DOMESTIC INPUT POLICIES IN FREE TRADE AREAS WITH NATIONAL ASYMMETRIES

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INTRODUCTION

Since 1963, world output growth has averaged about 3 percent per year, while world trade has grown more than 10 percent a year, expanding from US $30.5 billion to US $8,267 billion in 1996 [WTO, 1997]. Over this period, countries in the international economy have grown increasingly interdependent, mostly due to closer trade integration through trade liberalization at both regional and global levels. At the global level, the 1994 Uruguay Round Agreement in the General Agreement on Tariffs on Trade (GATT) marked a giant step toward global free trade by instituting major reductions in trade barriers throughout the world. Under its authority, the World Trade Organization (WTO) continues to promote even freer trade through international regulations. At the regional level, currently 23 regional trade blocs are in operation, the *raison d'etre* of which is to facilitate freer regional trade [World Bank, 1998].

As the movement towards free trade continues, a country's ability to capture rent through traditional trade policy options is being dismantled. As a result, a global policy concern is that regulators in countries bound by free trade agreements will be tempted to use non-trade policies to improve welfare. Indeed, as Richardson [1994] and Keen and Lahiri [1993] observe, most trade policies can be replicated using a combination of domestic policy instruments. The ability of individual countries to circumvent free trade agreements through nontraditional methods has even led to some recent support for the creation of an international tax court [Azzi, 1998]. As a result, the negotiating agendas of such organizations as the WTO, the European Union (EU), or North American Free Trade Agreement (NAFTA), now go far beyond the traditional topics of tariffs and quotas to include domestic issues such as labor and environmental policies [Gerber, 2000].

As the WTO continues to push for the removal of distortionary policies, further study on the use of alternative mechanisms is important. Input policies, in particular, provide regulators with attractive strategic instruments, because they have indirect effects on the production processes, making them less likely to draw attention from competitors in a Free Trade Association (FTA). Input taxes (subsidies) in imperfectly competitive frameworks have been largely ignored in the mainstream international trade literature. This is in contrast with the environmental economics literature, in which taxes on polluting inputs have been discussed in imperfectly competitive international trade frameworks [Duval and Hamilton, 2001; Conrad, 1993].

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Unlike most trade policies that govern traded goods, which are, for the most part, harmonized across countries, input policies vary widely between countries. For example, a significant labor tax differential exists between France and Spain in the European Union. This has resulted in the French fruit and vegetable industry arguing that Spain is distorting trade by setting significantly lower labor taxes. Is this labor tax asymmetry lowering the national welfare of the high-tax country (in this case, France) to the benefit of the low-tax country? Recognizing that countries and firms within countries are not identical may provide a strong justification for the existence and possible optimality of international asymmetries in domestic input taxes. This paper addresses this issue, of importance to all WTO and regional FTA member countries, by deriving both cooperative and non-cooperative optimal domestic input policies when national asymmetries exist within FTAs. We consider input policy in the broad sense, which may include taxes on labor, capital, or natural resources, but also includes taxes on R&D and information technology infrastructure depending on the industry under consideration.

In recent years, imperfectly competitive trade models have yielded important insights to explain the role of domestic output policy tools as strategic instruments in international markets. Research in this strand of literature, which began with the seminal papers of Dixit [1984] and Brander and Spencer [1985], often imposes symmetry across countries. The motives for taxation that arise in the presence of domestic consumers when an industry is imperfectly competitive have been generally ignored, except for Eaton and Grossman [1986] who isolate a term-of-trade effect in the case of output taxes in a Cournot duopoly framework. Consequently, the focus of the analysis is typically centered on a production distortion effect of domestic tax policy, where a country subsidizes output to increase the foreign market share of its domestic producers. The symmetry assumption typically results in the optimality of tax harmonization, a result also commonly found in the competitive trade literature.

In contrast, the idea of transnational asymmetry is at the heart of competitive trade models. For example, in a Ricardian model trade occurs because of differences in production technology, and in the Heckscher-Ohlin model trade occurs because of differences in factor endowment. Indeed, trade cannot occur in a competitive model without some form of asymmetry between trade partners. This paper combines some of the most realistic components of the competitive and strategic trade literatures by developing a two-way trade model with both imperfect competition and countries with production and consumption asymmetries.

The model presented here integrates effects that have been identified separately in the previous literature, including a profit-shifting effect [Brander and Spencer, 1985] and a terms-of-trade effect [Eaton and Grossman, 1986], to examine how input policies change when countries within an FTA differ in both the number of consumers and in the size and cost-efficiency of producers. In particular, the model allows for asymmetries in production costs and the number of firms in each country, which provides a measure of competitive advantage.

The framework we employ allows us to address all the major strategic effects simultaneously without loss of clarity and provides a context with which to better understand the implications of the combined effects of industry size and efficiency,

consumer location, and imperfect competition on input, rather than output, policies. The results contribute to the growing literature on indirect tax harmonization. However, the focus is on tax harminization when countries are non-identical. This is unlike Lahiri and Raimondos-Moller [1998], which focuses on tax harmonization when tax revenues are used for endogenous public good provision. The model yields particular insight into the relationships between domestic and foreign consumption and production, because the central influences in non-cooperative tax policy reduce to an intuitive condition regarding the domestic net trade balance.

When countries cooperate in setting domestic input policies, the optimality of an input tax harmonization strategy within the FTA depends critically on the shape of the production technology and national asymmetries in production costs (that is, comparative advantage) under imperfect competition. This result suggests that FTA regulators may set different input taxes not only in each country, but also in each industry within a country. While input policy harmonization is generally sub-optimal, harmonization of competition policies (that is, anti-trust regulations) within the FTA is a prerequisite to any harmonization of input policies.

THE MODEL

This section develops a framework to highlight the effects of transnational asymmetries on optimal input policies. The model is developed as a two-stage game. In the first stage, the regulator in each country sets an input subsidy (tax) and the subsidy rate set by each member of the customs union is revealed. In the second stage, firms choose output levels taking all input subsidies set in stage one as exogenous.

The model is comprised of two producing countries that belong to a single market or union that precludes explicit trade promotion policies (that is, output subsidies). Consumers in the two countries have identical preferences, regardless of their country of origin, although the *size* of each consumer market (that is, the number of consumers in each country) may differ.[1] Firms within each country are homogeneous and produce a single non-differentiated product with a single input (for example, labor) that is subject to domestic tax policy. Across countries, production costs and the number of firms may differ, as would be the case when countries differ in infrastructure, resources and technological endowments. Finally, to complete the specification of the model, intra-industry trade between the two countries, as well as export to regions outside the two countries, occur without transportation costs.[2] Although it has no valid dynamic foundation, we adopt a conjectural variations approach because it provides a convenient way to characterize the spectrum of oligopoly outcomes and has been commonly used in the literature since Bresnahan [1981].

Consider the problem of a representative firm in country i. Let $C_i(y_i,w(s_i))$ denote the cost function, where y_i is output, $s_i$is the domestic tax or subsidy set in the preliminary stage of the game, and $w(s_i)$ is the market price of the input subject to the domestic policy. The cost function is assumed to be twice continuously differentiable for the allowable range of y_i, increasing ($C_{y_i} > 0$ and convex ($C_{y_iy_i} > 0$).

To provide greater clarity to the model, we describe the input market price by the linear function:

$$w(s_i) = w_0 - s_i, \tag{1}$$

where w_0 is the base price of the input.

With homogenous consumers and no transportation costs between the two countries, it follows that a single market price prevails. Let $P = P(Y)$ denote the price of the consumer good. World production, Y, is specified as

$$Y = Y_1 + Y_2 = n_1 y_1 + n_2 y_2, \tag{2}$$

where Y_1 and Y_2 denote the total domestic production, y_1 and y_2 denote the output of a representative firm, and n_1 and n_2 denote the number of firms in country 1 and 2, respectively.

The optimal output choice of a representative firm in country i is characterized as the solution to

$$\underset{y_i}{\text{Max}}\, \pi_i = P(Y) y_i - C[y_i, w(s_i)]. \tag{3}$$

The necessary and sufficient conditions for a maximum are

$$P + \delta_i y_i P' = C_{y_i}[y_i, w(s_i)], \tag{4}$$

and

$$2\,\delta_i P' + \delta_i^2 y_i P' < C_{y_i y_i}.^3 \tag{5}$$

respectively, where analogous conditions exist for firms in country j and where $\delta_i \nabla \partial Y/\partial y_i, \delta_i \in (0, n_i)$ is the conjecture of a firm in country i about its impact on other firms in the FTA.

The following conditions contribute to the existence and stability of the equilibrium [Novshek, 1985]:

$$C_{y_i y_i} - \delta_i y_i P' > 0 \tag{6}$$

$$P' + \delta_i y_i P'' < 0 \tag{7}$$

Using equations (1) through(7) and making use of the demand condition, $P = P(Y)$, it is possible to express individual firm output as a function of the subsidy in each country, such that $y_1 = f(s_1, s_2)$ and $y_2 = F(s_1, s_2)$. Totally differentiating equations (4) and using equations (5) through (7), it can be easily verified that

$$\partial y_i/\partial y_j (s_i, s_j) < 0,\ i \neq j \tag{8}$$

That is, an increase in the output level of firms in country j will result in a decrease in the output level of individual firms in country i.

In the following sections, we consider the initial stage of the game in which the optimal domestic input policy is determined. In this stage, the objective of each regulator is to choose the domestic input subsidy (tax) that maximizes national welfare.

OPTIMAL INPUT POLICY AT THE CUSTOMS UNION LEVEL

The optimal input subsidies derived in this section are those that would be recommended by a regulatory agency operating at the customs union level when all production is consumed within the union. The problem is formally equivalent to one in which countries cooperatively determine a subsidy pair $\{s_i, s_j\}$ to maximize joint welfare. The joint welfare maximum is completely characterized as the solution to

$$\underset{s_i, s_j}{Max}\, W_c = \left[\int_0^Y P(U)dU - P(Y)Y\right] + \sum_i \left[P(Y)Y_i - n_i C_i(y_i, w(s_i)) - n_i s_i x_i\right], \tag{9}$$

where x_i is the quantity of the subsidized input utilized by each firm, and where the problem is decomposed into separate consumer surplus and producer surplus components for consistency with the non-cooperative formulation that follows.

By Shepard's Lemma, we have $C_w = x_i$ which, with equation (4), yields the first-order condition of equation (9) with respect to s_i:

$$x_{y_i} n_i[\partial y_i/\partial s_i]s_i + x_{y_j} n_j[\partial y_j/\partial s_i]s_j = -P'[n_i\delta_i y_i(\partial y_i/\partial s_i] + n_j\delta_j y_j[\partial y_j/\partial s_i)], \tag{10}$$

where a similar condition holds for s_j. The regulator's optimal choice of the policy instruments, s_i^* and s_j^*, is found by solving these first-order conditions simultaneously.

From equation (10), the optimal cooperative tax rule, $\hat{s}_i$ is given by

$$\hat{s}_i = -[1/n_i x_{y_i}]\{P'[n_i\delta_i y_i + n_j\delta_j y_j(\partial y_j/\partial y_i)] + n_j x_{y_j}(\partial y_j/\partial y_i)\,\hat{s}_j\}, \tag{11}$$

where an equivalent expression holds for $\hat{s}_j$ .The cooperative tax rule in equation (11) depends on an imperfect competition effect, and a foreign tax effect, respectively. The imperfect competition effect is positive, which implies that the optimal domestic subsidy increases with the degree of imperfect competition. This effect captures the subsidy adjustment associated with sub-optimal production levels under oligopoly, and disappears under perfect competition (that is, when $\delta_i = \delta_j = 0$). The foreign subsidy effect is also positive by equation (8), which indicates that the optimal subsidy increases with the level of the foreign subsidy.

Solving $\hat{s}_i$ and $\hat{s}_j$ simultaneously yields the equilibrium subsidy for country i:

$$s_i^* = -[(\partial_i y_i P')/x_{y_i}]. \tag{12}$$

In equation (12), s_i^* is just a pure correction for imperfect competition in which the optimal subsidy leads price down to marginal cost. Note that the input subsidy reduces to an output subsidy when x_{y_i} is constant, as would be the case with fixed proportions technology.

The equilibrium subsidy for country i in equation (12) is positive and corrects for the imperfectly competitive structure of the industry. Notice that if both countries have identical production costs and domestic market structures, the optimal subsidy in equation (12) is uniform across countries, $s_i^* = s_j^*$. Indeed, from (12) we arrive at:

> *Proposition 1. When asymmetries in production costs exist across countries, domestic input policy harmonization is generally sub-optimal under imperfect competition.*

Proof. Equating first-order condition (4) for representative firms in countries i and j, we have, in equilibrium, $P'(\delta_i y_i - \delta_j y_j) = C_{yi} - C_{yj}$. It follows that if $C_{yi} > C_{yj}$, $\delta_j y_j > \delta_i y_i$ and the optimal subsidies equation (12) are non-uniform within the FTA under imperfect competition as long as $\partial(y_i / x_{yi}) / \partial y_i \neq 0$. Q.E.D.

Hence, input policy harmonization within a homogenous set of countries—such as may be the case among producers in the current EU—is an optimal cooperative tax policy. However, the merits of tax harmonization in NAFTA or in EU after enlargement to Eastern European countries is less apparent. The proof of *Proposition 1* has the following corollary:

> *Corollary: A simultaneous reduction in the degree of imperfect competition in countries with different comparative advantage (that is, different production costs) increases the optimality of input tax harmonization within an FTA.*

Indeed, $P'(\delta_i y_i - \delta_j y_j) = C_{yi} - C_{yj}$ implies that reducing the degree of imperfect competition by implementing stricter competition policies (that is, anti-trust regulations) could reduce and ultimately eliminate production cost asymmetries among firms within the FTA (possibly by shifting all production to the low-cost country), making input tax harmonization more likely to be optimal. Because production costs are often asymmetric across countries, even in such an integrated FTA as the EU, implementation of strict cooperative competition policies may be a prerequisite to any tax harmonization policy. Note that this is consistent with the case of the United States and the EU where competition policies are decided at the federal and customs union level, respectively.

Another important implication of equation (12) is that the production technology affects the optimal subsidy rate. For example, with Leontief technology, $x_{y_i y_i} = 0$, the optimal input subsidy is non-uniform, and the optimal policy for the customs union is to subsidize the input more heavily in the low-cost country. The relatively higher subsidy in the low-cost country insures that output increases intended by the cooperating regulators occur where the costs are lowest, to the benefit of all FTA or customs union consumers. A strict tax harmonization policy within an FTA does not take into account each country's comparative advantage. In contrast, a non-uniform cooperative input policy provides incentives for each country to produce goods and services in which it has a comparative advantage.

When $x(y_i)$ is concave, $x_{y_iy_i} < 0$, the production process is convex and it follows that $\partial(y_i/x_{yi}) / \partial y_i > 0$. While production processes are generally concave, some input-output relationships may be convex under imperfect competition. For example, the relationship between inputs such as R&D or information infrastructure and outputs such as software, pharmaceuticals, or telephone calls may arguably be characterized by a convex production process through part of the relevant input-output space. In this case, a given level of the subsidy in the low-cost country yields a larger increase in output relative to the output increase from a similar input subsidy in the high-cost country, such that the optimal cooperative subsidy is again non-uniform under imperfect competition. More importantly, the level of non-uniformity of the optimal input policy increases with the convexity of the production process, as cooperative regulators subsidize inputs more heavily in the low-cost country and less in the high-cost country. Indeed, when the production technology is convex, economies of scale arise that provide an additional incentive for the cooperating regulators to shift production to low-cost countries. As a result, input tax harmonization may decrease customs union welfare significantly when production processes are convex by providing suboptimal incentives for the imperfectly competitive firms to take advantage of economies of scale.

When the production process is concave ($x(y_i)$ is convex), $x_{y_iy_i} > 0$, and $\partial(y_i/x_{yi}) / \partial y_i$ cannot be signed. In this case, the low-cost country is not necessarily the country that receives the largest input subsidy. The high-cost country becomes the high-subsidy country when the change in input per unit of output associated with a one-unit change in output is greater than one. In this case, a given level of the subsidy in the low-cost country yields a smaller increase in output relative to the output increase from a similar subsidy in the high-cost country. Consequently, the relative size of the subsidy rate in each country is ambiguous due to counterpoising efficiency and output effects. These finding are summarized in proposition 2:

> *Proposition 2: When production cost asymmetries exist across countries, the optimal policy for the FTA is generally to provide larger input subsidies to firms in the low cost country, particularly when the production process is convex under imperfect competition.*

Hence, while lower labor taxes in Spain or larger subsidies for R&D in Japan may appear to unfairly benefit these countries, this model indicates that such asymmetries may be optimal for Spain or Japan's free trading partners as long as these countries have lower production costs and true comparative advantages.

OPTIMAL INPUT POLICY AT THE NATIONAL LEVEL

When regulatory authority is housed at the national level, each country views its optimal input tax or subsidy as the outcome of a non-cooperative game. Each country now considers only its own consumers in the maximization of its domestic welfare. The distribution of consumers between countries is often ignored for the interest of tractability in international trade models; however, use of the following observation

allows consumer surplus to be conveniently incorporated in the domestic welfare calculation for the case of globally homogeneous consumers.

> *Observation. With globally homogeneous consumers, if country i's share of the consumer population is α_i, then consumer surplus in country i, CS_i, satisfies $CS_i \nabla \alpha_i CS$, where CS is consumer surplus derived from global demand.*

Proof. Define individual utility such that $U = U(y) + m$ where y is the quantity of good that is produced using the input being regulated, and m is the numeraire. It follows that household consumer surplus is

$$cs = U_y(y) - Py = \int_0^Y P_i(\tilde{y})d\tilde{y} - Py \tag{13}$$

where $P_i(y)$ is the inverse demand of individual i. Households have identical utility so that $P_i(y) = P(zy) = P(Y)$, where $P(Y)$ is aggregate inverse demand, and z is the number of homogenous households that comprise global demand for the good. Global consumer surplus is thus characterized by the following equalities

$$CS = z(cs) = z\left[\int_0^Y P_i(\tilde{y})d\tilde{y} - Py\right] = \int_0^Y P(\tilde{Y})d\tilde{Y} - PY \tag{14}$$

Next, let α_i denote the share of consumers in the customs union that are located in country i. Substitution into equation (14) yields

$$CS_i = \alpha_i z(cs) = \alpha_i\left[\int_0^Y P(\tilde{Y})d\tilde{Y} - PY\right] = \alpha_i CS \tag{15}$$

which completes the proof. Q.E.D.

Combined with our previous specification of the relative share (and size) of producers between countries, the above observation allows us to examine all possible combinations of domestic and foreign consumption and production in a single model. This extension of the conventional strategic trade framework is an important modification, as we show below that the outcome of tax policy depends, often critically, on the location in which consumption occurs. Moreover, the observation allows for a convenient representation of the net trade balance, which can now be written as $n_i y_i - \alpha_i Y$, where α_i is domestic consumption and $n_i y_i$ is domestic production in country i.

The objective function of a national regulator can now be expressed as

$$\underset{s_i}{Max}\, W_i = \alpha_i\left[\int_0^Y P(U)dU - P(Y)Y\right] + n_i\left\{P(Y)y_i - C_i\left[y_i, w(s_i)\right]\right\} - s_i n_i x_i \tag{16}$$

Upon use of equation (4) and Shephard's Lemma, the first-order condition is

$$\hat{s}_i = [\,P'/x_{y_i}]\{(n_i y_i - \alpha_i Y)[(\partial Y/\partial s_i)/(\partial Y_i/\partial s_i)] - \delta_i y_i\}. \tag{17}$$

Equation (17) defines the implicit reaction function for country i in the non-cooperative case and describes the structure of the equilibrium subsidy. The optimal subsidy set by a national regulator is composed of a net trade balance effect and a rent-shifting effect.[4] Equation (17) unifies the strategic effects described in the literature on domestic export policies, and supports the following proposition.

Proposition 3. The optimal non-cooperative input policy is influenced by the net trade balance effect as follows:

(i) If domestic production equals domestic consumption, $n_i y_i = \alpha_i Y$, the optimal non-cooperative input subsidy (tax) coincides with that in the cooperative case.

(ii) If domestic production is greater than domestic consumption, $n_i y_i > \alpha_i Y$, country i sets a smaller input subsidy (or a larger tax) than in the cooperative case.

(iii) If domestic production is smaller than domestic consumption, $n_i y_i < \alpha_i Y$, country i sets a larger subsidy (or a smaller tax) than in the cooperative case.

Part *(i)* of proposition 3 is characteristic of a symmetric two-way trade framework. In this case, the expression for the optimal non-cooperative tax is now the same as that derived in the cooperative case: without a trade balance, the entire strategic term disappears. All that remains is the correction for imperfect competition in each country, a feature that depends only on the competitive nature of firms and is therefore independent of any motivation for strategic trade. While the previous literature has recognized that a terms-of-trade effect does affect policy outcome under imperfect competition [Eaton and Grossman, 1986], proposition 3 reveals that the direction of the strategic effect is entirely dependent on the value of the net trade balance. In an imperfectly competitive setting, the net trade balance is composed of a production effect and a consumption effect that work against each other. The relative importance of each effect depends on the asymmetries that exist across countries within the FTA. When the two effects are equal, global welfare is maximized, and scale effects never matter. Note that domestic consumption includes consumption of both the domestic and foreign-made products. Thus, the net trade balance is zero whenever total consumption equals total production in each country, regardless of whether trade occurs.

Parts *(ii)* and *(iii)* of proposition 3 relate both to conventional strategic trade frameworks characterized by an absence of domestic consumers in country i, $\alpha_i = 0$, as well as to asymmetric two-way trade oligopoly frameworks in which domestic consumers are present in one or both of the producing countries [Krugman, 1990]. In a conventional strategic trade framework, the consumption distortion is often removed by consigning all consumers in the international economy to a "third country" (that is, $\alpha_i = 0$ and $\alpha_j = 0$), in which case equation (17) reduces to:

$$\hat{s}_i = [(P'y_i)/x_{y_i}]\{n_i[1 + (\partial Y_j/\partial s_i)/(\partial Y_i/\partial s_i)] - \delta_i\}. \quad (18)$$

[5]

In equation (18), the term in parenthesis represents the production side of the trade balance effect, which we will refer to hereafter as the production distortion. Under circumstances in which a single Cournot firm produces all output in country i ($n_i = 1$ and $\delta_2 = 1$), the first component of the production distortion effect vanishes.[6] All that remains is a single strategic term, the so-called "rent-shifting" effect, identical to the optimal (unilateral) output subsidy originally derived by Brander and Spencer [1985]. Alternatively, if one relaxes the assumption of a single domestic firm (or single group of collusive firms), as would be the case when domestic or international anti-trust laws prevent such industrial structures, a more general condition for strategic subsidization obtains in the case without domestic consumers in country i. Namely,

$$n_j(\partial y_j/\partial y_i) + (n_i - \delta_i) < 0. \tag{19}$$

The first term of the inequality in equation (19) is a generalized rent-shifting effect, which represents the domestic regulator's incentive to subsidize the input in order to gain market share in the FTA output market and thereby increase domestic industry profit. The second term represents the regulator's incentive to set an input tax in order to capture rent from foreign consumers. Intuitively, the country with the larger industry has a greater incentive to tax because the tax can be shifted into the price and capture rent from the foreign consumers. The extent to which the tax or subsidy is shifted into the price, $\partial P/\partial s_i$ satisfies

$$\partial P/\partial s_i = P'[n_i(\partial y_j/\partial s_i) + n_j\,(\partial y_j/\partial s_j] \tag{20}$$

From the comparative static analysis, we know that $\partial y_i/\partial s_i$ and $\partial y_j/\partial s_j$ have opposite signs. Thus, a larger number of domestic firms increase a country's ability to shift a tax into price, giving it a greater incentive to tax, even under imperfect competition. Indeed, when asymmetries in number of firms are large enough, the incentive to tax becomes greater than the incentive to subsidize in this generalized version of the rent-shifting effect. Note, however, that, by inequality (19), a country with lax competitive policies and imperfectly competitive firms (larger δ_2) is more likely to subsidize inputs. This last result is summarized in the following proposition:

> *Proposition 4: The degree of imperfect competition, as influenced by domestic competitive policies, counterbalances the input tax incentives from production asymmetries and the resulting net trade balance effect in Proposition 3, increasing the likelihood that a country will subsidize inputs.*

When only one domestic firm exists, or when all domestic firms collude, a positive subsidy rate follows directly from equation (8); however, when there are multiple domestic firms, or when collusion is not possible, the optimal policy outcome is ambiguous: either an input tax or a subsidy is optimal. France, for example, is a major exporter of agricultural products within the EU. Because agriculture remains a very competitive industry, our results suggest that French regulators are likely to set

smaller domestic input subsidies or higher input taxes than would be optimal in the cooperative case. This phenomenon is partially reflected in the fact that France has set tougher regulations on the environment, a major input in agricultural production, than many other countries in the EU. The French producers may thus benefit from EU regulators increasing involvement in national policies.

Further insight in this issue can be gained by considering the special case of linear demand and constant marginal cost for all Cournot firms. In this case, if all consumers are located in a third country, input subsidization is optimal when

$$n_i < n_j + 1. \tag{21}$$

With linear demand and constant marginal costs, an input subsidy is preferable to an input tax in country i only when at least one more firm produces in country i than in country j. This special case demonstrates the striking effect of asymmetry in industry size on the optimal policy outcome in an FTA. Barrett [1994] pointed out that an input subsidy may be optimal as long as the number of domestic firms is "not too large". Equation (21) reveals an important dependence between the optimal non-cooperative input policy and the *relative* number of firms in each country within the FTA. Ignoring integer issues, we summarize this result in the following corollary.

> *Corollary: In a linear Cournot oligopoly framework with all consumers located in a third non-producing country, asymmetries in industry size across countries, rather than the absolute number of firms in one country, lead the country with the larger number of firms to set an input tax rather than an input subsidy.*

Returning to our asymmetric two-way trade framework, both the consumption distortion and production distortion are present and equation (17) may be written equivalently as

$$\hat{s}_i = (P'/x_{y_i})\{n_i y_i[1 + (\partial Y_j/\partial Y_i) - (\delta_i/n_i)] - (\alpha_i Y)[1 + (\partial Y_j/\partial Y_i)]\} \tag{22}$$

In equation (22), the presence of domestic consumers increases the regulator's incentive to set a subsidy. Indeed, the larger the share of world consumers located in country i, the more likely country i is to set an input subsidy in the optimal non-cooperative policy. Nonetheless, the policy outcome under imperfect competition continues to depend on the net trade balance; that is, the bias of the non-cooperative input subsidy relative to the cooperative welfare maximizing input subsidy depends entirely on the terms of trade.

Equation (22) also shows that the production distortion and the consumption distortion tend to offset each other, and, as demonstrated in proposition 3, offset each other completely in a balanced trade situation. Consequently, symmetric models of strategic trade, which tend to emphasize the production-distortion motive and downplay the consumption-distortion motive, tend to produce policy prescriptions of domestic subsidies. However, the relative importance of the distortions depends on

the terms of trade: the optimal policy for a net exporting country with a sufficiently large net trade balance is a domestic input tax. The outcome is that non-cooperating countries within the FTA will set different domestic input taxes. However, the earlier derivation of optimal cooperative taxes show that this outcome does not constitute, in itself, proof of FTA welfare reducing strategic behavior by the member countries.

CONCLUSION

It is well understood that input policy has the potential to be used as a strategic tool to increase domestic welfare. This paper has demonstrated that the presence of tax asymmetries in a customs union or FTA does not constitute evidence that countries employ input policies strategically. To answer the question raised in the introduction, Spain's lower labor taxes do not necessarily decrease welfare in the EU or France. In fact, because Spain is an exporter of fruits and vegetables in the EU, the Spanish regulators have a strategic incentive to set higher labor taxes on the domestic fruit and vegetable industry, which would ultimately benefit the French industry but could also reduce overall EU welfare. Given that Spain has a comparative advantage in the production of fruits and vegetables, the industry is almost perfectly competitive, and that the production process is concave, our model suggests that the optimal cooperative labor taxes for the fruit and vegetable industry in France and Spain are small and slightly lower in Spain.

Our analysis of the optimal cooperative input policy under imperfect competition reveals that tax harmonization is not a necessary characteristic of the social optimum when asymmetries in production costs exist across countries. Indeed, we show that input tax harmonization is unlikely to be optimal when cost-asymmetries exist. The results also indicate that the shape of the production process influences optimal input taxes, suggesting that regulators should set optimal cooperative input subsidy (tax) levels, not only one country at a time, but also one industry at a time. Input tax harmonization under imperfect competition for industries with convex technologies, such as the telecommunication and software industries, is likely to be particularly counter-productive. Input policy harmonization in FTAs where countries and industries across countries vary widely in size, domestic consumer base, and production technology, or in FTAs with no unified competition policies is always welfare reducing.

Indeed, the analysis highlights the importance of asymmetries across countries in the determination of the optimal non-cooperative input policy. We find the profit-shifting effect in strategic trade models is found to be one component of a more general effect, which we call a 'net trade balance' effect. This effect depends on the existence of asymmetry in the number of firms, the domestic consumer base, or in the cost of production per firm between nations within the FTA or customs union. Allowing for asymmetry in any one of these possible dimensions endogenizes the competitiveness of the foreign and domestic industries and leads to the non-optimality of homogenous taxes across countries and industries within countries. Asymmetries in the number of firms or in the level of production costs across countries can result in a regulator imposing a tax rather than a subsidy on an input used intensively by a net

exporting industry, even under imperfect competition. Asymmetries in size of the consumer base (population) and the degree of imperfect competition in the domestic industry can also significantly affect the tax level, and result in larger input subsidies or lower input taxes in countries with more consumers and more stringent competition policies. Because such transnational asymmetries are a universal characteristic of competitive trade models, more research is needed on the effects of asymmetry on optimal trade policy under oligopoly.

NOTES

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1. The assumption of homogeneous consumer preferences across countries applies most directly to situations characterized by FTAs (the EU, NAFTA, ASEAN, MERCOSUR and SADC), which are generally comprised of countries with similar ethnic and cultural backgrounds.
2. In the event that neither country has a consumer base, the model reduces to the three-country framework commonly used in trade models with imperfect competition.
3. For notational convenience, the arguments of all functions are hereafter suppressed.
4. The net trade balance effect, (the first part of the bracketed term in equation (17)), is sometimes referred to as a terms-of-trade effect in the literature.
5. Note that equation (17) reduces to equation (18) as long as there are no consumers in country *i*. The absence of consumers in producing country *j* is not a necessary condition for (18) to hold.
6. Alternatively, this result would also hold in the case of perfect collusion between domestic firms in country *i*.

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