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Welfare-Enhancing Export Subsidies:

Comment and Extension

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Comments welcome.

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1. Introduction

In a recent paper in The Journal of Political Economy, Itoh and Kiyono, 1986 (hereafter IK) demonstrate a new case for export subsidies. The idea of export subsidies is not new. One justification of previous papers is second-best considerations (Feenstra, 1986; Dutton, 1988). Another is strategic considerations in an oligopoly model (Tower, 1983; Spencer and Brander, 1985). Still others include unusual preferences (e.g., extensions of Kemp, 1967). The IK analysis relies on none of these to justify otherwise counterintuitive subsidies. Rather, it stresses the concept of marginality of goods. Goods just at the margin of trade should have exports subsidized and other goods should not. They come to these conclusions with a two-country model with Ricardian production of three or more goods.[1]

Because export subsidies are popular among policy makers, particularly in agriculture and in "strategic" industries, it is important to place the IK subsidy justification in context. This comment presents two major points. First, it should be made clear that the IK case is second best. There are several policy instruments their home country could use, and a subsidy is not the one that maximizes home welfare. This comment advances several propositions to make the point. Second, the IK case is not really new. Rather, it can be interpreted in terms of the cross-price effect justification offered by Feenstra (1986). Since the IK results seem to come from the highly restrictive nature of their model, it is useful to place them into a more general category.

2. Subsidy as Second-Best Policy

In this section I compare effects on home welfare of the IK export subsidy to effects of two alternatives, an export tax and an import tariff. To do this, I first derive expressions for the optimal (home welfare-maximizing) values of the subsidy, tax, and tariff, each taken alone. I then show that the export tax dominates the subsidy as well as the tariff and that the ranking of subsidy versus tariff is ambiguous. I also show that a tariff and subsidy together can duplicate effects of the optimal tax. Propositions 1 and 2 below demonstrate the optimal levels of the three instruments. Proposition 3 shows the superiority of the export tax over the export subsidy. Proposition 4 indicates that the tax is superior to a tariff. Number 5 contains a condition for ranking the subsidy and tariff, and 6 is a proposition demonstrating equivalency of a subsidy and a tariff together to the optimal export tax alone.

All propositions are demonstrated with the simple version of the IK model, which contains three goods, all produced with a single factor and constant returns to scale. Two countries produce the goods and engage in trade. The home country exports good 1 and the foreign country exports good 3. Good 2 is the marginal good, with the potential for net trade in either direction. Trade in that good is assumed to flow in only one direction at any given time. Tastes in the two countries are Cobb-Douglas in form.

Proposition 1: The optimal level of subsidy on exports of good 2 is $s = 1 - (a_1 a_2^* / a_2 a_1^*)$. (Here a_i is the labor input per unit of good i production. Asterisks indicate requirements for the foreign country.)

Proof: As shown in IK, a subsidy on exports of good 2 benefits the home country by raising the relative price of good 1 abroad. Given that tastes are Cobb-Douglas and that the foreign country does not produce good 1, net demand for that good abroad is unit elastic but only up to the point where the foreign country has an incentive to begin production of good 1. That occurs when the relative price of 1 abroad, P_1^*/P_2^*, equals the relative cost of producing 1 abroad, a_1^*/a_2^*. At that point, net demand for good 1 becomes infinitely elastic. Thus the best strategy for the home country is to push the relative price of good 1 up just to the point where the demand elasticity suddenly jumps. This condition occurs when:

$$\frac{P_1^*}{P_2^*} = \frac{a_1^*}{a_2^*}$$

Since $P_1^* = P_1$, and $P_2^* = P_2(1-s)$, and $P_1/P_2 = a_1/a_2$, we obtain the subsidy expression above.

Proposition 2: In the three-good, two-country IK world, the home country could substitute either an export tax on good 1 or an import tariff on good 3 for the good 2 export subsidy. The optimal tax would be:

$$t = \frac{a_2 a_1^*}{a_1 a_2^*} - 1$$

The optimal tariff would be:

$$\tau = \frac{a_3 a_2^*}{a_2 a_3^*} - 1$$

Proof: These expressions can be derived in the same way as the optimal subsidy. The tax would be raised to the point where it became preferable to the foreign country to begin production of good 1 itself. The tariff would be raised to the point where it became profitable for producers at home to produce good 3 rather than importing it (where $P_3/P_2 > a_3/a_2$).

Proposition 3: For the home country, the optimal subsidy is a second-best situation, dominated by the optimal export tax.

Proof: Using the indirect utility function, compare levels of welfare in the two situations. Given Cobb-Douglas preferences, indirect utility is:

$$V = y \left[\frac{\delta_1}{P_1}\right]^{\delta_1} \left[\frac{\delta_2}{P_2}\right]^{\delta_2} \left[\frac{\delta_3}{P_3}\right]^{\delta_3}$$

Income levels in the two situations are:

$$y^s = \frac{P_1/a_1}{1 + \delta_3 \left[\dfrac{a_2 a_1^*}{a_2^* a_1} - 1\right]} \left\{ L + \delta_1^* L^* \left[\frac{a_2}{a_2^*} - \frac{a_1}{a_1^*}\right]\right\}$$

$$y^t = \frac{P_1}{a_1} \left\{ L + \delta_1^* L^* \left[\frac{a_2}{a_2^*} - \frac{a_1}{a_1^*}\right]\right\}$$

Indirect utility levels are:

$$V^s = \frac{1}{1 + \delta_3 \left[\dfrac{a_2 a_1^*}{a_2^* a_1} - 1\right]} \left\{ L + \delta_1^* L^* \left[\frac{a_2}{a_2^*} - \frac{a_1}{a_1^*}\right]\right\} \left[\frac{\delta_1}{a_1}\right]^{\delta_1} \left[\frac{\delta_2}{a_2}\right]^{\delta_2} \left[\frac{\delta_3}{a_3^* a_1/a_1^*}\right]^{\delta_3}$$

$$V^t = \left\{ L + \delta_1^* L^* \left[\frac{a_2}{a_2^*} - \frac{a_1}{a_1^*}\right]\right\} \left[\frac{\delta_1}{a_1}\right]^{\delta_1} \left[\frac{\delta_2}{a_2}\right]^{\delta_2} \left[\frac{\delta_3}{a_3^* a_2/a_2^*}\right]^{\delta_3}$$

$V^t > V^s$ if:

$$\left\{ 1 + \delta_3 \left[\frac{a_1^* a_2}{a_1 a_2^*} - 1\right]\right\} \left[\frac{a_1 a_2^*}{a_2 a_1^*}\right]^{\delta_3} > 1$$

Let the left-hand expression be denoted Z. By the comparative advantage relationships defined in IK, $a_1^* a_2 / a_1 a_2^* > 1$. Assume for a moment that

$a_1^*a_2/a_1a_2^* = 1$. Then $Z = 1$ as well and the condition above is an equality. The partial derivative of Z with respect to $(a_1^*a_2/a_1a_2^*)$ is positive. Therefore, when $a_1^*a_2/a_1a_2^* > 1$, $Z > 1$ as well. Thus $V^t > V^s$.

This relationship reflects the fact that the IK subsidy is a second-best instrument for taking advantage of monopoly power in exports; the export tax is a first-best instrument. This result can be explained intuitively on two grounds. First, the tax is a more direct method of taking advantage of monopoly power in good 1. And second, the tax does not distort relative prices in the home country, while the subsidy does. I.e., with the export tax, $P_3/P_2 = a_3^*/a_2^*$, where the latter ratio represents the relative opportunity costs of producing goods 3 and 2. With the export subsidy, $P_3/P_2 = (1-s)a_3^*/a_2^*$. With the subsidy, relative prices at home do not reflect relative opportunity costs.

Proposition 4: Home welfare is greater with the optimal tax on exports of good 1 than with the optimal tariff on imports of good 3.

Proof: Utility with the tariff is:

$$V^{\tau} = \frac{L}{1 + \delta^3\left[\dfrac{a_2a_3^*}{a_3a_2^*} - 1\right]} \left[\frac{\delta_1}{a_1}\right]^{\delta_1} \left[\frac{\delta_2}{a_2}\right]^{\delta_2} \left[\frac{\delta_3}{a_3}\right]^{\delta_3}$$

$V^t > V^{\tau}$ if:

$$\left\{1 + \delta_1^* \frac{L^*}{L}\left[\frac{a_2}{a_2^*} - \frac{a_1}{a_1^*}\right]\right\}\left\{\delta_3\left[\frac{a_2^*a_3}{a_3^*a_2}\right]^{(\delta_3-1)} + (1-\delta_3)\left[\frac{a_2^*a_3}{a_3^*a_2}\right]^{\delta_3}\right\} > 1$$

If $a_2^*a_3/a_3^*a_2$ were equal to 1, the left-hand side would exceed 1 (given that the home country has a comparative advantage in good 1 relative to good 2). For higher levels of $a_2^*a_3/a_3^*a_2$, the left hand side is larger as well. Since

$a_2^*a_3/a_3^*a_2 > 1$ by assumption, the inequality above is assured. Thus the optimal export tax is better for the home country than the optimal tariff.

The intuition of this result is similar to that for proposition 3. The tariff imposes distorted relative prices at home (the relative price of good 3 at home exceeds its relative opportunity cost). The tax does not. Instead the export tax shifts the distortion burden to the foreign country.

Proposition 5: The optimal tariff on imports of good 3 is preferable for the home country to the optimal subsidy on exports of good 2 if and only if:

$$1 > \frac{1 + \delta_3\left[\dfrac{a_2a_3^*}{a_2^*a_3} - 1\right]}{1 + \delta_3\left[\dfrac{a_2a_1^*}{a_1a_2^*} - 1\right]}\left\{1 + \delta_1^*\frac{L^*}{L}\left[\frac{a_2}{a_2^*} - \frac{a_1}{a_1^*}\right]\right\}\left[\frac{a_3a_1^*}{a_1a_3^*}\right]^{\delta_3}$$

Proof: Comparison of V^S and V^{τ} leads to this result.

Both the optimal tariff on 1 and the optimal export subsidy on 2 are both second best; neither dominates the other for all situations. If $V^X - V^S = D$, it can be shown that:

$$\frac{\partial D}{\partial(a_1/a_1^*)} > 0 \qquad \text{and} \qquad \frac{\partial D}{\partial(a_3/a_3^*)} < 0$$

If a_1/a_1^* rises, ceteris paribus, so the home comparative advantage in good 1 declines, then the subsidy becomes less advantageous relative to the tariff. If a_3/a_3^* rises, ceteris paribus, so the home <u>disadvantage</u> in good 3 increases, then the tariff becomes less advantageous relative to the subsidy. Also:

$$\frac{\partial D}{\partial \delta_3} < 0 \qquad \text{and} \qquad \frac{\partial D}{\partial \delta_1^*} < 0$$

indicating that a stronger taste of the home country for good 3 or the foreign country for good 1 increases the relative advantage of the subsidy relative to the tariff. Certainly these results are intuitively plausible.

Proposition 6: The optimal tax on exports of good 1 is equivalent in effect to the optimal subsidy on exports of good 2 accompanied by a tariff of $\tau = (a_2 a_1^* / a_1 a_2^*) - 1$ on imports of good 3.

Proof: The value of the indirect utility function is identical to that for the tax above.[2]

This section demonstrates that of several alternative policy options available to country 1, the export subsidy on the marginal good is clearly second best. It is always dominated by an export tax on the good always exported by the home country. It may be dominated by a tariff on the good always imported by the home country. The IK justification for an export subsidy for policy purposes is therefore quite weak.

3. IK Results Related to Feenstra Cross-Price Effects

Feenstra shows with a three-good model that cross-price effects between two export goods can imply that an export subsidy on one of the two can increase home welfare. The cross-price effects can occur either on the export supply side (in the home country) or on the import demand side (in the foreign country). In Feenstra's model, whether a subsidy is called for depends on the strength of these cross-price effects. The IK model can be reinterpreted as one with extreme cross-price effects between goods 1 and 2 on the supply side of the market. These extreme effects derive from the Ricardian form of production.

In the simple IK model, the home country produces and exports goods 1 and 2 and imports good 3. The foreign country produces 2 and 3, exporting only 3. Tastes in each country are Cobb-Douglas in form. A key assumption of their model is the Ricardian form of production, with only labor being used as an input. In each country the production possibility frontier between the two goods produced is linear. This implies that, as long as both are produced in a country, the ratio of their prices within that country is set by their relative labor input requirements. Also, any small change in that price ratio leads to termination of production of the good whose relative price has dropped. Thus, when the price ratio equals the input requirement ratio, the two goods are perfect production substitutes. When it does not, substitutability becomes zero. Loosely speaking, the own-price and cross-price supply derivatives equal infinity in the first situation and zero in the second. This fact can be utilized in applying Feenstra's analysis.

Feenstra (p. 254) presents an expression indicating whether an export subsidy is welfare-enhancing to the home country. Translated somewhat, his expression calls for a subsidy on exports of good 2 when:

$$\frac{x^*_{12}}{x^*_{22}} - \frac{x_{12}}{x_{22}} > \frac{(x_2/x_1)A}{(x^*_{22}\ x_{22})} \qquad (1)$$

where $A = x_{11}x_{22} - (x_{12})^2 + x_{22}x^*_{11} - x_{12}x^*_{12}$. Here x_i is net exports of good i, x_{ij} is the compensated derivative of x_i with respect to price j, and asterisks indicate that a symbol applies to the foreign country. Net exports of good 2 can be written as:

$$\frac{\partial R}{\partial P_2} - \frac{\partial E}{\partial P_2} = q_2 - c_2 = x_2$$

where R and E are the standard revenue and expenditure functions. As is well known, their derivatives with respect to prices give supply and compensated demand for the relevant goods. The supply and demand functions are zero degree homogeneous in prices, so that:

$$P_1q_{21} + P_2q_{22} + P_3q_{23} = 0 \qquad (2)$$

$$P1c_{21} + P_2c_{22} + P_3c_{23} = 0$$

where q_{2i} and c_{2i} are derivatives with respect to p_i. These restrictions, as well as similar ones for goods 1 and 3, can be used to evaluate expression (1) as applied to the IK model. It will also be useful to remember the symmetry of the Hessian matrix of partial derivatives. Using these conditions, it can be shown[3] that expression (1) in the IK case approaches arbitrarily close to:

$$P_2/P_1 > 0 \qquad (3)$$

This condition clearly is met in the IK model, indicating that a subsidy is called for on exports of good 2.

The implication of this exercise is that the IK special case of a subsidy on a marginal good is really a subcase of the cross-price effect justification of Feenstra.

Feenstra (p. 254) explains his condition as requiring that "goods 1 and 2 are stronger complements abroad than at home, or stronger substitutes at home than abroad." In the IK case, substitutability at home is infinite and substitutability abroad is finite. Condition (1) is easily fulfilled.

In an important extension, Feenstra points out (p. 260) that the condition for a subsidy is different if optimal taxes or subsidies are applied by the home country to all goods. In such a case a subsidy on exports of good 2 is called for if: $x^*_{12}/x^*_{11} > |x^*_2/x^*_1|$

In the IK model, $q^*_{12} = q^*_{11} = 0$, so the condition is:

$$c^*_{12}/c^*_{11} > |x^*_2/x^*_1|$$

Since the left-hand side is negative for the IK model, the condition fails. If an optimal tax or subsidy has been applied to exports of good 1, then exports of good 2 should not be subsidized.

4. Summary and conclusion.

This comment makes two important points. First, the export subsidy policy presented by Itoh and Kiyono is clearly a second-best policy, a fact not clear in their paper. Here we derive the optimal value of that subsidy and compare it to alternatives of an export tax and an import tariff. The export tax unambiguously dominates the IK subsidy, as well as the tariff. In addition, in some situations the tariff dominates the IK subsidy. These rankings indicate a significantly reduced appeal of the IK export subsidy as a policy instrument.

The second important point is that the IK analysis is actually a special case of the second-best subsidy argument of Feenstra. In that case cross-price effects between export goods in supply or demand can create conditions in which an export subsidy is beneficial (although not first best). The "marginality" of good 2 as an export actually indicates the high cross-price elasticity of supply, which makes it a candidate for subsidy according to Feenstra.

Endnotes

1. IK also perform an analysis with a continuum of goods model like that of Dornbusch, Fischer, and Samuelson, 1977. This comment will focus on the simpler, three-good model. The principal difference between the two models is that the authors treat the marginal good as endogenous in the continuum of goods model but predetermined in the discrete goods model. The essential results concerning export subsidies are the same.

2. These propositions are not all easy to prove in the continuum of goods model. Analogous propositions do hold when specific functional form is given to the a's as functions of the good index (n), at least for the case of a linear function. It has not been possible to prove them in more general form, though intuition suggests that they hold for the same reasons as the propositions in the three-good model.

3. See the appendix.

Appendix

To derive (3), break (1) into parts. First:

$$\frac{x^*_{12}}{x^*_{22}} = \frac{q^*_{12} - c^*_{12}}{q^*_{22} - c^*_{22}}$$

Since good 1 is not produced abroad, $q^*_{12} = 0$ (given Ricardian production).

Also, q^*_{22} is essentially infinite, so that the first term disappears. Thus:

$$\frac{x^*_{12}}{x^*_{22}} = 0$$

Next, consider that:

$$\frac{x_{12}}{x_{22}} = \frac{q_{12} - c_{12}}{q_{22} - c_{22}}$$

From (2), symmetry and the fact that $q_{13} = 0$ (since good 3 is not produced at home), we know that:

$$q_{12} = - \frac{P_2}{P_1} q_{22}$$

Thus:

$$\frac{x_{12}}{x_{22}} = \frac{-(P_2/P_1)\ q_{22} - c_{12}}{q_{22} - c_{22}}$$

As indicated in the text, if good z is produced, then q_{22} is infinite. Thus, this term approaches a limit of:

$$\frac{x_{12}}{x_{22}} = - \frac{P_2}{P_1}$$

Putting these two parts of the left-hand side of (1) together yields:

$$\frac{x^*_{12}}{x^*_{22}} - \frac{x_{12}}{x_{22}} = \frac{P_2}{P_1}$$

In the right-hand side of (1), divide $A/x_{22}x^*_{22}$ into two parts,

$$A_1 = \frac{x_{11}x_{22} - (x_{12})^2}{x_{22}x^*_{22}} \quad \text{and} \quad A_2 = \frac{x^*_{11}}{x^*_{22}} - \frac{x_{12}x^*_{12}}{x_{22}x^*_{22}}$$

For A_1, we get:

$$A_1 = \frac{(q_{11} - c_{11})(q_{22} - c_{22}) - (q_{12} - c_{12})^2}{x_{22}x_{22}^*}$$

Here $q_{12} = -\frac{P_2}{P_1} q_{22} = -\frac{P_1}{P_2} q_{11}$ (since $q_{13} = q_{23} = 0$).

Also $c_{12} = -(\frac{P_2}{P_1} c_{22} + \frac{P_3}{P_1} c_{23}) = -(\frac{P_1}{P_2} c_{11} + \frac{P_3}{P_2} c_{13})$.

Thus:

$$A_1 = \frac{(q_{11} - c_{11})(q_{22} - c_{22}) + (\frac{P_1}{P_2} q_{11} - \frac{P_1}{P_2} c_{11} - \frac{P_3}{P_2} c_{13})(\frac{P_2}{P_1} q_{22} - \frac{P_2}{P_1} c_{22} - \frac{P_3}{P_1} c_{23})}{x_{22}x_{22}^*}$$

$$= \frac{\frac{P_3^2}{P_1P_2} c_{13}c_{23} - \frac{P_3}{P_2} x_{11}c_{23} - \frac{P_3}{P_1} x_{22}c_{13}}{x_{22}x_{22}^*}$$

This expression approaches zero in value, given the presence of both x_{22} and x_{22}^* in the denominator.

In the second part, A_2, the first term approaches zero also, since x_{11}^* is clearly finite but x_{22}^* is not. Also, since x_{12}^* is clearly finite, the two large terms in the denominator of the second term clearly dominate x_{12} in the numerator. Thus A_2 approaches zero as well.

If we use this heuristic approach to evaluating (1), we find that the condition becomes:

$$\frac{P_2}{P_1} > 0$$

as in (3) in the text.

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