yield and government payments losses.

Summary and Implications

Other policy options or elasticity alternatives could easily be used in this model. It only requires entering the different values and recomputing the results. This exercise, especially the yield analysis, indicates the substantial effect on policy impact analysis of different behavioral assumptions for the model.

The results of the anlaysis could be used to place wider ranges on the policy impacts. The ranges based on uncertain yields and participation rates become wider if uncertain parameters are also taken into account. This could be accomplished from Table 4, for example, by using the export and total use range from the high elasticity case and the stocks, price and cost ranges from the low elasticity case. These ranges would then include values obtained under both sets of elasticities. In the case of net returns, the inclusive range is the union of the ranges, or $8324 - $10067 million.

Another type of conclusion that may be drawn from this anlysis is that a cautious administrator interested in potential budget exposure would be better off to err by using a set of elasticities that are "too low" than a

set that is "too high". The lower elasticities will tend to generate a wider range of prices and government costs, meaning there is less potential for surprises on the budget outlays.

Table 1. Elasticity Means from Survey, a One Standard Deviation Range on Elasticities and the Corresponding Reduced-form Multipliers.

Elasticities	Base (Mean)	High (Mean - s.d.)	Low (Mean + s.d.)
Feed	-.36	-.45	-.27
Nonfeed	-.17	-.32	-.02
Export	-.70	-1.02	-.38
Free Stock	-.52	-.97	-.07
Reserve Stock	-.66	-1.26	-.06
Substitution Effect			
Reserve Stock	-.60	-.76	-.44
CCC Stock	-.64	-.87	-.41
Total Elasticity 85/86	-.38	-.54	-.21
Impact Multipliers			
(per 100 mil. bu. prodn.)			
Feed (bu.)	34.4	30.8	46.5
Nonfeed (bu.)	4.4	5.9	0.9
Exports (bu.)	30.7	32.0	30.0
Free Stock (bu.)	17.5	12.9	20.3
Reserve Stocks (bu.)	13.4	18.4	2.2
Price ($/bu.)	-.059	-.042	-.106

Source: A survey of the NCR-134 mailing list for government and university economists. The mean and standard deviation were computed from the 10 courageous respondents.

Table 2. Initial (Base) Levels of Supply and Use for the Analysis and the Yield Impact with Mean Elasticities.

	85/86 Base	Mean elasticity	
		Low Yield	High Yield
Acres and Yield			
Acres Idled (mil.)	4.2	4.2	4.2
Acres Planted (mil.)	80.8	80.8	80.8
Acres Harvested (mil.)	71.3	70.8	71.8
Yield per Acre (Bu.)	110.0	95.0	115.0
Supply (Mil. Bu.)			
Beginning stocks plus PIK	1360	1360	1360
Production	7848	6731	8263
Imports	1	1	1
Total	9209	8092	9624
Utilization (Mil. Bu.)			
Feed and Residual	4226	3842	4286
Food, Seed and Industry	1147	1098	1155
Domestic Total	5373	4939	5440
Exports	1938	1595	1991
Total Utilization	7311	6535	7432
Ending Stocks (Mil. Bu.)			
Farmer Owned Reserve	900	750	1044
CCC owned	550	550	670
Private, Free	448	257	478
Total	1898	1557	2192
Prices and Triggers ($/Bu.)			
Iowa Season Average	2.50	3.16	2.40
U.S. Season Average	2.60	3.26	2.50
Deficiency Payment Rate	0.48	-	0.48
Loan Rate	2.55	2.55	2.55
Reserve Loan Rate	2.55	2.55	2.55
Reserve Release	3.25	3.25	3.25
Target Price	3.03	3.03	3.03

Table 3. Differences in Key Results When Using Low and High Price Elasticities - Participation Rate Impacts

Variable	Range of Values Resulting from Rates of 20 to 60%	
	Low Elasticity	High Elasticity
	- - - Million Bushels - - -	
Exports	1980-1896	1982-1894
Total Use	7418-7204	7406-7216
Reserve + CCC Stocks	1453-1447	1475-1425
Total Stocks	1999-1937	2011-1924
	- - - $/Bushel - - -	
U.S. Farm Price	2.45-2.75	2.54-2.66
	- - - Million $ - - -	
Nonrecoverable Cost	1316-2419	1322-2763
(Deficiency payments)	(727-1833)	(727-2182)
Net Loan and Forfeitures	1512-1497	1569-1440
Farm Net Returns	7832-10717	8511-10414

Table 4. Differences in Key Results When Using Low and High Price Elasticities - Yield Impacts

Variable	Range of Values Resulting from Yields Range of 95-115 Bu/Acre	
	Low Elasticity	High Elasticity
	- - - Million Bushels - - -	
Exports	1723-1966	1580-2014
Total Use	6756-7384	6543-7474
Reserve + CCC Stocks	893-1772	1245-1670
Total Stocks	1336-2240	1549-2149
	- - - $/Bushel - - -	
U.S. Farm Price	3.36-2.50	3.07-2.50
	- - - Million $ - - -	
Nonrecoverable Cost	405-2532	836-2487
(Deficiency payments)	(0-1818)	(302-1818)
Net Loan and Forfeitures	84-2325	981-2066
Farm Net Returns	10028-10067	8324-10059