WORKING PAPERS

ESTIMATING PRODUCER WELFARE WHEN INPUT AND OUTPUT

Estimating Producer Welfare Change when Input and Output Prices Change Simultaneously

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Economic analysis of a proposed policy change may require
quantifying the gains or losses to an industry when input and product prices change simultaneously. Past studies have often measured such welfare changes by summing the effect of an input price change and the effect of a product price change, each taken in isolation of one another. For example, in published studies of the social benefits of rescinding tariff and quota protection of domestic textile and apparel industries, a comparative static analysis of the gains to trade liberalization has typically been performed for the two industries separately. 1 That is, the gains to trade liberalization were evaluated in the textile industry and in the apparel industry, but not for trade liberalization in both industries simultaneously. The authors most probably were not interested in estimating the effects of liberalization in just one of these industries, since such estimates would have questionable value due to political realities: It is unlikely that trade restraints on apparel would be removed without doing the same for textiles, since to do so would place domestic apparel producers at a competitive disadvantage vis a vis foreign producers.

Moreover, simply adding the gains calculated separately for trade liberalization in the two vertically related industries involves a potentially significant overestimation error.2 This error arises in two ways: first, the gain to downstream (apparel) producers, i.e., the gain in "consumer surplus" in the upstream (textile) industry, would be based on the higher, pre-liberalization price in the downstream industry and so would be an overestimate; and, second, the producer loss in the downstream industry (apparel) would be based on the higher, pre-liberalization price in the upstream industry and so would be an underestimate. 3

A more appropriate approach would be to analyze the gains to trade liberalization when trade restraints are (simultaneously) removed from both industries. Unfortunately, this necessitates estimating the net gain or loss to downstream producers as the prices of their input and

1 See Cline (1987), Hufbauer et al. (1986).

2 Perhaps in recognition of this problem, some authors have
left it to the reader to perform this addition. [Cline (1987).]

3 That is, the producer welfare change so estimated would be
greater that the true change. Equivalently, any gain would be overestimated and any loss (in absolute value terms) would be underestimated. Similarly, this approach would underestimate the producer welfare change ariSing from the levying of tariffs in both upstream and downstream markets.

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product fell simultaneously as a result of trade 1ibera1ization. 4 An estimation of this sort is complicated by the simultaneous shifting of both the industry's factor demand curve and product supply curve.

This paper develops analytically a graphic representation and a mathematical approximation for the change in producer welfare when both a factor price and a product price change simultaneously. The analysis assumes the producer operates in competitive factor and product markets, which permits the later generalization from the case of one firm to the case of multiple firms constituting an industry. Two additional simplifying assumptions are invoked: First, the ratio of the factor input to product

n - pq - Prq - V(q) + F (2)
Any simultaneous change in prices p and P--for example as a result of tariffs or taxes--wou1d affect producer welfare:

[Po(~q) + (~p)qd
r[Po(~q) + (~P)qd

where subscripts indicate the initial and subsequent time periods.

(3)

Note

P1r-------------~~~~--~~------------------

Por------------1~~--------~~~--~~--~~------

DEMAND

OS 0 S Od Od o 1 I 1 1 0
1 I
I I
I I
I I
I I
I I
I ,
I
,

P1 I I
I d , e

a b I c ,

, I

Po

I ,I

~ DOMESTIC SUPPLY
WITH TARIFFS

DEMAND

qS S qd qd 1 qo 1 0

The first area is the sum of areas A, B, C, D, E and F, while the second area is the sum of a, b, and c.

A different result would be obtained if one were to adopt the
crude approach of simply summing the estimate of the gain/loss arising from an isolated price change in the upstream market, with the estimate of the gain/loss arising from an isolated price change in the downstream market. For example, consider the case of tariffs levied on textiles and apparels, as represented in Figure A, where the tariffs cause prices to simultaneously rise in the two vertically related markets. If the resulting downstream gain and upstream loss were estimated without taking into account the interrelationship of the two industries, the upstream loss would be calculated relative to the original demand curve (i.e., no tariff on apparel), and the downstream gain would be calculated relative to the original supply curve (i.e, no tariff on textiles). This estimate of the gain would be the sum of areas a, b, c, d, e, g, and i in the lower panel and the estimate of the loss would be A, B, C, and F in the upper panel. Upon summing these, a measure of the change in producer welfare (-a-2b-2c+A+B+C+F) would be obtained. 11 This is less than the true measure (-a-b-c+A+B+C+D+E+F) by the area (b+c+D+E) and so represents an underestimate. Alternatively, if the exercise were instead one of calculating the change in producer welfare when both prices decreased, i.e., tariffs were rescinded, an overestimate of the same amount would be obtained.

The error that would arise from this crude approach is potentially large. In fact, the error cannot be bounded so to assure that it would be small relative to the actual gain or loss to the producer(s). This can be seen by considering a simultaneous change in input and output prices that in fact leaves producer welfare unchanged. In this case, any gain or loss arrived at by the crude approach is entirely error. Consequently, the ratio of error to true gain/loss would be infinite. 12

Finally, it might be argued that a crude approach requires less information in order to calculate the net change in producer welfare. Specifically, one would need the initial prices and quantities, the

11 Note that, due to similar triangles, the sum of the areas of triangles, band c, must equal the sum of the areas of the triangles, d, e, g, and i.

12 In order to reach this conclusion, it is necessary to show
that the error, given by the area of (b+c+D+E), is nonzero. Now, from equations (9a) and (9b), (b+c) can be shown to be approximately equal to (1/2)€g(~P/P)(~p)q (where €g is defined in absolute value terms), while (D+E) is approximately equal to (1/2)€~(~p/p)(~P)Q. For any (nonzero) ~p and (nonzero) ~P that would leave the firm's profit unchanged, both terms would be nonzero and positive. Since the error of the estimate is nonzero, while the true value is defined to be zero, the ratio of error to the true value can not be bounded.

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change in prices, and the elasticities of supply and factor demand. While the more accurate approach presented here would involve determining new quantities on shifted supply and factor demand schedules, the informational needs for this are in fact not any greater than for the crude approach. If one assumes that the factor is in more or less constant proportion with output, the only additional datum needed is that proportion (r). This can be computed from the initial quantities.

Specifically, to arrive at the post-price

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