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TRADE AND INDUSTRIAL POLICY OF TRANSITION ECONOMIES

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Abstract

Trade reforms in transition economies are analyzed in a model of trade and vertical product differentiation. We first show that trade liberalization in transition economies reduces the local firm's output and raises the prices of all variants. Second, we find that neither free trade nor the absence of a subsidy are optimal. Third, there exists a rationale for a government commitment to use socially optimal trade and industrial policies to release the domestic firm from low-quality production. Finally, we establish an equivalence result between the effects of exchange rate changes and those of trade policy on price competition (but not on social welfare).

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1 Introduction

Some policymakers at international organizations and elsewhere seem to conduct their analyses of most Central and Eastern European Countries (CEECs) in the same way as any market-oriented economy. They consider our knowledge of trade policy to be applicable to that part of the world. In particular, they would argue that economic reforms should include the opening up of markets, the liberalization of trade and the reduction of support provided to agriculture and industry. Around 1989, most CEECs began to pursue rather liberal agricultural, industrial and trade policies but subsequently were confronted with *inflation and a large decline in output* (IMF, 2000), the drop being less in sectors where quality and design issues were of less importance (Brenton and Gros, 1997). Thus, not surprisingly, some CEECs in recent years have reintroduced higher levels of domestic support (Valdes, 1999). While not questioning the direction of these reforms, the primary concern of this paper is about the optimal trade policy of CEECs and whether the complete opening up to international trade is an adequate policy option. We will show that the response of firms to trade policy, and the effect of such policy on domestic welfare can differ markedly from that of received theory.

The economic characteristics of an economy in transition have been largely discussed in the literature. Bearing in mind that transition economies emerge from central planning, a (limited) number of stylized facts have inspired our framework of analysis:

- The presence of institutional entry barriers implies that industries are highly concentrated.
- A limited concern for quality standards has often driven firms in transition economies to supply goods whose quality is inferior to that of Western firms. The data suggest that average unit values of imports over exports vary significantly across transition economies. For example, Lankhuizen (2000) shows a quality advantage of imports over exports for the majority of sectors of the Baltic countries. Average export unit values for the Czech Republic, Hungary, Poland and Slovenia are generally lower than what is observed for Mediterranean countries (Aturupane *et al.*, 1999).
- A heritage of socialist institutions is the separation of research and development activity from production processes. This represents an important obstacle to the diffusion of technological progress. It is therefore not surprising to find little evidence of quality upgrading during the last decade (Aturupane *et al.*, 1999).
- Except for the Baltic countries, the current nominal protection rates reveal high

levels of tariff protection, from two to three times those of the U.S. or the European Union.[1]

- Nominal exchange rates in most CEECs fell sharply during the second half of the 1990s but recently stabilized. Rates of depreciation versus the U.S. dollar range between 25% for the Czech Koruna during that period to about 300% for the new Russian Ruble in 1998 only.

Though the prominence of these features varies from country to country the primary common elements of CEECs that we shall embody in our model are the existence of (i) a quality gap between domestic and Western goods, (ii) a high level of government intervention in economic activity, and (iii) large depreciations of their currencies.[2]

Our framework of analysis is a duopoly model of vertical product differentiation and international trade. Consumers in the transition economy, henceforth also referred to as the *domestic* economy, have heterogenous preferences for the sole product attribute, quality. We assume that the domestic market is not totally served in equilibrium, i.e., the market size is endogenous. The quality-differentiated good is supplied by a domestic firm and by imports from a foreign producer. In order to meet preferences, firms must incur a fixed cost of quality development. We allow for firms to be asymmetric in regard to their setup technologies and assume that the foreign firm is more efficient than the domestic firm. We study a three-stage game. In the first stage, the government of the transition economy chooses a trade and/or industrial policy.[3] The instrument considered for trade policy is an ad valorem tariff,[4] while industrial policy is implemented through taxes or subsidies. In the second stage, firms select their qualities to be produced, and thus incur the fixed costs. Finally, in the third stage, firms indulge in price competition and demand is satisfied. Backward induction allows us to solve for a subgame perfect equilibrium. The nature of the game gives a special role to quality which, once set, can only be modified in the long-run.

[1] See Table 6.6 at the World Bank website (http://www.worldbank.org/data) for countries' average tariffs.

[2] Even though less developed countries may have characteristics similar to those described for transition economies, the former have historically attracted foreign direct investments and therefore have experienced a greater concern for quality.

[3] Industrial policy refers to government intervention geared towards strengthening the market position of the domestic firm with respect to foreign competition.

[4] It is more and more common for tariffs and subsidies to be specified in ad valorem terms, i.e., as a percentage of the selling price. The US International Trade Commission has indeed made suggestions to convert most specific, compound and complex rates of duty to their ad valorem equivalents (see http://www.usitc.gov).

In our model a unique risk-dominant subgame perfect equilibrium in pure strategies arises. Such equilibrium is characterized by the existence of a quality differential between the two variants. We show that a tariff on high-quality imports is a *pro-competitive* device. Moreover, it enables the domestic government to extract rents from the foreign firm.[5] These effects working together yield a higher social welfare, which justifies a role for an international commercial policy. We also show that absence of an industrial policy is not optimal either, since a subsidy on low-quality home production upgrades qualities, is pro-competitive, and in turn raises welfare. First best policy thus typically consists of a subsidy on the low-quality home product and a tariff on high-quality imports.

Our analysis allows us to contribute to several important debates. First, the collapse in output of transition economies has been given several interpretations, mostly linked to shortages of materials. In Blanchard and Kremer (1997), transition causes a breakdown of complex chains of production, mainly when a dominant supplier for critical inputs is involved. In Bennett *et al.* (1999), firms respond to material supply bottlenecks by cutting exports disproportionately. In our model, differently, when the firm in the transition economy produces a low-quality product, liberalization of trade gives rise to (i) a reduction in the output of the local firm and (ii) an increase in the price of all variants. Both effects, output drop and inflation, may be contrary to what policy makers had initially intended by liberalizing trade.[6] Second, one of the primary factors behind market structure in an industry is productivity and technology improvements (see e.g., Petrakis and Roy, 1999). In most transition economies, the existence of a more centralized system of research and development reduces the relative competitiveness of local firms as the diffusion of know-how is slower than elsewhere. The question is whether low-quality local firms are doomed to produce low-quality products or whether a government commitment to use tariffs and subsidies may challenge the quality leadership of the foreign firm. In this regard, our results provide a rationale for a policy that induces leapfrogging: when the relative cost inefficiency of the local firm is not too large, there exists a socially optimal trade and industrial policy that ceases the quality leadership of the foreign firm. This enables local firms to reap higher profits from high-quality production which could potentially finance the adoption of new technologies and cost-reducing investments. Finally, the empirical literature has suggested

[5] Krishna (1987) and Das and Donnenfeld (1987) show that a tariff against a foreign producer may be welfare improving even though it may result in quality downgrading. Interestingly, we shall see here that this type of result still holds when foreign producer faces domestic competition.

[6] Metzler (1949), in a general equilibrium context, was the first to point out the possibility that a tariff could lower the domestic price of the imported good and therefore reduce competing local production. Here, in contrast, a drop in domestic production follows from trade liberalization.

a symmetry between the long-run pass-through of tariffs and exchange rates (Feenstra, 1989). This implies that the response of import prices to changes in tariffs can be used to predict the effect of changes in exchange rates and vice versa. Introducing exchange rates in our model, we observe an important distinction between the impact of exchange rate changes and tariff policy in the sense that, an exchange rate depreciation is always welfare deteriorating, as opposed to tariffs, which can enhance welfare. However, equivalence results are obtained in regard to the impact on import prices, the intensity of competition, quantities imported and hedonic prices. A substantial depreciation can also cause the local firm to leapfrog the foreign competitor.

Our model of international trade incorporates the features of Mussa and Rosen's (1978) model of quality choice. The oligopoly version of this model has received enormous attention in the industrial organization literature on vertical product differentiation (Shaked and Sutton, 1982, 1983; Gabszewicz and Thisse, 1986; Tirole, 1988; Ronnen, 1991; Motta, 1993; Cremer and Thisse, 1994; Crampes and Hollander, 1995; Lehmann-Grube, 1997, etc.), as well as in the international trade literature (Das and Donnenfeld, 1987, 1989; Reitzes 1992; Ries, 1993; Motta *et al.*, 1997; Herguera *et al.* 2000, etc.). Most of the latter work has analyzed the impact of quantitative restrictions in the form of import quotas and VERs. Motta *et al.* (1997), differently, show that the quality leader maintains its position when two countries producing different quality levels open up to international trade. To the best of our knowledge, neither the impact of tariffs, subsidies and exchange rates nor the choice of the optimal tariff policy has been considered in an international quality-differentiated duopoly setting. A major insight we obtain is that the activist government has an incentive to alter market structure by committing to a trade and industrial policy. Thus, our work can be seen as complementary to Motta *et al.* (1997). Fersthman *et al.* (1999) have estimated the effect of tax reform in the automobile market in Israel. They argue that the impact of taxation in this type of vertically differentiated market is complex due to the fact that a tax affects not only prices but also the profile and quality of products. We believe that our analysis contributes to a deeper understanding of the implications of government intervention in this type of markets.

The rest of the paper is organized as follows. Section 2 describes the model formally. Section 3 outlines the firms' optimal decisions and presents the impact of trade liberalization on equilibrium output and prices. Section 4 studies the incidence of tariffs and domestic production subsidies, shows the non-optimality of free trade and selects the optimal policy. Section 5 examines equivalence results between exchange rate variations and trade policy. Finally, Section 6 concludes. The Appendix contains most of the proofs to facilitate the reading.

2 The Model

We consider a transition economy in trade relations with the rest of the world, which we shall also refer to as the "domestic" and "foreign" country, respectively. Suppose that a population of measure 1 lives in the transition economy and that preferences of consumer θ are given by the quasi-linear (indirect) utility function:

$$U = \begin{cases} \theta q - p & \text{if he/she buys a unit of a good of quality } q \text{ at price } p \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

Consumers buy at most one unit. Suppose that the consumer-specific quality taste parameter θ is uniformly distributed over $[0, \overline{\theta}]$, $\overline{\theta} > 0$.

There are two firms competing in the market of the transition economy, a domestic firm and a foreign exporting firm, the latter marked with *. We assume that firms must incur a fixed cost of quality development, which is a convex function of quality. Once the quality of the good is determined, production takes place at a common marginal cost that is normalized to zero for both firms.[7] Total costs of firms in their respective currencies are denoted $cC(q)$ and $c^*C(q)$, respectively. For mathematical convenience, we assume $C(q)$ to be a homogeneous function of degree $k \geq 2$, $C'(q) > 0$, $C''(q) > 0$, and $C(0) = 0$.[8] Let e be the expected exchange rate defined as the foreign currency price of domestic currency.[9] We assume that $ec \geq c^*$, that is, measured in the same currency, the foreign firm is at least as efficient as the domestic firm in producing any quality level.[10] As we shall see later, development cost asymmetries matter for the selection of an equilibrium in qualities.

The presence of heterogeneity in consumer tastes for quality implies that it is optimal for the two firms to differentiate their goods by choosing different quality levels. The intuition is that a strategy of quality differentiation relaxes price competition among the firms. Let us denote low quality by q_l and high quality by q_h, $q_h > q_l$. The corresponding prices charged in the transition economy are p_l and p_h and suppose, for

[7] This specification of costs captures the distinctive features of *pure* vertical differentiation models, where the costs of quality improvements fall primarily on fixed costs and involve only a small or no increase in unit variable costs (see Shaked and Sutton, 1983).

[8] The degree of homogeneity of the cost function is assumed to be greater than or equal to 2 in order to guarantee existence of equilibrium. Given that the revenue functions of the duopolists are convex in own quality, the cost function must be sufficiently convex to ensure maximization.

[9] An increase in e means an appreciation of the transition economy's currency; a decrease in e means a depreciation.

[10] There are reasons to assume that the foreign firm is more efficient than the domestic firm. For example, Murphy and Shleifer (1997) argue that countries with higher human capital have a comparative advantage in producing high-quality goods.

a moment, that $p_h \geq p_l$, i.e., a high-quality is sold at a higher price, assumption which will be verified later in equilibrium. Firms' demand functions are obtained as follows. Denote by $\widetilde{\theta}$ the buyer who is indifferent between buying high quality or low quality. From (1), $\widetilde{\theta} = (p_h - p_l)/(q_h - q_l)$. Denote by $\widehat{\theta}$ the consumer indifferent between acquiring the low-quality good or nothing, that is, $\widehat{\theta} = p_l/q_l$. Hence, high-quality good is demanded by those consumers such that $\widetilde{\theta} < \theta < \overline{\theta}$. Likewise the low-quality variant is demanded by those buyers such that $\widehat{\theta} < \theta < \widetilde{\theta}$. As θ is uniformly distributed on $[0, \overline{\theta}]$, we derive domestic demands for high- and low-quality goods:

$$D_l(.) = \frac{p_h - p_l}{\overline{\theta}(q_h - q_l)} - \frac{p_l}{\overline{\theta} q_l}, \; D_h(.) = 1 - \frac{p_h - p_l}{\overline{\theta}(q_h - q_l)} \tag{2}$$

Observe that one of these quantities is met by imports from the foreign firm.

We study a three-stage complete information game. First, the government in the transition economy chooses (i) a trade policy, and (ii) a domestic industrial policy. This consists in the announcement of a tariff t on imports and a subsidy s on home production.[11] Given the government's policy, the market evolves in the next two stages. In stage 2, firms decide simultaneously on whether to produce low or high quality and then incur the fixed costs of quality development. In the third stage, firms select their prices and make their supply decisions. Each firm holds Bertrand (price) conjectures about the decision of the other firm. In this game the active government acts as a Stackelberg leader by precommiting itself to a specific tariff-cum-subsidy policy that will not be changed later. Thus, the appropriate solution concept is subgame perfectness.

We solve the model by backward induction. We consider first the price competition stage and determine the equilibrium taking (i) any profile of quality choices and (ii) any policy intervention (t, s) as given. Then we consider the reduced-form game in qualities and the Nash equilibrium of this subgame determines firms' quality selection, for any given (t, s). Finally, the domestic government chooses the optimal policy (t, s) taking into account the expected exchange rate and firms' cost asymmetries and anticipating the equilibrium of the continuation game. It is assumed that the exchange rate cannot be determined by the government.

[11] Of course we also allow for negative tariffs and negative subsidies: $t > 0$ implies taxation while $t < 0$ indicates subsidization of imports. Similarly $s < 0$ implies taxation of domestic production.

3 Market Equilibrium

We now proceed to derive the equilibrium outcome in stage 3. The domestic firm may in principle choose to produce a variant whose quality is either lower or higher than the foreign firm's variant. Let us consider the former case.[12] Using the pair of demands in (2), and taking trade and industrial policy (t, s) and quality choices (q_h, q_l) as given, the problem of the domestic firm consists of finding p_l so as to maximize:

$$\pi_l = (1+s)p_l \left(\frac{p_h - p_l}{\overline{\theta}(q_h - q_l)} - \frac{p_l}{\overline{\theta} q_l} \right) - cC(q_l)$$

On the other hand, the rival firm chooses p_h to maximize its profits:[13]

$$\pi_h^* = e(1-t)p_h \left(1 - \frac{p_h - p_l}{\overline{\theta}(q_h - q_l)} \right) - c^* C(q_h)$$

Solving the pair of reaction functions in prices, we obtain the subgame equilibrium prices of the two variants:

$$p_l = \frac{\overline{\theta} q_l (q_h - q_l)}{4q_h - q_l}, \ p_h = \frac{2\overline{\theta} q_h (q_h - q_l)}{4q_h - q_l} \tag{3}$$

Equilibrium prices depend only upon the two qualities but not directly upon the policy instruments and the exchange rate. The relative price of domestic production p_l/p_h is proportional to relative qualities q_l/q_h while the hedonic price of the high-quality variant is strictly higher than the low-quality one, $p_h/q_h > p_l/q_l$.

Consider now firms' quality selection. In this second stage, firms take (t, s) as given, anticipate the equilibrium prices of the continuation game obtained in (3), and choose their qualities to maximize reduced-form profits. These are obtained by substituting (3) into the expressions for profits above. In particular, the domestic firm selects q_l to maximize:

$$\pi_l = (1+s) \frac{\overline{\theta} q_l q_h (q_h - q_l)}{(4q_h - q_l)^2} - cC(q_l)$$

[12] In Section 4 we discuss the case where the home firm produces high quality.

[13] In this context, the so-called profits of the foreign firm are expected profits, namely the payoffs after taking the expectation operator with respect to the multiplicative uncertainty caused by the exchange rate e.

Likewise, the foreign firm chooses the high quality q_h to optimize:

$$\pi_h^* = e(1-t)\frac{4\overline{\theta}q_h^2(q_h - q_l)}{(4q_h - q_l)^2} - c^*C(q_h)$$

First order conditions give the reaction functions in qualities $q_h(q_l)$ and $q_l(q_h)$. To simplify expressions define $\mu = q_h/q_l$, with $\mu \geq 1$ since $q_h \geq q_l$. Variable μ represents the gap in the quality selection of firms. It measures the degree of product differentiation and thus relates to the extent of price competition. The foreign firm's reaction function in quality $q_h(q_l)$ and the domestic firm's reaction function in quality $q_l(q_h)$ are represented in Figure 1, for a cost function quadratic in quality.

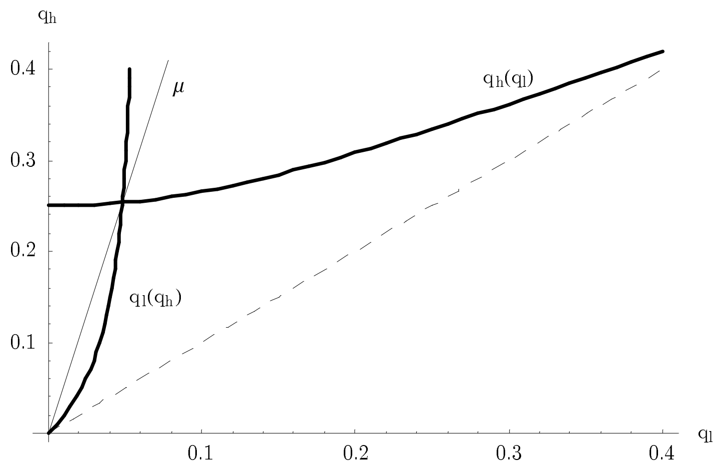

Figure 1: Firms' best response functions in qualities ($c = c^* = e = \overline{\theta} = 1$).

Both curves slope upwards, therefore qualities are strategic complements.[14] A candidate subgame perfect equilibrium is given by the intersection of these two curves. The gradient of the ray going through the origin and the equilibrium point is the quality gap μ. (The dashed line is the 45 degrees line, which illustrates that $q_h > q_l$ in a candidate equilibrium.) Using the definition of μ and the fact that $C'(\cdot)$ is a homogeneous function of degree $k-1$, the ratio of first order conditions can be written as:

$$\frac{ec(1-t)}{c^*(1+s)} = \frac{\mu^k(4\mu - 7)}{4(4\mu^2 - 3\mu + 2)} \tag{4}$$

This expression implicitly defines the equilibrium product differentiation μ as a function of the home firm's development cost relative to the foreign firm's cost, after correcting

[14]For larger degrees of homogeneity k these curves become flatter, but qualities remain strategic complements.

for tariff, subsidy and exchange rate. We shall refer to the LHS of (4) as the *relative development cost.*

As the LHS of (4) is a positive number, if an equilibrium exists, it must be the case that $4\mu - 7 > 0$, i.e., $\mu > 7/4$. Note that the RHS of (4) can be rewritten as the product of μ^{k-1} and $\mu(4\mu - 7)/[4(4\mu^2 - 3\mu + 2)]$, and that these two functions are increasing in μ, and bounded away from zero for all $\mu > 7/4$. Hence, the RHS of (4) increases monotonically with μ. This implies that there is a unique real solution to (4) satisfying $\mu > 7/4$, which is denoted by:

$$\mu = F(\overset{+}{c}, \overset{-}{c^*}, \overset{+}{e}, \overset{-}{s}, \overset{-}{t}, \overset{-}{k}) \tag{5}$$

The signs reported in (5) are readily found by looking at the way relative development cost relates to its components. Equation (5) implies that firms' cost asymmetries in similar currency units can be mitigated or reinforced by government intervention via tariffs and subsidies. For example, a subsidy on the low-quality product ($ds > 0$) or a tariff on high-quality imports ($dt > 0$) reduces the relative development cost of the home firm and thus μ increases. Another observation that comes out of (5) is the similarity between the impact of a policy intervention and the influence of exchange rate changes on the quality gap. A depreciation of the domestic currency (or equivalently an appreciation of the foreign currency, $de < 0$) has an impact similar to that of a tariff on high-quality imports, or to that of a subsidy on low-quality home production. We further elaborate on these issues in Section 5.[15]

From the reaction functions in qualities and by rewriting (2) and (3), we obtain:

$$D_l = \frac{\mu}{4\mu - 1}, \; D_h = \frac{2\mu}{4\mu - 1} \tag{6}$$

$$\widehat{\theta} = \frac{\overline{\theta}(\mu - 1)}{(4\mu - 1)} \tag{7}$$

$$p_l = \frac{\overline{\theta}(\mu - 1)q_l}{(4\mu - 1)}, \; p_h = \frac{2\overline{\theta}(\mu - 1)q_h}{(4\mu - 1)} \tag{8}$$

[15] Since the RHS of (4) increases exponentially with k, it is readily seen that, for any given relative cost, μ falls sharply as k rises. Most existing models of vertical product differentiation assume that development costs are quadratic ($k = 2$). While larger k values have implications for the quantitative results, it turns out that the qualitative results we derive are insensitive to k.

$$C'(q_l) = (1+s)\frac{\overline{\theta}\mu^2(4\mu-7)}{c(4\mu-1)^3} \tag{9}$$

$$C'(q_h) = e(1-t)\frac{4\overline{\theta}\mu(4\mu^2-3\mu+2)}{c^*(4\mu-1)^3}. \tag{10}$$

Equation (5) together with (6) to (10) characterize the stage 2 equilibrium. These equations give rise to a few observations which will be useful later. Quantities demanded given by (6) are negatively related to μ. Market size, which is also obtained by looking at the position of the marginal consumer who is indifferent between acquiring the low-quality variant or nothing (see (7)), is also negatively related to μ. These remarks gather the fact that a larger quality gap is associated with higher prices, and thus with lower sales. Indeed, a measure of price competition is obtained by taking the ratio of prices in (8), $p_h/p_l = 2\mu$. Any decrease in the quality gap intensifies price competition and prices decline. The role of μ is therefore absolutely central to our analysis.

Trade Liberalization

We are now ready to switch our attention to a first application of our model, namely, trade liberalization. Many policymakers at international organizations consider trade liberalization as one of the major economic reforms to be adopted by CEECs in transition. Our model however illustrates some potential problems with this policy prescription that arise once quality is endogenous. Assume that an equilibrium exists[16] and consider trade liberalization in our framework, that is, a reduction of the import tariff t. Then:

Proposition 1 *Independently of initial conditions and as long as the firm in the transition economy is a low-quality producer, trade liberalization causes a decline in domestic output and an increase in the price of all variants.*

Proof: See the Appendix.

The reason for this result is that trade liberalization enables firms to choose "extremes" on the quality spectrum with the aim at reducing competition. Hence, it brings about an increase in the price of both variants and consequently a domestic output drop. Proposition 1 thus suggests that trade liberalization may have been a contributing factor to the decline in output and to the inflation experienced in many CEECs.

[16] The discussion about existence and uniqueness of equilibrium is postponed until Section 4.

These effects are presumably contrary to what policymakers of these countries had intended initially and thus motivate a deeper examination of the welfare implications of government intervention.[17]

4 Trade and Industrial Policy

Finally, in the first stage of the game the domestic government chooses a trade and industrial policy (t, s) that maximizes domestic welfare. We assume that tariff revenues net of subsidies are uniformly distributed among consumers. Therefore social welfare equals the unweighted sum of domestic consumer surplus, net revenues generated by the tariff-cum-subsidy policy and profits of the domestic firm:

$$W = CS + tp_h D_h - sp_l D_l + \pi_l \tag{11}$$

Consumers surplus is given by:

$$CS = \int_{\frac{p_h - p_l}{q_h - q_l}}^{\overline{\theta}} (xq_h - p_h)dx + \int_{p_l/q_l}^{\frac{p_h - p_l}{q_h - q_l}} (xq_l - p_l)dx$$

Employing (8) and undertaking some algebraic computations, consumers surplus can be written more conveniently as:

$$CS = \frac{\overline{\theta}\mu^2(4\mu + 5)q_l}{2(4\mu - 1)^2} \tag{12}$$

where μ is given by (5) and q_l is obtained from (9). On the other hand, tariff revenues from high-quality imports can be written as:

$$TR_h \equiv tp_h D_h = \frac{t4\overline{\theta}\mu^2(\mu - 1)q_l}{(4\mu - 1)^2} \tag{13}$$

and home production subsidies as:

$$SC_l \equiv sp_l D_l = \frac{s\overline{\theta}\mu(\mu - 1)q_l}{(4\mu - 1)^2}.$$

[17] It can be shown that if the domestic firm produces high quality instead and imports are of low quality, trade liberalization brings about an increase in domestic output. This means that the incidence of trade liberalization is sensitive to whether firms are producers of low or of high quality. This may explain why developed countries may have larger incentives to commit to free trade and therefore different tariff schedules than transition economies.

Using (9) and Euler's theorem, reduced-form profits of the domestic firm can be written as:

$$\pi_l = \frac{(1+s)\overline{\theta}\mu q_l}{k(4\mu-1)^3}\left[k(4\mu-1)(\mu-1)-\mu(4\mu-7)\right] \tag{14}$$

Adding these expressions we can write transition economy's welfare as:

$$W_l = \frac{\overline{\theta}\mu}{(4\mu-1)^2}\left[\frac{4\mu^2+7\mu-2}{2}+4t\mu(\mu-1)-\frac{(1+s)\mu(4\mu-7)}{k(4\mu-1)}\right]q_l \tag{15}$$

Let us denote the first two factors of (15) as $A(\cdot)$.

There is frequent discussion about the options for reforming CEECs' trade regime. Some transition economies have argued that foreign trade should be liberalized more slowly than internal markets to lessen the decline in output (see Proposition 1). These countries maintain therefore high import tariffs and low domestic prices through a system of subsidies and administrative controls. In contrast, the following quote highlights the position adopted by most international organizations:

> "In transition economies ... trade controls therefore tend to be relatively ineffective at protecting firms or raising tariff revenues, and instead breed corruption." (World Bank, 1996, p.32)

The subsequent analysis sheds some light into this important debate and the next propositions provide some foundations as to the implications of government interventions in transition economies.

4.1 Positive Analysis of Trade and Industrial Policy

Starting from the benchmark case of free trade and absence of industrial policy ($s = t = 0$) the implications of a small tariff on high-quality imports are described in the following result:

Proposition 2 *A small tariff on high-quality imports leads to (a) a quality downgrade of both variants, (b) a decline of both variants' prices and hedonic prices, (c) an increase in the quantities sold and in the number of consumers being served, (d) a fall in domestic profits, (e) a decrease in consumers surplus, and (f) an increase in social welfare.*

Proof: See Appendix.

Figure 2 provides the main intuition for this result. A tariff on high-quality imports shifts downwards the best response function of the foreign firm (from $q_h(q_l)$ to $q_h(q_l;t)$).

Since both firms' reaction functions are strictly increasing, a tariff results in *quality downgrading* of both variants. Interestingly, as shown in (5), the high quality falls more than the low quality, and thus the quality gap (and the gradient μ) falls. A tariff on high-quality imports is therefore a *pro-competitive device.*

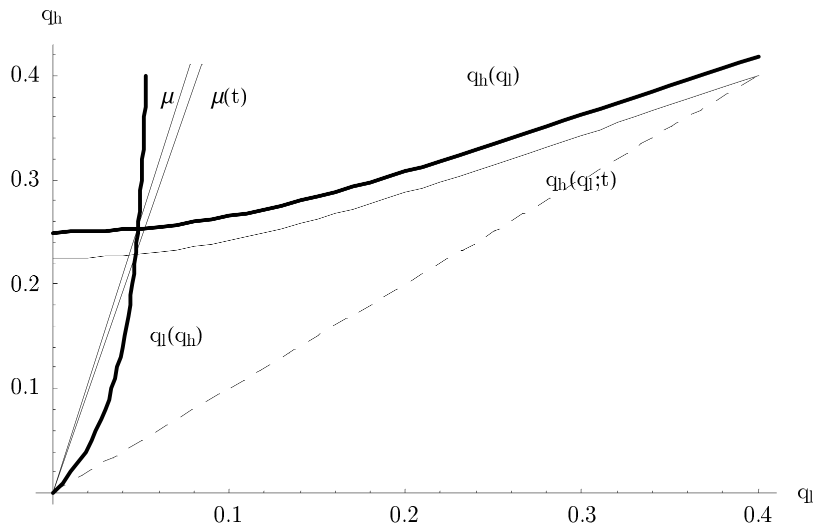

Figure 2: A tariff on high-quality imports.

To study whether a tariff is desirable from a social welfare viewpoint, both the beneficial effects of increased competition and the detrimental effects of quality downgrading must be taken into consideration. It turns out that the fall in qualities offsets the beneficial effects associated to tougher competition and thus consumer surplus falls. Domestic profits also decrease due to the increased competition. Interestingly, tariff revenues accruing from high-quality import taxation are large enough to make the policy measure attractive from a welfare viewpoint.[18]

We now evaluate the incidence of a small subsidy on low-quality domestic production. Again starting from the benchmark case of free trade and no subsidy ($s = t = 0$) we obtain the following result:

[18] It is interesting to compare this result to previous work. A linear demand function and zero marginal cost in Brander and Spencer (1984) would yield the result that a tariff against a foreign producer leaves imports and consumer surplus unchanged. Thus, it is unambiguously welfare improving because enough rent is extracted from the foreign seller. When quality is endogenous like in Krishna (1987), a tariff reduces quality, leaves imports unchanged and thus reduces consumer surplus. Our analysis here yields the insight that if there is a case for a tariff against a foreign monopolist when quality is endogenous, this case is reinforced in our duopoly framework because the tariff is a pro-competitive device.

Proposition 3 *A small subsidy on low-quality home production leads to: (a) a quality upgrade of both variants, (b) a decline of both variants' hedonic prices (c) an increase in quantities sold and in the number of consumers being served, (d) an increase in domestic firm's profits, (e) an increase in consumer surplus, and (f) an increase in social welfare.*

Proof: See the Appendix.

Figure 3 shows that a subsidy on low-quality production shifts the best response function of the domestic firm to the right (from $q_l(q_h)$ to $q_l(q_h; s)$). Since both firms' reaction functions are strictly increasing, the subsidy results in *quality upgrading* of both variants. However the low quality rises more than the high quality and thus the quality gap between the variants declines (see (5)). Therefore, a subsidy on low-quality domestic production is also a *pro-competitive device.*

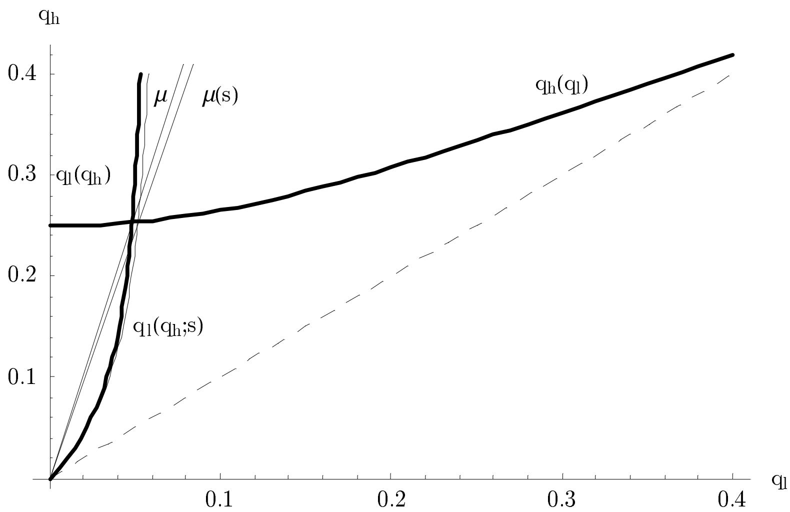

Figure 3: A subsidy on low-quality domestic production.

It is clear from Proposition 3 that subsidization of low-quality domestic production enhances welfare because a subsidy (i) raises the quality of the variants and (ii) fosters price competition between the firms. This in turn implies that goods of superior quality are bought by more customers at lower hedonic prices, yielding a welfare gain sufficiently large to offset subsidization expenses.

In summary, Propositions 2 and 3 indicate that the absence of government intervention in the form of free trade or zero subsidy is not an optimal policy prescription. A small tariff results in quality downgrading but improves welfare because enough income is taken away from the foreign firm to compensate for the reduction in both consumer surplus and domestic profits. In contrast, a subsidy raises welfare because it results in quality upgrading and intensifies price competition. Evidently, a tariff on foreign production seems to be less appealing than a subsidy on local production because it deteriorates qualities. Of course, when compared to a subsidy the attractiveness of a tariff increases as the opportunity cost of public funding rises.

4.2 Optimal Policy

Having concluded the proceeding analysis with the non-optimality of free trade, we are now in a position to determine the socially optimal trade and industrial policy (t, s). It is important to note that like in Lehmann-Grube (1997), production of high quality yields substantially higher profits than low quality. Therefore there may exist a strong incentive for a local firm to threaten the quality leadership of the foreign firm. In turn, the latter may wish to maintain its position in the quality spectrum. These reflections motivate two central theoretical questions in the model. First, when will the market equilibrium be such that the domestic firm produces low quality and the foreign firm high quality? Second, are local firms doomed to produce low-quality products or is it possible that a commitment by the active government to use a socially optimal policy can challenge the quality leadership of the foreign firm? These are two distinct questions that we address in what follows.

Selection of Equilibria

For any given government intervention (t, s), there may potentially be two equilibrium quality spectra in our continuation game. In the first equilibrium, high quality is produced abroad while in the second it is produced locally. We refer to the first situation as Assignment 1 and to the second as Assignment 2. Since domestic profits are a component of social welfare, the expression to be maximized is different across cases.

Consider first Assignment 1. In this case, the quality gap is given by the solution to (4). Let us rename the solution to this equation as μ_1. The equilibrium qualities are in this case obtained from (9) and (10):

$$q_l = C'^{-1}\left[(1+s)\frac{\overline{\theta}\mu_1^2(4\mu_1-7)}{c\,(4\mu_1-1)^3}\right],\; q_h^* = C'^{-1}\left[e(1-t)\frac{4\overline{\theta}\mu_1(4\mu_1^2-3\mu_1+2)}{c^*\,(4\mu_1-1)^3}\right].$$

Consider now the alternative quality spectrum defined by Assignment 2. In this case a new market equilibrium can be derived following the steps outlined in Section

3. In particular, the equilibrium product differentiation would be given by the solution to:

$$\frac{c^*(1+s)}{ec(1-t)} = \frac{\mu^k(4\mu-7)}{4(4\mu^2-3\mu+2)}. \tag{16}$$

Observe that (16) only differs from (4) in its LHS. Denote the solution to (16) as μ_2. Then, under Assignment 2, equilibrium qualities are:

$$q_h = C'^{-1}\left[(1-t)\frac{4\overline{\theta}\mu_2(4\mu_2^2-3\mu_2+2)}{c\,(4\mu_2-1)^3}\right],\ q_l^* = C'^{-1}\left[e(1+s)\frac{\overline{\theta}\mu_2^2(4\mu_2-7)}{c^*\,(4\mu_2-1)^3}\right].$$

It turns out that these two proposed equilibrium configurations are not feasible for all parameter constellations. The next result characterizes the selection of equilibria employing the risk-dominance criterion of Harsanyi and Selten (1988).

Proposition 4 *Given any trade and industrial policy (t,s), in the unique risk-dominant equilibrium low quality is produced by the domestic firm if and only if $c^* < ec(1-t)/(1+s)$. When $c^* = ec(1-t)/(1+s)$ the domestic firm may produce either high or low quality.*

Proof: See the Appendix.

Lemma 8 in the Appendix provides a general proof of this Proposition for c^* sufficiently low compared to $ce(1-t)/(1+s)$. In this case, the assignment where the low quality is produced abroad is not a subgame perfect equilibrium because the foreign firm, which is highly efficient, finds it profitable to deviate and leapfrog the domestic firm. However, when firms' cost asymmetries are small, the proof requires a more powerful equilibrium concept, namely, the risk-dominance criterion. This refinement selects away the equilibrium in which the domestic firm produces high quality whenever the foreign firm is more efficient in relative terms.[19]

Proposition 4 indicates that trade and industrial policies have a bearing on the relative development cost of the domestic firm, and therefore on the equilibrium market structure. Indeed for any e, c^* and c there exist many pairs (t,s) such that the inequality above is reversed, thus inducing leapfrogging. This outcome seems attractive because high-quality production generates substantially higher profits.[20] However,

[19]Cabrales *et al.* (2000) find that the risk-dominance criterion is supported by the behavior of experimental subjects in 2×2 coordination games similar to ours.

[20]These higher profits could be used to finance productivity and technology improvements (to lower c) in the future and make the new quality configuration sustainable in the long run without government support.

such a policy may be distortionary and have negative consequences for the government budget balance. An interesting question that arises is under which conditions leapfrogging is socially optimal.

Policy induced leapfrogging

For any e, c^* and c, let us define $W_i(t,s)$, $i = 1,2$ as the social welfare under any policy mix (t,s) in Assignment i. Denote by (t_1, s_1) the maximizer of $W_1(t,s)$, that is, $(t_1, s_1) = \arg\max W_1(t,s)$ s.t. $c^* \leq ec(1-t_1)/(1+s_1)$. Likewise, $(t_2, s_2) = \arg\max W_2(t,s)$ s.t. $c^* \geq ec(1-t_2)/(1+s_2)$. Hence $W_i(t_i, s_i)$ is the maximum level of welfare attained under Assignment i, $i = 1, 2$. Then:

Proposition 5 *[A] Consider the set of policy interventions such that the firm in the transition economy manufactures low quality. Then the best policy mix* (t_1, s_1) *involves (i) a positive tariff on high-quality imports and (ii) a subsidy (tax) on low-quality domestic production if firms' cost asymmetries are large (small).*
[B] Consider the set of policy interventions such that the firm in the transition economy manufactures high quality. Then the best policy mix (t_2, s_2) *involves (i) a positive tariff on low-quality imports and (ii) a subsidy (tax) on high-quality domestic production if firms' cost asymmetries are large (small).*
[C] The optimal policy is (t_1, s_1) *if and only if* $W(t_1, s_1) > W(t_2, s_2)$. *Otherwise, the optimal policy is* (t_2, s_2).

Proof: See the Appendix

Figure 4 depicts the optimal levels of welfare under the two assignments for different values of ec/c^*. The curves $W_1(t_1, s_1)$ and $W_2(t_2, s_2)$ represent the optimal welfare levels when low and high quality is produced at home, respectively. Upon the observation of these two curves, it is clear that $W_2(t_2, s_2)$ lies above $W_1(t_1, s_1)$ when cost asymmetries ec/c^* lie to the left of point A in the graph. In this region of parameters, the activist government finds it beneficial to introduce a trade and industrial policy (t_2, s_2) that induces leapfrogging. In contrast, to the right of point A, $W_1(t_1, s_1)$ lies above $W_2(t_2, s_2)$ and government induced leapfrogging is not optimal. This policy would require subsidies that are too large so that a higher level of welfare is attained by letting high-quality production to occur abroad.

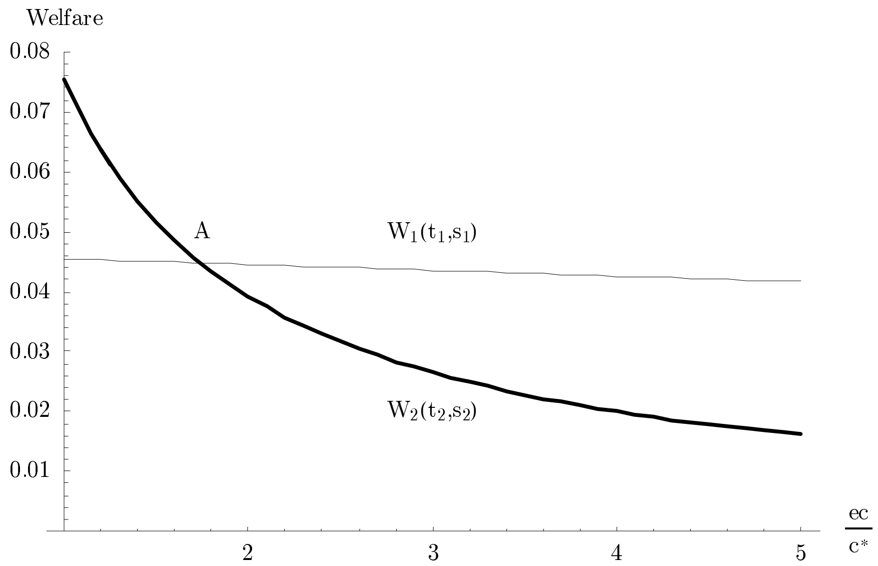

Figure 4: Optimal welfare levels under the two quality spectra.

5 Exchange rate movements

Earlier in the paper we have identified similarities between trade and industrial policies and expected exchange rate variations. Central to the comparison is equation (5), which shows that an expected depreciation of the currency brings about changes in product differentiation and price competition which are similar to those of a tariff on imports, or of a subsidy on domestic production. A major difference is, however, that exchange rate changes do not affect the government budget balance. In the remainder of this section we formalize the role of expected exchange rate changes on the market equilibrium. We start by noting an equivalence result whose proof is straightforward and thus omitted.

Proposition 6 *Starting from free trade ($t = s = 0$) there exists, for any c, c^*, an exchange rate e such that the quality gap and thus price competition are equal to those under the optimal trade policy. Quantities imported and hedonic prices are the same too.*

This result suggests that since most CEECs have experienced large depreciations of their currencies, this has contributed to reduce product differentiation among firms and foster price competition. From a welfare perspective, however, there is a major drawback when a small depreciation of the currency occurs:

Proposition 7 *Irrespective of the quality produced by the domestic firm, a small depreciation of the transition economy's currency leads to a decrease in social welfare.*

Proof: See Appendix.

An intuitive reasoning can be given to this result. Consider for example the case of high-quality imports. We can refer to (5) and Proposition 2 to argue that an expected depreciation of the exchange rate of the transition economy leads to an increase in the quantities sold and to an increase in the size of the market. However, the drawbacks are that the domestic firm is harmed because of lower profits and consumer surplus decreases because the quality of both variants fall. As there is no effect on government revenues, social welfare unambiguously falls. The same can be argued for the case of low-quality imports.

Note finally that *large* depreciations of the exchange rate may induce leapfrogging like trade and industrial policies do. Indeed, for any level of cost asymmetries there exist some exchange rate e that offsets the difference between c and c^*, i.e., such that $c < c^*/e$, which according to Proposition 4 would lead the domestic firm to leapfrog the foreign competitor.[21] Depending on initial conditions, this might increase welfare because high-quality production yields substantially higher profits.

6 Discussion

This paper has considered the positive and the normative effects of trade and industrial policy in transition economies. The discerning features of these economies which have been emphasized in our model include the existence of a quality gap between Western goods and those manufactured in CEECs, the presence of a high level of government intervention in economic activity, and the observed large depreciations of their currencies.

Our framework of analysis has been a duopoly model of vertical differentiation and international trade. We have shown that (i) in absence of government intervention, the least efficient firm located in the transition economy produces a low-quality variant and imports are of high quality. (ii) The domestic government can raise welfare either by imposing a tariff on high-quality imports or by subsidizing home low-quality production, which proves the non-optimality of free trade. (iii) Trade liberalization contributes to inflation and results in an output drop of the local firm. Whether social welfare improves depends on initial conditions. (iv) Government intervention via tariffs

[21] These observations further imply that the import demand function has an inverted "v" shape in relation to the exchange rate. Leapfrogging gives rise to a discontinuity at some $\overline{e}$, where $\overline{e}$ satisfies $c\overline{e}(1-t)/(c^*(1+s)) = 1$. For any expected exchange rate below this value, imports are of low quality and increasing in the exchange rate. In contrast, for any expected exchange rate above $\overline{e}$, imports are of high quality and respond negatively to any further exchange rate appreciation.

and subsidies can induce the firm in the transition economy to leapfrog the quality of the foreign competitor. (v) Finally, there exists a partial equivalence result between an exchange rate depreciation and the government's optimal policy. This equivalence is however not complete because the former usually leads to social welfare losses.

An interesting extension of our model would be one which allows for foreign direct investments, which seem to be crucial for the economic development of some transition economies. A foreign acquisition of the local firm would only affect the first stage of the game in that domestic profits in (14) would now be repatriated abroad and therefore drop from the expression for domestic social welfare. In contrast, the market equilibrium would remain qualitatively unaffected.

A multi-firm framework could be analyzed along the lines of this paper, but at the cost of increased complexity. A taxonomy of cases would arise because of development cost differences among firms and their attempts to leapfrog each other. The risk-dominance criterion could still be applied numerically on a bilateral comparison of firms. Social welfare would be affected by the relative number of local firms and the optimal trade policy would become sensitive to the position of these firms on the quality spectrum.

There is a recent literature dealing with time-consistent strategic trade policy. The main contribution of this work is to show that the optimal trade policy may be sensitive to the different assumptions about government precommitment (see e.g. Leahy and Neary, 1999). Our setting implicitly assumes that the activist government can credibly commit to its policy choice before firms make price and quality decisions. We have also assumed away the possibility that the foreign country engages into retaliatory trade policies (see e.g. Collie, 1991), or argues that the domestic government actions are inconsistent with the country's bid to join the World Trade Organization (see e.g. Bagwell and Staiger, 1999). Alternative models could therefore be used to study questions similar to those raised in our model assuming a non-committal government or possible retaliatory policies.

7 Appendix

Proof of Proposition 1: From (6), we obtain the partial derivative of D_l with respect to t :

$$\frac{\partial D_l}{\partial t} = \frac{-1}{(4\mu - 1)^2} \frac{\partial \mu}{\partial t}$$

From (5) it follows that $\partial\mu/\partial t < 0$. As a result we have $\partial D_l/\partial t > 0$. Hence, a decrease in t decreases output of the local firm. To show that prices decline after trade liberalization notice that

$$\frac{dp_l}{dt} = q_l \frac{\partial p_l}{\partial \mu}\frac{\partial \mu}{\partial t} + \frac{p_l}{ql}\frac{dq_l}{dt}$$

It is readily seen that $\partial p_l/\partial\mu > 0$. Notice also that the RHS of (9) increases with μ. Since $C(\cdot)$ is convex, then we have $\partial q_l/\partial\mu > 0$ and therefore

$$\frac{dq_l}{dt} = \frac{\partial q_l}{\partial \mu}\frac{\partial \mu}{\partial t} < 0.$$

Therefore $dp_l/dt < 0$. One shows similarly that $dp_h/dt < 0$. ■

Proof of Proposition 2: Note first that applying the implicit function theorem to equation (4) we have that $\partial\mu/\partial t < 0$.
(a) Notice that the RHS of (9) increases with μ. Since $C(\cdot)$ is convex, then we have $\partial q_l/\partial\mu > 0$ and therefore

$$\frac{dq_l}{dt} = \frac{\partial q_l}{\partial \mu}\frac{\partial \mu}{\partial t} < 0.$$

Since $q_h = \mu q_l$, it follows that $dq_h/dt < 0$.
(b) To show that hedonic prices fall with t, note that $\partial(p_h/q_h)/\partial\mu > 0$, as observed earlier, and thus $d(p_h/q_h)/dt < 0$. One shows similarly that $d(p_l/q_l)/dt > 0$. To show that prices fall notice that $\partial p_h/\partial\mu > 0$ and $\partial p_l/\partial\mu > 0$. Using (a), it follows that $dp_h/dt < 0$ and $dp_l/dt < 0$.
(c) Using (6), we have

$$\frac{dD_l}{dt} = \frac{\partial D_l}{\partial \mu}\frac{\partial \mu}{\partial t} = \frac{-1}{(4\mu-1)^2}\frac{\partial \mu}{\partial t} > 0.$$

Since $D_h = 2D_l$, then $dD_h/dt > 0$.
(d) The profits of the domestic firm in the absence of industrial policy can be written as $\pi_l = \overline{\theta} q_l F(\mu) - cC(q_l)$ where $F(\mu) = \mu(\mu-1)/(4\mu-1)^2$. We need to find the sign of

$$\frac{d\pi_l}{dt} = \overline{\theta} q_l F'(\mu)\frac{\partial \mu}{\partial t} + \left[\overline{\theta} F(\mu) - cC'(q_l)\right]\frac{dq_l}{dt} \tag{17}$$

Now we can use (9) to state that $\overline{\theta} F(\mu) - cC'(q_l) = \overline{\theta}\mu F'(\mu)$ where $F'(\mu) = (2\mu +$

$1)/(4\mu-1)^3$. Therefore equation (17) reduces to

$$\frac{d\pi_l}{dt}=\overline{\theta}F'(\mu)\left[q_l\frac{\partial\mu}{\partial t}+\mu\frac{dq_l}{dt}\right]=\overline{\theta}F'(\mu)\frac{dq_h}{dt}<0,$$

where the inequality follows from (a).
(e) Using (12) we can compute

$$\frac{dCS}{dt}=\frac{\partial CS}{\partial\mu}\frac{\partial\mu}{\partial t}+\frac{\partial CS}{\partial q_l}\frac{dq_l}{dt}.$$

Note that $\partial CS/\partial\mu=\overline{\theta}\mu\left[\mu(8\mu-6)-5\right]q_l/\left(4\mu-1\right)^3>0$ and that $\partial CS/\partial q_l>0$. Then, using the results above we obtain that $dCS/dt<0$.
(f) Finally, social welfare equals $W=CS+TR_h+\pi_l$. Now, notice that $d\pi_l/dt<0$ and $dCS/dt<0$ as shown in (d) and (e) respectively. Then welfare can only rise whenever import tariff proceeds are large enough. We need to compare the relative magnitude of these two forces working in opposite directions. Notice that, as shown in (a), q_l falls with t, and therefore $C(q_l)$ does so too. Therefore, to prove the result it is enough to show that

$$\left.\frac{dTR_h}{dt}\right|_{t=0}+\left.\frac{d(CS+R_l)}{dt}\right|_{t=0}>0$$

where R_l denotes the revenues of the domestic firm. Now, observe that $dTR_h/dt|_{t=0}=4\overline{\theta}\mu(\mu-1)q_h/(4\mu-1)^2>0$, and that $CS+R_l=\overline{\theta}(2+\mu)q_h/2(4\mu-1)$. Therefore

$$\left.\frac{d(CS+R_l)}{dt}\right|_{t=0}=-\frac{9\overline{\theta}q_h}{2(4\mu-1)^2}\frac{\partial\mu}{\partial t}+\frac{\overline{\theta}(2+\mu)}{2(4\mu-1)}\frac{dq_h}{dt}$$

Observe that

$$\frac{dq_h}{dt}=\frac{\partial q_h}{\partial t}+\frac{\partial q_h}{\partial\mu}\frac{\partial\mu}{\partial t}.$$

Using the Euler's theorem and equations (4) and (10) we can obtain the following derivatives:

$$\begin{aligned}\frac{\partial q_h}{\partial\mu}&=-\frac{2(5\mu+1)q_h}{(k-1)\mu(4\mu-1)(4\mu^2-3\mu+2)}<0\\ \frac{\partial q_h}{\partial t}&=-\frac{q_h}{(k-1)(1-t)}<0\end{aligned}$$

Then, taking into account the signs of these derivatives, to prove the claim it is enough to show that

$$\left.\frac{dTR_h}{dt}\right|_{t=0} = \frac{4\overline{\theta}\mu(\mu-1)q_h}{(4\mu-1)^2} > \frac{\overline{\theta}(2+\mu)}{2(4\mu-1)}\left.\frac{\partial q_h}{\partial t}\right|_{t=0},$$

or

$$\frac{4\overline{\theta}\mu(\mu-1)q_h}{(4\mu-1)^2} > \frac{\overline{\theta}(2+\mu)}{2(4\mu-1)}\frac{q_h}{(k-1)}$$

Since, for a given μ, the RHS of this equation decreases with k, it is enough to show that the inequality holds for the minimum k, i.e., $k=2$. It obtains that it must be the case $4\mu^2-7\mu-6>0$, which is true for any solution to (4). ■

Proof of Proposition 3: Note first that applying the implicit function theorem to equation (4) we have that $\partial\mu/\partial s<0$.
(a) Notice that the RHS of (10) decreases with μ. Since $C(\cdot)$ is convex, then we have $\partial q_h/\partial\mu<0$ and thus

$$\frac{dq_h}{ds} = \frac{\partial q_h}{\partial \mu}\frac{\partial \mu}{\partial s} > 0.$$

Since $q_l = q_h/\mu$, it follows that $dq_l/ds > 0$.
(b) Using (8) we have that $p_h/q_h = 2\overline{\theta}(\mu-1)/(4\mu-1)$. Since

$$\frac{\partial(p_h/q_h)}{\partial\mu} = \frac{6\overline{\theta}}{(4\mu-1)^2} > 0,$$

then $d(p_h/q_h)/ds<0$. One shows similarly that $d(p_l/q_l)/ds<0$.
(c) Using (6), we have

$$\frac{dD_l}{ds} = \frac{\partial D_l}{\partial\mu}\frac{\partial\mu}{\partial s} = \frac{-1}{(4\mu-1)^2}\frac{\partial\mu}{\partial s} > 0.$$

Since $D_h = 2D_l$, then $dD_h/ds>0$.
(d) Domestic firm's profits can be written as $\pi_l = (1+s)\overline{\theta}q_lF(\mu) - cC(q_l)$ where $F(\mu)=\mu(\mu-1)/(4\mu-1)^2$. We need to find the sign of

$$\frac{d\pi_l}{ds} = \overline{\theta}q_lF(\mu) + (1+s)\overline{\theta}q_lF'(\mu)\frac{\partial\mu}{\partial s} + \left[(1+s)\overline{\theta}F(\mu) - cC'(q_l)\right]\frac{dq_l}{ds} \tag{18}$$

Now we can use (9) to state that $(1+s)\overline{\theta}F(\mu) - cC'(q_l) = (1+s)\overline{\theta}\mu F'(\mu)$ where

$F'(\mu) = (2\mu+1)/(4\mu-1)^3$. Therefore equation (18) reduces to

$$\begin{aligned} \frac{d\pi_l}{ds} &= \overline{\theta} q_l F(\mu) + (1+s)\overline{\theta} F'(\mu) \left[q_l \frac{\partial \mu}{\partial s} + \mu \frac{dq_l}{ds} \right] \\ &= \overline{\theta} q_l F(\mu) + (1+s)\overline{\theta} F'(\mu) \frac{dq_h}{ds} > 0, \end{aligned}$$

where the inequality follows from (a). Likewise, one can prove that gross profits $\widetilde{\pi}_l = \pi_l + s\overline{\theta} q_h F(\mu)/\mu$ by noting that $F(\mu)/\mu$ declines with μ.
(e) From (12) consumer surplus can be written as

$$CS = \frac{\overline{\theta}\mu(4\mu+5)}{2(4\mu-1)^2} q_h.$$

Then,

$$\frac{dCS}{ds} = \frac{\partial CS}{\partial \mu}\frac{\partial \mu}{\partial s} + \frac{\partial CS}{\partial q_h}\frac{dq_h}{ds}$$

Note that $\partial CS/\partial \mu = -\overline{\theta}(28\mu+5)q_h/\left(4\mu-1\right)^3 < 0$ and that $\partial CS/\partial q_h > 0$. Then, using the results above we obtain that $dCS/ds > 0$.
(f) Finally, social welfare equals $W = CS - SC_l + \pi_l = CS + \widetilde{\pi}_l$. Now, since $d\widetilde{\pi}_l/ds > 0$ and $dCS/ds > 0$ as shown in (d) and (e) respectively, it follows that $dW/ds > 0$. The proof is now complete. ■

Proof of Proposition 4: We first prove a partial result given in Lemma 8 below stating that for sufficiently large cost differences the domestic firm produces low quality in the unique subgame perfect equilibrium. After this, we numerically apply the risk-dominance criterion to our game and conclude that the domestic firm produces low quality in the unique refined subgame perfect equilibrium if and only if $c^* < ec(1-t)/(1+s)$.

Lemma 8 *For any government intervention* (t,s) *and any other parameters there exists* $\widehat{c}^*$ *such that for all* $c^* < \widehat{c}^*$ *the unique quality configuration which is part of a subgame perfect equilibrium is such that low quality is produced by the domestic firm (Assignment 1).*

Proof: Consider the context of Assignment 2. Next we show that the foreign firm finds it beneficial to leapfrog the domestic firm whenever $c^*/e(1-t)$ is sufficiently low compared to $c/(1+s)$. Consider the foreign firm contemplating to leapfrog rival's quality choice. Then, this firm would choose q to maximize deviating profits given by:

$$\widehat{\pi}_h^* = e(1-t)\frac{4\overline{\theta}q^2(q-q_h)}{(4q-q_h)^2} - c^*C(q)$$

The first order condition is:

$$e(1-t)\frac{4\overline{\theta}q(4q^2-3qq_h+2q_h^2)}{(4q-q_h)^3} - c^*C'(q) = 0 \tag{19}$$

Let us define $q = \lambda q_h$ where $\lambda \geq 1$. Then, from (19) we can write:

$$C'(q) = e(1-t)\frac{4\overline{\theta}\lambda(4\lambda^2-3\lambda+2)}{c^*(4\lambda-1)^3} = C'(\lambda q_h) = \lambda^{k-1}(1+s)\frac{4\overline{\theta}\mu_2(4\mu_2^2-3\mu_2+2)}{c\,(4\mu_2-1)^3}$$

From this relationship, we can obtain:

$$\frac{(1+s)\,c^*}{(1-t)\,ec} = \frac{\lambda(4\lambda^2-3\lambda+2)}{\lambda^{k-1}(4\lambda-1)^3}\frac{(4\mu_2-1)^3}{\mu_2(4\mu_2^2-3\mu_2+2)}$$

Using equation (16) we can substitute c^*/ec to obtain:

$$\frac{\mu_2^{k+1}(4\mu_2-7)}{4\,(4\mu_2-1)^3} = \frac{(4\lambda^2-3\lambda+2)}{\lambda^{k-2}(4\lambda-1)^3} \tag{20}$$

Refer to the solution of this equation as λ_2. Note that the LHS of (20) increases with μ_2, while its RHS decreases with λ. Thus, μ_2 and λ_2 are inversely related.

We are now ready to compare deviating profits

$$\begin{aligned}\widehat{\pi}_h^* &= e(1-t)\frac{4\overline{\theta}\lambda_2^2(\lambda_2-1)}{(4\lambda_2-1)^2}q_h - c^*C(q)\\ &= e(1-t)\frac{4\overline{\theta}\lambda_2^2(\lambda_2-1)}{(4\lambda_2-1)^2}\mu_2 q_l - c^*C(\lambda_2\mu_2 q_l)\end{aligned}$$

with equilibrium benefits

$$\pi_l^* = e(1-t)\frac{\overline{\theta}\mu_2(\mu_2-1)}{(4\mu_2-1)^2}q_l - c^*C(q_l).$$

The foreign firm would deviate whenever $\widehat{\pi}_h^* \geq \pi_l^*$, i.e., if and only if

$$e(1-t)\overline{\theta}\left[\frac{4\lambda_2^2(\lambda_2-1)}{(4\lambda_2-1)^2}\mu_2 - \frac{\mu_2\,(\mu_2-1)}{(4\mu_2-1)^2}\right] \geq \frac{(\lambda_2^k\mu_2^k-1)c^*C(q_l)}{q_l}. \tag{21}$$

Now, using Euler's theorem, we note that

$$\frac{C(q_l)}{q_l} = \frac{C'(q_l)}{k} = \frac{e(1-t)\overline{\theta}\mu_2^2(4\mu_2-7)}{kc^*(4\mu_2-1)^3},$$

Then we can rewrite (21) as follows:

$$\frac{4\lambda_2^2(\lambda_2-1)}{(4\lambda_2-1)^2} - \frac{(\mu_2-1)}{(4\mu_2-1)^2} \geq (\lambda_2^k\mu_2^k-1)\frac{\mu_2(4\mu_2-7)}{k(4\mu_2-1)^3}$$

Or,

$$\frac{4\lambda_2^2(\lambda_2-1)}{(4\lambda_2-1)^2} - \lambda_2^k\frac{\mu_2^{k+1}(4\mu_2-7)}{(4\mu_2-1)^3} \geq \frac{1}{(4\mu_2-1)^2}\left[(\mu_2-1) - \frac{\mu_2(4\mu_2-7)}{k(4\mu_2-1)}\right]$$

We can use (20) to substitute $\lambda_2^k\mu_2^k$ to obtain:

$$\frac{4\lambda_2^2}{(4\lambda_2-1)^2}\left[(\lambda_2-1) - \frac{(4\lambda_2^2-3\lambda_2+2)}{k(4\lambda_2-1)}\right] \geq \frac{1}{(4\mu_2-1)^2}\left[(\mu_2-1) - \frac{\mu_2(4\mu_2-7)}{k(4\mu_2-1)}\right]$$

Note now that the LHS of this expression in an increasing function of λ_2, while its RHS decreases with μ_2. Notice also that the LHS varies at a higher rate than the RHS. Since λ_2 increases while μ_2 decreases as c^* falls, it is clear that there exists some sufficiently low $\overline{c}^*$ such that for all $c^* < \overline{c}^*$ the above inequality holds. As a result, the foreign firm would find it beneficial to deviate and leapfrog the domestic firm.

We show now that, in contrast, Assignment 1 is an equilibrium when c^* is sufficiently low. To prove this, let us first see that both firms' profits at the proposed equilibrium are non-negative. Later we will check that no firm has an incentive to leapfrog its rival's choice. Equilibrium profits for the low-quality firm under Assignment 1 can be written as (using Euler's theorem):

$$\pi_l = (1+s)\frac{\overline{\theta}\mu_1(\mu_1-1)}{(4\mu_1-1)^2}q_l - \frac{cq_lC'(q_l)}{k}$$

We can use the first order condition (9) to obtain

$$\pi_l = \frac{(1+s)\overline{\theta}\mu_1 q_l}{k(4\mu_1-1)^3}\left[k(4\mu_1-1)(\mu_1-1)-\mu_1(4\mu_1-7)\right] > 0 \text{ for all } k>1 \tag{22}$$

whenever $q_l > 0$. But in a proposed equilibrium $\mu_1 > 0$ and thus q_l and q_h are also positive. One proves that profits of the high-quality firm are positive similarly.

Let us see now that no firm would leapfrog rival's choice under Assignment 1 whenever c^* is sufficiently low. Consider the case of "upward" leapfrogging first, i.e., suppose the domestic firm deviates by leapfrogging its rival's quality. In such a case, home firm would select $q \geq q_h$ to maximize deviating profits:

$$\widetilde{\pi}_h = (1+s)\frac{4\overline{\theta}q^2(q-q_h)}{(4q-q_h)^2} - cC(q)$$

The first order condition is:

$$(1+s)\frac{4\overline{\theta}q(4q^2-3qq_h+2q_h^2)}{(4q-q_h)^3} - cC'(q) = 0$$

Define $v \geq 1$ such that $q = vq_h$. Then, we can write:

$$C'(q) = (1+s)\frac{4\overline{\theta}v(4v^2-3v+2)}{c(4v-1)^3} = C'(vq_h) = v^{k-1}e(1-t)\frac{4\overline{\theta}\mu_1(4\mu_1^2-3\mu_1+2)}{c^*\left(4\mu_1-1\right)^3}$$

From this equality, we obtain that in the optimal deviation v must satisfy:

$$\frac{(1-t)\,ec}{(1+s)\,c^*} = \frac{v(4v^2-3v+2)}{v^{k-1}(4v-1)^3}\frac{\left(4\mu_1-1\right)^3}{\mu_1(4\mu_1^2-3\mu_1+2)} \tag{23}$$

Using equation (4), we can substitute ec/c^* to rewrite (23) as:

$$\frac{v(4v^2-3v+2)}{v^{k-1}(4v-1)^3} = \frac{\mu_1^{k+1}(4\mu_1-7)}{4\left(4\mu_1-1\right)^3} \tag{24}$$

Denote the solution to this equation as v_1 and notice that v_1 and μ_1 are inversely related since the LHS of (24) decreases with v and its RHS increases with μ_1. We can now compare deviating profits $\widetilde{\pi}_h$ with those at the proposed equilibrium π_l. Domestic firm does not deviate whenever $\widetilde{\pi}_h \leq \pi_l$. Equilibrium profits are given by (22) while deviating profits can be written as:

$$\widetilde{\pi}_h = (1+s)\frac{4\overline{\theta}q^2(q-q_h)}{(4q-q_h)^2} - cC(q) = (1+s)\frac{4\overline{\theta}v_1^2(v_1-1)}{(4v_1-1)^2}q_h - v_1^k\mu_1^k C(q_l)$$

We can use equation (24) and Euler's theorem to write $\widetilde{\pi}_h$ as:

$$\widetilde{\pi}_h = \frac{(1+s)4\overline{\theta}v_1^2}{k(4v_1-1)^3}\mu_1 q_l \left[k(4v_1-1)(v_1-1) - (4v_1^2 - 3v_1 + 2)\right]$$

Now, equations (23) and (24) imply that as c^* falls, v_1 falls and μ_1 increases. As a result, by simple inspection of $\widetilde{\pi}_h$ and π_l one concludes that there exists $\underline{c}^*$ such that for all $c^* < \underline{c}^*$ Assignment 1 is an equilibrium of the continuation game. The case of "downward" leapfrogging is readily ruled out by observing that low-quality production yields lower profits that high-quality production, ceteris paribus. Therefore there exists $\widehat{c}^* = \min\{\underline{c}^*, \overline{c}^*\}$ such that for all $c^* < \widehat{c}^*$ Assignment 1 constitutes the only quality configuration that can be part of a subgame perfect equilibrium. The proof of Lemma 8 is now complete.

In what follows we apply the Harsanyi-Selten criterion to our setting. This refinement allows us to rule out an equilibrium where high quality is produced domestically whenever $c^* < ec(1-t)/(1+s)$. Both firms face the choice between the equilibrium given by Assignment 1 ($A1$) and the one given Assignment 2 ($A2$). Let us represent firms' choices between both assignments by the following matrix:

		Foreign Firm	
		A_1^*	A_2^*
Domestic Firm	A_1	π_l, π_h^*	π_l^{12}, π_h^{*12}
	A_2	π_l^{21}, π_h^{*21}	π_h, π_l^*

where π_l^{12} and π_h^{*12} denote the payoffs to the low-quality domestic firm and to the high-quality foreign firm, respectively, when the former chooses to produce the low-quality given by Assignment 1 and the latter chooses to produce the low-quality given by Assignment 2. π_l^{21} and π_h^{*21} are similarly interpreted.

As indicated above, when cost differences are small, $\{A_1, A_1^*\}$ and $\{A_2, A_2^*\}$ are both equilibria of the subgame with corresponding firms' payoffs (π_l, π_h^*) and (π_h, π_l^*), respectively. Let $G_{11} = \pi_l - \pi_l^{21}$ be the gains the domestic firm obtains by predicting correctly that the foreign firm will select Assignment 1. Likewise, $G_{12} = \pi_h - \pi_l^{12}$ denotes the gains the domestic firm derives by forecasting correctly that the foreign firm will select Assignment 2. Similarly, for the foreign firm we have $G_{21} = \pi_h^* - \pi_h^{*12}$ and $G_{22} = \pi_l^* - \pi_h^{*21}$. It is said that Assignment 1 risk-dominates Assignment 2 whenever $G_{11}G_{21} > G_{12}G_{22}$.

Unfortunately, applying theoretically this refinement to our game is very difficult because the maximizers of $\pi_l, \pi_h^*, \pi_l^*, \pi_h, \pi_h^{*12}, \pi_l^{12}, \pi_l^{21}$ and π_h^{*21} cannot be obtained explicitly. Thus, we have chosen to simulate our model using polynomial cost functions of various degrees. Figure 5 depicts the gains G_{11}, G_{21}, G_{12} and G_{22} as a function of the effective relative costs $ec(1-t)/(c^*(1+s))$, for a quadratic cost of quality function.

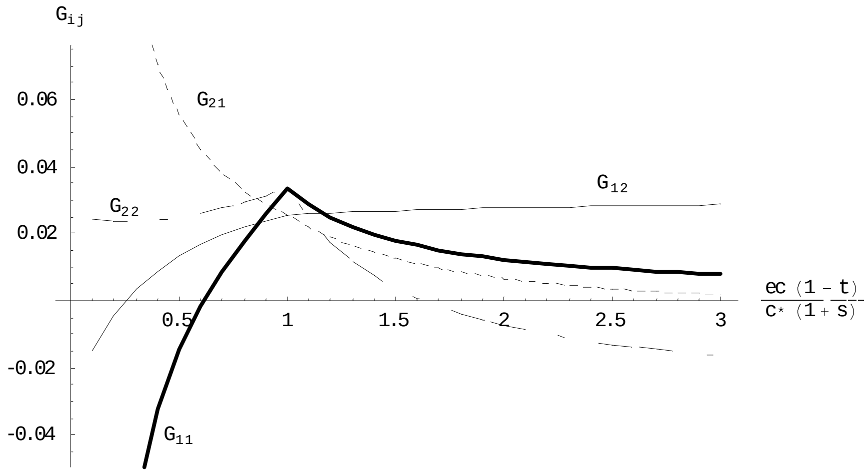

Figure 5

Inequality $G_{11}G_{21} > G_{12}G_{22}$ can be evaluated by observing Figure 6. This graph shows $G_{11}G_{21}$ and $G_{12}G_{22}$ as a function of relative costs. It can be seen that $G_{11}G_{21} > G_{12}G_{22}$ if and only if relative costs are greater than 1. This implies that Assignment 2 is ruled out whenever domestic firm is (relatively) less efficient than foreign firm. Otherwise, assignment 1 is selected away. We have conducted a number of simulations with different polynomial cost functions and the selection criterion does not change.

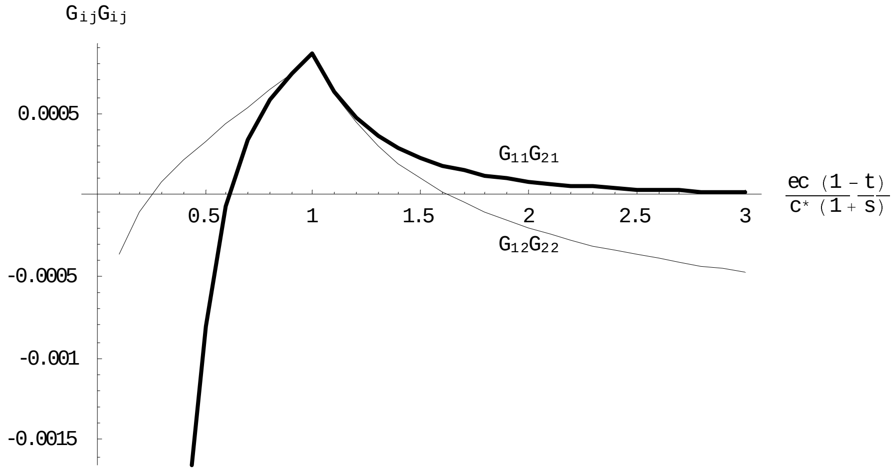

Figure 6: Harsanyi-Selten criterion.

Proof of Proposition 5: Note that social welfare is given by (15) provided that the domestic firm manufactures a low-quality good. Otherwise welfare is given by

$$W = CS - sp_hD_h - tp_lD_l + \pi_h. \tag{25}$$

Therefore the active government must find (t, s) to maximize (15) subject to the constraint that $c/(1+s) \leq c^*/(e(1-t))$. If welfare attains a maximum at an interior point, then the first order conditions that must be satisfied can be rearranged in the following manner:

$$\frac{dW}{dt} = \frac{W}{1-t}\left[\frac{(1-t)}{A}\frac{4\overline{\theta}\mu^2(\mu-1)}{(4\mu-1)^2} - \alpha\beta\right] \tag{26}$$

$$\frac{dW}{ds} = \frac{-W}{1+s}\left[\frac{(1+s)}{A}\frac{\overline{\theta}\mu^2(4\mu-7)}{k(4\mu-1)^3} + \alpha\beta - \frac{1}{k-1}\right] \tag{27}$$

where $\alpha = (d\mu/dr)(r/\mu)$, with $r = ec(1-t)/c^*(1+s)$, and $\beta = (dW/d\mu)(\mu/W)$.[22] Here α represents the elasticity of the quality gap μ with respect to the relative development cost given in (4), which is positive. β represents the elasticity of social welfare with respect to the quality gap μ. This elasticity is also positive. The explicit values of α and β are cumbersome and therefore omitted.

[22] Equations (26) and (27) are presented in a compact way. There is a series of steps that we omit here to save on space.

Suppose for the moment that the constraint of the program is not binding, i.e., $c/(1+s) < c^*/(e(1-t))$. The best interior trade and industrial policy provided that foreign firm will produce high-quality is a pair (t,s) solving the first order conditions (26) and (27), along with equations (4), (9) and (10). We can isolate $\alpha\beta$ from (26) and (27) to obtain:

$$(1-t)k(k-1)4\overline{\theta}\mu^2(\mu-1)(4\mu-1) = A(\cdot)k(4\mu-1)^3 - (1+s)(k-1)\overline{\theta}\mu^2(4\mu-7)$$

Using the expression for $A(\cdot) = W_l/q_l$ above, this equation reduces to:

$$\begin{aligned} 8k\mu(\mu-1)(4\mu-1)t &= (4\mu-1)\left[8(k-1)\mu(\mu-1) - 4\mu^2 - 7\mu + 2\right] \\ &\quad +2k\mu(4\mu-7)(1+s) \end{aligned}$$

Therefore

$$t = \frac{[8(k-1)\mu(\mu-1) - 4\mu^2 - 7\mu + 2]}{8k\mu(\mu-1)} + \frac{2(1+s)(4\mu-7)}{8k(\mu-1)(4\mu-1)}. \tag{28}$$

This equation gives an interior equilibrium relationship between t and s. It further shows that the best trade policy when high quality will be produced abroad is a *positive* tariff, irrespective of whether local production is subsidized or taxed.[23] This stems from the fact that a tariff on foreign production enables domestic government to extract sufficient rents from the foreign firm to offset any other distortionary effects.

It may very well happen that the solution to the system of equations (4), (9), (10), (26) and (27) violates the constraint $c/(1+s) \leq c^*/(e(1-t))$. If this is so, it is readily seen that when cost asymmetries are low, i.e., $c^*/ec \simeq 1$, then domestic production is also taxed. Otherwise, for c^*/ec sufficiently low, $s < 0$. Let (t_1, s_1) be the solution to such program. Then $W_1(t_1, s_1)$ denotes the welfare level attained under the best trade and industrial policy provided high-quality production occurs abroad.

The same steps as before can be taken to study the best policy mix among the set of policy interventions such that high-quality production occurs domestically. For this purpose government must choose (t,s) to optimize (25) subject to the constraint that $c/(1+s) \geq c^*/(e(1-t))$. We do not report details of these computations here since they do not add further insights. Let (t_2, s_2) be the solution to this second program and

[23] Note that $s \geq -1$. Moreover, it can be seen that if the constraint is not binding then μ is a number greater than 5 and thus the first summand of (28) is positive.

$W_2(t_2, s_2)$ the corresponding welfare level when home firm produces high-quality. The optimal policy is obviously given by the solution to the overall program, that is, (t_1, s_1) if and only if $W_1(t_1, s_1) > W_2(t_2, s_2)$; otherwise (t_2, s_2). We illustrate this solution by means of Figure 4 in the main body of the paper. ■

Proof of Proposition 7: Let us first consider the case where the low-quality variant is produced at the domestic country. Assuming $t = s = 0$, social welfare is the sum of consumer surplus in (12) and domestic firm's profits in (14) $W_1 = \overline{\theta}\Gamma(\mu)q_l/2$ where $\Gamma(\mu) = \left[16\mu^4 + 24\mu^3 - 15\mu^2 + 2\mu - 8\mu^3/k + 14\mu^2/k\right]/(4\mu - 1)^3 > 0$. We need to compute

$$\frac{dW_1}{de} = \frac{\overline{\theta}}{2}\left[\Gamma(\mu)\frac{\partial q_l}{\partial \mu} + q_l\frac{\partial \Gamma(\mu)}{\partial \mu}\right]\frac{\partial \mu}{\partial e}$$

Since $\partial q_l/\partial \mu > 0$, $\partial\Gamma(\mu)/\partial\mu > 0$, using (5) we conclude that and $dW/de > 0$.

Consider now the case where the domestic firm produces high-quality. Social welfare is now computed by adding consumers surplus in (12) and the profits derived from high-quality production $W_2 = \overline{\theta}\Psi(\mu)q_h/2$ where
$\Psi(\mu) = \left[48\mu^3 - 32\mu^3/k - 24\mu^2 + 24\mu^2/k + 3\mu - 16\mu/k\right]/(4\mu - 1)^3 > 0$. Partial differentiation yields

$$\frac{dW_2}{de} = \frac{\overline{\theta}}{2}\left[\Psi(\mu)\frac{\partial q_h}{\partial \mu} + q_h\frac{\partial \Psi(\mu)}{\partial \mu}\right]\frac{\partial \mu}{\partial e}.$$

From the equilibrium condition corresponding to this case in (16), we obtain that $\partial\mu/\partial e < 0$. Notice also $\partial q_h/\partial\mu < 0$ and that $\partial\Psi(\mu)/\partial\mu < 0$. We conclude that $dW/\partial e > 0$. Therefore, a devaluation ($de < 0$) gives rise to a decrease in welfare in both cases. ■

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