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Export Subsidies and Profit-Shifting in Vertical Markets

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This study examines the interaction between export subsidies and profit-shifting in a vertical production system consisting of agricultural commodity production, and intermediate and final good processing, where the latter two stages may be characterized by imperfect competition. Using a model with general functional forms for demand, comparative statics indicate that an export subsidy to an unprocessed agricultural commodity, under certain circumstances, can have greater profit-shifting effects at the final processing stage compared to an export subsidy targeted at the final processed good.

Key words: export subsidies, profit-shifting, vertical markets

Introduction

A key outcome of the Uruguay Round Agreement on Agriculture (URAA) of GATT was the imposition of meaningful restraints on the use of agricultural export subsidies. Notwithstanding this, very few countries either have actually changed their policies substantially in order to conform with the commitments they made on signing of the URAA, or have made plans to reduce their export subsidy commitments in the future [U.S. Department of Agriculture (USDA)]. Use of export subsidies worldwide averaged $8.4 billion over 1995–96, with the European Union (EU) accounting for about 84% of the value of these subsidies. Even though U.S. expenditures on export subsidies through the Export Enhancement Program (EEP), and other subsidy programs, are considerably smaller than those incurred by the EU, expenditures rose to $121 million in 1996 (USDA).[1]

Since the inception of EEP and other export subsidy programs, several studies have examined the impact of such subsidies, with most focusing on the domestic and international price effects of wheat export subsidies (e.g., Abbott, Paarlberg, and Sharples; Bohman, Carter, and Dorfman; Anania, Bohman, and Carter). A characteristic of this particular research has been the focus on a single market level, that of the unprocessed agricultural commodity subject to the export subsidy. Very little research has focused

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[1] Other U.S. programs include the GSM-102/103, export credit guarantee program, and the Foreign Market Development and Market Promotion Programs (Ackerman, Smith, and Suarez).

on the interaction between export subsidies at different stages of the food system—essentially ignoring the fact that while the U.S. has typically targeted most of its export subsidies at unprocessed agricultural commodities (such as wheat and oilseeds), the EU has targeted nearly 70% of its export subsidies to high-value products (including processed food products such as vegetable oils and pasta) (Ackerman, Smith, and Suarez). Such a gap in research is also surprising in light of the argument that targeting export subsidies at high-value products will generate greater economic benefits than export subsidies to unprocessed agricultural commodities (Ackerman, Smith, and Suarez; Paarlberg).

An exception to the above discussion is a study by Paarlberg, who examined the effects of export subsidies in the case of an unprocessed agricultural commodity (wheat) which can be processed into an intermediate good (wheat flour), where both goods are exported and export subsidies can be targeted at either of the two levels of the production system. Paarlberg, however, did not consider the possibility that part(s) of a multi-stage production system is (are) imperfectly competitive. In both the U.S. and EU, intermediate processing has quite concentrated market structures. For example, in oilseed crushing, the four-firm concentration ratio is estimated to be 83% in the U.S. (Larson), and 85% in the EU (Scoppola), while in flour milling, the four-firm concentration ratio is 70% in the U.S. (Wilson), and ranges from an average of 30% in France and Germany (Sutton) to 81% in the United Kingdom (Bodjduniak and Sturgess). In the case of final good processing, there is substantial empirical evidence to suggest it is concentrated in both the U.S. and EU (Connor and Schiek; Strak and Morgan; Sutton), and that firms in this sector may exercise oligopolistic power (Bhuyan and Lopez).

Given there is some potential for imperfectly competitive behavior, and hence monopoly profits in the intermediate and final good processing stages of the food system, the general issue of interest in this analysis is the extent to which export subsidies can have different profit-shifting effects depending on the point in the vertical system where the export subsidy is used; i.e., does it matter whether an export subsidy is targeted at either the unprocessed agricultural commodity, the intermediate good, or the final processed good?

The use of trade policies in vertical markets has been broadly addressed in a series of papers in the international economics literature by Spencer and Jones (1991, 1992), and more recently by Ishikawa and Spencer. In Spencer and Jones (1991), the market structure is one where, in the home country, there is a vertically integrated firm controlling exports of both an intermediate and a final good. This firm then competes in a foreign country with a firm that produces the final good, and also has the option of either importing the intermediate good or producing it at higher cost. In the absence of trade in the intermediate good, and assuming Cournot interaction between the two firms producing the final good, the optimal policy for the home country is one of subsidizing exports of the final good, which is essentially the Brander and Spencer (1985) result. In the case of trade in intermediate and final goods, if profit margins are higher for trade in the former, the optimal policy is a tax on exports of the final good in order to shift toward trade in the intermediate good.

In the case of the foreign country, if the home country supplier of the intermediate good has the opportunity to engage in vertical foreclosure, and again assuming Cournot competition in the final good market, Spencer and Jones (1992) show it is optimal for the foreign government to tax imports of the final good. This strategy has the effect of reducing the profit margin on the final good for the home firm relative to the profits it can earn from exporting the intermediate good, hence reducing its incentive to vertically foreclose in the intermediate good. Consequently, by shifting market share to the foreign competitor, the tariff on the home final good generates an increase in demand for the imported intermediate good.

Ishikawa and Spencer use a similar type of structure, except foreign firms supply the intermediate good. Based on their findings, the case for an export subsidy to the home firm is somewhat weakened as rents are shifted to the foreign intermediate good producers, assuming Cournot competition in both the intermediate and final good markets. Conversely, given appropriate demand conditions, an export subsidy to the home firm can have beneficial effects because it reduces the inefficiency due to double-marginalization, generating a terms-of-trade gain on imports by the home country of the intermediate good.

In this study we also examine the interaction between export subsidies and profit-shifting in a vertical production system, where each stage of production downstream from agriculture may be characterized by imperfect competition. While we adopt a market structure very similar to the earlier research cited above, our focus is on comparing the profit-shifting effect for the case where an export subsidy can be targeted at either a final processed good or at an unprocessed agricultural commodity, where the latter enters the production process for an intermediate good subsequently used in production of the final processed good. Our analysis is designed to capture the earlier observation that some countries (such as the U.S.) have typically targeted export subsidies at unprocessed agricultural commodities, while others (such as the EU) have focused on processed food products.

The remainder of the article is organized as follows. In the next section, a model of a vertical production system is developed using a general functional form for demand. Comparative statics of introducing different export subsidies are then explored, followed by an examination of the sensitivity of the results to model assumptions. In the final section, we provide a summary of the analysis and draw some policy implications.

A Theoretical Model

As illustrated in figure 1, the vertical structure analyzed here consists of three stages: an agricultural sector, an upstream intermediate processing sector, and a final processing sector. Oligopoly in the downstream final processing sector is modeled as a Nash equilibrium in outputs. A home and a foreign processing firm compete in the downstream final goods market in a third-country import market. Both downstream firms process an intermediate good supplied to them by a single upstream processing firm in their respective countries. We assume there is no trade in the intermediate good, implying the home and foreign intermediate processing firms only compete with each other indirectly via derived demand effects. In turn, the upstream firms process an agricultural commodity, where the foreign upstream firm can import the agricultural commodity from the world market as well as utilize domestic sources. The technology of production is assumed to be one of fixed proportions, whereby one unit of the intermediate good is required to produce one unit of the final good. Arms-length pricing between the upstream and downstream stages is also assumed, so that downstream firms take upstream prices as given. In addition, agricultural commodity prices are treated as exogenous.

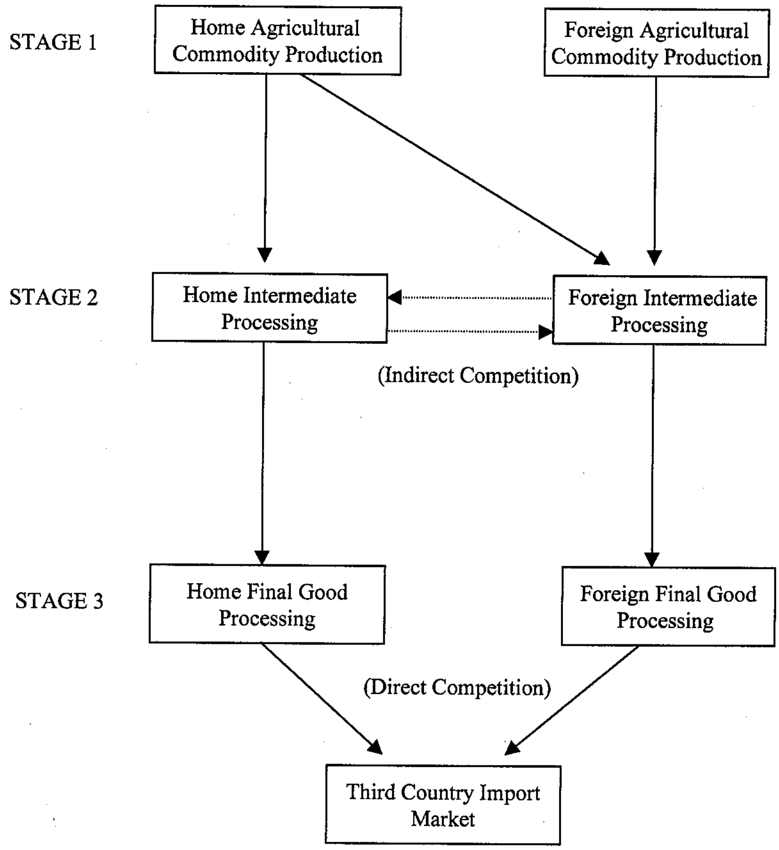

Figure 1. Vertical market share

In terms of timing, it is assumed upstream firms make their decisions first, followed by downstream firms. Given agricultural commodity prices, and derived demand for the intermediate good, the upstream processing firms act as profit-maximizing monopolists. The equilibrium prices of the intermediate good are then taken as given by the downstream processing firms who set output to maximize profits, generating a Nash equilibrium in the final goods market. Further, if policy instruments such as export subsidies are used, government is assumed to set the policy prior to firms making their profit-maximizing choices so that the overall equilibrium is sub-game perfect. This assumption rules out noncredible behavior by firms; i.e., a firm playing Nash at the downstream stage is only able to increase output if its government has already pre-committed to an export subsidy (see Brander and Spencer 1985). To solve the model, equilibrium is derived for the downstream market first, and then the upstream market.

While the market structures of the intermediate and final good processing sectors are relatively simple, they do capture the stylized facts about market structure outlined in the previous section; i.e., markets in the intermediate and final processing sectors are concentrated, generating the possibility of imperfectly competitive behavior, and hence monopoly profits. The upstream and downstream markets could be modeled more generally as n-firm oligopolies in a manner similar to Ishikawa and Spencer. This, however, adds unnecessary mathematical complexity, and (as will be discussed later) affects only the magnitude of the effects and not the direction.

Equilibrium in the Downstream Processing Market

Letting h and f be the quantities of the final good sold by the home and foreign downstream processing firms, respectively, the relevant inverse demand functions in the importing country can be written as follows:

(1) $$p_h(h, f)$$

and

(2) $$p_f(h, f),$$

where p_h and p_f are the respective prices of the home and foreign downstream processing firms. These functions satisfy the following properties, with the second subscript being the relevant first derivative: $p_{h,h} < 0$, $p_{f,f} < 0$ (downward-sloping demands); $p_{h,f} < 0$, $p_{f,h} < 0$ (substitute products); $p_{h,f} = p_{f,h}$ (Slutsky symmetry); and $p_{h,h}p_{f,f} - p_{h,f}p_{f,h} \geq 0$, with equality if the final goods are perfect substitutes (see Dixit 1986). Given (1) and (2), the relevant downstream profit functions are written as:

(3) $$\pi_h(h, f; z_h) = p_h(h, f)h - (c_h - z_h)h$$

and

(4) $$\pi_f(h, f; z_f) = p_f(h, f)f - (c_f - z_f)f,$$

where c_h and c_f are the downstream firms' marginal costs in terms of the purchase of the intermediate good, and z_h and z_f can be interpreted as shocks to each firm's marginal cost—for example, either a per unit export subsidy to the processed good paid by the foreign government ($z_f > 0$), a change in the price of the intermediate good (e.g., $z_h < 0$, $z_f > 0$), or a per unit tariff levied by the importing country ($z_f < 0$).

The first-order conditions for profit maximization are denoted by:

(5) $$\pi_{h,h} = p_h(h, f) + h \cdot p_{h,h} - c_h + z_h = 0$$

and

(6) $$\pi_{f,f} = p_f(h, f) + f \cdot p_{f,f} - c_f + z_f = 0.$$

Expressions (5) and (6) can be interpreted as implicit reaction functions for the home and foreign downstream processing firms, respectively, representing the optimal output choice for each firm given the output choice of the other firm. Simultaneous solution of the first-order conditions generates the Nash equilibrium in outputs for the downstream market, derived by totally differentiating (5) and (6):

(7) $$\pi_{h,hh}dh + \pi_{h,hf}df + \pi_{h,hz}dz_h = 0$$

and

(8) $$\pi_{f,fh}dh + \pi_{f,ff}df + \pi_{f,fz}dz_f = 0.$$

For ease of analysis, (7) and (8) can be rearranged in matrix form:

(9) $$\begin{bmatrix} \pi_{h,hh} & \pi_{h,hf} \\ \pi_{f,fh} & \pi_{f,ff} \end{bmatrix} \begin{bmatrix} dh \\ df \end{bmatrix} = \begin{bmatrix} -dz_h \\ -dz_f \end{bmatrix}.$$

In what follows, the interest is in determining the comparative static effects of varying the downstream processing firms' costs of purchasing the intermediate good, and the effects of varying the per unit subsidy/tariff, i.e., dz_i $\{i = h, f\}$. Given (9), the solution to the system is found by rearranging in terms of dh and df and inverting, where Δ is the determinant of the π matrix in (9), containing the own- and cross-effects of changes in output on downstream firms' marginal profits:

$$\begin{bmatrix} dh \\ df \end{bmatrix} = \frac{1}{\Delta}\begin{bmatrix} \pi_{f,ff} & -\pi_{h,hf} \\ -\pi_{f,fh} & \pi_{h,hh} \end{bmatrix}\begin{bmatrix} -dz_h \\ -dz_f \end{bmatrix}. \tag{10}$$

For stability of the Nash equilibrium, the diagonal of the π matrix must be negative, where the second-order conditions are $\pi_{h,hh} < 0$ and $\pi_{f,ff} < 0$. Also, the determinant Δ must be positive, i.e., $\Delta \equiv (\pi_{h,hh}\pi_{f,ff} - \pi_{h,hf}\pi_{f,fh}) > 0$ (see Brander and Spencer 1984, 1985; Dixit 1986).

The latter stipulation is implied by the following conditions: $\pi_{h,hf} < 0$ and $\pi_{f,fh} < 0$, and also $|\pi_{h,hh}| > |\pi_{h,hf}|$ and $|\pi_{f,ff}| > |\pi_{f,fh}|$. The first condition states that the home (foreign) firm's marginal profit declines in the output of the foreign (home) firm. This is the case of "normal" Nash-Cournot behavior, where firms' reaction functions are downward-sloping, and (to use Bulow, Geanakoplos, and Klemperer's terminology) each firm regards its good as a *strategic substitute* for the other firm's good. From the second condition, the own-effect of output on a firm's marginal profits outweighs cross-effects, where the condition is satisfied as long as marginal cost is nondecreasing (see Brander and Spencer 1985).

Equilibrium in the Upstream Processing Market

Rearranging the first-order conditions (5) and (6) gives the inverse derived demand functions facing the upstream processing firms, where the downstream firms' costs c_i $\{i = h, f\}$ are equivalent to the upstream firms' prices p_i^u $\{i = h, f\}$, and z_i $\{i = h, f\}$ are the downstream policy instruments that shift the inverse derived demand curves facing upstream firms:

$$p_h^u(h, f) + z_h \tag{11}$$

and

$$p_f^u(h, f) + z_f. \tag{12}$$

Firms' profits at the upstream stage can then be written as:

$$\pi_h^u(h, f; z_h^u, z_h) = p_h^u(h, f)h - (c_h^u - z_h^u - z_h)h \tag{13}$$

and

$$\pi_f^u(h, f; z_f^u, z_f) = p_f^u(h, f)f - (c_f^u - z_f^u - z_f)f, \tag{14}$$

where c_i^u $\{i = h, f\}$ are the costs to upstream processing firms of purchasing the agricultural commodity, and $h(f) = h^u(f^u)$ given the assumption of fixed proportions. The notation z_i^u $\{i = h, f\}$ can be interpreted as shocks to upstream firms' marginal costs. For example, an export subsidy targeted to the unprocessed agricultural commodity will affect these costs. Equilibrium for the upstream market is derived in a manner similar to the downstream market, and can be represented by:

$$\begin{bmatrix} dh^u \\ df^u \end{bmatrix} = \frac{1}{\Delta^u} \begin{bmatrix} \pi^u_{f,ff} & -\pi^u_{h,hf} \\ -\pi^u_{f,fh} & \pi^u_{h,hh} \end{bmatrix} \begin{bmatrix} -(dz^u_h + dz_h) \\ -(dz^u_f + dz_f) \end{bmatrix}. \tag{15}$$

Note, even though each upstream processing firm is assumed to be a monopoly supplier to each downstream firm, changes in output by either upstream firm affect the marginal profits of the other upstream firm through their derived demand curve, given changes in output by the downstream processing firms. Hence, both own-effects and cross-effects on firms' marginal profits are included in the upstream equilibrium matrix. Similar conditions to the case of the downstream equilibrium described in (10) are assumed for the π^u matrix in (15), containing the own- and cross-effects of changes in downstream and upstream output on upstream firms' marginal profits, i.e., $\Delta^u > 0$, $\pi^u_{h,hf} < 0$, $\pi^u_{f,fh} < 0$, $|\pi^u_{h,hh}| > |\pi^u_{h,hf}|$, and $|\pi^u_{f,ff}| > |\pi^u_{f,fh}|$.

Comparative Statics

Policies Targeted at the Downstream Processing Stage

The focus of this section is the effect on output, prices, and profits of a per unit export subsidy targeted at the foreign firm at the downstream stage. This emphasis captures the idea that some countries, such as those in the EU, typically target a large portion of their export subsidies at final processed goods. The analysis can easily be applied to a per unit import tax imposed by the importing country, but throughout the remaining discussion we focus only on export subsidies, as these are the primary consideration of the study.

■ *Output Effect.* Using (10), and setting $dz_h = 0$:

$$dh = \frac{\pi_{h,hf} \cdot dz_f}{\Delta} \tag{16}$$

and

$$df = \frac{\pi_{h,hh} \cdot -dz_f}{\Delta}. \tag{17}$$

Given $\pi_{h,hh} < 0$, $\pi_{h,hf} < 0$, and $\Delta > 0$, home downstream output will fall with a foreign export subsidy ($dh/dz_f < 0$), and foreign downstream output will increase ($df/dz_f > 0$), where, due to the condition $|\pi_{h,hh}| > |\pi_{h,hf}|$, then $|df| > |dh|$.

■ *Price Effect.* The inverse demand functions given in (1) and (2) can be totally differentiated, where the changes in price, given a foreign export subsidy, are defined as follows:

$$dp_h = p_{h,h} \cdot dh + p_{h,f} \cdot df \tag{18}$$

and

$$dp_f = p_{f,f} \cdot df + p_{f,h} \cdot dh. \tag{19}$$

From the conditions written on the inverse demand functions, and the signs on dh and df, if the goods are perfect substitutes (i.e., $p_{h,h} = p_{h,f}$ and $p_{f,f} = p_{f,h}$), then both dp_h/dz_f and $dp_f/dz_f < 0$ for a foreign export subsidy. In general, these results will also hold for the case of imperfect substitutes (i.e., $p_{h,h} \neq p_{h,f}$ and $p_{f,f} \neq p_{f,h}$).

■ *Profit Effect.* Totally differentiating the profit functions (3) and (4), the changes in profits are given as:

(20) $$d\pi_h = h \cdot p_{h,h} \cdot df - h$$

and

(21) $$d\pi_f = f \cdot p_{f,f} \cdot dh + f.$$

Given the conditions assumed on the inverse demand functions, and the signs of dh and df, $d\pi_h/dz_f < 0$ and $d\pi_f/dz_f > 0$ for a foreign export subsidy. Essentially, this is the Brander and Spencer (1985) result: the foreign downstream export subsidy shifts profits to the foreign processing firm away from the home processing firm.[2]

Upstream Effects of Downstream Policies

It is important to note there will be feedback effects of a foreign downstream export subsidy on intermediate processing output, prices, and profits.

■ *Output Effect.* Using (15), and setting $dz_h = 0$:

(22) $$dh^u = \frac{\pi^u_{h,hf} \cdot dz_f}{\Delta^u}$$

and

(23) $$df^u = \frac{\pi^u_{h,hh} \cdot -dz_f}{\Delta^u}.$$

Given $\pi^u_{h,hh} < 0$, $\pi^u_{h,hf} < 0$, and $\Delta^u > 0$, home upstream output will fall with a foreign export subsidy ($dh^u/dz_f < 0$), and foreign upstream output will increase ($df^u/dz_f > 0$), where, due to the condition $|\pi^u_{h,hh}| > |\pi^u_{h,hf}|$, then $|df^u| > |dh^u|$.

■ *Price Effect.* The inverse derived demand functions in (11) and (12) can be totally differentiated, where the changes in upstream prices, given a downstream foreign export subsidy, are defined as follows:

(24) $$dp^u_h = p^u_{h,h} \cdot dh^u + p^u_{h,f} \cdot df^u$$

and

(25) $$dp^u_f = p^u_{f,f} \cdot df^u + p^u_{f,h} \cdot dh^u + 1.$$

If the own-price effects $p^u_{i,i}$ $\{i = h, f\}$ are not significantly larger than the cross-price effects $p^u_{i,j}$ $\{i \neq j\}$, and given that $|df^u| > |dh^u|$, then for a foreign downstream export subsidy, $dp^u_h/dz_f < 0$. In addition, as long as the absolute value of the slope of the foreign

[2] In the case of pasta products, the Italian government has used export subsidies, negatively affecting the profits of U.S. pasta manufacturers (see U.S. International Trade Commission).

inverse derived demand function $|p^u_{f,f}| < 1$, then $dp^u_f/dz_f > 0$.[3] Therefore, for a given equilibrium level of output at the downstream stage, the home (foreign) intermediate good price falls (rises) with an export subsidy to the foreign downstream firm.

■ *Profit Effect.* In the case of upstream firms' profits, totally differentiating the profit functions (13) and (14) gives:

(26)
$$d\pi^u_h = h \cdot p^u_{h,h} \cdot df^u - h$$

and

(27)
$$d\pi^u_f = f \cdot p^u_{f,f} \cdot dh^u + f.$$

Given the signs of dh^u and df^u, for an export subsidy to the final good, $d\pi^u_h/dz_f < 0$ and $d\pi^u_f/dz_f > 0$; i.e., profits are shifted to the foreign intermediate processing firm with an export subsidy to the foreign downstream processing firm. Essentially, an export subsidy targeted at the foreign downstream firm harms the home downstream and upstream processing firms.[4]

Policies Targeted at the Unprocessed Agricultural Commodity

Instead of a per unit export subsidy being targeted at the foreign processing firm at the downstream stage, suppose an equivalent export subsidy is targeted at the unprocessed agricultural commodity in the home country which can be imported by firms producing the intermediate good in the foreign country. This approach captures the notion that countries such as the United States have targeted most of their export subsidies at unprocessed agricultural commodities. Following the existing literature on the effects of commodity export subsidies in competitive markets, such a policy is expected to lower the foreign upstream processing firm's costs (dz^u_f) by lowering the agricultural commodity's world price and, depending on the elasticity of supply, raise the home upstream processing firm's costs (dz^u_h) (see, for example, Paarlberg, p. 121).[5] In turn, these cost changes are transmitted to the foreign and home downstream processing firms (dz_i) $\{i = h, f\}$, and consequently downstream firms' outputs, prices, and profits. We focus first on the *upstream* processing stage.

■ *Output Effect.* Using expression (15), the effects on upstream output of an export subsidy to the agricultural commodity by the home country are represented by:

(28)
$$dh^{u*} = \frac{\pi^u_{f,ff} \cdot dz^u_h + \pi^u_{h,hf} \cdot dz^u_f}{\Delta^u}$$

and

(29)
$$df^{u*} = \frac{-\pi^u_{f,fh} \cdot dz^u_h + \pi^u_{h,hh} \cdot dz^u_f}{\Delta^u},$$

[3] Following Ishikawa and Spencer, the exact condition is that the elasticity of the slope of the inverse derived demand function must be less than one.

[4] There will also be feedback effects from the intermediate processing sector to the agricultural sector, which are not modeled explicitly here.

[5] We assume the change in the world price of the agricultural commodity is fully transmitted to the foreign upstream firm.

where the asterisk on dh^{u*} and df^{u*} distinguishes the effects of an export subsidy to the unprocessed agricultural commodity from those of a subsidy to the final processed good. Given the conditions assumed on the profit matrix π^u in (15), $dh^{u*}/(dz_h^u + dz_f^u) < 0$ and $df^{u*}/(dz_h^u + dz_f^u) > 0$.

■ *Price Effect.* Totally differentiating the inverse derived demand functions (11) and (12), the upstream price changes are given as:

(30) $$dp_h^{u*} = p_{h,h}^u \cdot dh^u + p_{h,f}^u \cdot df^u$$

and

(31) $$dp_f^{u*} = p_{f,f}^u \cdot df^u + p_{f,h}^u \cdot dh^u.$$

If the own-price effects $p_{i,i}^u$ $\{i = h, f\}$ are greater than the cross-price effects $p_{i,j}^u$ $\{i = h, f\}$, then the increase (decrease) in agricultural commodity prices—which raises (lowers) the home (foreign) upstream processing firm's marginal costs—outweighs the effects of the inward (outward) shift in the derived demand curve due to cross-effects. Given the signs on dh^{u*} and df^{u*} from (28) and (29), and assuming symmetric output effects $|df^{u*}| = |dh^{u*}|$, an export subsidy to the agricultural commodity causes the home upstream firm's price to rise $(dp_h^{u*}/(dz_h^u + dz_f^u) > 0)$, and the foreign upstream firm's price to fall $(dp_f^{u*}/(dz_h^u + dz_f^u) < 0)$.

It is also important at this point to say something about the *incidence* or pass-through of the marginal cost change by upstream processing firms, which affects intermediate prices faced by downstream processing firms. Given own-price effects upstream are expected to dominate, it is well known from the public finance literature that the degree of pass-through will be a function of the convexity (concavity) of the inverse derived demand function (see Seade 1980, 1985; Myles). For example, if the inverse demand function were linear, as the upstream monopolists face a marginal revenue curve that slopes at twice the rate of the demand curve, they will *undershift* changes in their marginal costs $(dp_i^{u*}/dz_i^u < 1)$. In contrast, with sufficient convexity in the demand function, the upstream firms will *overshift* changes in their marginal costs $(dp_i^{u*}/dz_i^u > 1)$.[6]

■ *Profit Effect.* Totally differentiating the profit functions (13) and (14), changes in upstream firms' profits are denoted by:

(32) $$d\pi_h^{u*} = h \cdot p_{h,h}^u \cdot df^u - h$$

and

(33) $$d\pi_f^{u*} = f \cdot p_{f,f}^u \cdot dh^u + f.$$

Given the signs of dh^u and df^u, for an export subsidy to the agricultural commodity, $d\pi_f^u/(dz_h^u + dz_f^u) < 0$ and $d\pi_f^{u*}/(dz_h^u + dz_f^u) > 0$; i.e., profits are shifted to (away from) the foreign (home) intermediate processing firm with an export subsidy to the unprocessed agricultural commodity.

Next, we turn to the *downstream* sector.

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[6] The precise conditions for the extent of *under/overshifting* are given by the elasticity of the slope of the inverse derived demand function, known as Seade's E. This is defined as $E^u = i^u \cdot (p_{i,ii}^u / p_{i,i}^u)$ $\{i^u = h, f\}$, and represents upstream firm output. If $E^u < 1$, there is *undershifting*, and if $E^u > 1$, there is *overshifting* (Seade 1980, 1985).

■ *Output Effect.* Using (10), and remembering that changes in upstream firms' prices (dp_i^{u*}) affect downstream firms' marginal costs (dz_i), changes in downstream output are designated by:

(34) $$dh^* = \frac{\pi_{f,ff}\cdot dz_h + \pi_{h,hf}\cdot dz_f}{\Delta}$$

and

(35) $$df^* = \frac{-\pi_{f,fh}\cdot dz_h + \pi_{h,hh}\cdot -dz_f}{\Delta}.$$

Given the conditions written on π, then $dh^*/(dz_h + dz_f) < 0$ and $df^*/(dz_h + dz_f) > 0$ for an export subsidy to the agricultural commodity. Hence, an export subsidy to the agricultural commodity (such as under EEP) can allow a foreign downstream processing firm to more effectively penetrate the importing country downstream market, and thereby gain market share.

A comparison of (34) and (35) with (16) and (17) reveals the effect on downstream output of an export subsidy to the unprocessed agricultural commodity relative to an equivalent export subsidy to the downstream good will depend on the degree of pass-through by the upstream processing firms, and the extent to which the export subsidy raises the home agricultural commodity price. Five possibilities can be considered:

1. Suppose there is complete pass-through upstream ($dp_i^{u*}/dz_i^u = 1$), and the export subsidy to the agricultural commodity has no impact on the home agricultural commodity price ($dz_h^u = 0$), i.e., home agricultural commodity supply is perfectly elastic. In this case, (34) and (35) collapse to (16) and (17) ($dh^* = dh$ and $df^* = df$), i.e., the downstream output effects are the same. This case is equivalent to what would occur under two quite different upstream processing market structures: (*a*) perfect competition upstream, where upstream firms fully pass through the change in costs, and (*b*) vertical integration between the upstream and downstream processing firms, where the upstream monopoly markup is removed, and the intermediate good's transfer price is equal to marginal cost.

2. Suppose there is complete pass-through upstream ($dp_i^{u*}/dz_i^u = 1$), and the export subsidy to the agricultural commodity does affect the home agricultural commodity price ($dz_h^u > 0$), i.e., home agricultural commodity supply is less than perfectly elastic. In this case, the output effects are $dh^* > dh$ and $df^* > df$, i.e., home (foreign) downstream output falls (rises) more. Again, this result is equivalent either to the case of perfect competition upstream, or vertical integration between the upstream and downstream processing firms.

3. Suppose there is overshifting upstream ($dp_i^{u*}/dz_i^u > 1$ and $dz_h^u > 0$). The output effects are then $dh^* > dh$ and $df^* > df$, i.e., home (foreign) downstream output falls (rises) more.

4. If there is undershifting upstream ($dp_i^{u*}/dz_i^u < 1$ and $dz_h^u = 0$), then the output effects are $dh^* < dh$ and $df^* < df$, i.e., home (foreign) downstream output falls (rises) less.

5. If there is undershifting upstream ($dp_i^{u*}/dz_i^u < 1$ and $dz_h^u > 0$), then the output effects dh^* and df^* may be smaller than dh and df, with the likelihood depending on the extent of undershifting.

■ *Price Effect.* Totally differentiating the inverse demand functions (1) and (2), downstream price changes are calculated as:

(36) $$dp_h^* = p_{h,h} \cdot dh^* + p_{h,f} \cdot df^*$$

and

(37) $$dp_f^* = p_{f,f} \cdot df^* + p_{f,h} \cdot dh^*.$$

Given the signs on dh^* and df^*, with similar output effects (i.e., $|dh^*| \approx |df^*|$), the price effects are $dp_h^*/(dz_h + dz_f) \geq 0$ and $dp_h^*/(dz_h + dz_f) \leq 0$ for an export subsidy to the commodity for imperfect substitutes, holding close to equality if the goods are perfect substitutes. In addition, if the goods are perfect substitutes, and $|dh^*| \neq |df^*|$, the direction of the price change depends on which is the larger of the output effects.

■ *Profit Effect.* Totally differentiating the profit functions (3) and (4), the changes in downstream profits are represented by:

(38) $$d\pi_h^* = h \cdot p_{h,h} \cdot df^* - h$$

and

(39) $$d\pi_f^* = f \cdot p_{f,f} \cdot dh^* + f.$$

Given the conditions assumed on the inverse demand functions, and the signs on dh^* and df^*, then $d\pi_h^*/(dz_h + dz_f) < 0$ and $d\pi_f^*/(dz_h + dz_f) > 0$ for an export subsidy to the agricultural commodity.

Comparing (38) and (39) with (20) and (21), the difference in profit effects depends on the difference between $|df^*|$ and $|df|$, and between $|dh^*|$ and $|dh|$. For example, if possibility 2 holds, the downstream profit-shifting effects may be greater for an export subsidy to the unprocessed agricultural commodity compared to an equivalent export subsidy to the final processed good. Profit-shifting is greater because an export subsidy to the agricultural commodity is assumed to increase the price of the agricultural commodity for the home upstream firm, which in turn increases the price of the home intermediate good. This outcome is illustrated in figure 2, where the foreign downstream firm's reaction function is shifted outward to R_f', while the home downstream firm's reaction function is shifted inward to R_h', the new Nash equilibrium occurs at N', the foreign firm's output expands to f', and the home firm's output falls to h'.

The extent to which the profit-shifting effects are greater, however, will depend on the cross-effects, and the degree to which the upstream processing sector passes through the change in agricultural commodity prices. As discussed above, cross-effects and pass-through will be reflected in the values of dh^* and df^* from (34) and (35), and the five cases outlined will translate into different effects on downstream profits. These results suggest that export subsidies targeted at an unprocessed agricultural commodity, which can then be utilized by foreign processing firms, under certain circumstances may have a greater negative effect on domestic processing firms' profits than export subsidies targeted at foreign processors by their respective governments.

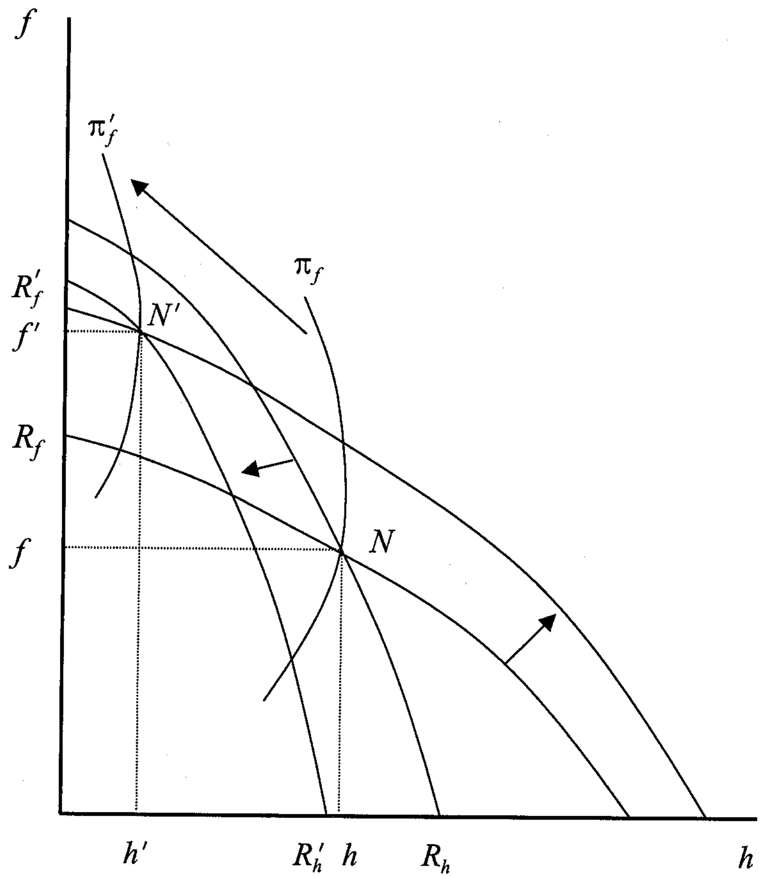

Figure 2. Profit-shifting and export subsidies

Sensitivity of Results to Assumptions

In order to evaluate how general the results are, it is useful to consider the sensitivity of the results to some of the underlying assumptions of the model. With respect to *market structure*, the upstream and downstream markets could be modeled as n-firm oligopolies in a manner similar to Ishikawa and Spencer. As noted earlier, this adds unnecessary complexity, but the direction of the effects will be the same as the structure outlined here. In the limit, however, as the numbers of firms in the upstream and downstream markets are increased, the Nash equilibrium converges asymptotically to the competitive outcome (Friedman). Consequently, upstream and downstream oligopoly profits disappear, and there will be no profit-shifting effects due to export subsidies.[7]

In addition, the key results concerning pass-through by upstream processing firms are preserved if that sector is treated as an oligopoly as opposed to a monopoly. Seade (1980, 1985) has shown that convexity (concavity) of the demand curve in an oligopoly affects the extent of pass-through of cost changes. This result is also dependent on the

[7] Based on results reported by Dixit (1984), if the number of firms increases in a Nash-Cournot game, eventually it is optimal to promote tacit collusion with an export tax.

presence of imperfect competition. For example, if the upstream processing sector in each country is treated as an oligopoly, the marginal revenue curve will rotate toward the derived demand curve (Hay and Morris). Assuming convexity of the demand curve is such that there is undershifting of changes in marginal costs, the shift from monopoly to oligopoly upstream simply increases the extent of pass-through of cost changes. Full pass-through will occur only if the intermediate processing sector is perfectly competitive, irrespective of the convexity (concavity) of the demand function (see Myles). This would also be the case if there were vertical integration between the downstream and upstream firms, where the intermediate good is priced at marginal cost and changes in marginal cost are fully passed through within the integrated firm. These market structures were captured in possibilities 1 and 2 outlined in the previous section.

A game-theoretic criticism of the type of *vertical market structure* used in this analysis has been raised by Ishikawa and Spencer. Essentially, it is assumed the downstream processing firms act strategically in the final good market, but act as price takers in the intermediate good market. Although this assumption is common in vertical market models, it does ignore the possibility either that downstream firms can exert some monopsony power or that there is bilateral monopoly (see, for example, Salinger). It is not exactly clear how either of these market structures would be incorporated into a model where the upstream processing firms move first to produce the intermediate good. One possibility, as noted by Ishikawa and Spencer, is to allow several firms to compete at the final stage, thus reducing the potential for monopsony power. Alternatively, it can be assumed the upstream intermediate firms sell to a large number of different downstream sectors, reducing any monopsony power one individual downstream sector may have.[8] This seems a plausible assumption for the food system where intermediate inputs, such as flour or semi-processed vegetable oils, may be inputs into a variety of downstream processed food products.

In terms of the *technology*, the assumption of fixed proportions has been commonly posited in both the trade and industrial organization literatures [see, e.g., Salinger's analysis of vertical markets and market foreclosure, and the works of Spencer and Jones (1991, 1992), and Ishikawa and Spencer on imperfect competition and trade in intermediate and final goods]. If, however, a variable proportions technology is allowed for downstream, some of the effects of the increase in home intermediate input prices will be mitigated, because home downstream intermediate firms substitute toward a lower cost input. Nevertheless, the downstream profit-shifting effects will still remain, because the foreign downstream processing firms increase their output at the expense of the home firms due to lower intermediate input prices. In reference to figure 2, the foreign firm's reaction function still shifts out, but the inward shift of the home firm's reaction function will be less, depending on the home firm's ability to substitute away from the higher cost intermediate good.

Finally, we address the slope of the *reaction functions*. It was assumed the home (foreign) processing firm's marginal profit declines in the output of the foreign (home) processing firm. It is possible, given sufficient convexity of the demand function, for this condition to be reversed, such that reaction functions are upward-sloping in output space and products are regarded as *strategic complements* (Bulow, Geanakoplos, and

[8] An alternative suggested by Ishikawa and Spencer is to assume the downstream firms play a Kreps and Scheinkman type game where capacity constraints ensure Cournot outcomes with price-taking behavior.

Klemperer). Necessarily, this will affect the comparative static results obtained. For example, an export subsidy to the foreign downstream processing firm will increase the outputs of both downstream firms, lowering prices and profits of both firms. However, following Brander and Spencer (1985), we consider this case "perverse," and therefore ignore it.[9]

Summary and Conclusions

Using a model designed to allow for imperfectly competitive behavior, we have examined the profit-shifting effects of a foreign export subsidy targeted to a final processed good in a vertical market system. These profit-shifting effects were compared to those of a home export subsidy targeted to exports of an agricultural commodity subsequently used in production of a foreign intermediate good, which is then used in a foreign exported final good. Based on our results, an export subsidy to the unprocessed agricultural commodity may have greater profit-shifting effects in the final goods market than a downstream foreign export subsidy. In addition, both types of subsidy will result in profits being shifted from the home to the foreign upstream processing firm.

While specific assumptions were made in deriving our findings, relaxing key assumptions relating to market structure and technology does not undermine the basic direction of the results. However, the magnitude of profit-shifting does depend critically on two factors: the extent to which a home export subsidy to an unprocessed agricultural commodity raises its home price, and the degree of pass-through of these price changes by upstream processing firms.

Following the previous literature on commodity export subsidies in competitive markets, the benchmark is characterized as the case where the export subsidy raises the home agricultural commodity price, lowers the agricultural commodity's world price, and where there is also complete pass-through of such price changes by upstream processing firms to downstream processors. This scenario leads to greater downstream profit-shifting effects as compared to a downstream foreign export subsidy. Therefore, if there is either over- or undershifting of changes in the price of the agricultural commodity by the upstream firms, the downstream profit-shifting effects will be either exacerbated or diluted. The actual magnitude of over- or under-shifting of agricultural commodity prices in the U.S. and European upstream processing sectors, however, is ultimately an empirical issue.

In conclusion, while the broader distributional effects of these policies have not been considered explicitly in the analysis, our results suggest that policy makers may need to pay careful attention to the upstream and downstream profit-shifting effects which can occur when export subsidies (such as EEP) are applied to unprocessed agricultural commodities, and when other countries (such as those in the EU) target a larger proportion of their export subsidy budget to processed food products. Specifically, the implications for policy depend on whether or not countries make good on their commitments in the URAA to reduce export subsidies.

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[9] Nevertheless, it should be noted that if the model were set up in action space rather than output space, where actions can be either output or prices, "normal" Bertrand behavior with upward-sloping reaction functions in price space is implied by $\pi_{h,hf} > 0$ and $\pi_{f,fh} > 0$ (see Bulow, Geanakoplos, and Klemperer; Leahy and Neary).

If the EU and the U.S. do not reduce their use of export subsidies, then it is clear from our analysis the U.S. would be better off targeting such subsidies at the processing sector, although not for the reasons commonly asserted. The conventional argument for targeting export subsidies at high-value products rests largely on potential multiplier effects such as increased employment. In this study, the argument for targeting such subsidies at downstream stages rests on the fact that export subsidies on bulk products may proffer a terms-of-trade advantage to foreign exporters of processed goods and/or tax domestic downstream industries by raising the costs of intermediate goods. It should be noted, however, this is a second-best policy for the U.S. If the U.S. and EU simultaneously target export subsidies at their respective processing sectors, the net effect is to increase output on the world market, drive down the prices of final processed goods, and lower the profits of U.S. and EU processors.

Alternatively, if the URAA agreement on reduction of export subsidies were binding, the analysis presented here shows U.S. processing firms would actually benefit from two effects. First, if the EU were to reduce export subsidies targeted at final processed goods, U.S. processing firms would increase their market share and profits at the expense of EU processing firms. In addition, this action would increase derived demand for the intermediate good from U.S. upstream processing firms. Second, if the U.S. were to reduce export subsidies targeted at unprocessed agricultural commodities, upstream processing costs would decline in the U.S., while they would rise in the EU. Likewise, depending on the degree of pass-through, downstream processing costs would be lowered in the U.S., and raised in the EU. In turn, reducing export subsidies would increase the market share and profits of U.S. final processing firms at the expense of EU final processing firms.

More broadly, for policy makers and researchers involved with the export subsidy issue in the World Trade Organization, closer attention should be paid to the stage at which subsidies are targeted because subsidies have potential impacts on trade and welfare that are not necessarily apparent in standard, perfectly competitive single-stage models.

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