VALUATION OF CROP AND LIVESTOCK REPORTS: METHODOLOGICAL ISSUES AND QUESTIONS

J. Bruce Bullock, Daryll Ray, and Boubaker Thabet

It is an understatement to say that the Statistical Reporting Service is not the farmers' and ranchers' most popular USDA agency. Many agricultural producers are quick to express their concerns that SRS production reports have a negative impact on farm prices and farm incomes. There appears to be a widespread feeling among producers that release of information about their current and planned production levels results in a transfer of wealth from producers to other groups.

Opinions of North and South Dakota farmers and ranchers revealed in a 1978 survey are probably quite similar to those of agricultural producers in other parts of the U.S. Seventy-eight percent of the Dakota respondents expressed the opinion that other groups benefited more from SRS reports than did agricultural producers. Non-producer groups most frequently named as benefiting from this information were grain and livestock buyers, food processors, and speculators. Futhermore, the respondents expressed considerable skepticism about the accuracy of USDA information. "Only about one-fourth felt that government reports could be trusted almost always or most of the time. About one in five said he could 'hardly ever' trust government data. In addition, two-to-one majorities felt that private commercial services were more accurate than government surveys, and that operators did not give accurate information when they did participate. Furthermore, most Dakota operators expressed the belief that publication of government reports depresses prices they receive . . . (Jones et al., pp. xvii)."

The opinions expressed in the Dakota survey contain three common misconceptions about SRS reports. (1) USDA production forecasts must be perfectly accurate to be of value to producers, and inaccurate forecasts generate welfare transfers from agricultural producers to other groups of society. (2) If USDA reports on the size of the current crop were not released, prices would somehow be higher than is the case when the reports are released. (3) Inaccurate USDA production reports are a major cause of short-run resource misallocation in agriculture.

Following this line of reasoning, some producers suggest that the way to "beat the system" is to report false production plans on USDA producer surveys. Producers often express the opinion that reports of high levels of production depress prices. Thus, they reason that if producers under-report production plans, the USDA report will underestimate production, and prices will be higher than if producers had accurately reported production. Is that true? Under what conditions, if any, does the release of production estimates and producers' production intentions work to the detriment of producers? Is it in producers' interest falsely to report current and/or planned production levels? If so, is it in their interest to inflate or deflate actual production numbers?

This paper answers that set of questions and demonstrates that the three misconceptions mentioned above are indeed invalid.

Conceptual Framework

Throughout this paper, we are dealing with a production adjustment situation in which there are no carry-over stocks. Producers use imperfect information to formulate a price expectation for the coming period P*. Based on P*, producers commit the productive resources necessary to achieve the planned level of output Q_p, corresponding to P* on the producer supply (planning) curve SS that exists at the time the production process is initiated (Figure 1). Sometime after the initiation of the process, but prior to harvest time, the USDA releases an estimate of the forthcoming level of production $\hat{Q}$ ($\hat{Q}$ is the USDA estimate of Q_p). Using this information and, perhaps also, private production forecasts, producers then formulate a new price expectation $\hat{P}$, with the assistance of professional market analysts and the futures market. For simplicity, we will assume that the market demand curve in the coming period DD is known with certainty at the time (but not before) the USDA report is re-

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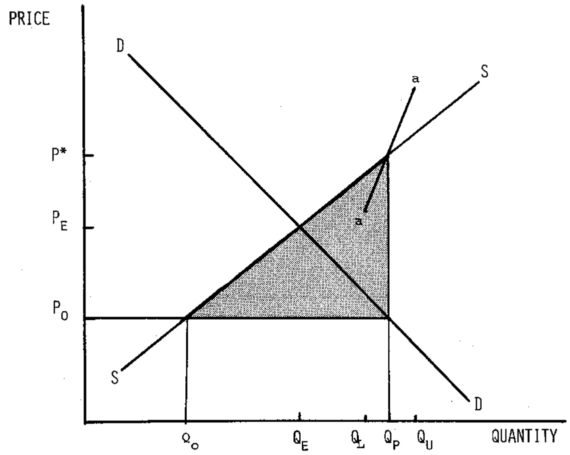

FIGURE 1. Impact of $P^* > P_e$ without USDA Production Forecast

leased. Obviously, DD cannot be known with certainty prior to harvest. However, in order to focus on the USDA production forecast as the only source of error, we will assume away the forecast error associated with not knowing DD with certainty. This assumption alters only the magnitude of adjustments that are made in response to the USDA forecasts. It does not alter the nature or validity of the conclusions drawn in this paper.[1]

Producers alter plans on the basis of their revised price expectations $\hat{P}$. However, since the production process is already ongoing, producers' adjustment is limited to points along the supply adjustment curve aa. The length and slope of aa depends on the product being produced and the point during the production process at which the USDA report is released (Bullock, 1976, 1981). Producers then adjust output to Q_r at harvest time, generating a realized price P_r.

We are not concerned here with how P* is formed. It may be nothing more than last period's price, or it may be the product of a sophisticated expectations model. However, since P* is formed without perfect knowledge, it is unlikely that P* will be equal to P_e, the equilibrium price that would exist, if producers had perfect information about supply and demand in the coming period. We will consider three situations ($P^* > P_e$), ($P^* < P_e$), and ($P^* = P_e$). For each of these situations, we will examine the following conditions with respect to USDA production forecasts: A, no USDA forecasts are released; B, a perfectly accurate USDA forcast is released (i.e., $\hat{Q} = Q_p$); C, the USDA underestimates planned production (i.e., $\hat{Q} < Q_p$); D, the USDA overestimates planned production (i.e., $\hat{Q} > Q_p$). For purposes of discussion, we will assume that condition C occurs because responding producers deliberately under-report production; and that condition D occurs because responding producers deliberately over-report production in an effort to "beat the system."

IMPACT OF PRODUCTION FORECASTS ON PRODUCER NET INCOME

I. P* EXCEEDS P_e

A. No USDA Forecast

Figure 1 illustrates the situation in which $P^* > P_e$, and no USDA reports are released. In the absence of additional information about the amount of production in process, output Q_p would be placed on the market at harvest, generating a price P_o, and resulting in a shortfall of income relative to cost on all output greater than Q_o represented by the shaded area in Figure 1. Note that the resource misallocation results from the inability of producers to anticipate equilibrium conditions—not from the existence of erroneous USDA forecasts. The impact of USDA production forecasts $\hat{Q}$ must be evaluated on the basis of whether the existence of these reports expands or reduces the shaded area in Figure 1.

B. Perfectly Accurate USDA Forecast ($\hat{Q} = Q_p$)

The impacts of an accurate USDA forecast are illustrated in Figure 2. The accurate USDA forecast of production generates a revised price expectation of $\hat{P}$ and causes production to be reduced to Q_L (the maximum reduction possible under the circumstances). The realized price is then P_r, rather than P_o, which would have occurred in the absence of a USDA report. Thus, in this case, the release of an accurate USDA fore-

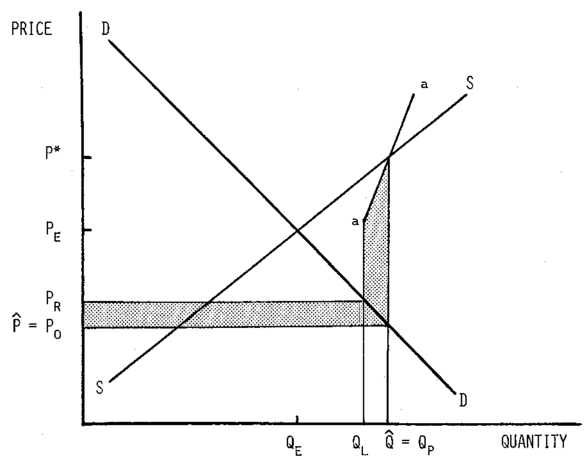

FIGURE 2. Impact of Perfectly Accurate USDA Production Forecast when $P^* > P_e$

[1] Thabet has generalized the model to account for possible errors in estimating aa, as well as production forecast errors. His results confirm the statement made here.

cast increases producer incomes by the amount of the shaded area in Figure 2, relative to what would have occurred in the absence of the USDA report. Clearly, the release of an accurate USDA report is in the interest of producers, as contrasted with the situation in which no USDA report is released.

C. USDA Underestimates Production ($\hat{Q} < Q_p$)

Should responding producers decide that it is in their interest to bias the USDA report downward by under-reporting production, the result would be $\hat{Q} < Q_p$ (Figure 3). Because only responding producers are aware of the report bias, the USDA report generates a new expected price $\hat{P}$ and results in output being reduced to Q_L (again the maximum reduction possible under the circumstances). The realized price is P_r, rather than P_o, which would have occurred in the absence of the USDA report. Thus, even though the USDA report underestimated planned production, the impact on producer income is the same as in the preceding situation in which the USDA report was perfectly accurate. Producer incomes are enhanced by the shaded area in Figure 3, even though the USDA report was inaccurate. Moreover, the false reports submitted by producers did not enhance their income position relative to accurate USDA reports.

Actually, in those situations where $Q_p > Q_e$, it is impossible for producers to under-report production and enhance their net income position relative to a perfectly accurate USDA forecast. However, it is possible for producers to harm themselves by causing the USDA report grossly to underestimate production. Note in Figure 3 that, for any forecast $Q_f \geqslant W_1$ output will be reduced to Q_L, and producer net income will be enhanced by the shaded area. For forecasts $W_2 < Q_f < W_1$, realized output will be between Q_L and Q_p, and producer income will be improved by some fraction of the shaded area in Figure 3. However, if $Q_f < W_2$, the revised price forecast will be greater than P*, and producers would be enticed expand rather than reduce output. The result would be a reduction in producer net income, compared to the situation in which there was no USDA report. Thus, in situations where $Q_p > Q_e$, it is never in the producer's interest to falsify production reports in an effort to cause the USDA report to underestimate Q_p.

D. USDA Overestimates Production ($\hat{Q} > Q_p$)

Figure 4 depicts the situation in which producers falsely over-report production plans, resulting in a USDA forecast $\hat{Q} > Q_p$. The impacts of this forecast are the same as with an accurate forecast. Output will be reduced to Q_L, and producer net revenues will be increased by the shaded area in Figure 4. Given that $Q_p > Q_e$, this conclusion holds, regardless of how large the over-forecast error is.

Implications. In situations where $Q_p > Q_e$, producers clearly benefit from the existence of the USDA report. Moreover, the forecast does not have to be accurate in order to generate benefits to producers. Any forecast $Q_f > W_2$ causes output to be reduced from the Q_p level and thus enhances producer net income relative to the no-report situation. Furthermore, there is no incentive for producers to report false production, because the impact of the report on their income is not affected by the magnitude of the forecast error $(\hat{Q} - Q_p)$ for all forecasts $Q_f > W_2$. Based on historical evidence, it is highly unlikely that a forecast error greater than $(\hat{Q} - W_2)$ will occur (Mlay and Tweeten; Houck and Pearson; Gorham). Moreover, if an error of this magnitude

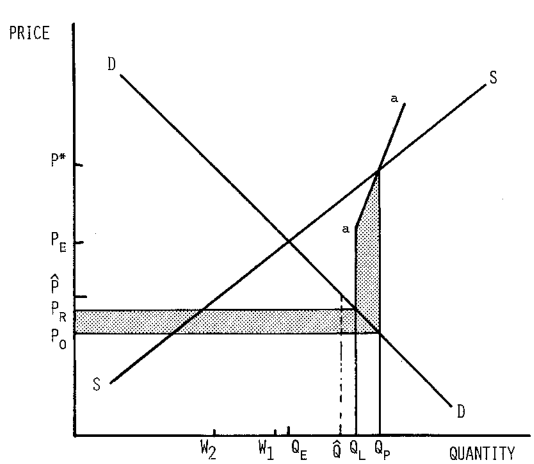

FIGURE 3. Impact of a USDA Underforecast when $P^* > P_e$

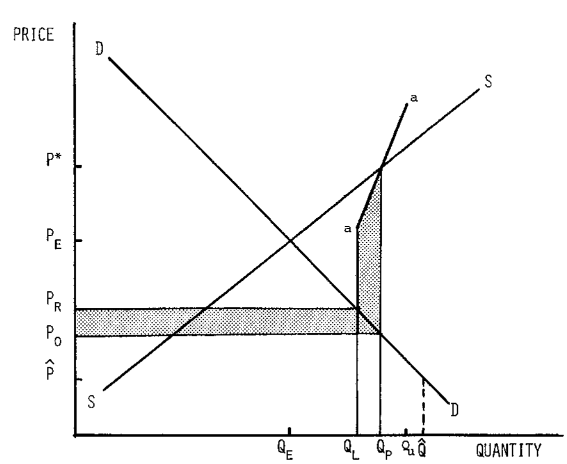

FIGURE 4. Impact of USDA Overforecast when $P^* > P_e$

did occur, it would likely be immediately obvious, judging from other available information, that a serious forecasting error had been encountered, and the report would be viewed with considerable skepticism.

II. P* LESS THAN P_e

A. No USDA Forecast

Now consider the situation in which $P^* < P_e$ and hence $Q_p < P_e$. In this case, producers are gearing up to produce less than the market equilibrium quantity as illustrated in Figure 5. In the absence of additional information, the output will be Q_p, and the realized price will be P_o. The question is: Given that $Q^p < Q_e$, how will the release of USDA production forecasts alter producer income relative to the situation in which no USDA report is released?

Since the market price would exceed marginal production costs at all levels of output between Q_p and Q_e, portions of the shaded area in Figure 5 represent potential increases in producer net income, if output is expanded beyond Q_p. However, at output levels greater than Q_p, the realized price would be less than P_o, and revenues on the Q_p units of production would be reduced accordingly. Thus, the impact on producer income of altering output from the Q_p level in response to USDA production reports depends on the elasticity of demand, and the capacity of producers to respond to the information provided by the USDA reports.

B. Perfectly Accurate USDA Forecast ($\hat{Q} = Q_p$)

If the USDA forecast correctly identifies $\hat{Q} = Q_p$ as the level of planned production, then the revised price expectation of $\hat{P}$ will cause output to be expanded to Q_u, resulting in a realized price P_r (Figure 6). Producer net returns are enhanced by the shaded area in Figure 6, relative to the situation where no USDA report is released. However, since $P_r < P_o$, there is also a reduction in producer net returns, represented by the hatched area of Figure 6. Thus, in this case, the net impact of the USDA production forecast on producer returns depends on the relative magnitude of the shaded area and the hatched area. If the demand curve for the product is inelastic at output Q_p, then the hatched area will exceed the shaded area, and net returns will be reduced by the release of the accurate USDA report. However, if demand is elastic, then net income of the industry would be expanded by the release of the USDA report.

C. USDA Underestimate of Production ($\hat{Q} < Q_p$)

Suppose that responding producers deliberately under-report production and thus cause the USDA forecast to underestimate planned production. As illustrated in Figure 7, the USDA underestimate of production $\hat{Q}$ generates a revised price expectation of $\hat{P}$, causing output to be expanded to Q_u and price at harvest time to be P_r. Thus, the impact on producer net income would be the same as for the perfectly accurate forecast that is indicated by the shaded and hatched areas in Figure 7. The same conclusion holds for any under-forecast $Q_f < Q_p$. Thus, if demand for the product is inelastic, it is not in producers' interests purposely to under-report production.

D. USDA Overestimate of Production ($\hat{Q} > Q_p$)

Figure 8 illustrates that an over-forecast will generate revised price expectations of $\hat{P}$ and re-

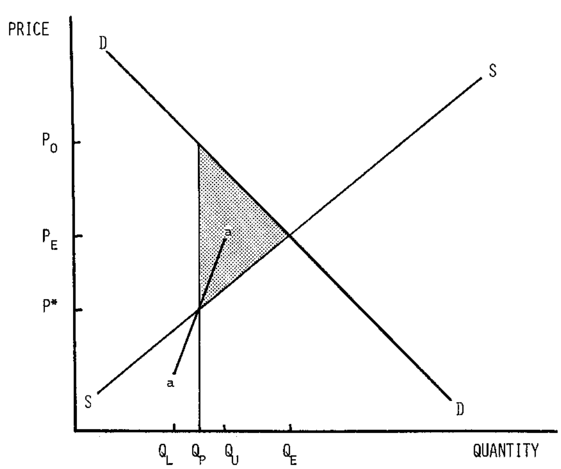

FIGURE 5. Impact of $P^* < P_e$ without USDA Production Forecast

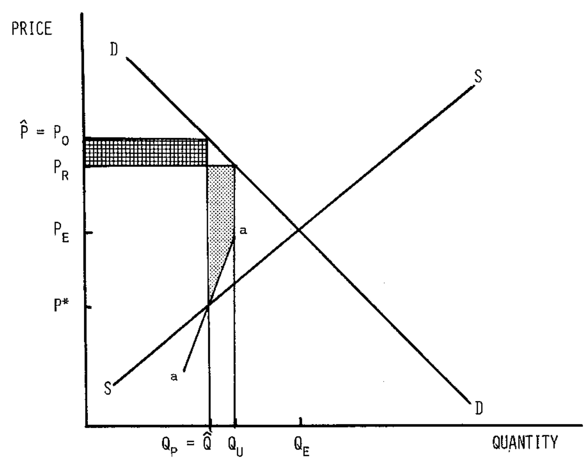

FIGURE 6. Impact of Perfectly Accurate Forecast when $P^* < P_e$

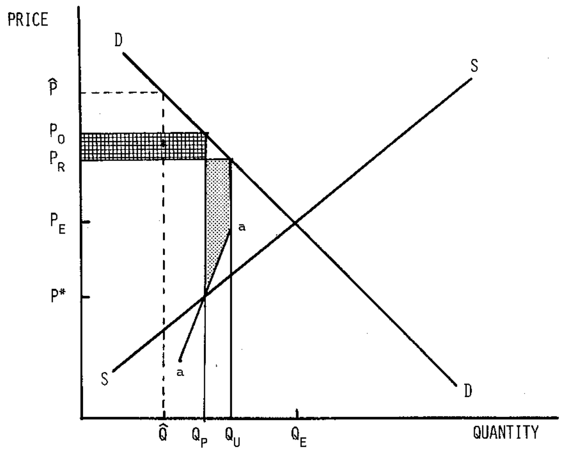

FIGURE 7. Impact of USDA Underforecast when $P^* < P_e$

sult in output being expanded to Q_u. Thus, the impacts of USDA overestimates of planned production (i.e., $\hat{Q} > Q_p$), when $P^* < P_e$ are the same as when $\hat{Q} = Q_p$ or $\hat{Q} < Q_p$, provided the over-forecast is greater than Q_p but less than Z_1. For forecast $Z_1 < Q_f < Z_2$, the output adjustment will be somewhere between Q_L and Q_u, and the change in producer new revenue will be some fraction of the areas shown in Figure 8. If $\hat{Q} = Z_2$, then there would be no change in output, because $\hat{P} = P^*$, and the result of this forecast would be the same as if no forecast had been released. If $\hat{Q} > Z_2$, then output would be reduced along aa, and the shaded area of Figure 8 (foregone net revenues) would be expanded, rather than reduced. However, the hatched area would also be expanded rather than be reduced. Thus, if $Q_p < Q_e$ and demand is inelastic, it is in producer interest for the USDA report grossly to overestimate production, so that output is further reduced from Q_p, thus increasing net revenue. However, the magnitude of the forecast error required to generate this impact is so large that it is unlikely to occur and for the USDA forecast to remain a credible piece of information.

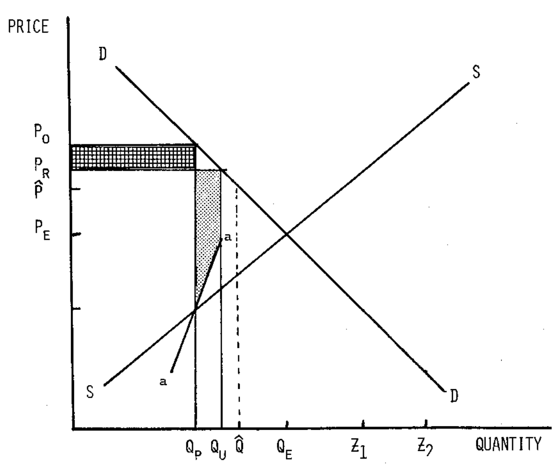

FIGURE 8. Impact of USDA Overforecast when $P^* < P_e$

Implications. If producers always have price expectations such that $P^* < P_e$ (and hence $Q_p < Q_e$) and if the demand for the product is inelastic, then the existence of the USDA production forecasts is detrimental to producer incomes. If these conditions always existed, producers would have a valid argument for suggesting that the forecasts be eliminated. However, to argue that P^* is always less than P_e requires (1) that we have perfect information, hence, knowledge of P_e; and (2) that producers as a group exercise supply restraint to take advantage of the inelastic demand. Assuming away the problem is hardly justification for arguing that the USDA production forecasts should not be released. Historical data on output, prices, and farm income strongly suggest that Q_p is seldom less than Q_e. Moreover, in those cases where Q_p has been less than Q_e, it was not recognized prior to the release of the USDA production forecasts.

III. P* EQUALS P_e

A. No USDA Forecast

If producers were always able accurately to anticipate market conditions, so that $P^* = P_e$, we would expect the equilibrium level of output to be produced each period. In this case, if no USDA report is released, production would remain at $Q_p = Q_e$. Thus, there would be no need for USDA reports to provide information about forthcoming levels of production if $P^* = P_e$. Moreover, a perfectly accurate USDA estimate of Q_p would have no impact on output or prices—and would thus have no value. However, if $P^* = P_e$, any forecast error would directly impact producer incomes. Therefore, if P^* always equals P_e, we should terminate SRS forecasting activities.

B. USDA Underestimate of Production ($\hat{Q} < Q_p$)

Suppose that the USDA forecast underestimates planned output (i.e., $\hat{Q} < Q_p = Q_e$), because responding producers deliberately under-reported production, thinking that this action would raise prices. The output projection would cause price expectations to change to $\hat{P}$ and output to expand to Q_u (Figure 9). Thus, producers would incur a reduction in net income as indicated by the hatched area in Figure 9. Therefore, if $P^* = P_e$, it is not in producers' interests to under-report production and, hence, cause realized output to be less than Q_p.

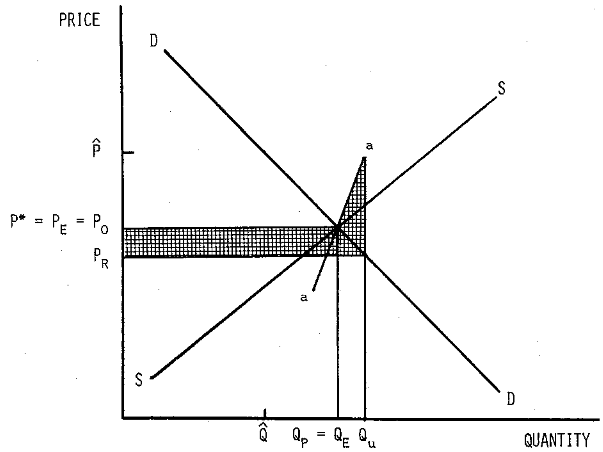

FIGURE 9. Impact of USDA Underforecast when $P^* = P_e$

C. USDA Overestimate of Production ($\hat{Q} > Q_p$)

If producers over-report production and cause $\hat{Q}$ to be greater than Q_p as illustrated in Figure 10, the release of the USDA report will cause output to be reduced to Q_L. Consequently, producer net income will be increased by the shaded area and decreased by the hatched area in Figure 10, relative to the situation in which no USDA report is released.

Implications. If $P^* = P_e$ and demand is inelastic, it is in producers' interest for the USDA report to be biased upward, causing a reduction in output and an increase in net returns. Thus, in this situation it is in producers' interests for responding producers to exaggerate production data, rather than accurately report production or to have no forecast at all. However, for the over-reporting strategy to be appropriate, producers must know *a priori* that $P^* = P_e$. Moreover, the producers reporting as part of the USDA survey must know how much they can collectively over-report production, so that $\hat{Q} > Q_p$ and still remains a credible report, so that the producers that were not included in the USDA sample accept the USDA forecast as a credible estimate of Q_p and thus reduce output.

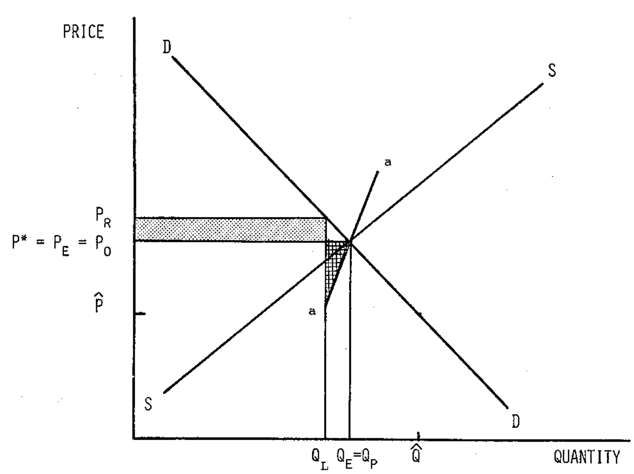

FIGURE 10. Impact of USDA Overforecast when $P^* = P_e$

CONCLUSIONS

Several conclusions can be drawn from the foregoing models. First, the release of accurate USDA production forecasts reduces producer net income *only* if planned production is less than market equilibrium (i.e., $\hat{Q}_p < Q_e$), and the demand for the product is inelastic. In this case, release of the report will lead to expanded production and a reduction of producer incomes. In all other cases, producer net income either is enhanced or does not change relative to the situation where no USDA reports are released.

Second, the contribution of USDA production forecasts to producer income is not a monotonic function of the size of the forecast error. Moreover, the value of the forecast is independent of the magnitude of the forecast error over a wide range of errors.

Third, when producers purposely reduce output below market clearing levels to take advantage of an inelastic demand, producers have nothing to gain (but could in some cases lose) by falsely reporting current or planned production on USDA surveys. Furthermore, in this special case, producer net income will be increased by respondents' over-reporting, rather than under-reporting, production as is sometimes suggested.

Finally, the inability of producers accurately to anticipate equilibrium price and output during the planning process is the primary source of short-run resource misallocation in agriculture. The magnitude of resource allocation problems will increase as $(P^* - P_e)$ increases. Moreover, the accuracy of producer price expectations relative to equilibrium market conditions is the primary determinant of the social value of USDA production forecasts.[2] The USDA reports have social value only if $Q_p \neq Q_e$, and hence a production adjustment is socially desirable. The social value of USDA production reports is generated through producer response to the USDA report, so that realized output (Q_r) is closer to Q_e than Q_p (the level of production that would occur in the absence of a USDA report). Thus, the USDA report will generate social benefits if $|Q_r - Q_e| < |Q_p - Q_e|$, or will generate social costs if $|Q_r - Q_e| > |Q_p - Q_e|$.

The amount of production adjustment that is

[2] To this point, the paper has focused on the impacts of USDA reports only on producer income. If we give consumers equal billing, then the impact of USDA reports is reflected by changes in combined producer and consumer surplus. The term "social value" refers to changes in the combined surplus.

socially desirable depends on the magnitude of $|Q_p - Q_e|$, which is determined by the magnitude of $|P^* - P_e|$. The amount of production adjustment that actually takes place (i.e., $Q_p - Q_r$) depends on the slope of aa and the range over which aa is defined; that is, the magnitude of ($Q_u - Q_L$) at the time the forecast is released (Figure 1). Therefore, the potential social benefits to be generated by a USDA production forecast depend on ($Q_p - Q_e$) and ($Q_u - Q_L$), not on the magnitude of the USDA forecast error.

These observations make it possible to draw some tentative conclusions about decision criteria to be used by USDA program administrators contemplating changes in the production forecasting system.[3] The decision criteria listed below are expressed in terms of decisions required by budget restrictions. However, the converse would apply if the decision maker were dealing with an expanded budget.

(1) If a production forecast must be eliminated for either commodity X or commodity Y, then eliminate the report on the commodity for which historical evidence suggests that the expected value of ($Q_p - Q_e$) is the lowest, *ceteris paribus*.

(2) Since the social value of USDA production forecasts is not totally dependent on the accuracy of the forecasts, reduced accuracy of reports on both commodities will likely be preferable to elimination of either report.

(3) Whether eliminating a particular report or accepting reduced accuracy, the resource reductions should be focused on reports that are released late, rather than early, in the production process. For example, planting intentions reports would likely have much higher social value than would a report on estimated crop size late in the growing season.

FOOD FOR THOUGHT

As is often the case when we explore new concepts, our analysis raises as many questions as it answers. For example, we have suggested that producer forecast error $|P^* - P_e|$ is a much more important source of resource misallocation in agriculture than is the magnitude of the USDA production forecast error $|\hat{Q} - Q_e|$. Therefore, it appears that, perhaps, we should focus considerable effort on helping producers reduce the magnitude of $|P^* - P_e|$. Moreover, we have suggested that if a USDA production forecast is to be eliminated, then eliminate the report for which the expected value of $|Q_p - Q_e|$ is lowest. But how do we identify P_e and Q_e? Can we define market equilibrium in an empirically meaningful way? Is the P^* on which producers base their production plans their estimate of P_e? Should it be? If P_e and Q_e define the socially optimal level of output, perhaps we should provide estimates of $\hat{P}_e$ and $\hat{Q}_e$, along with our estimates of planned production and the resulting price. How do food and agriculture policies affect farmers' perceptions of P_e? What is the appropriate use of P_e in policy development and administration? What are the dynamic implications for P_e following a severe shock to agricultural markets?

Numerous questions remain unanswered. These questions provide an opportunity for research that could provide exceptionally high returns in the future.

REFERENCES

Bullock, J. Bruce. "Some Concepts for Measuring the Economic Value of Rural Data." *Amer. J. Agr. Econ.* 63(1981):346–52.

Bullock, J. Bruce. "Social Costs Caused by Errors in Agricultural Production Forecast." *Amer. J. Agr. Econ.* 58(1976):76–80.

Gorham, M. "Public and Private Sector Information in Agricultural Commodity Markets." *Econ. Rev.* Federal Reserve Bank of San Francisco, 1978, pp. 30–38.

Houck, James P. and D. Pearson. "Official Production Estimate for Corn and Soybeans: Preparation and Accuracy." *Minnesota Agricultural Economist,* No. 578, April 1976, Agricultural Extension Service, University of Minnesota.

Mlay, Gilead and Luther Tweeten. "Measuring the Accuracy of USDA Projections of Wheat Carryout." Research Report, Oklahoma Agricultural Experiment Station, Stillwater, Oklahoma, forthcoming.

Thabet, Boubaker. "Valuation of USDA Crop and Livestock Reports." Ph.D. thesis, Department of Agricultural Economics, Oklahoma State University (1982).

[3] These conclusions perhaps should be stated as testable hypotheses. A portion of Thabet's work will include using the POLYSIM model to test these hypotheses within a simulation framework.