A SUGGESTED PROCEDURE FOR DETERMINING THE EFFECTS OF FOOD AID ON MARKET PRICE AND PRODUCTION: AN ILLUSTRATIVE CASE[1]

by

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INTRODUCTION

Background

Section 401(b) of the Agricultural Trade and Development Act of 1954 as amended, popularly known as Public Law 480 (PL 480) states that "No agricultural commodity maybe financed or otherwise made available under the authority of this Act except upon determination of the Secretary of Agriculture that adequate storage facilities are available in the recipient country at the time of exportation of the commodity to prevent spoilage or waste of the commodity, and the distribution of the commodity in the recipient country will

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not result in substantial disincentive to, or interference with domestic production or marketing in the country." This amendment is known as the Bellmon amendment.

Incentive price as interpreted by the Agency for International Development (A.I.D.) is that level of price that covers the cost of production plus incentive profit.[3]. Although the FVA paper did not define incentive profit, it is reasonable to assume that it is equal to the normal return to capital investment in the agriculture sector. Therefore, this amendment implies that the amount of food aid to any country should not exceed that level which causes market price to decrease below the cost of production plus normal return to capital in the agriculture sector.

Several studies have demonstrated that food aid in excess quantities serve as disincentive to domestic production. Other things being equal, an increase in supply from whatever source, e.g. food aid, commercial import or from domestic production tend to reduce market price. This price reduction has two effects. First, it increases the purchasing power of the consumers, allowing them to purchase more of the same commodity. Second, it reduces the profit of the producers, causing them to cutback on subsequent production, engage in more profitable enterprises or seek non-farm employment.

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[3]A.I.D./FVA, "Background Paper and Guide to Addresing Bellmon Amendment Concerns on Potential Food Aid Disincentives and Storage", July, 1985, p. 13.

The major obstacle in determining the optimum level of food aid to food deficient countries is the lack of data from which to estimate the demand and supply of major cereals. Therefore, this study aims to address this constraint by demonstrating an analytical procedure that requires only readily available data from published sources. These include price elasticity of demand, price elasticity of supply, annual domestic production, annual average price and annual level of food aid.

PROCEDURE

The procedure involves four steps, namely, (1) estimating proxies for the demand and supply functions, (2) estimating the effect of the change in market price on the level of consumption and production, (3) estimating the effects of changes in consumption and production on consumers' gains and producers' losses, and (4) estimating the incremental benefit/cost ratio of food aid.

Estimating the Demand and Supply Functions

Estimating the demand and the supply functions involves the application of the point-slope formula to the price elasticity of demand and supply. Assume that the following data are given:

--- price elasticity of demand: $e_d = -(dQ/dP)(P/Q)$

--- price elasticity of supply: $e_s = (dQ/dP)(P/Q)$

--- annual domestic production (Q)

--- annual average price (P), and

--- food aid (dQ)

The proxy demand function, $P_d = a_1 - b_1Q$ and the proxy supply function, $P_s = a_2 + b_2Q$ can be derived from the above data through a series of steps. The first step is to find the price flexibility of demand by taking the reciprocal of the price elasticity of demand as in Eq.(1).

(1) $f_d = (dP/dQ)(Q/P)$

This formula is more convenient to use than the price elasticity formula because it is consistent with the conventional form of the demand curve $P_d = a_1 - b_1Q$, where b_1 is the slope, dP/dQ of the demand curve and (Q,P) is the mean point in the quantity-price coordinate.

The second step is to find the slope of the demand curve b_1 by solving for dP/dQ in Eq. 1.

(2) $dP/dQ = b_1 = (f_d.P)/Q$

The third step is to solve for the intercept a_1 as shown in in Eq 3.

(3) $a_1 = P + b_1Q$.

Finally, the proxy demand function is obtained by combining the intercept in Eq. 3 and the slope in Eq. 2 as shown in Eq. 4.

(4) $P_d = a_1 - b_1Q$.

The supply function can be derived similarly. First, convert the supply elasticity to price flexibility as shown in Eq. 5.

5) $f_s = (dP/dQ)(Q/P)$,

Second, fine the slope b_2 and the intercept, a_2 as shown respectively in Eq. 6 and 7.

(6) $dP/dQ = b_2 = (f_sQ)/P$.

(7) $a_2 = P - b_2Q$.

Finally, write the proxy supply function in Eq. 8 by combining Eq. 6 and Eq. 7.

(8) $P_s = a_2 + b_2Q$.

Estimating the Effect of Food Aid on Market Price

If the food aid dQ is added to the domestic production Q, the market price P is reduced by an amount dP. This is shown in Equ.(9).

$$(9)\quad P_d + dP = a_1 - b_1(Q+dQ)$$
$$= a_1 - b_1Q - b_1dQ.$$

The effect of food aid dQ on market price is shown in Eq. 10, which is obtained by subtracting Eq. 4 from Eq. 9.

$$(10)\quad dP = -b_1dQ.$$

Equation (10) shows the relationship between food aid, dQ, on the change in price dP. Specifically, it means that the reduction in price dP is equal to the product of the slope of the demand function b_1 and the level of food aid dQ.

Estimating the Effect of Food Aid on Production

In order to estimate the effect of food aid on production, an equation that relates the change in price dP, (estimated in Eq.10) with the supply function (Eq. 8) is needed. Such a relationship is shown in Eq. 13, which is derived from Eq. 8 through Eqs. 11 and 12.

11) $P_s + dP = a_2 + b_2(Q + dQ_s)$

$= a_2 + b_2Q + b_2dQ_s.$

Subtract Eq. 8 from Eq. 11 and the result is Eq. 12..

(12) $dP = b_2dQ_s.$

Solve for dQ_s in Eq. 12.

(13) $dQ_s = dP/b_2.$

Equation (13) shows the cutback in production dQ_s by dividing the change in market price dP by the slope of the supply function b_2.

Estimating Consumers' Gains and Producers' Losses

In this analysis, we assume that the market is at equilibrium at market supply Q_e and at a market price P_e. At this point, the consumers buy everything that the producers have to offer. However, with the introduction of food aid dQ, the equilibrium is disturbed, --- the market price is reduced from P_e to $(P_e - dP)$, consumption is increased from Q_e to $(Q_e + dQ_d)$ and producers cut back their production from Q_e to $(Q_e - dQ_s)$.

If consumers' gain (CG) is defined as the reduction in consumers expenditures for the purchase of the same amount or more food commodities; and producers' loss (PL) is defined as the value of cutback in production resulting from decreased price; CG and CL can be estimated as in Eqs. 14 and 15.

$$(14).CG = (P_e - dP)(Q_e + dQ_d) - P_eQ_e$$
$$= P_edQ_d - dPQ_e - dPdQ_d.$$

Since P_e, Q_e and dQ_d are given, and dP is estimated in Eq.10, GC can be estimated as in Eq. 14. Similarly CL can be determined in Eq. 15 since P_e, Q_e are given, dP is obtained in Equation (10) and dQ_s is given in Equation 13.

$$(15)\ CL = (P_e - dP)(Q_e - dQ_s) - P_eQ_e$$
$$= -P_edQ_s - dPQ_e + dPdQ_s.$$

Estimating the Incremental Benefit Cost Ratio

If food aid is given as a grant (Title II) the incremental benefit cost ratio is shown in Equation (16)

(16). IBCR = CG/CL.

If, however, the food aid is purchased on concessional terms, (Title I) the IBCR is given in Equation (17).

17. $IBCR = CG/(CL + P_edQ_d)$.

Bangladesh: An Illustrative Case

The following data are specific for rice in Bangladesh:

--- price elasticity of demand: $e_d = -.45$

--- price elasticity of supply: $e_s = .20$

--- Annual average price : $P_e = \$275/\text{ton}$

--- Annual average production: $Q_e = 16000$ thousand tons

--- Annual food aid: $dQ = 2600$ thousand tons.

Estimating the Proxy Demand and Supply Functions

The first step is to find the slope of the demand function by applying Eq. 2 on the above data.

(2) $b_1 = f_d P_e / Q_e$

$= -2.22(275)/16000$

$= -.0382$

The second step is to find the intercept using Equation (3).

(3) $a_1 = P_e + b_1 Q_e$

$= 275 + .0382(16000)$

$= 886.20$

Combining Equations (2) and (3), the proxy demand function can be written as as Eq. 4.

(4) $P_d = 886.20 - .0382Q$

Similarly, the slope, and the intercept are given respectively in Equations (6) and (7) and the supply function is written as Equation (8).

(6) $b_2 = f_s P_e / Q_e$

$= 5.00(275)/16000$

$= .0859$

(7) $a_2 = P_e - b_2 Q_e$

$= 275 - .0859(16000)$

$= 275 - 1374.40$

$= -1099.40$

(8) $P_s = -1099.40 + .0859 Q_s$

Estimating the Effects of Food Aid On Price

Equation (10) in the previous section, the price effect of food aid in Bangladesh is given below:

(1) $dP = -b_1 dQ$

$= -.0382(2600)$

$= -\$99.32$

The price reduction of $99.32 per ton occurs only when the full amount of 2600 thousand tons are released in the market at one time. This is equivalent to a reduction from $275/ton to $175.68 per ton or 27.5c/kg to 17.5c/kg. In practice, however, a reduction in price of this magnitude seldom occurs because food aid deliveries are spread over several months or stored in government warehouses and released for the purpose of stabilizing seasonal fluctuations as well as regional differences in prices. If food aid in Bangladesh is spread over a six months period of approximately 435 thousand tons per month, the price decrease would be about $16.62/ton to a level of $258.40 per ton. This is equivalent to a reduction of 27.5 cents/kg to 25.8 cents/kg. For Bangladesh, as in other countries, the magnitude as well as the the timing of food aid arrivals in country are important aspects of negotiation.

Estimating the Effect of Food Aid on Production

Following Eq. 13 in the previous section, the effect of food aid on production in Bangladesh is given below.

$$(13)\quad dQ_s = dP/b_2,$$
$$= -99.32/.0859$$
$$= -1156$$

In addition to the price effect of food aid, The above result show that for Bangladesh, a 2600 thousand tons of food aid causes (a) increased consumption by the amount of the food aid, and (b) decreased production by 1156 thousand tons.

Estimating Consumers' Gains and Producers' Losses

Consumers' gain (CG) is defined as the reduction in consumers expenditure for food due to decrease in price. Conversely, producers' loss (PL) is the value of cutback in production due to decrease in market price. They are estimated as Equations (14) and (15) respectively in the previous section.

$$(14)\ CG = (P_e - dP)(Q_e + dQ_d) - P_eQ_e$$
$$= P_edQ_d - dPQ_e - dPdQ_d$$
$$= (275)(2600) - (99.32)(16000) - (99.32)(2600)$$
$$= -1,132,352$$

$$(15)\ CL = (P_e - dP)(Q_e - dQ_s) - P_eQ_e$$
$$= -P_edQ_s - dPQ_e + dPdQ_s$$
$$= -(275)(1156) - (99.32)(16000) + (99.32)(1156)$$
$$= 1,792,206$$

The incremental benefit cost ratio (ICBR) is given in Equations 16 and Equation 17 depending on whether the food aid is Title II or Title I.

$$(16)\ ICBR = CG/CL$$
$$= -1132353/1792206$$
$$= .63 \quad \text{for Title II}$$

$$(18)\ ICBR = CG/(CL + P_edQ_d)$$
$$= 1132352/(1792206 + (275)(2600))$$
$$= 1132352/(2507206)$$
$$= .45 \quad \text{for Title I}$$

SUMMARY AND CONCLUSIONS

The methodology developed in this paper allows one to determine the price, production and distributional impact of food aid. The analysis is simple, requiring only a modicum knowledge of intermediate economic theory and simple algebra. The data requirement is not demanding. Such data as price elasticity of demand and supply, annual average price, annual domestic production and annual food import (concessional purchase or grant) are all that is needed. Normally, these data are available in published forms in country ministries, in research organizations or donor agencies.

Making allowances for the limitations of the data and the procedure, the results, when interpreted with care and caution, can give insights to interesting policy questions. For example, the analysis shows how consumers expand their consumption, and how producers cutback on their production as a result of reduction in market price. The magnitude of consumers' gain vis-a-vis producers' loss can also be estimated. The analysis can not specify an appropriate trade off between consumers gains and producers losses because in the final analysis, the determination of trade-off is as much an economic as well as a social decision that must be seriously considered not only by economists but also politicians.

The simplicity of the procedure causes some concern to statisticians. First demand and supply parameters are not derived statistically. Consequently, their reliability can not be determined in the usual statistical sense. Second, the model is static. Production response is simultaneous to change in market price without considering appropriate time lag corresponding to production cycles. Also, this model does not account for the impact of food aid on substitute or competing products. Some of these can be remedied through the use of more sophisticated models and statistically determined parameters with dynamic characteristics. In model building, there is a trade-off between simplicity and practicality on one hand and precision and cost on the other. Only the policymaker or the decision maker can determine the appropriate trade-off. For rough estimates of magnitudes and direction of effects, the above analysis is sufficient especially for USAID missions with limited database and computing capability.

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