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Agricultural trade liberalization and downstream market power: some extensions

Mohammad Mainul Hoque
Iowa State University

John R. Schroeter
Iowa State University, johns@iastate.edu

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Exports of agricultural commodities to developed countries play a significant role in the economies of many developing countries. The elimination of import tariffs has the potential to benefit producers in the developing countries, but estimates of the effect of trade liberalization typically assume perfect competition. Significant concentration in the food processing and retailing sectors of the U.S. and the EU undermine the plausibility of this assumption in the case of agricultural trade, however. Sexton, Sheldon, McCorriston, and Wang (SSMW, 2007) developed a model of the effects of trade liberalization that accounts for the vertically-linked and concentrated characteristics of the developed countries' food markets. Their principal qualitative finding is that an analysis based on the assumption of competitive conduct will overstate the effects of trade liberalization if food processing and retailing firms exercise market power. This result is sensitive to their choice of functional forms, however, as this paper demonstrates with an analysis in which SSMW's linearity assumption is replaced by constant elasticity specifications for supply and demand. We also extend the SSMW analysis by considering ad valorem tariffs, a case for which the results exhibit both qualitative and quantitative differences from those for the unit tariff case.

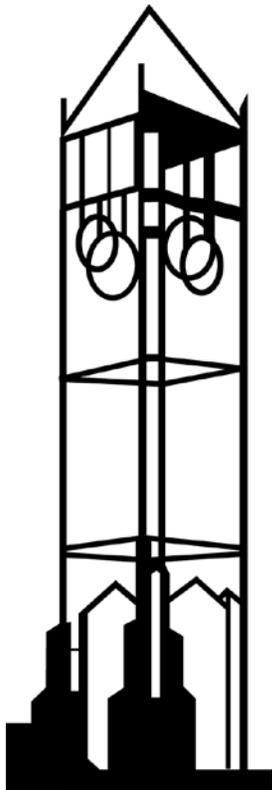# Agricultural Trade Liberalization and Downstream Market Power: Some Extensions

Mainul Mohammad Hoque, John R. Schroeter

IOWA STATE UNIVERSITY
Department of Economics
Ames, Iowa, 50011-1070

Agricultural Trade Liberalization and Downstream Market Power:

Some Extensions

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Mohammad Mainul Hoque

John R. Schroeter

Iowa State University

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Abstract: Exports of agricultural commodities to developed countries play a significant role in the economies of many developing countries. The elimination of import tariffs has the potential to benefit producers in the developing countries, but estimates of the effect of trade liberalization typically assume perfect competition. Significant concentration in the food processing and retailing sectors of the U.S. and the EU undermine the plausibility of this assumption in the case of agricultural trade, however. Sexton, Sheldon, McCorriston, and Wang (SSMW, 2007) developed a model of the effects of trade liberalization that accounts for the vertically-linked and concentrated characteristics of the developed countries' food markets. Their principal qualitative finding is that an analysis based on the assumption of competitive conduct will *overstate* the effects of trade liberalization if food processing and retailing firms exercise market power. This result is sensitive to their choice of functional forms, however, as this paper demonstrates with an analysis in which SSMW's linearity assumption is replaced by constant elasticity specifications for supply and demand. We also extend the SSMW analysis by considering *ad valorem* tariffs, a case for which the results exhibit both qualitative and quantitative differences from those for the unit tariff case.

1. Introduction.

Agriculture plays a key role in developing countries' economies. According to the United Nation's Food and Agriculture Organization, agriculture's share in developing countries' GDP is a little more than ten percent, but more than half of the economically active population is engaged in this sector (FAO 2004, Table A4). The majority of developing countries' export earnings come from a few agricultural commodities, and, therefore, trade in agriculture has more significant implications for the low income countries than for the rich countries. In recognition of these facts, increasing the access of low-income, agricultural commodity exporting countries to developed countries' markets has been one of the central issues in the last several rounds of World Trade Organization negotiations.

Motivated by the belief that increased access to developed countries' markets will boost producers' earnings and accelerate economic growth, developing countries advocate the elimination of high agricultural tariffs.[1] Agricultural imports from developing countries are used as raw materials for the food and beverage industries in the developed countries, however, and the impact of trade liberalization in agricultural commodity markets will depend on conduct in these industries. An increasing pace of consolidations and rising market concentration in developed countries' food processing and retailing sectors raises the prospect of non-competitive conduct by firms in these sectors.[2] Although most agricultural trade policy analyses in the literature rely on the competitive market paradigm, Sexton, Sheldon, McCorriston, and Wang (SSMW, 2007) have incorporated the vertically-linked and concentrated characteristics of developed countries' food markets in their analysis of the impact of agricultural trade liberalization on developing countries' economic development.[3] The SSMW model assumes price-taking behavior by farmers in the developing country and consumers in the developed country, but allows for possible oligopoly/oligopsony conduct by food processors and retailers in the developed country. Their main qualitative result is that an analysis based on the assumption of competitive conduct will *overstate* the impact of the removal of a tariff if firms exercise market power. Using their model, they calculate the magnitude of the upward bias in the competitive model's estimates of the effects of trade reform, for various patterns and degrees of market power in the developed country's marketing channel.

The SSMW model assumes linear farm supply and retail demand curves. As they note, however, the choice of a functional form for demand and supply is not innocuous in an analysis of tax incidence. In particular, their choice of linear specifications predestines their main qualitative finding of smaller effects of trade liberalization for the case of market power than for the case of perfect competition. SSMW also confine their analysis to the case of removal of a unit tariff, while noting that a natural extension would address the prevalent case of an *ad valorem* tariff. This case is of potential interest because an *ad valorem* tariff, unlike a unit tariff, changes the slope of the tax-inclusive supply curve, making it less elastic and increasing the potential for the exercise of oligopsony power.

In this paper, we extend the SSMW analysis in two obvious directions: We replace their linear demand and supply specifications with constant elasticity functional forms, and we investigate the effects of trade liberalization in the cases of both unit and *ad valorem* tariffs. The switch to constant elasticity functions reverses SSMW's finding that trade reform has a smaller impact with market power than with competitive conduct. The intuition for this result is straightforward and is presented in the next section. The results for unit and *ad valorem* tariffs have important qualitative as well as quantitative differences.

2. Extensions of the SSMW framework.

The choice of linear specifications for supply and demand predestines SSMW's finding of smaller effects of trade liberalization for the case of market power than for the case of perfect competition. Figures 1 and 2 illustrate the intuition of this result in a simple setting. There is a single marketing stage standing between farm supply of the raw commodity and retail demand for the final processed product. A fixed proportions relationship holds between quantities at the farm and retail levels, so that both quantities can be measured in the same units, and the marketing sector operates at constant marginal cost. In a perfectly competitive equilibrium with a tariff, depicted in Figure 1, the spread between the retail and farm prices, $P_r^* - P_f^*$, would be the sum of marginal marketing cost and the tariff wedge. The retail and farm prices and the tariff are observed; on the assumption of perfect competition, the portion of the price spread in excess of the tariff is attributed to marginal marketing cost. As a result of trade liberalization, the tariff

wedge is removed and equilibrium quantity increases from Q^* to Q^{**}, the point at which the farm-retail price spread is equal to marginal cost alone.

With a linear demand curve, marginal revenue for a monopoly marketing sector would be linear and twice as steep as demand. The tariff equilibrium in Figure 2 involves the same linear demand and supply curves, the same tariff wedge, and the same initial values for quantity and farm and retail prices as in Figure 1. But in Figure 2, this *status quo* tariff equilibrium is assumed to be a monopoly equilibrium leading to a different inference about the magnitude of marginal cost. Marginal marketing cost plus the tariff, in this monopoly equilibrium, determines the size of the gap between the farm price and *marginal revenue*, not the retail price. Eliminating the tariff shrinks this gap but, because the marginal revenue curve is steeper than demand, removal of the tariff wedge results in a smaller quantity adjustment in this case than in the case of competitive equilibrium. The distance between Q^* and Q^{**} is smaller in Figure 2 than in Figure 1.

Figure 2 illustrates the special case of monopoly equilibrium. In a monopsony case, equilibrium would occur at the quantity for which marginal marketing cost plus the tariff (if any) would equal the difference between the demand price and marginal factor cost. Because the marginal factor cost curve is linear and twice as steep as supply, the quantity adjustment resulting from the elimination of a tariff would also be smaller for monopsony than for perfect competition. Finally, any particular imperfectly competitive equilibrium could be characterized, in the familiar way, as an outcome in which marketing firms acted as if they faced a "perceived" marginal revenue curve (a weighted average of demand and marginal revenue) and a "perceived" marginal factor cost curve (a weighted average of supply and marginal factor cost). These curves would also be linear and steeper than demand (in the case of perceived marginal revenue) or supply (in the case of perceived marginal factor cost), so the model would also predict a smaller quantity response to trade liberalization for oligopoly/oligopsony than for perfect competition.

With constant elasticity specifications for both demand and supply, it is less clear how the effects of trade liberalization under market power would compare to predictions based on the assumption of competitive behavior. The constant elasticity functional form for either demand or supply (in inverse form) is

$$P = aQ^\beta,$$

where P is price, Q is quantity, and a is a positive constant. In the case of demand, $\beta = -1/\eta < 0$, where $\eta > 0$ is the absolute value of the elasticity of demand. In the case of supply, $\beta = 1/\varepsilon > 0$, where $\varepsilon > 0$ is the elasticity of supply. Marginal revenue or marginal factor cost are given by

$$\frac{d(PQ)}{dQ} = a(1 + \beta)Q^\beta,$$

and perceived marginal revenue or perceived marginal factor cost are given by $a(1 + \theta\beta)Q^\beta$, where θ, a "conduct parameter," is between 0 and 1. A value of 1 for θ corresponds to pure monopoly or monopsony whereas a value of 0 corresponds to competitive conduct. The slopes of demand/supply, on the one hand, and perceived marginal revenue/factor cost, on the other, are $a\beta Q^{\beta-1}$ and $a\beta(1 + \theta\beta)Q^{\beta-1}$, respectively. For supply, with $\beta > 0$, perceived marginal factor cost is steeper than supply at any given quantity, and we have the same qualitative result as in the case of linear functional forms: The effects of tariff elimination would be greater under competition than under oligopsony. For demand, however, with $\beta < 0$ (but $|\theta\beta| < 1$ to insure the positive perceived marginal revenue necessary for an equilibrium), demand is steeper than perceived marginal revenue. With a constant elasticity demand curve, the effects of trade reform would be smaller under competition than under oligopoly, a prediction that reverses the result for the linear case. In replacing SSMW's linear functional forms with constant elasticity specifications for both supply and demand, it is thus no longer clear *a priori* how the effects of trade reform in the presence of market power will compare to those in the competitive benchmark case. So to discover the direction of any bias in estimates based on the competitive paradigm, it is necessary to perform a simulation analysis using a model calibrated to reflect the quantitative features of real-world agricultural commodity markets.

The SSMW analysis investigated the effects of the removal of a unit tariff but, as they note, many real world tariffs are *ad valorem*. An *ad valorem* tariff makes the tax-inclusive supply curve of the farm commodity less elastic. This creates greater scope for the exercise of oligopsony power in the farm market: A given value for processors' oligopsony conduct parameter will translate into a greater pricing distortion the less elastic is the supply curve. This

means that there are greater potential benefits from the removal of an *ad valorem* tariff than from the removal of a unit tariff that involves the same dollar-per-unit tax assessment in equilibrium. So another goal of our analysis is to explore how the effects of trade liberalization differ for the cases of unit and *ad valorem* tariffs.

3. The Model.

SSMW consider a setting in which farms in a developing country produce and export a primary commodity to a developed country. The processors and retailers, which together comprise the downstream sector in the developed country, process the imported raw agricultural product and sell it to domestic consumers. Trade in the primary commodity is subject to a tariff (either unit or *ad valorem*) imposed by the developed country. Conversion of the farm product to the retail good does not allow substitution between the raw commodity and other inputs, so quantities at the farm, wholesale, and retail market stages can all be measured in retail-product-equivalent units, for example, and denoted by the same variable. Both processors and retailers operate at constant marginal cost. Producers in the developing country and consumers in the developed country are price-takers, whereas processors and retailers may exercise market power in their input and output markets.

Let Q denote the quantity of the good and let P_r, P_w, and P_f denote the retail, wholesale, and farm prices, respectively. The retail demand and farm supply functions can then be represented, in inverse form, by

$$P_r = D_r(Q) \text{ and } P_f = S_f(Q).$$

Adopting constant elasticity specifications, we have, for demand and supply respectively:

$$Q = AP_r^{-\eta_r} \text{ and } Q = BP_f^{\varepsilon_f},$$

where η_r is the absolute value of the elasticity of retail demand, ε_f is the elasticity of farm supply, and A and B are positive parameters. Expressed in inverse form, these become:

$$P_r = D_r(Q) = \left(\frac{Q}{A}\right)^{-1/\eta_r} \tag{1}$$

and $P_f = S_f(Q) = \left(\frac{Q}{B}\right)^{1/\varepsilon_f}.$ (2)

Let c_r and c_p denote the marginal costs for retailers and processors, respectively.

As in SSMW, we will consider three scenarios for the exertion of market power by processors and/or retailers. "Single stage market power" describes the case in which one stage, either processors or retailers, exercises market power in both its input and output markets while the other stage behaves competitively. In "successive oligopsony," retailers exert oligopoly power in their output (retail) market and oligopsony power in their input (wholesale) market, while processors are price takers in the wholesale market but exert oligopsony power over producers in the farm market. In "successive oligopoly," processors exert oligopsony power over producers in the farm market and oligopoly power over retailers in the wholesale market. Retailers are price takers in the wholesale market but exert oligopoly power over consumers in the retail market. Like SSMW, we do not treat the case of bilateral oligopoly in the wholesale market.

3.1. Single stage market power.

First assume that processors have some degree of market power in both their input and output markets while retailers behave competitively. More specifically, start with the special case of processor pure monopsony in the farm market and pure monopoly in the wholesale market. As price takers, retailers will purchase the wholesale product up to the point at which retail price is equal to the wholesale price plus retailers' marginal cost:

$$P_r = D_r(Q) = P_w + c_r,$$

confronting processors with the wholesale (inverse) demand function:

$$P_w = D_w(Q) \equiv D_r(Q) - c_r.$$ (3)

Profit for the processing sector is given by

$$\Pi_p = D_w(Q)Q - \left(S_f(Q) + T\right)Q - c_pQ,$$

for the case of a T dollar unit tariff, or

$$\Pi_p = D_w(Q)Q - (1+t)S_f(Q)Q - c_pQ,$$

for the case of an *ad valorem* tariff at proportionate rate t. For the unit tariff case, differentiating the profit function with respect to Q and setting the result to zero yields

$$P_w\left(1 - \frac{1}{\eta_w}\right) = P_f\left(1 + \frac{1}{\varepsilon_f}\right) + c_p + T,$$

where η_w is the absolute value of the elasticity of wholesale demand. Using equation (3) to substitute for P_w and η_w:

$$P_r\left(1 - \frac{1}{\eta_r}\right) = P_f\left(1 + \frac{1}{\varepsilon_f}\right) + c_r + c_p + T. \tag{4}$$

Equation (4), a first-order condition for the maximization of processor sector profit for the case of pure monopsony/monopoly, can be adapted to accommodate intermediate degrees of input and/or output market power through a standard device involving "conduct parameters." The result is

$$P_r\left(1 - \frac{\theta_w}{\eta_r}\right) = P_f\left(1 + \frac{\phi_f}{\varepsilon_f}\right) + c_r + c_p + T, \tag{5}$$

where θ_w reflects processors' degree of oligopoly power in the wholesale market and ϕ_f reflects processors' degree of oligopsony power in the farm market. A value of 1 for θ_w (ϕ_f) corresponds to pure monopoly (monopsony) while a value of 0 for θ_w (ϕ_f) corresponds to price taking behavior in the wholesale (farm) market. Thus, for the case of single stage market power in the hands of processors, and a unit tariff, equilibrium for the model is determined by equations (1), (2), (5), and (6):

$$P_w = P_r - c_r. \tag{6}$$

For the *ad valorem* tariff case, equation (5) is replaced by equation (5'):

$$P_r\left(1 - \frac{\theta_w}{\eta_r}\right) = P_f(1+t)\left(1 + \frac{\phi_f}{\varepsilon_f}\right) + c_r + c_p. \tag{5'}$$

The case of single stage market power in the hands of retailers (retailers have oligopoly/oligopsony power and processors are price takers) works out in a very similar fashion. The equilibrium for this case is described by equations (1), (2), (7), and (8):

$$P_r \left(1 - \frac{\theta_r}{\eta_r}\right) = P_f \left(1 + \frac{\phi_w}{\varepsilon_f}\right) + c_r + c_p + T, \qquad (7)$$

$$P_w = P_f + T + c_p, \qquad (8)$$

for the case of the unit tariff, and by equations (1), (2), (7'), and (8'):

$$P_r \left(1 - \frac{\theta_r}{\eta_r}\right) = P_f(1 + t)\left(1 + \frac{\phi_w}{\varepsilon_f}\right) + c_r + c_p, \qquad (7')$$

$$P_w = (1 + t)P_f + c_p, \qquad (8')$$

for the case of the *ad valorem* tariff. In these expressions, θ_r is a conduct parameter indexing retailers' degree of oligopoly power in the retail market and ϕ_w is a conduct parameter indexing retailers' degree of oligopsony power in the wholesale market. The range of values for these indices is, again, $0 - 1$, with 0 identifying price taking behavior and 1 corresponding to pure monopoly or monopsony conduct. Comparing equations (5) and (7), and equations (5') and (7'), it is clear that, in both the unit tariff and the *ad valorem* tariff cases, for given degrees of buyer and seller market power, the equilibrium values for P_r, P_f, and Q are independent of whether the market power is exercised by retailers or processors.

As noted in the previous section, SSMW's assumption of linear functional forms for supply and demand insures that the projected effects of trade liberalization will be smaller under market power than under competition. One other consequence of linear functional forms is that, in the case of market power, the model always predicts that profit of the marketing sector increases with trade liberalization. The marketing sector's profit margin is simply the sum of oligopoly and oligopsony distortions. Since linear specifications insure that these distortions always increase with quantity (for example, the vertical distance between demand and marginal revenue increases with quantity), and since trade liberalization always leads to an increase in quantity, marketing sector profit must go up as the tariff is removed. With our model's constant elasticity functional forms, this outcome is not assured. Consider the case of processors' market

power with a unit tariff, for example. The profit margin is $P_r - P_f - c_r - c_p - T$ so, from equation (5), processing sector profit is

$$\Pi_p = \left(P_r \frac{\theta_w}{\eta_r} + P_f \frac{\phi_f}{\varepsilon_f} \right) Q.$$

Substituting for P_r and P_f from equations (1) and (2) and differentiating:

$$\frac{d\Pi_p}{dQ} = \frac{\theta_w}{\eta_r} \left(1 - \frac{1}{\eta_r} \right) P_r + \frac{\phi_f}{\varepsilon_f} \left(1 + \frac{1}{\varepsilon_f} \right).$$

If demand is inelastic (an assumption reflected in the values we use later for calibration of the model), profit decreases with quantity, and therefore with trade liberalization, if there is oligopoly power only ($\phi_f = 0$), but increases with trade liberalization if there is oligopsony power only ($\theta_w = 0$).[4]

3.2. Successive oligopsony.

In this scenario, processors exercise oligopsony power over producers but are price takers in their output (wholesale) market, while retailers have market power in both their input (wholesale) and output (retail) markets. The first step is to derive processors' supply function and, to that end, we begin by assuming that processors have pure monopsony power over producers. For the case of a unit tariff, profit for the processing sector is

$$\Pi_p = P_w Q - \left(S_f(Q) + T \right) Q - c_p Q.$$

The first order condition is

$$P_w = S_f(Q) \left(1 + \frac{1}{\varepsilon_f} \right) + c_p + T,$$

which can be adapted to accommodate intermediate degrees of market power as follows:

$$P_w = S_f(Q) \left(1 + \frac{\phi_f}{\varepsilon_f} \right) + c_p + T, \tag{9}$$

where, as before, ϕ_f indexes processors' degree of oligopsony power. Equation (9) defines the supply function that retailers face in the wholesale market: $P_w = S_w(Q)$.

Retail sector profit is given by

$$\Pi_r = D_r(Q)Q - S_w(Q)Q - c_r Q,$$

leading to the first order condition

$$P_r\left(1 - \frac{\theta_r}{\eta_r}\right) = P_w\left(1 + \frac{\phi_w}{\varepsilon_w}\right) + c_r, \tag{10}$$

where θ_r, η_r, and ϕ_w are as previously defined and ε_w is the elasticity of wholesale supply. Using equation (2) to substitute for $S_f(Q)$ in equation (9) and solving yields:

$$Q = B\left(\frac{P_w - c_p - T}{1 + \frac{\theta_f}{\varepsilon_f}}\right)^{\varepsilon_f}.$$

Differentiating:

$$\varepsilon_w = \frac{dQ}{dP_w}\frac{P_w}{Q} = \varepsilon_f \frac{P_w}{P_w - c_p - T}.$$

Substituting this expression into equation (10), using equation (9) to substitute for P_w, and simplifying, the result is:

$$P_r\left(1 - \frac{\theta_r}{\eta_r}\right) = P_f\left(1 + \frac{\phi_f}{\varepsilon_f}\right)\left(1 + \frac{\phi_w}{\varepsilon_f}\right) + c_r + c_p + T. \tag{11}$$

Finally, for the successive oligopsony case with a unit tariff, equilibrium is described by equations (1), (2), (11), and (12), a slightly modified version of equation (9):

$$P_w = P_f\left(1 + \frac{\phi_f}{\varepsilon_f}\right) + c_p + T. \tag{12}$$

The successive oligopsony case with an *ad valorem* tariff is described by equations (1), (2), (11'), and (12'):

$$P_r\left(1 - \frac{\theta_r}{\eta_r}\right) = P_f(1 + t)\left(1 + \frac{\phi_f}{\varepsilon_f}\right)\left(1 + \frac{\phi_w}{\varepsilon_f}\right) + c_r + c_p \tag{11'}$$

$$P_w = P_f(1 + t)\left(1 + \frac{\phi_f}{\varepsilon_f}\right) + c_p \tag{12'}$$

3.3. Successive oligopoly.

In this scenario, retailers exercise oligopoly power over consumers but are price takers in their input (wholesale) market, while processors have market power in both their input (farm) and output (wholesale) markets. In this case, the analysis begins with a derivation of retailers' demand for the wholesale product, and proceeds to a first order condition characterizing profit maximization for the processing sector. Omitting details, equilibrium, in the case of the unit tariff, is determined by equations (1), (2), (13), and (14):

$$P_r \left(1 - \frac{\theta_r}{\eta_r}\right)\left(1 - \frac{\theta_w}{\eta_r}\right) = P_f \left(1 + \frac{\phi_f}{\varepsilon_f}\right) + c_r + c_p + T \tag{13}$$

$$P_w = P_r \left(1 - \frac{\theta_r}{\eta_r}\right) - c_r \tag{14}$$

In the case of the *ad valorem* tariff, equilibrium is determined by equations (1), (2), (13'), and (14):

$$P_r \left(1 - \frac{\theta_r}{\eta_r}\right)\left(1 - \frac{\theta_w}{\eta_r}\right) = P_f(1 + t)\left(1 + \frac{\phi_f}{\varepsilon_f}\right) + c_r + c_p \tag{13'}$$

4. Calibrating and Solving the Model.

Our analysis of the effects of trade liberalization will use the following approach. We will first calibrate the model to insure that its *status quo* tariff equilibrium reflects representative values for supply and demand elasticities, and for the tariff's and farmers' shares of retail price. Then we will consider various scenarios for market power in the marketing channel. Each scenario will imply a different breakdown of the after-tariff balance of the farm-retail price spread into marginal processing and retailing costs, on the one hand, and oligopoly/oligopsony pricing distortions, on the other. For each scenario, we will use the first-order condition for the appropriate model to solve for the implied value of marginal marketing cost, $c_r + c_p$. Holding marginal cost fixed at this level and setting the tariff parameter equal to zero, the model will then be re-solved to determine the free trade values of Q, P_r, and P_f.

As an illustration of this exercise, consider the case of a unit tariff and the market power scenario of successive oligopsony characterized by specific values for the conduct parameters, θ_r, ϕ_f, and ϕ_w. Given assumed demand and supply elasticities, and calibrated values for P_r, P_f, and T, equation (11) can be solved for $c_r + c_p$. Holding marginal cost fixed at this level, setting T equal to zero to reflect trade liberalization, and substituting from equations (1) and (2) with calibrated values of demand and supply parameters A and B, equation (11) becomes an equation nonlinear in a single unknown, Q. It can be solved by numerical methods for the free-trade equilibrium value for quantity. Substitution back into equations (1) and (2) gives the free-trade equilibrium values of retail and farm prices.[5]

In their simulation analysis, SSMW calibrated the model to reflect representative values for supply and demand elasticities, and for the farmers' and the tariff's share of the retail price. But their calibration method imposed these representative values at a hypothetical free-trade competitive equilibrium, rather than at the actual *status quo* equilibrium, which involved a tariff and was assumed to incorporate market power. This leads, in some cases, to sizeable differences between these representative values and the actual *status quo* equilibrium values of the parameters.[6] Thus, their comparisons of the impact of trade reform for different assumptions about the degree of *status quo* market power confound the effects of changing conduct with the effects of changing demand and supply elasticities. To avoid this problem we calibrate our model to exhibit representative elasticities and the farmers' and the tariff's shares of retail price at the *status quo* equilibrium instead of at the free-trade competitive equilibrium.

To begin, we normalize units so that the initial tariff equilibrium quantity corresponds to $Q^* = 100$, and the initial tariff equilibrium producers' price (net of the tariff) corresponds to $P_f^* = 1$. From equation (2), this fixes the value of B at 100, regardless of the value of supply elasticity. SSMW cite representative examples of imported agricultural commodities for which the farmers' share of retail price is in the range of 5% to 10%. We calibrate the model to a *status quo* tariff equilibrium retail price of $P_r^* = 15$, implying a farmers' share of 6.67%. With $Q^* = 100$, $P_r^* = 15$, and given a value for demand elasticity, equation (1) fixes the value of the demand parameter: $A = 100/15^{-\eta_r}$. We assume retail demand and farm supply elasticities of 0.6 ($\eta_r = \varepsilon_f = 0.6$), as do SSMW. Finally, again following SSMW, we consider the effects of

elimination of a tariff, either unit or *ad valorem*, that, in the *status quo* equilibrium, amounts to 20% of the farm price. Thus we take T or tP_f^* to be 0.2, implying that $t = 0.2$.

5. Simulation Results.

Using the normalizations and the methods described in the previous section, we simulated the effects of trade liberalization for both unit and *ad valorem* tariffs for each of the following market power scenarios: single-stage, oligopsony only; single-stage, oligopoly only; single-stage, oligopoly and oligopsony; successive oligopsony; and successive oligopoly. Once again, "successive oligopsony" refers to retailer oligopoly and oligopsony combined with processor oligopsony. And "successive oligopoly" refers to processor oligopoly and oligopsony combined with retailer oligopoly. For the cases in which market power is exercised in more than one market, the simulations could be performed for any combinations of values for the conduct parameters. For purposes of illustration only, we show results for the symmetric cases in which all non-zero conduct parameters share a common value. So for the case of successive oligopsony, for example, we show results for cases in which $\theta_r = \phi_f = \phi_w$.

The results of the simulations are presented in Figures 3 and 4. These figures depict the quantity impacts of trade liberalization for each of the market power scenarios described above, with symmetric conduct parameter values in the range $[0, 0.35]$, and for both unit (Figure 3) and *ad valorem* (Figure 4) tariffs.[7] In each case, the quantity effects of removal of the tariff are expressed as a proportion of the quantity effect that the model would predict based on an assumption of competitive conduct.[8] Thus the focus of these Figures is on the errors that would result if forecasts of the impact of trade liberalization were based on an erroneous assumption of competitive conduct.

For the case of market power and a unit tariff, Figure 3 shows that projections undertaken assuming competition would overstate the true effects only in the case of single-stage oligopsony, and then only slightly. For example, with single-stage oligopsony and $\phi = 0.35$, the actual quantity impact of the removal of a unit tariff would be 96.4% of that predicted for the competitive case. For any scenario involving oligopoly power in at least one stage, the actual effects of trade liberalization exceed those that would be calculated based on the competitive

paradigm, and sometimes quite dramatically so. For example, in the successive oligopoly case with conduct parameter values of 0.35, the quantity effect would be 3.86 times larger than in the competitive case. Again, these findings contrast with SSMW's results based on a model in which the assumption of linear functional forms guarantees smaller impacts for the market power cases.

In another departure from SSMW's results, the incorporation of additional layers of market power does not always affect trade liberalization's impacts monotonically. For example, with a unit tariff, oligopsony (only) in the retail stage, and $\phi = 0.25$, the quantity effect of the removal of the tariff is 0.974 times the quantity effect for competition. With the retail sector exercising oligopoly power over consumers as well as oligopsony power over processors, and $\theta = \phi = 0.25$, the quantity effect increases to 1.580 times the competitive effect. But now adding another layer of market power, oligopsony at the processor level to give us our "successive oligopsony" scenario, the quantity effect for $\theta = \phi = 0.25$ falls to 1.491 times the competitive effect. In general, the addition of a new oligopoly stage to a given market power scenario increases the effects of trade reform, whereas the addition of a new oligopsony stage slightly mitigates them. The discussion in Section 2 provides the intuition for this result. For oligopsony with a constant elasticity supply curve, as with a linear supply curve, the perceived marginal factor cost curve is steeper than supply, insuring a smaller quantity adjustment to the removal of a tariff wedge. For oligopoly, perceived marginal revenue is flatter than demand and the quantity adjustment is magnified.

With a unit tariff, as Figure 3 illustrates, the introduction of oligopsony power at one or more stages tends to mitigate the effects of trade liberalization because perceived marginal factor cost is steeper than supply. For the *ad valorem* tariff case with oligopsony power, there is a countervailing effect: An *ad valorem* tariff makes the supply curve facing processors less elastic thus increasing the scope for the exercise of market power and increasing the oligopsony distortion for any given conduct parameter value. Eliminating an *ad valorem* tariff thus tends to reduce the oligopsony distortion at a given quantity and this, by itself, would lead to a bigger quantity response to trade liberalization. Figure 4's plot of the effects of tariff removal for the *ad valorem* case shows that this second effect outweighs the first. Even for the case of single-stage oligopsony, the effects of trade liberalization are greater (with $\phi = 0.35$, for example, 1.534

times greater) than the projected effects based on an assumption of competition. Moreover, adding an oligopsony stage to a particular market power scenario always increases the impact of the removal of the tariff. For example, starting with oligopoly power at the retail stage only, and $\theta = 0.25$, the quantity effect is 1.649 times the competitive effect. Adding oligopsony at the retail stage, with $\phi = \theta = 0.25$, the effect increases to 2.250 times the competitive effect. Going from single stage oligopoly and oligopsony at the retail level to successive oligopsony by adding oligopsony power at the processor level, the quantity impact, with $\phi = \theta = 0.25$, jumps to 3.026. There is also a significant difference in the magnitudes of the effects of trade liberalization for the unit tariff and *ad valorem* tariff cases. For example, with a unit tariff and successive oligopoly with conduct parameters equal to 0.1, the quantity effects of removal of the tariff are 38.5% greater than the effect with competition. With an *ad valorem* tariff, the same market power scenario, and the same conduct parameter values, the quantity effect is 61.9% greater than that predicted for competition.

6. Conclusion.

For many developing countries, the majority of their export earnings are attributable to agricultural commodities sold to developed countries and subject to tariffs. The removal of these tariffs will increase the volume of trade and the prices received by developing country producers. But because these commodities are used as inputs in the food processing and retailing industries of the developing countries, firm conduct within these industries will have an influence on the magnitudes of the effects of trade liberalization. Sexton, Sheldon, McCorriston, and Wang (SSMW, 2007) carried out an analysis of the role of downstream market power in determining the effects of trade liberalization for the case of a unit tariff. Their model predicts more modest impacts of trade reform when firms in the processing and retailing sectors exercise market power than when they behave competitively. Unfortunately, that qualitative result is sensitive to their choice of linear forms for the farm supply and retail demand functions, as we show with our extension to the case of constant elasticity specifications. We also consider the case of an *ad valorem* tariff which is shown to have results that differ both qualitatively and quantitatively from the results for the unit tariff case.

Notes:

1. The belief that liberalization of trade is beneficial to producers in developing countries is not universally accepted. McMillan *et al.* (2002) and Wilcox and Abbott (2004) discuss examples from the Mozambique cashew nut sector and the Ivory Coast cocoa market, respectively, in which the gains from liberalization appear to have largely been captured by processors or exporters in the developing countries rather than farmers.

2. Sexton, *et al.* (2007) summarize the findings of several studies detailing the extent of concentration in food processing and retailing in the U.S. and the EU.

3. Ahn and Lee (2010) is one recent example of agricultural trade policy analysis that accounts for market power in the food marketing channel.

4. In the case of an *ad valorem* tariff with oligopsony power, trade liberalization is more likely to result in a decrease in marketing sector profit. In this case, elimination of the tariff makes the supply curve more elastic and therefore reduces the scope for the exercise of oligopsony power and, for a given conduct parameter, reduces the oligopsony distortion at any given quantity.

5. A decomposition of marginal marketing cost, $c_r + c_p$, into processors' and retailers' shares would be required in order to use equation (12) to solve for the free-trade equilibrium value of wholesale price, P_w.

6. For example, SSMW imposed supply and demand elasticities of 0.6 at the free-trade competitive equilibrium. But, in their "successive oligopsony" case, with uniform values of 0.2 for the conduct parameters, the actual demand and supply elasticities at the tariff equilibrium are 1.20 and 0.45, respectively. For successive oligopsony with conduct parameter values of 0.4, the corresponding elasticities are 1.65 and 0.34.

7. The structure of the model imposes restrictions on the range of relevant values for the conduct parameters. For example, equation (13') for the successive oligopoly, *ad valorem* tariff case must be consistent with positive marginal cost in order to be meaningful. Given the model's normalizations for prices ($P_r = 15$ and $P_f = 1$), and the calibrated values of the model's parameters ($\eta_r = \varepsilon_f = 0.6$ and $t = 0.2$), and assuming symmetric conduct parameter values, this requires $\theta_r = \theta_w = \phi_f < 0.3828$. The other market power scenarios, for both *ad valorem* and unit tariffs, are less restrictive in this respect. Thus limiting attention to conduct parameter values in the interval $[0, 0.35]$ will insure consistency for all of the cases.

8. The comparisons of quantity effects between market power and competitive scenarios are quite reflective of the corresponding comparisons for other magnitudes of interest. For example, in the case of a unit tariff and single stage market power with $\theta = \phi = 0.2$, Figure 3 shows that the quantity effect of trade liberalization would be 41.6% greater than the quantity effect of the removal of the tariff in the competitive case. Likewise, the effects on P_r, P_f, and consumer and producer surplus in this market power case would exceed the impacts that the competitive model would predict for these variables by amounts ranging from 40.9% to 42.1%.
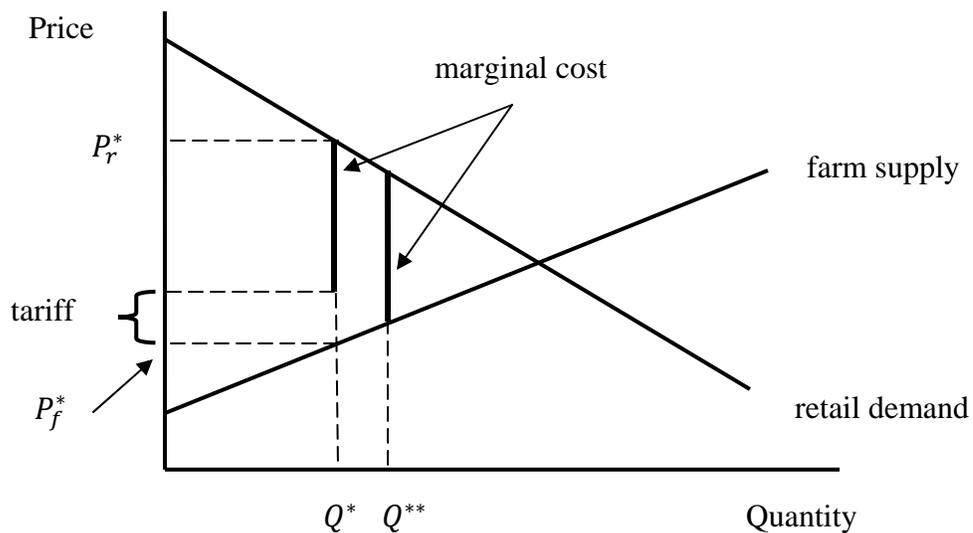
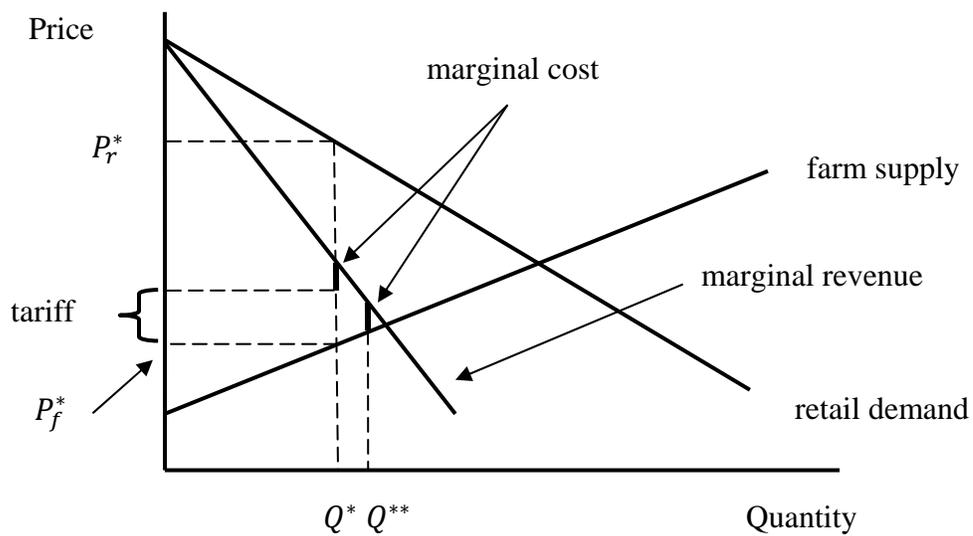Figure 1. The effects of trade liberalization with competition.

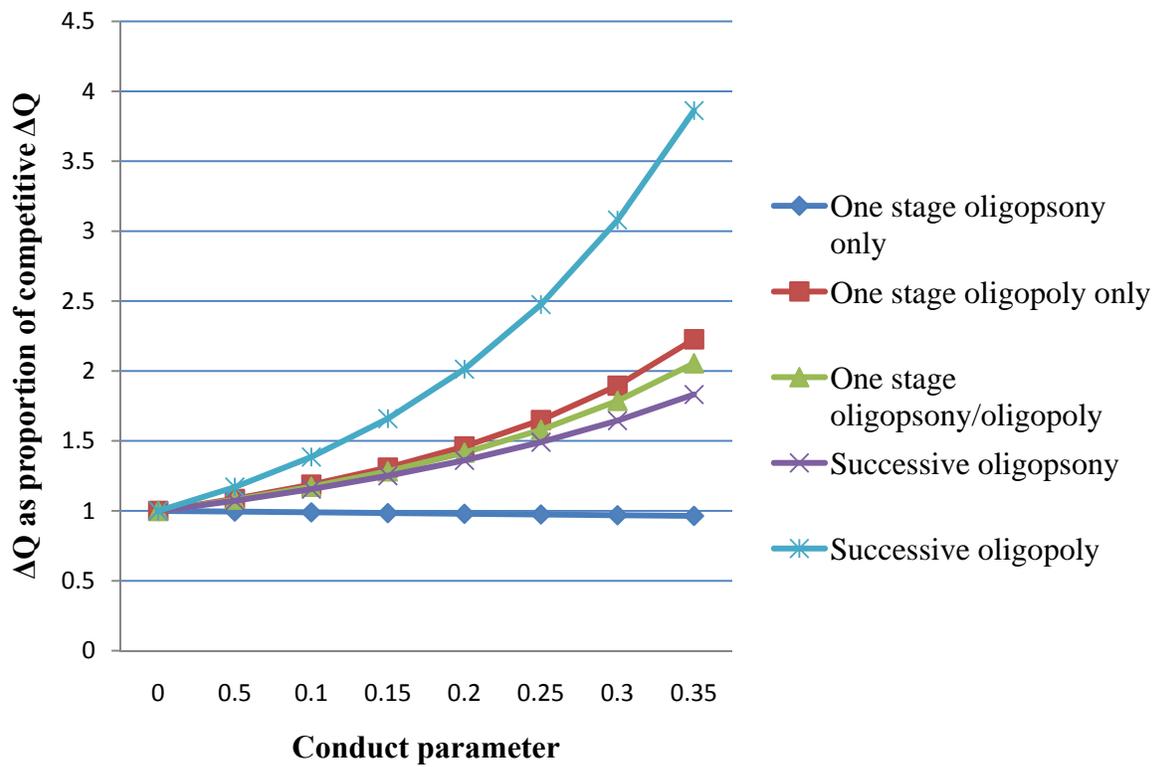Figure 2. The effects of trade liberalization with monopoly.

Figure 3. Quantity effects of trade liberalization – unit tariff case.
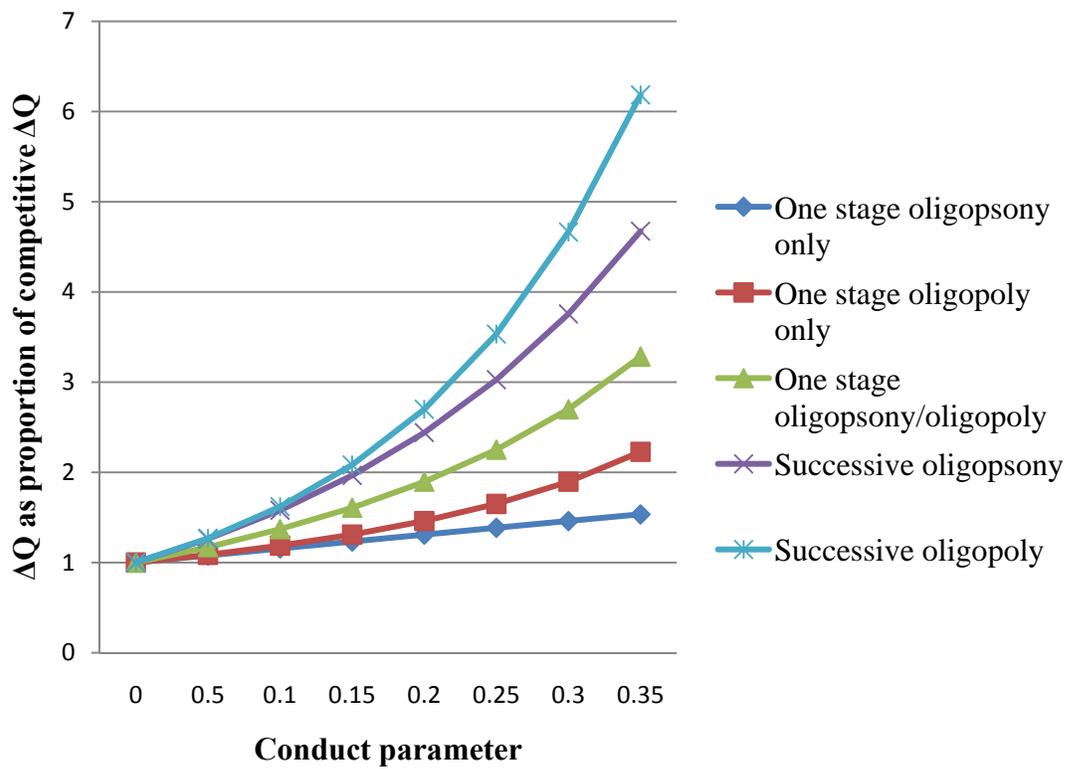
Figure 4. Quantity effects of trade liberalization – *ad valorem* tariff case.

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