APPLICATION OF PRICE ELASTICITIES TO FARM POLICY ANALYSIS: COMMENT

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In an article titled, "Application of Price Elasticities to Farm Policy Analysis," Bateman and Stennis [1] present an intriguing analysis of the use of demand elasticities for U.S. farm policy in the world market perspective. They present two different approaches to demonstrate the importance of the world market to U.S. agriculture and conclude that unilateral reduction in production of U.S. farm products is not likely to enhance and to maintain farm income unless the farm commodities under consideration are almost perfectly inelastic in the world market and/or the U.S. is the only or dominant source of supply. The analyses are based on the estimated elasticities and the logic of economic deduction.

One of the analytical procedures Bateman and Stennis use to estimate the elasticity of foreign demand for U.S. exports is well known and is discussed elsewhere [2, 3, 4, 5]. The alternative approach they offer is the subject of this comment. By comparing the estimates obtained from the two approaches, Bateman and Stennis claim that the two procedures offer similar and comparable results. The purpose herein is to identify the potential pitfalls inherent in their suggested alternative approach of estimating demand elasticities for policy analysis.

DEMAND VS. SUPPLY

To illustrate the flaws of Bateman and Stennis' analysis the numerical example given in Table 1 [1, p. 108] is reconstructed here. The problem simply stated is to derive the "net U.S. elasticity" or "realized price response" of demand for U.S. soybeans from given demand and supply conditions. Given that the U.S. accounts for about 49.8 percent of total world production of soybeans, ". . . a 30 percent cut in U.S. production would result in a 14.9 percent reduction in world production" [1, p. 108]. The price elasticity of demand for soybeans at the world level was estimated to be −0.4 [3]. On the basis of the known variables, Bateman and Stennis suggest that this implies a 37.4 percent increase in the price of soybeans, or −0.1494/−0.4 = 0.3735. Because the price elasticity of demand is defined as the relative responsiveness of quantity demanded to changes in commodity price, the net U.S. elasticity, according to Bateman and Stennis, is calculated as −0.8, or −0.3/0.374. The rest of the figures presented in Table 1 [1] can be obtained in similar fasion. Implicitly, the authors have assumed that the percentage change of quantity demanded for soybeans at the world level and in the U.S. is the same as the percentage change of world production given a reduction in U.S. production of soybeans in the manipulation of demand elasticities.

An inspection of Table 1 [1] would suggest that "net U.S. elasticity" is approximately twice as large as "world demand elasticity," or a constant proportion to the magnitude of world demand elasticity. Hereafter it is shown that Bateman and Stennis' calculation is cumbersome and inappropriate, and can be reduced to a simple rule that the net U.S. elasticity is equal to the world demand elasticity divided by the U.S. share of world production, and the same results as presented in their article can be obtained regardless of the magnitude of the reduction in U.S. production.

The demand elasticity in the rest of the world is defined as:

$$(1) \qquad e_w = (\Delta D_w/D_w) \times (P/\Delta P) = -0.4$$

where D_w represents the quantity of soybeans demanded in the rest of the world, P is the world price of soybeans, and the symbol Δ denotes "change in." Following Bateman and Stennis' reasoning, equation 1 is rearranged:

$$(2) \qquad P/\Delta P = e_w/(\Delta D_w/D_w)$$

$$= -0.4/-0.1494 = 2.6776,$$

or

$$\Delta P/P = 0.3737.$$

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Helpful comments by J. C. Purcell, J. R. Allison, and the *Journal* reviewers are gratefully acknowledged.

The percentage change of quantity demanded at the world level, $\Delta D_w/D_w$, is defined by Bateman and Stennis as the percentage reduction of world production resulting from a given percentage cutback in U.S. production. Thus,

$$(3) \qquad \Delta D_w/D_w = (\Delta Q/Q) \times (Q/Q_w)$$

$$= (-0.3) \times 0.498 = -0.1494$$

where Q and Q_w are quantities of soybeans produced in the U.S. and the world, respectively. By substitution, equation 2 becomes:

$$(4) \quad P/\Delta P = e_w/[(\Delta Q/Q) \times (Q/Q_w)]$$

$$= -0.4/[(-0.3) \times (0.498)] = -0.4/-0.1494.$$

If both sides of equation 4 are multiplied by $\Delta Q/Q$, the result is:

$$(5) \qquad (\Delta Q/Q) \times (P/\Delta P) = e_w/(Q/Q_w)$$

$$= -0.4/0.498 = -0.803.$$

This is Bateman and Stennis' definition of net U.S. elasticity. From equation 5, it is obvious that the net U.S. elasticity is the quotient of world demand elasticity divided by the proportion of U.S. production in total world production. Therefore, the statements, "... if the elasticity of demand coefficient for the world market is equal to the proportion of the market [Q/Q_w] supplied by an exporter ..., the net elasticity to the exporter is unitary .... For elasticities greater than the market share, the net response would be elastic ...." [1, p. 108], are truisms of their representation of net U.S. elasticity, but their representation does not seem to be supported by any economic theory.

Equation 5 suggests that the resulting net U.S. elasticity depends only on the magnitude of U.S. share in the total world production and is invariant with any level of cutbacks in U.S. production. This property of the estimating procedure is inconsistent with the statement by the authors, "Although a change of the magnitude discussed here would certainly not be small, the authors believe such a large change would mean a more elastic response...." [1, p. 107], and "... this article does not include analysis for output reductions of less than 30 percent; however, the conceptual argument is consistent for any level" [1, p. 110].

DEMAND CURVE VS. ELASTICITY OF DEMAND

Another mistake that Bateman and Stennis have committed in their analyses is that "production cuts will tend to move the U.S. toward the more inelastic portion of the demand curve, as is demonstrated in equation 4. As W_2 decreases, more weight is given the inelastic domestic market. Reduction of production in an inelastic market will increase total revenue in that component of the market; however, this effect would occur at considerably lower levels of production than are typical today. Whether farmers would benefit from higher prices at a loss of more than 40 percent of the market volume is questionable" [1, p. 109].

The authors have not estimated the demand for soybeans, but have implicitly assumed a demand curve which is convex to the origin and has a slope approaching infinity at higher prices. Otherwise, a leftward movement along the demand curve means a movement toward the more elastic rather than the more inelastic portion of the demand curve.

More significantly, the elasticity estimate obtained from equation 4 [1] simply suggests that the total (weighted) elasticity for U.S. soybeans for a given demand and supply situation is price inelastic, or close to unit elasticity. The implication to be drawn from this estimated price elasticity is that farmers would benefit from higher prices, or at least remain equal, because the loss of revenue from export sales will be more than, or at least, compensated by the gain of revenue from the domestic market. This is true as long as total elasticity for soybeans remains less than unitary. It is noted that the relative weights (W_1 and W_2) as well as the demand elasticities (e_d, e_x and e_t) will change, for a given change in the U.S. soybean production. The reason is that the price elasticity varies as one moves along the demand curve or as the demand curve shifts. From equation 4 [1] alone, no certain inference about the change of elasticity can be drawn. The results therefore may not be as straightforward as the authors have suggested. Indeed the effect of reduction in U.S. production and therefore the volume of U.S. exports on the export elasticity is evident from equation 2 [1]. From equation 2 [1], it is shown that as the volume of U.S. exports decreases, the export elasticity will increase which in turn will counter-affect the decrease of W_2 on the total elasticity for U.S. soybeans as demonstrated in equation 4 [1]. This effect is not mentioned in Bateman and Stennis' analysis in forming their farm policy conclusion. Although the policy implications they present seem plausible and valid, the logic of their deduction does not appear to be convincing.

It is recognized that the demand for soybean exports is growing, but it is also very elastic. Thus, if the price of soybeans rises as a result of reduction in U.S. production, the quantities demanded for exports should decrease due to the reduction of available supply for exports

and increased use of substitutes as the price of soybeans is forced up.

The elasticity of demand for U.S. soybean exports can become more elastic as a result of either unilateral reduction in U.S. production or an increase of foreign production of soybeans or soybean substitutes. Historically, the latter has been the case for U.S. soybeans. In particular, the rapid growth in Brazilian soybean production in recent years has been remarkable and significant. Rising from an inconsequential level, Brazilian soybean exports have taken their toll on U.S. soybean exports. The U.S. share of the world market has decreased to about two-thirds of the world total compared with more than 80 percent of world total a decade ago. Moreover, the proportion of U.S. soybeans exported to foreign markets has also increased rapidly in recent years, suggesting a greater degree of dependency on foreign markets. As a result, the combined effect will be evident with greater export and total elasticities. Price stability would be expected to be greater in the future for a given change in U.S. production than in the past years. Therefore, exchange earnings to the U.S. soybean industry as well as gross income for the U.S. soybean farmers would be reduced if supply control were instituted as a farm policy to maintain or increase farm income for the U.S. soybean producers.

This critique is not intended to discredit the merits of Bateman and Stennis' quest in demonstrating the usefulness of price elasticities in farm policy analysis. They have, in effect, successfully illustrated the instrumental power of the application of economic theory to agricultural policy evaluation. Nevertheless, the reader should be cautioned against the inherent problems of their proposed analytical procedure. Careful and precise application of economic terminology is indeed an indispensable tool for sound and meaningful exercises of economic analysis.

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