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Effects of Tariffication on Price Variability

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I. Introduction

Agricultural trade has generally been treated as an exceptional case to the principles of free trade. Non-tariff barriers (NTBs), such as quotas and variable import levies, have been used worldwide not only by agricultural importing countries but also by exporting countries. According to the Uruguay Round agreements, all agricultural non-tariff trade barriers should be converted into equivalent tariffs and, further, these tariffs should be reduced over time. Each country has the authority to choose the tariff types when it converts NTBs to tariffs such as ad valorem tariff, specific tariff, alternative tariff or compound tariff (GATT 1994). The rationale for converting NTBs to tariffs has a solid basis in both the economic theory of trade distortions and the workings of international institutions dealing with trade liberalization.

Most of the trade policy literature on NTBs and tariffs has analyzed the effect of non-tariff versus tariff policies on welfare, price, and trade volume. Papers often analyze only one specific type of tariff, commonly a specific or ad valorem tariff. But, as mentioned above, a variety of tariffs can be used by individual countries.

Even though tariffs are generally considered to be more efficient than other trade restrictions, converting NTBs into tariffs

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may sometimes increase the price variability of goods for importing or exporting countries. The degree of price variability under tariff measures also depends on the type of tariff selected. Therefore agricultural trade will be affected differentially by various types of tariffs.

In fact, the motivation for non-tariff barriers in many countries is to insulate domestic markets from frequent changes in world prices. Most non-tariff measures not only insulate the domestic market from external instability, but also transfer the burden of adjustment of domestic instability to the world market. The representative example is the variable import levies which is one of the central features in the EC common agricultural policy.

Price instability originates basically from two sources.[1] One is from policy induced instability. The other is from natural random factors which influence both supply and demand of commodities. Production especially is affected by weather, disease, technical change, and input availability, while demand varies due to income and taste changes. Stochastic supply and demand like this cause prices to fluctuate. Price variability can be increased through policies affecting foreign trade, or can be decreased through stabilization policies such as buffer stock and price forecasting. But, the impacts of each policy may differ between the domestic and world market.

Price instability has been a persistent issue in agricultural economics. Most studies on price stabilization have originated with the pioneering works of Waugh (1944), Oi (1961) and Massell (1969). Much of the theoretical work on price variability has focused on the international and domestic welfare implications of stabilization. Hueth and Schmitz (1972) have extended the model to an open economy. Turnovsky (1976) has extended the basic framework to included more complex functional specifications such as adaptive expectations and multiplicative disturbances.

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[1] Although instability is usually associated with uncertainty, both are not synonymous. Uncertainty is related to the ex ante factor, whereas instability is an ex post record of the stochastic events.

Johnson (1975) claims that trade barriers increase price instability in the world market. His analysis concluded that freer world trade would tend to lessen international price instability for most agricultural products. Bale and Lutz (1979) and Zwart and Blanford (1989) show that different policies can have a markedly different impacts on the transmission of instability that normally arises from natural random factors, such as weather, disease, and income shock associated with supply and demand shocks.

The purpose of this paper is to examine the effects of different tariff measures on domestic and world price variability. The paper basically uses a two-country equilibrium model to show that price variability can be affected by various tariffs in the importing country.

II. Conversion of Non-tariff Barriers into Tariffs

The issue of equivalence of tariffs and non tariff barriers has been cast in terms of the existence of an equivalent tariff for a long time (Bhagwati 1968; Melvin 1986). But the GATT tariffication proposal, as part of the effort to bring agricultural trade into a more fully market-oriented system, offers a simple method of conversion. This method defines the equivalent tariff in terms of the nominal rate of protection, and thus is based on the price gap between the domestic market (with price p_d) and the world market (with price p_w).

According to the tariffication proposal, non-tariff barrier should be converted into equivalent tariff calculated from the price gap between domestic and world prices for some recent period. The specific equivalent tariff (S) is then defined as a fixed charge per unit of product imported, namely, $S=(P_d-P_w)$ and the ad valorem equivalent tariff (t) is defined as a fixed percentage of value, i.e., $t=[(P_d-P_w)/P_w]*100$. There are also two other equivalent tariffs, the alternative tariff and compound tariff. The alternative tariff is defined as either $S=(P_d-P_w)$ or $t=[(P_d-P_w)/P_w]*100$. The bigger will be generally applied to imports under alternative tariff. The compound tariff is defined as

the weighted sum of the specific and ad valorem tariff, i.e., $P_d = P_w(1+ t_c) + S_c = P_w + \lambda s + (1-\lambda)\ tP_w$, where $0 < \lambda < 1$.

Thus, the tariff equivalent calculated from non-tariff barriers may be one of the four types of tariffs. If the domestic price is \$4/kg and the representative world price is \$2/kg for a commodity protected by non-tariff barriers at a given base period, then the specific equivalent tariff would be \$2/kg, the ad valorem equivalent tariff be 100 percent of unit import price (generally C.I.F price) and the alternative equivalent tariff be \$2/kg or 100 percent, but the compound equivalent tariff would be one of many combinations calculated by the value of λ. If a country replaces its non-tariff barriers with a 100 percent tariff or \$2/kg specific tariff under domestic price \$4/kg and world price \$2/kg at the base period, then four types of tariffs have the same effects in the sense that each tariff yields not only the same tariff burden but also the same level of imports and output and the same domestic price at a given specific base time. Despite the usefulness of equivalence in deriving such results, it is now well known that tariffs and quotas are generally not equivalent in most situations beyond the static competitive model.[2] Indeed, the case of uncertainty raises the interesting issue on price variability. Before we proceed, it is useful to distinguish between the effects of specific and ad valorem tariffs on the domestic price variability when the world price is fluctuating. For example, suppose the small country that faces a randomly fluctuating world price for its importable good, if the world price increases from \$2 to \$4, then the domestic price under the ad valorem tariff would increase from \$4 to \$8 and the domestic price under the specific tariff would go from \$4 to \$6. This example illustrates that the ad valorem import tariff increases the domestic price variability more than the specific tariff. Therefore, the type of tariff selected is a very important determinant that affects price

[2] The simplest case of non-equivalence arises when the parameters of the economy are shifting over time. Vousden (1985) consider some examples so-called dynamic non-equivalence.

variability.

III. Mathematical Framework

The model considers an individual country facing the rest of the world in one commodity. The results are obtained by using a simple two-country, one-commodity trade model which includes a random error term in the demand and supply equation.

The domestic supply and demand for the particular commodity of this country are assumed to be linear with additive disturbance, specified as follows;
Demand is given by

(1) $Q_d = a - bP + u$

where Q_d is the quantity demanded in the domestic market. Supply is given by

(2) $Q_s = c + dP + e$,

where Qs is the quantity supplied in the domestic market, and P is the domestic price.

Suppose now that the producer price and consumer price are the same here. The source of variability in the domestic market is the stochastic fluctuations in demand caused by taste change and production caused by weather or disease. The terms a, b, c, d are fixed coefficients in the linear demand and supply functions and u and e denote zero mean independent random variables with variance σ_u^2 and σ_e^2, respectively associated with demand and production uncertainty. The disturbances in demand and supply are purely random, uncorrelated across country or time with $E(u,e)=0$, $E(u) = 0$, $E(e) = 0$, $E(u^2) = \sigma_u^2$, $E(e^2) = \sigma_e^2$. By the same token, the following linear demand and supply equations are given for the foreign country.

(3) $Q^*_d = a^* - b^*P^* + u^*$

(4) $Q^*_s = c^* + d^*P^* + e^*$

where superscript * denotes the foreign country.

Assuming there are no stock changes in both countries, the international market clearing equation is given by

(5) $Q_d - Q_S = Q^*_s - Q^*_d$

where the foreign country is now supposed as the exporting country.

In the absence of trade, the market clearing price in home country that is assumed to be self-sufficient in the product before tariffication is given by:

(6) $P_d = \frac{a-c+u-e}{b+d} = \overline{P} + \frac{u-e}{x}$ and $Var(P_d) = \frac{\sigma_u^2 + \sigma_e^2}{x^2}$

where $x = b + d$, $\overline{P}$ is the expected price ($\overline{P} = \frac{a-c}{b+d}$).

To begin with, consider the effects of free trade and fixed quota on the price variability.

Fixed Quota

The imposition of a fixed quota (q) in the home country before tariffication results in the following equilibrium prices and variances in the home and foreign market.

(7) $P_d = \frac{a-c-q+u-e}{b+d} = \overline{P} + \frac{u-e}{x}$ and $Var(P_d) = \frac{\sigma_u^2 + \sigma_e^2}{x^2}$,

where $\overline{P} = \frac{a-c-q}{b+d}$, $x = b+d$.

From the above equation, it is obvious that no instability

is transmitted between domestic and world market under a fixed quota system. This says that under a quota all variability comes from the place where it originated and is absorbed in itself as in the closed economy case.

Free Trade

The free trade equilibrium for the model can be derived under to the assumption that producer and consumer prices are equal the world price in any given time. Then free trade price and its variance are as follows;

$$(8)\ P_{ft} = \frac{a+a^*-c-c^*+u+u^*-e-e^*}{b+d+b^*+d^*} = \overline{P} + \frac{U-E}{x+x^*}$$

and $\mathrm{Var}(P_{ft}) = \frac{\Sigma^2}{X^2}$,

where $\overline{P} = \frac{a+a^*-c-c^*}{X}$, $x = b+d$, $x^* = b^*+d^*$, $X = x+x^*$, $U = u+u^*$,

$E = e + e^*$ and $\Sigma^2 = \sigma_u^2 + \sigma_e^2 + \sigma_{u^*}^2 + \sigma_{e^*}^2$.

As an effect of free trade, both countries may enjoy a greater stability even though it is not so in all cases. To see this, it can be verified that in the case of n trading countries, the variance of the price under free trade is given by;

$$(9)\ \mathrm{Var}(P_{ft}) = \sum_{i=1}^{n} (\sigma_{ui}^2 + \sigma_{ei}^2)/(\sum_{i=1}^{n} x_i)^2 = \sum_{i=1}^{n} x_i^2 * Var(P_i)/(\sum_{i=1}^{n} x_i)^2,$$

where subscript i denotes the country, $x_i = b_i + d_i$.

Hence the variance of the world price under free trade is a weighted sum of the variances of the closed countries' prices, but it adds up to less than the weighted averages of these variances. In that sense, international trade can be regarded as a risk pooling system that stabilizes the price fluctuation. As the number of trading countries increases, the variance of the world price decreases. If n approaches infinity, then the variance of the

world price tends to be zero. Nevertheless, for a finite number of trading countries, it is possible for some countries to experience larger price variability under the free trade rather than that under no trade or fixed quota(Bale and Lutz,1979).

Now, consider the effects of types of tariff on the price variability after levying the selected tariff on a commodity in an importing country.

Specific Tariff

A specific tariff is expressed as S dollars per unit of the import good. So domestic price (P_d) in the importing county is equal to the world price(P_w) plus specific tariff (S), i.e.,

$$(10)\quad P_d = P_w + S.$$

Plugging equation (10) into (5) and from the equilibrium condition we can solve the world price and its variance under specific tariff.

$$(11)\quad P_w = P_{ft} + \frac{-b-d}{b+d+b^*+d^*}S \quad \text{and} \quad Var(P_w) = \frac{\Sigma^2}{X^2}$$

where $P_{ft} = \frac{a+a^*-c-c^*+u+u^*-e-e^*}{b+d+b^*+d^*}$, $\Sigma^2 = \sigma_u^2 + \sigma_e^2 + \sigma_u^{2*} + \sigma_e^{2*}$

and $X = b + d + b^* + d^*$.

From (11), the domestic price and its variance after levying a specific tariff is

$$(12)\quad P_d = P_{ft} + \frac{b^*+d^*}{b+d+b^*+d^*}S \quad \text{and} \quad Var(P_d) = \frac{\Sigma^2}{X^2}.$$

From comparing (11) and (12), we see that the price variances for the domestic and foreign market after introduction of the specific tariff is equal to the free trade variance. In other words, as the results of tariffication, the introduction of a specific

tariff in an importing country has the same effect of free trade on price variability in the sense of not changing the degree of price variability under free trade.

Ad valorem Tariff

An ad valorem tariff is expressed as t percent of the C.I.F. import price and can be simply described by the following condition.

(13) $P_d = P_w(1+t)$.

Plugging (13) into (5) and from the equilibrium condition the world price and its variance under the ad valorem tariff can be derived as follows.

(14) $P_w = \dfrac{a+a^*-c-c^*+u+u^*-e-e^*}{(b+d)(1+t)+b^*+d^*}$ and $\mathrm{Var}(P_w) = \dfrac{\Sigma^2}{(x(1+t)+x^*)^2}$

where $x = b + d$, $x^* = b^* + d^*$, and $\Sigma^2 = \sigma_u^2 + \sigma_e^2 + \sigma_{u^*}^2 + \sigma_{e^*}^2$.

From (13) and (14), the domestic price and its variance after levying the ad valorem tariff are expressed as (15).

(15) $P_d = \dfrac{a+a^*-c-c^*+u+u^*-e-e^*}{(b+d)(1+t)+b^*+d^*}(1+t)$ and

$$\mathrm{Var}(P_d) = (1+t)^2 \frac{\Sigma^2}{(x(1+t)+x^*)^2}.$$

Comparing the world price variance under ad valorem tariff with that of the specific tariff, we can find the fact that (14) is less than (11) for $t > 0$. In other words, the price variability in the world market under the ad valorem tariff is lower than under the specific tariff or free trade. These results basically confirm the claim of Bale and Lutz (1979), Zwart and Blanford (1989) that with an ad valorem tariff, world price variability is lower than that under free trade or under specific

tariff.

However, an ad valorem tariff increases the price variability in the domestic market of importing country more than the specific tariff, comparing (15), which is the variance of domestic price under the ad valorem tariff, with (12), which is the price variance of domestic market under the specific tariff. We see that the ratio of variance is greater than one ((15)/(12)> 1). This is because under ad valorem tariff, the world price movements are reflected in the domestic price as a form amplified; for example, a rise in world price by α implies a rise in domestic price by $(1+t)\alpha$, whereas under specific tariff, the movements in the domestic price exactly equal the movements in the world price.

Alternative Tariff

An alternative tariff is expressed as t percent of the C.I.F. import price or S dollars per unit of the import good and can be described by the following condition.

(16) $P_d = P_w(1+t)$ or $P_d = P_w + S$.

In general, the bigger duty between ad valorem and specific tariffs applies to the import good. Under the alternative tariff, an import commodity is confronted with two types of tariff according to import price. In other words, considering fixed quota before tariffication, if $P_w < \overline{P} = (a-c-q)/(b+d)$ then a specific tariff would be applied to imports, whereas if $P_w > \overline{P} = (a-c-q)/(b+d)$ then an ad valorem tariff would be applied. We assume that each situation occurs with probability (π, $1-\pi$), that is, π is the probability of applying the specific tariff to imports, and the case of ad valorem occurs with probability $1-\pi$. From this assumption we can get the variance of domestic and world prices under the alternative tariff as follows.

(17) $\mathrm{Var}(P_w) = \pi \ \mathrm{Var}(P_{wS}) + (1-\pi)\mathrm{Var}(P_{wt}) = \pi \dfrac{\Sigma^2}{x^2} + (1-\pi)\dfrac{\Sigma^2}{(x(1+t)+x^*)^2}$

where $x = b + d$, $x^* = b^* + d^*$, $X = x + x^*$ and $\Sigma^2 = \sigma_u^2 + \sigma_e^2 + \sigma_u^{2*} + \sigma_e^{2*}$

$$(18)\quad Var(P_d) = \pi Var(P_{ds}) + (1-\pi)Var(P_{dt}) = \pi \frac{\Sigma^2}{X^2} + (1-\pi)(1+t)^2 \frac{\Sigma^2}{(x(1+t)+x^*)^2}$$

where subscript s and t denote the specific tariff and ad valorem tariff respectively.

Thus, the variance of the world price after levying the alternative tariff is bigger than that of the ad valorem tariff and is less than that of the specific tariff. Similarly we can also get the variance of the domestic price and can conclude that the variance of the domestic price after levying the alternative tariff is greater than that of the specific tariff, and less than that of the ad valorem tariff.

Compound Tariff

A compound tariff is an additive form of the specific tariff and the ad valorem tariff so that it can be expressed by the following condition.

$$(19)\quad P_d = P_w(1 + t_c) + S_c = P_w + \lambda s + (1-\lambda)tP_w, \text{ where } 0 < \lambda < 1.$$

Where S_c and t_c denote the specific factor and ad valorem factor under compound tariff subject to $P_w(1+t_c)+S_c=P_w(1+t)=P_w+S$, i.e., the tariff burden in terms of price gap among the types of tariff is the same at the initial period of tariffication.

When a commodity is imported, this tariff system levies a specific tariff and an ad valorem tariff simultaneously. By the same procedure as used previously, the equilibrium world price and its variance can be solved under compound tariff.

$$(20)\quad P_w = \frac{a + a^* - c - c^* + u + u^* - e - e^* - (b+d)s_c}{(b+d)(1+t_c) + b^* + d^*}$$

and $$Var(P_w) = \frac{\Sigma^2}{(x(1+t_c)+x^*)^2}$$

where $x=b+d$, $x^*=b^*+d^*$ and $\Sigma^2 = \sigma_u^2 + \sigma_e^2 + \sigma_u^{2*} + \sigma_e^{2*}$.

From equation (20), we find the fact that the variance of world price under the compound tariff is greater than that of the ad valorem tariff, since $t_c < t$, however, it is less than that under the specific tariff. In other words, the compound tariff increases the price variability of the world market more than the ad valorem tariff, and less than the specific tariff. A compound tariff increases the price instability of the domestic market relatively less than that under the ad valorem tariff since (21) is less than (15) for $t_c < t$, while it increases the domestic price variability relatively more than that under the specific tariff.

$$(21)\ P_d = \frac{a + a^* - c - c^* + u + u^* - e - e^* - (b+d)s_c}{(b+d)(1+t_c) + b^* + d^*}(1+t_c) + s_c \text{ and}$$

$$Var(P_d) = \frac{\Sigma^2}{(x(1+t_c)+x^*)^2}(1+t_c)^2$$

where $s_c = \lambda s$, $t_c = (1-\lambda)t$, $x=b+d$, $x^*=b^*+d^*$ and $\Sigma^2 = \sigma_u^2 + \sigma_e^2 + \sigma_u^{2*} + \sigma_e^{2*}$.

The comparison with an alternative tariff is much more complicated and the result is somewhat ambiguous, but when we make some reasonable assumptions we can infer some implications. The difference of variances between the compound tariff and the alternative tariff depends on magnitudes of π and λ. Assuming all things are constant, the bigger magnitudes of π and λ are related to the greater effect of world price variability and the smaller effect of domestic variability. The price variances associated with various types of tariffs are summarized in Table1.

TABLE 1 The effects of various types of tariffs on price variability in domestic and world market

tariff	Domestic price (P_d) variance	World price (P_w) variance
Free trade(no tariff)	$\frac{\Sigma^2}{X^2} = \frac{\Sigma^2}{(x+x^*)^2}$	$\frac{\Sigma^2}{X^2}$
Specific	$\frac{\Sigma^2}{X^2}$	$\frac{\Sigma^2}{X^2}$
Ad valorem	$(1+t)^2 \frac{\Sigma^2}{(x(1+t)+x^*)^2}$	$\frac{\Sigma^2}{(x(1+t)+x^*)^2}$
Alternative	$\pi \frac{\Sigma^2}{X^2} + (1-\pi)(1+t)^2 \frac{\Sigma^2}{(x(1+t)+x^*)^2}$	$\pi \frac{\Sigma^2}{X^2} + (1-\pi) \frac{\Sigma^2}{(x(1+t)+x^*)^2}$
Compound	$\frac{\Sigma^2}{(x(1+t_c)+x^*)^2} (1+t_c)^2$	$\frac{\Sigma^2}{(x(1+t_c)+x^*)^2}$

IV. Conclusions

This paper has demonstrated that various types of tariffs, after conversion of non tariff barriers into tariffs, have very different effects on price variability in both the importing country and the exporting country. The price variances associated with various types of tariffs show that world price variability under the ad valorem tariff is less than under other types of tariffs, however the magnitude of domestic price variance is the smallest under the specific tariff. In other words, the specific tariff as per unit import tax relatively reduces the domestic price variability due to change in world price rather than other types of tariffs. The effect of imposing a tariff on world price variability tends to be increased under the specific tariff and decreased under the ad

valorem tariff.

To date, particularly with respect to agricultural products, most countries are interested in internal price stability rather than in world price stability in order to support the producer price of the domestic market generally. Thus, many countries insulate the domestic market from the world market through various non-tariff barriers. Many of these barriers are designed to stabilize domestic price by breaking the link to world price. It is true that the tariffication proposals by GATT promise to provide a framework for reducing trade barriers. However a drawback of such proposals is that the effect of various types of tariff on price variability is different depending on which tariff is selected by each country. For the future works, this analysis might be extended to explain why the type of tariff selected by countries is different by commodities and what is the welfare implications of consumer and producer from the selected tariffs.

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