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ABSTRACT

Import-Competition, Market Power and Productivity Change

by Daniel A. Traca*

We explore how the competitive pressure of imports affects productivity, at the firm level. There are two conflicting effects of import-competition: the pro-competitive effect fosters productivity, while the direct effect hinders it. The pro-competitive effect dominates in the steady-state, yielding free-trade as the optimal long run policy. However, under a large initial productivity gap, the firm shuts down. Here, a temporary tariff sways the firm to *fight*, and ensures survival, which is welfare increasing. Trade liberalization, around the steady-state, increases productivity growth and closes the gap. However, a radical liberalization kills the domestic firm. Gradualism increases the likelihood of survival, and increases welfare.

ZUSAMMENFASSUNG

Importkonkurrenz, Marktmacht und Produktivitätsänderungen

In dem Beitrag wird untersucht, wie Wettbewerbsdruck aufgrund von Importen die Produktivität von Unternehmen beeinflußt. Zwei gegensätzliche Effekte der Importkonkurrenz sind zu unterscheiden: Der wettbewerbsfördernde Effekt begünstigt die Produktivität während der direkte Effekt sie behindert. Der wettbewerbsfördernde Effekt dominiert im stationären Gleichgewicht, das im Rahmen von freiem Handel als optimale Langfriststrategie angesehen werden kann. Besteht jedoch eine große anfängliche Produktivitätslücke, dann kommt es zu einer Schließung der Unternehmen. Hier können temporäre Zölle es ermöglichen, daß die Firmen sich im Wettbewerb behaupten und so ihr Überleben sichern, was zu einem Wohlfahrtsanstieg führt. Eine Lockerung des Freihandels bei stationärem Gleichgewicht führt zu einem Anstieg des Produktivitätswachstums und schließt die Lücke. Eine radikale Handelsliberalisierung führt jedoch zu einem Schließen des heimischen Unternehmens. Schrittweises Handeln erhöht die Wahrscheinlichkeit des Überlebens und einen Anstieg der Wohlfahrt.

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* I have benefited dearly from the comments of Jagdish Bhagwati, Ron Miller and Dani Rodrik. All usual disclaimers apply.

1. Introduction

The prospect of sizable firm-level productivity gains has been a driving force behind recent trade liberalization efforts in the developing world[1]. This paper provides a framework for interpreting the conventional wisdom that '*in creating competition for domestic products in home markets, imports provide incentives for firms* [to invest] *to improve their* [productivity]' (Balassa, 1988).

Investment in productivity encompasses those costly learning activities, not necessarily formal R&D, that firms undertake to improve the efficiency of their operations (e.g. the purchase of blueprints, the training of workers, or the effort of managers). Previous literature has addressed a myriad of motivations for the impact of trade on productivity, at the firm and sector level. Although the role of competition is frequently cited, the analytical foundations of the argument have never been too clear (for a survey, see Rodrik, 1995).

In this paper, we study the path of investment in productivity of a firm that sells only in the domestic market, where it faces competition from imperfectly substitute imports. Like the literature on endogenous growth (see Barro and Sala-i-Martin, 1992), we assume the presence of increasing returns to investment in productivity, thus yielding a positive steady-state growth rate. Foreign productivity growth causes the price of imports to fall at an exogenous, constant rate, imposing competitive pressure on the domestic firm. Likewise, trade liberalization (e.g. a tariff cut) is also a source of competitive discipline.

The international competitive pressure increases investment in productivity, through the impact of lower import prices on the output of domestic firms. Taking the popular notion that the cost of expanding productivity and efficiency is independent of firm size, we infer that the incentives to invest in productivity increase with the firm's output[2]. Hence, as Rodrik (1992b) shows, trade liberalization increases investment in productivity, only to the extent that it expands output[3].

Now, if the domestic market is not perfectly competitive, a decline in import prices

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1 A myriad of empirical studies seem also to uphold the notion that trade liberalization induces productivity gains at the firm level (Krishna and Mitra, 1994; Harrison, 1994; Nishimizu and Page, 1991; Tybout et al., 1991; Corbo and De Melo, 1985, Tybout and Roberts, 1995).

2 Surveying the evidence, Cohen (1995) asserts that recent research shows a close, positive monotone relationship between size, particularly plant size, and R&D, lending support to a cost-spreading advantage to firms with larger output.

3 Recent literature (e.g. Roberts and Tybout, 1991) has focused on the role of output expansions from trade liberalization in increasing productivity through economies of scale. Tybout and Westbrook (1995) claim that, for Chile and Colombia, scale economies fail to explain the gains in firm productivity, and underscore a residual component that includes a concept of productivity similar to ours, but fail to recognize that it too may be related to output.

has two conflicting effects on the incentives to expand productivity and efficiency: the direct effect and the pro-competitive effect. The direct effect hampers productivity growth, implying the contraction of output from the decline in demand for the domestic good. Conversely, the pro-competitive effect fosters investment in productivity, reflecting the expansion of output due to the decline in domestic mark-ups, from the loss of market power[4].

Until now, the theory has said very little on the outcome of the interplay of these two conflicting forces. Roberts and Tybout (1991) argue that simulation models have shown that the pro-competitive effect usually dominates, in particular for the most efficient firms in the industry. But, according to Miyagiwa and Ohno (1995), most theoretical work assumes that trade liberalization hurts investments in productivity, because it reduces the firm's output. As we argue below, the latter conjecture is inconsistent with the survival of the domestic firm during the pre-reform years.

In a dynamic, infinite-horizon framework the domestic firm has to continuously invest in productivity growth, in order to make up for the expansion of its foreign competitors and avoid exit. Implicitly, the growth of foreign productivity promotes domestic growth, as the decline of the price of imports expands domestic output and fosters investment in productivity. Thus, the pro-competitive effect dominates the direct effect, in the steady-state of the productivity growth path, if the firm survives import-competition.

However, when the initial productivity gap to foreign competitors is too large, the direct effect dominates, since the firm's market power is too small for the pro-competitive effect to be of first-order. In this case, the pressure of imports may prove too intense, leading the domestic firm to concede and exit the market in the long run. The imposition of a temporary tariff in this infant stage sways the firm to fight and catch up, thus ensuring its long term competitiveness.

Moreover, given that the direct effect prevails, the temporary protection of an infant-industry to ensure survival is welfare increasing, thus suggesting that the firm's incentives to concede and exit are higher than the social optimal. First, as Levy and Nolan (1991) point out, protection improves welfare, when it increases the output of a domestic firm with market power, i.e. when the direct effect dominates. Second, here, protection increases welfare also by expanding productivity, since market power implies that investment is socially sub-optimal.

However, if the pro-competitive prevails, free-trade is the best policy, as protection decreases output and productivity, thus adding to the distortion created by domestic

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4 The notion that trade liberalization increases competition and reduces mark-ups is widespread (see, for example, Helpman and Krugman, 1989 or Smith, 1994). It has recently been documented empirically (Levinshon, 1993; Harrison, 1994; Krishna and Mitra, 1994). Moreover, a myriad of simulation studies seem to support the notion that trade liberalization may expand firm output, due to the pro-competitive effect (e.g. Devarajan and Rodrik, 1991).

market power. Given the predominance of the pro-competitive effect in the vicinity of the steady-state, this implies that the optimal, time-consistent tariff path entails free-trade in the long run (steady-state).

The removal of existing tariffs has non-monotone effects. Starting from the steady-state, a small trade liberalization yields an increase in the productivity growth of the domestic firm. This increase is temporary, and allows the firm to compensate for the loss of protection by expanding its intrinsic competitiveness, to catch up with its foreign competitors. In the long run, the domestic firm's profitability and market power return to their initial (steady-state) level.

However, when the tariff is high, a radical cut leads the firm to concede, cutting down productivity growth and eventually exiting the market[5]. Since, as mentioned above, a small liberalization induces the firm to catch up, a gradual approach to tariff reform increases the chances of survival for domestic firms, even if the reform schedule is fully anticipated. From a normative standpoint, such gradual approach is advisable, under certain conditions, in order to make-up for the firm's excessive incentives to exit, discussed above.

The next section presents a formal discussion of the pro-competitive and direct effects, and their relation to productivity growth. In section three we set up the dynamic problem, taking the case where preferences are CES. We establish our main result on the prevalence of the pro-competitive effect on the steady-state, discuss a new argument for temporary protection and analyze the effects of trade liberalization. Finally, section four concludes the paper.

2. Productivity Growth, Firm Size and the Price of Imports.

To illustrate the impact of competitive pressure and trade policy on the incentives to invest in productivity growth, we start with a simple model where an import-competing firm faces a one shot decision to invest in productivity growth. Later, we examine a dynamic model where this investment decision is repeated in an infinite horizon framework.

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5 Empirically, the exit of the firm creates a selection bias, since firms where productivity growth is hurt by the liberalization will vanish from the sample. This will bias upwards the estimates of the average effect of trade liberalization on firms' productivity growth.

2.1 A Simplified Model

Consider a sector where a domestic and a foreign good, denoted respectively by x and y, are imperfect substitutes, and there are no domestic substitutes. Assume also that a single firm (the domestic monopolist) produces good x[6]. Good x is produced with a linear technology: x=AL, where A is productivity and L is labor, yielding a constant unit cost, given by: c=w/A, where w is the wage. Before production and sales, the firm decides on the expenditure in productivity growth. An expenditure of $\omega\alpha$ yields an increase in productivity from its initial level (A_0) such that: $A=A_0(1+\alpha)$, hence bringing the unit cost down to: $c\equiv c_0(1+\alpha)^{-1}$; with $c_0=w/A_0$. We address α and ω as the rate and the cost of productivity growth, respectively.

Also, let $f \equiv f^*(1+\tau)$ denote the domestic price of the foreign good (where f^* is the import-price and τ the tariff), which the firm takes as given with perfect foresight. A decline in f, arising from trade liberalization or lower import-prices (e.g. higher foreign productivity), represents an increase in the competitive pressure that the domestic monopolist faces.

Now, let $\pi(c, f) \equiv \max_x\{p(x,f)x - cx\}$ denote the profit function, where p(x,f) is the inverse demand. The firm chooses productivity growth to maximize: $v \equiv \pi(c, f) - \beta^{-1}\omega\alpha$, where β is the discount factor[7]. Equation (1), where $x(c,f) \equiv \text{argmax}\ \{p(x,f)x - cx\}$ denotes the profit maximizing output, shows the first order condition[8].

$$\beta \frac{c_0\, x\left(\frac{c_0}{1+\alpha}, f\right)}{(1+\alpha)^2} = \omega \tag{1}$$

Clearly, output is the sole channel through which the competitive pressure of imports influences the firm's investment. Differentiating (1), we obtain:

$$\frac{d\alpha}{df} = \Psi \frac{dx}{df} \quad ; \quad \Psi = \frac{1+\alpha}{x\left(\varepsilon_{x,c}+2\right)} > 0 \tag{2}$$

The term ψ is positive from the second order condition: $d^2v/d\alpha^2<0$[9]. From (2), we

6 The absence of domestic competition embodied in this framework provides a simplified benchmark for the study of the competitive pressure of imports. 'Ultimately, it is the force of competition - whether external or internal - that challenges firms and induces the response of technical change, innovation, and sustained efforts to increase productivity and reduce cost' (Nishimizu and Page, 1991).

7 We use a two period approach for consistency with the forthcoming sections of the paper.

8 $\partial\pi/\partial\alpha=\partial\pi/\partial c\ \partial c/\partial\alpha$. We have applied the envelope theorem to obtain: $\partial\pi/\partial c= -x(c,f)$. Of course, $\partial c/\partial\alpha=-c_0(1+\alpha)^{-2}$.

9 $\varepsilon_{x,c}$ denotes the elasticity of output to the firm's unit cost, and is negative from the second order conditions of static profit maximization: $d^2\pi/dx^2<0$.

obtain that an increase in competitive pressure, from a decline in f, expands domestic productivity when it expands the monopolist's output. Conversely, productivity growth declines with an increase in competitive pressure, if the reduction in the price of imports hurts output. Below, we show that the sign of dx/df is indeterminate, i.e. that competitive pressure has an ambiguous impact on productivity growth.

2.2 Direct and Pro-Competitive Effects

Changes in import prices affect output in two distinct and conflicting ways. First, there is the direct effect, due to the (imperfect) substitutability of the domestic and foreign goods: *if the price of the domestic good is kept constant, a decline in the price of imports decreases the output and the market share of the domestic firm, as consumers substitute toward imports*.

Second, there is the pro-competitive effect, describing how the decline in the price of imports increases the price-elasticity of demand for the domestic good, hence reducing the mark up and price of the domestic good. Of course, the pro-competitive effect works to expand output.

Formally, the impact of the price of imports on output, can be obtained through the implicit differentiation of the first-order condition: $p(x,f) + x\, p_x(x,f) = c$, and is shown below.

$$\text{(3)} \qquad \frac{dx}{df} = \Omega\left[\, p_f + x p_{xf} \right] \quad ; \qquad \Omega \equiv -\left(\varepsilon_{x,c}\, x / c\right)^{-1} > 0$$

The term p_f denotes the *direct* effect of the price of imports on output, measuring the decline in demand as consumers substitute toward imports, for which prices have fallen. It is strictly positive, since the domestic and foreign goods are substitutes. The term p_{xf} is unsigned from basic economic theory. To embody the pro-competitive effect, and in line with the literature (e.g. Helpman and Krugman , 1989; Devarajan and Rodrik, 1991; Roberts and Tybout, 1991), we assume that p_{xf} is negative. Thus we reflect the notion that the domestic firm will react to competitive pressure from imports by cutting its mark-up. Implicit is the negative correlation between the elasticity of demand and the price of imports. Empirically, the hypothesis of a pro-competitive effect has been recently validated by research on trade liberalization episodes in Turkey (Levinshon, 1994), Ivory Coast (Harrison, 1994), India (Krishna and Mitra, 1995) and Korea (Kim, 1996).

Given the role of output on the incentives to invest in productivity growth (equation 2), and the ambiguity of the impact of import-competition on output (equation 3), the impact of import-competition on firm productivity is uncertain. The direct effect thwarts productivity growth by shrinking output, while the pro-competitive aspect, which expands output, encourages it. Both outcomes are clearly possible from a theoretical standpoint, although (as we shall see later) some additional qualifications can be made in the context of a dynamic model.

2.3 Welfare and Trade Policy

Before we proceed to the dynamic model, however, we address welfare. The question in point is whether, when a decline in competitive pressure increases productivity growth, a case can be made that protection enhances welfare. Thus we focus on the impact of a change in the tariff on welfare.

Equation (4) displays our measure of social welfare.

$$(4) \qquad W = \{ u(x,y)/\lambda - p(x,f)x - fy \} + v(c,f) + \tau f^* y$$

$u(x,y)/\lambda - p(x,f)x - fy$ denotes the consumer surplus, where λ is the marginal utility of income; $v(c,f)$ measures producer surplus; and $\tau f^* y$ denotes tariff revenue, with $y \equiv y(c,f)$ standing for the equilibrium level of imports. Of course, $\partial y/\partial f < 0$ and, since $\varepsilon_{x,c}<0$, $\partial y/\partial c>0$. Recall that $x \equiv x(c,f)$ denotes profit-maximizing output.

After some algebraic manipulation, which makes use of the envelope condition: $u_x/\lambda=p$; $u_y/\lambda=f$, and taking into account equation (2), we obtain:

$$(5) \qquad (f^*)^{-1} \, dW/d\tau = \underbrace{(p-c)}_{\textbf{(aI)}} \{1 + \underbrace{\Phi \, \partial x/\partial c}_{\textbf{(aII)}} \} \, \partial x/\partial f + \tau f^* \{\underbrace{\partial y/\partial f}_{\textbf{(bI)}} + \underbrace{\partial y/\partial c \, \Phi \, \partial x/\partial f}_{\textbf{(bII)}} \}$$

$$\Phi = -\Psi c/(1+\alpha)<0$$

Table 0-1 Tariffs, Competitive Pressure and Welfare

Dominant Effect	(aI)	(aII)	$\partial x/\partial f$	(bI)	(bII)	$dW/d\tau$ at $\tau=0$
Pro - Competitive	+	+	-	-	+	< 0
Direct	+	+	+	-	-	> 0

The welfare impact of the competitive pressure from a decline in protection needs to take several factors into account. First, the two dimensions of the domestic monopolist's choices, namely: (I) pricing and (II) investment in productivity. Secondly, the interdependence of the distortions imposed by (a) the domestic firm's market power and (b) the tariff itself. Levy and Nolan (1991) and Rodrik (1988) address the impact of protection on the distortion of pricing decisions created by the presence of market power. Here, we address also the distortion imposed on investment decisions.

Market power distorts the producers' pricing and investment decisions, yielding that the levels of output and investment in productivity are below the social optimal. Terms (aI) and (aII) denote the impact of competitive pressure on this distortion. As the table shows, if the pro-competitive effect dominates, a lower price of imports reduces the distortion imposed by market power on pricing (aI) and investment (aII), by expanding output and, consequently, productivity growth. Conversely, when the direct effect dominates, the increase in competitive pressure from trade liberalization enhances the distortion imposed by market power.

Terms (bI) and (bII) measure the impact on the distortion introduced by the tariff itself. (bI) shows that due to tariffs, import levels are below the social optimal. Clearly, an increase in the tariff aggravates this distortion. (bII) shows that tariffs cause investment to be above the socially desirable levels - the firm fails to internalize that, by capturing market share from imports, it aggravates the sub-optimality of import-levels. Given this, an increase in the tariff may expand welfare if it reduces investment (i.e. the pro-competitive effect dominates), as captured in (bII).

The last column in Table 2-1 entails two crucial lessons for trade policy. First, if the pro-competitive effect dominates, then free trade is the optimal policy[10]. Here, the goal should be to maximize the competitive pressure on domestic firms, in order to reduce the distortion from domestic market power. This is the widely held view of *imports as market discipline* (Levinshon, 1994). Second, however, when the direct effect dominates, a small tariff increases welfare and, therefore, the optimal tariff is strictly positive[11].

3. A Dynamic Model with CES Preferences

3.1 The Firm's Intertemporal Problem

Now, we take into account the intertemporal environment in which investments in productivity are undertaken. As we will see, the dynamic framework sheds light on the indeterminacy of the relative weight of pro-competitive and direct effects. In addition, it permits us to analyze the intertemporal impact of trade policy.

The firm's dynamic program is now to choose a path for investment in productivity growth solving (6):

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10 We assume here that (bII) is not large enough that, at high tariff levels, it becomes of first-order. Hence, (5) implies that $W(\tau)$ is decreasing, when the pro-competitive effect dominates, thus yielding the (global) optimality of free-trade. Intuitively, (bII) represents how an increase in the tariff, may reduce the distortion the tariff itself is creating, by hindering investment. Clearly, the best solution here is to do away with the source of the distortion, i.e. the tariff, altogether.

11 Although a small tariff increases welfare, if the direct effect prevails, such intervention is not the best policy. The distortion imposed by domestic market power consists of an overvaluation by the consumer of the cost of the resources used to produce the domestic good. The first best entails a per unit subsidy to consumption, sales or production, equalizing the price paid by the consumer to the shadow cost.

(6) $$\max_{\{\alpha_t\}_{t=0}^{\infty}} \sum_{j=0}^{\infty} \beta^t \left\{\pi(c_t, f_t) - \omega_t \alpha_t\right\}$$

Assuming that the rest of the economy is in a balanced growth path, we take the wage to remain unchanged, hence obtaining: $c_{t+1}=c_t\,(1+\alpha_t)^{-1}$, as the motion for the unit cost. The path for the price of imports depends the trajectory of the tariff (τ_t) and import-prices (f^*_t), both of which the firm anticipates with perfect foresight. For f^*_t, we take it that productivity growth abroad is positive, leading to a constant rate of decline of the price of imports: $f^*_{t+1}=f^*_t\,(1+\phi)^{-1}$; $\phi\geq 0$. As to τ_t, we assume for now that the tariff is constant ($\tau_t\equiv\tau$).

Finally, we assume that the cost of productivity growth is constant: $\omega_t=\omega$. This can be obtained by assuming that (a) the productivity enhancing technology has constant returns to scale to its inputs, (b) the efficiency of these inputs increases linearly with the accumulated level of productivity (*à la endogenous growth*) [12], and (c) their prices are constant.

3.1.1 CES Preferences: Profits, Output and Mark-Up.

To address the problem in (6), we focus on the case where preferences between the domestic and foreign good are represented by a CES utility function: $U=(x^{(\varepsilon-1)/\varepsilon} + y^{(\varepsilon-1)/\varepsilon})^{\varepsilon/(\varepsilon-1)}$; with ε is the elasticity of substitution. The absence of domestic competition is operationalized here by assuming that the expenditure in the sector is constant, and given by I[13]. From the consumer's utility maximization exercise, we obtain the demand function in (7), where p_t and f_t denote the prices of the domestic and the foreign good, respectively.

(7) $$x_t^d = \frac{p_t^{-\varepsilon}}{p_t^{1-\varepsilon} + f_t^{1-\varepsilon}} I$$

To express the static profit (π), it is useful to introduce the cost-ratio (R), measuring the ratio of the domestic price of imports to the monopolist's unit cost: $R\equiv f^*(1+\tau)/c$; $R>0$. Clearly, the productivity gap, which measures the lag of domestic productivity to

12 Formally, we have: $A_{t+1}-A_t = A_t f(z_t)$, where f has constant returns to scale and z_t denotes a vector of inputs. These include not only the standard measures of R&D activity (e.g. the number of engineers and scientists) but also other interpretations like: the effort of managers, the purchase of new blueprints, or the investment in new machinery to upgrade product quality or introduce new products, that make the model more amiable for developing countries.

13 A constant expenditure in the sector arises if consumers have Cobb-Douglas preferences over a large number of sectors, nesting the CES describing preferences is our import-competing sector, and we take nominal expenditure to denote the *numeraire*. As Grossman and Helpman (1992) show, under these conditions, expenditure in the sector corresponds to the Cobb-Douglas coefficient of the sector.

the world technological frontier, moves inversely with R.

Equations (8) and (9) show profits (π) and output (x) in terms of the mark-up. From equation (9), we have that the total cost of the domestic monopolist is given by H(m)I. We use the mark-up as an auxiliary variable, because a closed form solution is unattainable. Equation (10) defines the optimal mark-up, denoted by: $m_t \equiv p_t/c_t$, in terms of the cost-ratio[14].

(8)	$\pi_t = \Pi(m_t)I$	(8')	$\Pi(m) \equiv \{1 - m^{-1}\, \varepsilon/(\varepsilon-1)\}$
(9)	$x_t = H(m_t)I/c_t$	(9')	$H(m) = \varepsilon/(\varepsilon-1)\ m^{-2}\ \{\ (\ (\varepsilon-1)\ m - \varepsilon)^{-1} + m^{-1}\ \}^{-1}$
(10)	$R_t = m_t\ \{m_t\ (\varepsilon-1) - \varepsilon\}^{1/(\varepsilon-1)}$		$m_t \in\ ]\ \varepsilon/(\varepsilon-1), \infty[$

We denote the implicit function definining the optimal mark-up in terms of the cost-ratio, in equation (10), as: $m_t=M(R_t)$. Clearly, m_t increases with R_t (M'>0). It can also be shown that $\mathrm{Lim}_{R\to\infty} M(R)=\infty$ and $\mathrm{Lim}_{R\to 0} M(R)=\varepsilon/(\varepsilon-1)$. A decline in the domestic price of imports, from a reduction in τ_t or in f^*_t, yields a decline in R_t. From the expressions in (8) and (10), it brings down profits and the mark-up, in a manifestation of the pro-competitive effect.

Substituting M(.) in equation (8), we obtain profits in terms of the cost ratio; $\pi_t = \Pi_o(R_t) \equiv \Pi(M(R_t))$. It can be shown that the function Π_o is increasing ($\Pi_o'>0$) and concave ($\Pi_o''<0$), and that $\Pi_o(0)=0$.

Finally, substituting M(.) in (9), we obtain output in terms of the cost-ratio: $x_t=H_o(R_t)I/c_t$, with $H_o(R)\equiv H(M(R_t))$. Figure one displays the shape of H_o in terms of R_t.

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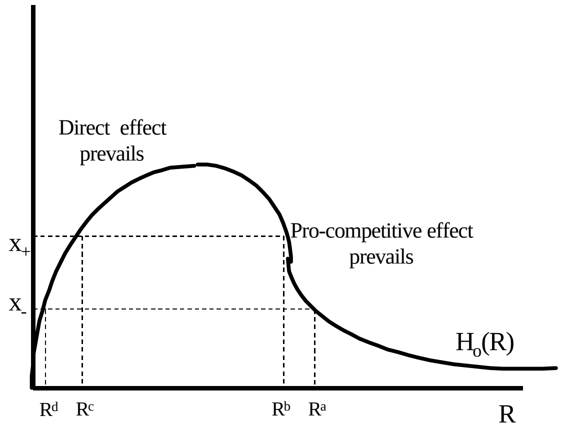
14 For a detailed algebraic derivation, see appendix 5.1.

Figure one: Output and competitive pressure



Output is a non-monotone function of the price of imports, depending on the cost-ratio. In the figure, a decline in f is depicted by a reduction in R. If R is large, the pro-competitive effect prevails and the decline in f ($R^a \rightarrow R^b$) causes an expansion in output ($x_- \rightarrow x_+$). If R is small, the direct effect dominates and trade liberalization ($R^c \rightarrow R^d$) decreases the monopolist's output ($x_+ \rightarrow x_-$).

The intuition for the non-linearity of the relationship between output and the price of imports, is as follows. On one hand, if the productivity gap is large (R is small), the mark-up is small and the pro-competitive effect, which relies on the decline of mark-ups, is of second order. Thus the direct effect dominates, and output falls when f declines. On the other, if the productivity gap is small, the domestic firm holds considerable market power and the mark-up is high. Hence the role of the pro-competitive effect strengthens, leading to an increase in output when the price of imports falls.

3.1.2 Dynamic Problem

Now, we solve the dynamic problem to obtain the path of investment in productivity of the domestic monopolist. Letting $V(c_t, f_t; \omega, \beta)$ denote the market value of the domestic firm at time t, i.e. the present discounted value of the monopolist's net stream of profit, we can write the Bellman equation for the firm's program as:

$$(11) \qquad V(R_t) = \max_{\alpha t} \ \Pi_o(R_t) - \omega\alpha_t + \beta\, V(R_{t+1})$$

With the motion of the cost-ratio given by:

(12) $$R_{t+1} = R_t \frac{1+a_t}{1+f}$$

The value function V(.) is increasing, continuous and strictly concave[15].

The solution for the domestic monopolist's problem is characterized by the first-order and envelope conditions, which after some algebraic manipulation can be written:

(13) $$-\omega(1+\alpha_t) + \beta V'(R_{t+1}) R_{t+1} \leq 0 \quad [=0 \text{ if } \alpha_t>0]$$

(14) $$V'(R_t)R_t = -\Pi_o' R_t/\omega + \beta V'(R_{t+1})R_{t+1}$$

Solving for the term $\Pi_o' R_t$, we obtain that it is given by $H(m_t)I$, where H(.) is given in (9'). Recall that $H(m_t)I$ is the expression for the total cost, thus bringing forth the notion that the latter measures the incentives for productivity growth, in this endogenous growth formulation.

3.1.3 The Steady-State

The solution to the monopolist's problem yields a stationary path, where Lim α_t as $t\rightarrow\infty$ is a constant: α $(0 \leq \alpha < \infty)$[16]. There are two steady-states to the monopolist's problem, corresponding to two long-term strategies. The monopolist's choice of strategy depends on the initial conditions. The monopolist may decide to either:

I. Fight foreign competition and compete for a spot in the marketplace or,

II. Concede and let its market share be unceasingly corroded by imports.

A corner solution in (13) embodies the long run aftermath of the strategy of conceding. In this case, the steady-state rate of productivity growth is zero and the cost-ratio converges to zero. The latter implies that profits also converge to zero (see equations 8 and 10). Hence, the decision to concede implies that the monopolist will shut down in the long run[17].

To fight is the only decision that allows the domestic monopolist to stay in the market

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[15] Proof: we can decompose V(.) as follows: $V(R_t) = \Pi_o(R_t) + \beta Z(R_t)$, where Z(.) is defined by the Bellman equation: $Z(R_t) = \max_{R_{t+1}} \{\Pi_o(R_{t+1}) - \beta^{-1}\omega(1+\phi) R_{t+1}/R_t + \beta Z(R_{t+1})\}$. Since $\Pi_o(R_t)$ is increasing, continuous, differentiable and strictly concave, these properties are maintained in $F(R_{t+1}, R_t) \equiv \Pi_o(R_{t+1}) - \beta^{-1}\omega(1+\phi) R_{t+1}/R_t$. Section 4.2 in Stokey et al. (1989) implies that these are also properties of $Z(R_t)$. Hence, they apply also to $V(R_t)$.

[16] Explosive solutions ($\alpha_t\rightarrow\infty$) can be ruled out since they will eventually yield negative profits, and the possibility of cycles can be precluded since, from (13) and strict concavity, $d R_{t+1}/ d R_t > 0$.

[17] In reality, the firm will just keep getting smaller. However, if we assume a small fixed cost, which is otherwise irrelevant, the firm will eventually close.

in the long run, competing with imports. If the monopolist decides to fight, equation (13) entails interior solutions (denoted here by the superscript z). The Euler equation characterizing the solution for the monopolist's problem, when the firm opts to fight, can be obtained from the manipulation of (13) and (14) and is shown in (15).

(15) $$\beta\, H(m^z_t) = \omega/I \{ 1+\alpha^z_{t-1} - \beta (1+\alpha^z_t) \}$$

From (15), we can obtain that, if the firm opts to remain in the market in the long run, the steady-state rate of growth of domestic productivity (α^z) equals the rate of growth of foreign productivity (ϕ)**[18]**. Consequently, the cost ratio (R^z) is constant in the steady-state. Thus, from (10) and since the tariff is constant, we obtain that the mark-up (m^z) is also constant.

(12) and (15) constitutes a system of non-linear, first order difference equations in α^z_t and R^z_t. From the paragraph above, if it exists, $\{\phi, M(R^z)\}$ is a stable stationary point of the system, where $m^z \equiv M(R^z)$ is given by the solution to:

(16) $$(1+\phi)(\beta^{-1}-1)\omega/I = H(m^z)$$

Assuming $(1+\phi)(\beta^{-1}-1)\omega/I < \max_m H(m)$, the quadratic nature of H(.) yields two solutions for equation (16), denoted by m^1 and m^2, with $m^1 > m^2$. We can thus obtain $R^1=M^{-1}(m^1)$ and $R^2=M^{-1}(m^2)$, with $R^1>R^2$, which are represented in figure two. Note that a striking feature of these stationary points is that in R^2 the direct effect dominates, while in R^1 the pro-competitive effect prevails. When it decides to fight, the firm will converge to R^1 (or m^1), since, as we show below, this is the only solution to (16) which is locally stable: $R^z = R^1$. Conversely, R^2 is an unstable stationary point.

3.1.4 The Steady-State. Direct and Pro-Competitive Effects

The stability of R^1 is directly related with the prevalence of the pro-competitive effect. In this section, we establish that the pro-competitive effect has to dominate in the neighborhood of the steady-state, so that the latter can satisfy the requirement that it is a stable stationary point of the difference equation. As we show in appendix 5.2, this result extends to conditions far more general than the particular shape of preferences (CES) assumed here.

The intuition is simple. To stay alive and maintain competitiveness, the domestic firm has to respond to the increase in the productivity of foreign firms with an equivalent in-

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[18] Solving equation (15) for the steady-state, we get: $H(m^z)=(1-\beta)(1+\alpha^z)\ \omega/I$. If $\alpha^z>\phi$, then $R_t^z\rightarrow\infty$ and $m_t^z\rightarrow\infty$. If $\alpha^z<\phi$, then $R_t^z\rightarrow 0$ and $m_t^z\rightarrow\varepsilon/\varepsilon\text{-}1$. From (9') we have: $\text{Lim}_{m\rightarrow\infty} H(m) = \text{Lim}_{m\rightarrow\varepsilon/\varepsilon-1} H(m) = 0$. Hence, if $\alpha^z\neq\phi$, the condition above becomes: $(1-\beta)(1+\alpha^z)=0$, in the limit. This condition is impossible for $\alpha^z>0$, thus establishing a contradiction. Hence, in any interior solution we have $\alpha^z=\phi$.

crease in productivity. Hence the pressure of declining import prices constitutes the disciplinary force inducing domestic productivity growth. Implicitly, the decline in the price of imports provides the necessary incentives by expanding domestic output, i.e. the pro-competitive effect dominates. Below, we establish this argument formally.

Proposition[19]: Pro-competitive and Direct effects in the Steady-State

In the steady-state, if imports and the domestic firm survive in the market, the pro-competitive effect dominates the direct effect, in the absence of domestic competition.

Proof: appendix 5.2

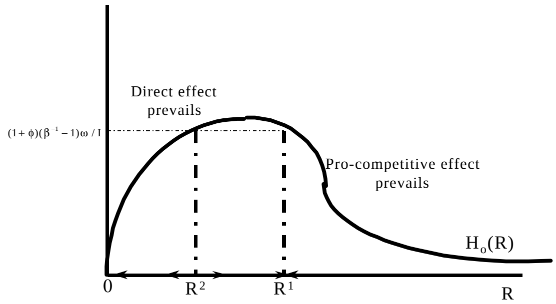
3.1.5 Dynamics and Adjustment

So, two long run solutions are possible: the firm may concede, or decide to fight foreign competition. In the first case, it will shut down in the long run. In the latter, it converges to a constant cost-ratio, in the vicinity of which the pro-competitive effect dominates. The firm's decision in conditioned by the initial cost-ratio.

Notably, the unstable stationary point R^2 defines a critical point. On one hand, if the initial cost-ratio is higher that R^2, the firm decides to fight and catch-up with its foreign competitors, closing the productivity gap toward R^z. On the other hand, if the initial cost-ratio is below R^2, the optimal decision is to concede, and the domestic firm is wiped out of the market following its encounter with foreign producers; although the firm is lucrative in the long-run, the costs of catching up make the process unprofitable. The critical cost-ratio (R^2) is independent of the tariff, as can be seen from (10) and (16). Figure two shows the steady-state, and the motion of the cost-ratio.

19 This result is valid independently of the shape of preferences between the domestic and the foreign goods, provided they are substitutes; and under a weaker version of the absence of domestic competition, where we allow for domestic competitors, although imposing that they are stagnant – see appendix 5.2.

Figure two: Dynamics and adjustment



If $(1+\phi)(\beta^{-1}-1)\omega/I$ is too large, the existence of an interior steady-state is undermined ($R^2 \rightarrow \infty$), since equation (16) has no solution. In this case, the only long-term equilibrium is the one encompassing the corner solution, which implies that the firm concedes independently of the initial cost-ratio. This represents situations where domestic producers have a long-run comparative disadvantage to the rest of the world. Note that this will happen if the competitive pressure of imports, measured by the foreign rate of productivity growth, is too high.

3.2 Trade Policy

Now, we discuss the short and long term impact of trade policy. First, we address the impact of tariffs on productivity. Second, we discuss a positive argument for temporary infant-industry protection. Third, we address the issue of trade liberalization, and the role of gradualism. Finally, fourth, we show that such measures of temporary protection increase welfare, from the free-trade benchmark, although the optimal policy always entails free-trade in the long run.

3.2.1 Tariffs and Productivity

As in the static case, the impact of tariffs on productivity depends on the strength of the pro-competitive and direct effects. However, in the dynamic context, tariffs have an intertemporal effect on productivity, which extends to before and after their actual implementation. Thus the following lemma:

Lemma: Let τ_i be the tariff at time I in the future, i>>0. If at time i the direct effect dominates the pro-competitive effect, an anticipated increase in τ_i expands the cost-ratio (by increasing productivity) in all upcoming periods: $\partial c_t/\partial \tau_i < 0;\ \forall t \geq 0$. If the pro-competitive effect dominates at i, the increase in protection reduces the level of productivity in all periods: $\partial c_t/\partial \tau_i > 0$; $\forall t \geq 0$.

Proof: see appendix 5.3

The principle at play here is similar to the static case. When the tariff expands output, it increases the benefits from a higher investment in productivity. In the dynamic context, these benefits depend on the overall future output, since current investments will also increase the *stock* of productivity in the future. Thus the expansion (contraction) of future output will increase (decrease) productivity throughout the horizon. Note that this implies that the expectations for the future path of trade policy are as important for productivity growth as actual current trade policy.

3.2.2 The Protection of Infant-Industries

As we saw in section 3.1.5, when the initial productivity gap is too large, so that the cost-ratio under fee-trade is below R^2, the firm concedes under the pressure of foreign competition, and eventually shuts down. In this section, we show how temporary protection may reverse the firm's decision to concede, swaying it to catch up with its foreign competitors. Thus the firm becomes competitive in the long run, after the removal of protection. Later (section 3.2.4.1), we show that such temporary protection is welfare increasing.

Let $\Re_t \equiv f_t^*/c_t$ denote the free-trade cost-ratio, that is $\Re_t \equiv R_t/(1+\tau_t)$. Take the case where the initial cost-ratio ($\Re_0$) is at R^2. Under free-trade, and given the stationary properties of R^2, $\Re_t$ will remain unchanged in all upcoming periods. $\Re_0=R^2$; $\Re_1(\tau_t=0)=R^2$; $\Re_2(\tau_t=0)=R^2$… Now, since at R^2 the direct effect dominates, the lemma in section 3.2.1 implies that the imposition of a small tariff in the first period will increase the investment in productivity thus raising $\Re_1(\tau_1>0;\tau_{t>1}=0)$ above R^2. From the recursive nature of the problem, this starts a process whereby $\Re_t$ converges to R^z, even if protection disappears after period one.

Now, *continuity* implies that if the initial gap, say $\Re_0$', is in the lower vicinity and sufficiently close to R^2 ($\Re_0$'<R^2), the imposition of the tariff will again raise $\Re_1$'$(\tau_1>0;\tau_{t>1}=0)$ above R^2 and initiate a process of convergence to R^z: $\Re_1$'$(\tau_1>0;\tau_{t>1}=0)$ >R^2 >$\Re_0$'. Note that, since $\Re_0$< R^2, the firm would have decided to concede and shut down, without the imposition of the tariff: $\Re_1$'$(\tau_t=0)$ < $\Re_0$'< R^2. Of course, the further away $\Re_0$' is from R^2, the higher the tariff ($\tau_1>0$) and/or the longer the tenure needed to raise $\Re_t$' above R^2, for some t, i.e. to reverse the monopolist's decision to concede.

This argument touches the traditional discussion on the protection of infant-industries. Unable to survive the pressure of foreign competition in the early stages, when the productivity gap is high, the firm may become profitable in the long run. The imposition of a tariff increases the benefits during the catch up process, hence sustaining long-term profitability and guaranteeing survival.

As Matsuyama (1991) points out, the time-consistency of temporary protection is a non-trivial matter, if we allow the domestic firm to internalize the impact of its investment on trade policy. If the government's credibility is less than perfect, the firm may opt not to invest, even under protection. The reason is that the firm knows that if it doesn't invest, the government has the incentives to carry on with protection, while if it invests it will lose protection, because it is now above R^2. Not investing and maintaining protection may clearly be a higher profit strategy.

3.2.3 Trade Liberalization

This section focuses on the positive implications of the model developed above for trade liberalization. First, we address the short and long term consequences of a once-and-for-all, un-announced reduction in the tariff. Second, we analyze briefly how gradualism increases the likelihood of survival of the domestic firm. In the next section, we discuss also the normative implications of gradualism.

Prior to the liberalization, the firm is in the steady-state (R^z), protected by a tariff (τ): $\Re^z = R^z/(1+\tau)$. Note that the higher is the tariff, the higher will be the actual productivity gap of the domestic firm, i.e. the lower $\Re^z$. We denote the post-liberalization tariff by τ' ($0 \leq \tau' < \tau$), thus implying that following the liberalization the cost ratio falls to $R' \equiv \Re^z (1+\tau')$.

3.2.3.1 Response to Trade Liberalization

Depending on its magnitude, a tariff reduction has asymmetric effects on the behavior of firms. Very large cuts in the tariff, bringing the cost ratio (R') below R^2, lead the domestic firm to concede. In this case, trade liberalization forces the firm to shut down in the long run. We address this as a *radical* reform. Since the cost-ratio has to fall below R^2, a *radical* liberalization may occur only if: $\Re^z < R^2$, that is, if the initial tariff is higher than τ^r, with: $1+\tau^r \equiv R^z/R^2$. This would imply that the tariff, and not the firm's intrinsic competitiveness, was the single, most important factor keeping the domestic firm alive[20].

On the other hand, non-radical reforms generate new incentives for an increase in efficiency (due to the pro-competitive effect), and lead to the shrinkage of the productivity gap, in the long run. Here, the cut in the tariff leaves the cost-ratio above the critical point ($R' > R^2$).

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20 Empirically, the case of a radical liberalization creates a selection bias, since cases where the liberalization hurts productivity growth are not present in the sample for long periods. A direct implication is that empirical studies with long series will bias upwards the estimates of the impact of trade liberalization on productivity growth.

To start, the liberalization will cut domestic mark-ups and profitability. Due to this (pro-competitive) effect, productivity growth rises above ϕ in the short-run, as the firm catches up and recovers the loss of market power from the liberalization. In the long run, however, productivity growth and the cost ratio return to their steady-state levels: ϕ and R^z, respectively. So too will the level of profits and mark-up, which depend only on the cost-ratio (see equations 8 and 10). Therefore, the firm compensates for the loss of protection by expanding its intrinsic ability to compete, closing the productivity gap.

Remarkably, the behavior of profits and mark-ups is similar the outcome of *satisficing behavior*, namely if their steady-state levels are (erroneously) interpreted as bliss points. The *satisficing* postulate has been a widely used to ascertain the benefits of foreign competition (Rodrik 1992a). It should be clear, however, that the catch up process is driven here by profit maximizing entrepreneurs, and not at all by *satisficing*.

Another way of interpreting our results is that following trade liberalization, a more efficient domestic firm, enjoying a smaller productivity gap vis-à-vis the rest of the world, will survive and increase productivity with the aim of catching up and recovering the loss of market share (non-radical liberalization). On the other hand, a less efficient firm will concede and be crowded out of the market by the pressure of imports (radical liberalization). The reason is as follows. First, since a more efficient firm holds higher market power at the time of the reform, the pro-competitive effect (related to the decline in mark-ups) will be stronger and foster productivity growth. Second, for a less efficient firm, the pro-competitive effect will be of second order and trade liberalization will hurt the market size and productivity growth[21]. Although this paper does not explore the issues of heterogeneity within domestic industry, this result opens a new scope for research in these matters.

3.2.3.2 Gradualism.

In the case where the initial tariff is high enough that a sudden, complete removal will prove *radical*, a gradual removal may permit the domestic firm to survive and face free-trade in the long run. Recall that radical liberalization occurs when a tariff that is higher than τ^r is removed, thus implying: $R'=\Re^z<R^2$. Just like in section 3.2.2, a temporary tariff that is high enough and/or lasts long enough, reverses the firm's decision to concede, and makes it competitive in the long run, under free-trade. In this case, such temporary tariff corresponds to a gradual reduction of the initial tariff.

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[21] Roberts and Tybout (1991) argue that 'even if exposure to competition reduces plant size by contracting demand, it is likely to hit the most inefficient plants hardest'.

3.2.4 Welfare

Although a thorough discussion of the optimal path for trade policy is well beyond the scope of this paper, we use this section to discuss whether the arguments made above for temporary protection of infant industries or gradualism in trade liberalization can be given a normative backing. To this end, we explore the effect of these polices on welfare, starting from the free-trade benchmark. As we will see, when the level of protection necessary is not too large, these policies do increase welfare. In addition, we show that the optimal policy entails free-trade in the long run.

The intertemporal measure of social welfare is denoted by W^t, and is shown below. W_i denotes welfare in period i, similarly to equation (4). W^t represents the discounted sum of periodic welfare from t onward. Since the welfare of previous periods cannot be altered, W^t contains all that is relevant for the evaluation of policies being set at t. Implicit is the firm's investment path, determining the path of cost ratio.

(17) $$W^t = \sum_{i= t, t+1,\ldots\infty} \beta^{i-t} W_i$$

(17a) $$W_i = \{ u(x_i,y_i)/\lambda - p(x_i,f_i)x_i - f_i y_i \} + \Pi(c_i,f_i) + \tau_i f^*_i\, y_i$$

3.2.4.1 Welfare Analysis of Infant Industry Protection and Gradualism

To analyze the impact of the policies of temporary protection suggested above, namely the arguments for infant-industry protection and gradualism, we start by analyzing the welfare effect of a small tariff in period t, taking as given $\tau_{i>t}$. Differentiating (17) with respect to τ_t, we obtain:

(18)

$$(f^*_t)^{-1}\, dW^t/d\tau_t = \underbrace{(p_t-c_t)\, \partial x_t/\partial f_t}_{\textbf{(aI)}} + \underbrace{\tau_t f^*_t\, \partial y_t/\partial f_t}_{\textbf{(bI)}} + \sum_{i\geq t} \beta^{i-t}\{\underbrace{(p_i-c_i)\, \partial x_i/\partial c_i}_{\textbf{(aII')}} + \underbrace{\tau_i f^*_i\, \partial y_i/\partial c_i}_{\textbf{(bII')}}\}\partial c_i/\partial f_t$$

$$\mathbf{sgn}\ \partial \mathbf{c_i}/\partial \mathbf{f_t} = -\ \mathbf{sgn}\ \partial \mathbf{x_t}/\partial \mathbf{f_t}$$ [22]

Since productivity growth is an intertemporal decision (see equation 15), equation (18) replaces the distortions associated with investment in the static case (see equation 5) with their intertemporal counterparts: (aII') and (bII'). These terms reflect the impact of a change in the tariff on the distortions imposed along the investment path by the presence of market power (aII') and the tariff itself (bII'). Parallel to the static case, we have:

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22 This result is immediate from the lemma in section 3.2.1. It states that if the pro-competitive effect prevails in period t, an increase in competitive pressure from a decline in τ_t leads to lower unit costs throughout the investment horizon.

(aII')<0 and (bII')>0.

Now, we analyze the impact on welfare of the policies of temporary protection studied above, starting from the free-trade benchmark. Note that we look only at wether these policies do better than free-trade, and not at their optimality.

Let t, in equation (18), correspond to period one. In their simplest form, the policies under scrutiny entailed the imposition of a small tariff in period 1, with free-trade afterwards. The marginal impact of an increase in τ_1 from the free-trade benchmark, can be obtained by computing (18) for the case where $\tau_1=0$, $\tau_{i>1}=0$. The outcome is shown in (19).

$$(19) \qquad (f^*_1)^{-1}\, dW^1/d\tau_1 = (p_1-c_1)\, \partial x_1/\partial f_1 + \sum_{i\geq 1} \beta^{i-1}\{(p_i-c_i)\, \partial x_i/\partial c_i\}\partial c_i/\partial f_1$$

Now, this temporary protection was suggested in situations where the productivity gap is very large, so that the direct effect dominates ($\partial x_1/\partial f_1>0$, $\partial c_i/\partial f_1<0$). Namely, when the cost-ratio is below R^2, under free-trade ($\Re_0<R^2$). In this case, equation (19) implies that an increase in τ_1, from the free-trade benchmark, would have a positive effect on welfare. Hence, when the tariff necessary to keep the domestic industry alive is not too large, such policy will be welfare improving.

Note that, if it expands welfare to protect the domestic monopolist, in order to reverse its decision to concede, then the incentives to exit are above the social optimum. The reason is the presence of domestic market, whereby the firm undervalues the benefits of its output, compared to consumers, thus being too prone to shut down.

3.2.4.2 Free-Trade in the Long Run

Although, as we said earlier, we will not attempt to establish the features of the optimal policy, equation (18) allows us to establish the optimality of free-trade in the long run. We focus on the sub-game perfect path for the optimal policy.

Our analysis of the steady-state in section 3.1.4 showed that there are two long run solutions. In one of them, the domestic firm concedes and shuts down. Clearly, in this case, a tariff will have only the standard distortionary effects, and free-trade is optimal.

In the other, the domestic firm decides to compete with imports, catching up towards a steady-state R^z, where the pro-competitive effect dominates. To show that free-trade is the best policy in this case, we show that no *one stage deviation* from this policy entails an increase in welfare (Fudenberg and Tirole, 1993), when the pro-competitive effect dominates throughout.

To see this, note that if the pro-competitive effect dominates in period t, we have $\partial c_i/\partial f_t>0$ and $\partial x_t/\partial f_t<0$. Therefore, equation (18) implies $dW^t/d\tau_t<0$ at $\tau_i=0$, $\forall i\geq t$, and an increase in τ_t hurts welfare. The same is true, if we preform a similar exercise in any upcoming period, since the pro-competitive effect dominates throughout. Hence, *no one-stage* deviation from free-trade along the equilibrium path pays off. Therefore, the free-trade path is the optimal, time-consistent (sub-game perfect) strategy, when the pro-competitive effect dominates along the equilibrium path. This is the case in the steady-state, when the domestic firm survives import-competition.

Thus, independently of the possibility of temporary protection in the early stages, in the long run, the optimal policy should entail free-trade, in order to maximize the benefits from the competitive pressure of imports in improving productivity and undermining the distortion imposed by the lack of domestic competition.

4. Conclusion

In this paper we have discussed the positive and normative implications of the link between import-competition, output and productivity. In particular, we have seen how a decline in the price of imports may expand output, due to the pro-competitive effect, thus expanding the incentives to invest in productivity. On the other side, the direct effect of import competition reduces output (and thus investment), rendering the final outcome ambiguous.

The domestic firm survives only when its initial productivity gap is small enough. If not, import-competition drives out the domestic firm. The imposition of a temporary tariff may succeed in reversing this outcome, thus securing the long-term survival of the domestic firm. If the necessary tariff is not too large, it will be welfare increasing.

If the firm has survived foreign competition, the pro-competitive effect dominates in the steady-state, hence illustrating the disciplinary role of imports. Around the steady-state, trade liberalization generates a temporary increase in the rate of growth, thus closing the productivity gap. It improves welfare, yielding that the optimal policy in the long run is free-trade.

However, when the existing tariff is very high, its abrupt removal may hurt productivity growth and lead the domestic firm to shut down. Consequently, a gradualist approach to trade liberalization increases the likelihood of survival of the domestic firm. It may even be advisable from a normative standpoint.

5. Appendix

This appendix is divided in three parts. First, we present the derivation of the profit function in equations (8) – (10) in 3.1.1. Secondly, we demonstrate the proposition in 3.1.4. Finally, third, we prove the lemma in 3.2.1.

5.1 The Profit Function in 3.1.1.

For simplicity, we omit the subscripts for time. Now, the problem is:

(5.1.0) $$\pi \equiv \max_p (p-c)x$$

(5.1.1) s.t. $$x = \frac{p^{-\varepsilon}}{p^{1-\varepsilon} + f^{1-\varepsilon}} I$$

Recall that f = f*(1+τ). The first order condition is:

(5.1.2) $$(p-c)\, x_p + x = 0$$

x_p can be obtained from (5.1.1), to be written:

(5.1.3) $$x_p = -x\left(\varepsilon\, p^{-1} + (1-\varepsilon)\frac{p^{-\varepsilon}}{p^{1-\varepsilon} + f^{1-\varepsilon}}\right)$$

Substituting (5.1.3) into (5.1.2) we have:

(5.1.4) $$(p-c)\left(\varepsilon\, p^{-1} + (1-\varepsilon)\frac{p^{-\varepsilon}}{p^{1-\varepsilon} + f^{1-\varepsilon}}\right) = 1$$

Taking m ≡ p/c and R ≡ f/c, to denote the mark-up and the cost-ratio, respectively, we obtain:

(5.1.5) $$(1-m^{-1})\left(\frac{m^{\varepsilon-1}R^{1-\varepsilon} + 1}{\varepsilon^{-1}m^{\varepsilon-1}R^{1-\varepsilon} + 1}\right) = 1$$

Solving (5.1.5) yields (5.1.6), which is equation (10) in the text:

(5.1.6) $$R = m\,\{m\,(\varepsilon-1) - \varepsilon\}^{1/(\varepsilon-1)} \qquad m_t \in\ ]\ \varepsilon/(\varepsilon-1), \infty[$$

On the other hand, from (5.1.0) and (5.1.2) we have:

(5.1.7) $$\pi = -\, x_p^{-1}\, x^2$$

Substituting x_p for the expression in (5.1.3) and solving, yields (5.1.8)

(5.1.8) $$\pi = (\varepsilon\,(f/p)^{1-\varepsilon} + 1)^{-1}$$

$(f/p)^{1-\varepsilon}$ can be computed from (5.1.4), in terms of m:

(5.1.9) $$(f/p)^{1-\varepsilon} = ((\varepsilon-1)\, m - \varepsilon)^{-1}$$

Finally, substituting in (5.1.8) we have (5.1.10), which corresponds to equation (8), in the text.

(5.1.10) $$\pi \equiv \{1 - m^{-1}\, \varepsilon/(\varepsilon-1)\}\, I$$

To obtain the expression for output, note that, from (5.1.1):

(5.1.11) $$c\, x = (m + R\, (f/p)^{-\varepsilon})$$

We can use (5.1.6) and (5.1.9) to substitute in (5.1.11), and obtain (5.1.12), which corresponds to equation (9) in the text.

(5.1.12) $$x = \varepsilon/(\varepsilon-1)\ m^{-2} \{ ((\varepsilon-1)\, m -\varepsilon)^{-1} + m^{-1} \}^{-1}\, I/c$$

5.2 Proof of the Proposition in 3.1.4.

We provide the proof of proposition one in a broader environment than the one developed in the text. We extend it by not imposing any form on consumers' preferences; and by taking a (weaker) version of the absence of domestic competition, where there exist domestic substitutes. However, we require that the domestic competitors' unit costs, denoted by the vector c^i, are constant, i.e. that their productivity is stagnant.

The decision on prices and quantities among domestic firms is a sequence of period-by-period Nash/Bertrand equilibria, contingent on c_t, f_t and c^i, hence yielding the per period profit function for our firm: Π (c_t, f_t , c^i), where c^i are constants.

Let $V(c_t,f_t,c^i\, ;\omega,\beta)$ denote the market value of the domestic firm at time t, i.e. the present discounted value of the monopolist's net stream of profits. We assume the existence of a function V(.,.), continuous and strictly decreasing in c, which satisfies all the necessary properties. Then, the Bellman equation is given in (5.2.1).

(5.2.1) $$V(c_t, f_t, c^i) = \max_{a_t} \left\{ \Pi\left(c_t, f_t, c^i\right) - w a_t + b\ V\left(c_t (1+a_t)^{-1}, f_t (1+f)^{-1}, c^i\right)\right\}.$$

We concentrate on stationary paths, where the rate of productivity growth converges to a constant, which constitutes an interior solution to the monopolist's problem. Let α^z denote the steay-state rate of productivity growth. Now, we demonstrate the proposition.

Proposition: Pro-competitive and Direct effects in the Steady-State

In the steady-state, if imports and the domestic firm survive in the market, the pro-competitive effect dominates the direct effect, in the absence of domestic competition.

Proof:

The first order condition under the assumption of an interior solution ($\alpha^z>0$) is:

(5.2.2) $$\omega = -\beta\, V_c(c_{t+1}, f_{t+1}, c^i)c_{t+1}\,(1+\alpha_t)^{-1}$$

Considering that c^i are constants, we ignore them henceforth.

Since $\Pi_c(c_t,f_t)= - x(c_t,f_t)$, the combination of (5.2.2) and the envelope condition: $V_C(c_t,f_t) = \Pi_c(c_t,f_t) + (1+\alpha_t)^{-1} V_C(c_{t+1},f_{t+1})$, yields the system of difference equations below, where for simplicity of notation, we define: $TC(c_t,f_t) \equiv c_t x_t(c_t,f_t)/\omega$. Equations (5.2.4) and (5.2.5), where the superscript + denotes the logarithm, are log-linear representations of the equations of motion.

(5.2.3) $$1 + \alpha_{t-1} = \beta\{TC(c_t, f_t) + 1 + \alpha_t\}$$

(5.2.4) $$c^+_t= c^+_{t-1} - \alpha_{t-1}$$

(5.2.5) $$f^+_t= f^+_{t-1} - \phi$$

Now, let C_t denote the path for the unit cost in its steady-state trajectory, which is defined below.

(5.2.6) $$C^+_t= C^+_{t-1} - \alpha^z$$

(5.2.7) $$TC(C_t, f_t) = (1+\alpha^z)\,(\beta^{-1}-1)$$

Substituting (5.2.4) into (5.2.3) and using (5.2.7), after some algebraic manipulation, we have:

(5.2.8) $$1 + \Delta_{t-1} + \alpha^z = \beta\{\, TC(c_t, f_t) + 1 +\Delta_t - (\Delta_{t-1} - \alpha^z)\}$$

where $\Delta_t = c^+_t - C^+_t$. Δ_t measures the distance of c_t to its steady-state path. In steady-state Δ_t=0.

Taking a log-linear decomposition of $TC(c_t, f_t)$ around the steady-state (C^+_t), and substituting in (5.2.8), yields (5.2.9), where $\Gamma_{TC,c}$ is the elasticity of total costs with respect to the unit cost computed at the steady state: (C_t,f_t).

(5.2.9) $$\Delta_{t+1} - W\,\Delta_t + b^{-1}\,\Delta_{t-1} = 0$$

$$W \equiv \beta^{-1}\,\{1+\beta + (1-\beta)\,(1+\alpha^z)\,\Gamma_{TC,c}\,\}$$

Equation (5.2.9) represents the dynamic path of the unit cost as it approaches the steady-state. Although C_t and f_t are decreasing at rates α^z and ϕ, respectively, we assume that $\Gamma_{TC,c}$ is constant. The complementary solution yields: Δ=0.

We will demonstrate that $\Gamma_{TC,c}>0$ represents the *sufficient and necessary* condition for stability. First, however, we show that we can reduce the interval in which $\Gamma_{TC,c}$ runs.

1. Second order condtion implies: $-1\leq \Gamma_{TC,c} \leq 1$.

To see that $\Gamma_{TC,c}>-1$ is a necessary condition to satisfy the second order requirements in the maximization problem (i.e. to ensure that α^z is a maximum), look at (5.2.2): around the steady-state: $V_C=\Pi_c$ and the equation can be rewritten: $1=(1+\alpha_t)^{-1}TC\left(\frac{c_t}{1+\alpha_t}, f_{t+1}\right)$. The RHS of (5.2.2) has to be decreasing in α which implies: $-\Gamma_{TC,c}-1<0$. Moreover, note that by definition $\Gamma_{TC,c}<1$. Therefore, we restrict $\Gamma_{TC,c}$ to the interval [-1,1].

2. Stability implies $\Gamma_{TC,c} \in$] 0 ,1]

Now, let a_1 and a_2 be the roots of the characteristic equation obtained from (5.2.9), then we have:

(5.2.10a) $$a_1 = W + \sqrt{W^2 - b^{-1}}$$ and,

(5.2.10b) $$a_2 = W - \sqrt{W^2 - b^{-1}}$$

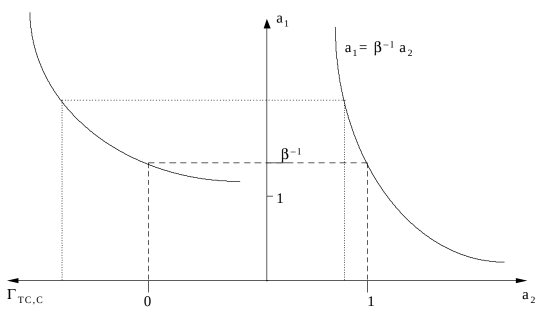
First, we show that W>1 is a necessary condition for stability. Since $\Gamma_{TC,c}>-1$ we have W>0. If $0<W\leq 1$ then a_1 and a_2 will be complex roots: the modulus of the complex roots is β^{-1} and, hence the system will not be stable.

Now, if W>1 then $a_1>1$. Moreover, a_1 is increasing with $\Gamma_{TC,c}$. On the other hand, we have $a_1.a_2=\beta^{-1}$. And, if $\Gamma_{TC,c}=0$, then $a_1=\beta^{-}1$ and $a_2=1$. These relationships allow us to obtain figure three. From the graph it is easy to see that if $\Gamma_{TC,c}\leq 0$, a_1 and a_2 will be greater or equal to one, which implies the system is not stable. If $\Gamma_{TC,c}>0$ we have: $a_1>\beta^{-1}$, $a_2<1$ which places us in saddle path converging towards the steady-state. Hence, $\Gamma_{TC,c}>0$ around the steady-state is a necessary condition to obtain local stability.

3. $\Gamma_{TC,c} \in$] 0 ,1] implies stability

If $\Gamma_{TC,c} > 0$ then W>1 and $a_1 > 1$. Thus, from figure three, if $\Gamma_{TC,c} \in$ [0 ,1] we will find ourselves in the saddle path.

Figure three: Roots of the Dynamic System



4. In steady-state, $\Gamma_{TC,c}$ >0 implies that the pro-competitive effect prevails

Since in the steady-state total costs: $TC(C_t,f_t)$ are constant, we have:

(5.2.11) $$\Gamma_{TC,c}\, \alpha^z + \Gamma_{TC,f}\, \phi = 0$$

Since $\Gamma_{TC,c}$, α^z and ϕ are positive, we have that $\Gamma_{TC,f}$ is negative. This clearly implies that output increases with a decline in the price of imports, i.e. that the pro-competitive effect will outweigh the direct effect around the steady-state #.

5.3 Proof of the Lemma in 3.2.1.

Lemma: Let τ_i be the tariff at time i. If at time i the direct effect dominates the pro-competitive effect: $\partial x(c_i,f_i)/\partial f > 0$, an anticipated increase in τ_i expands the cost-ratio (by increasing productivity) in all forthcoming periods: $\partial c_t/\partial \tau_i < 0;\ \forall t \geq 0$. If the pro-competitive effect dominates at i: $\partial x(c_i,f_i)/\partial f < 0$, the increase in protection reduces the level of productivity in all periods: $\partial c_t/\partial \tau_i > 0;\ \forall t \geq 0$.

(a) Assuming that $V(c_t,f_t)$ is strictly concave in c_t, which holds for the CES example in the text, c_{t+1} is a strictly increasing function of c_t, and vice-versa, given $\{f_{t+1}, f_{t+2}, ...\}$. To see this note that, from the first order condition in (5.2.2), we obtain:

$$dc_{t+1}/dc_t = -\beta\{\Pi_{cc}(c_{t+1}, f_{t+1})+V_{cc}(c_{t+1}, f_{t+1})\}/\omega c_t^2 > 0.$$

(b) Now, we show the effects of an anticipated increase in the price of imports in period i: $f_i' > f_i$. Let $c' = \{c_0, c_1', c_2', ...\}$ be the optimal path of productivity under $\underline{f'} = \{f_1, f_2, ..., f_i', f_{i+1}, ...\}$ and $c = \{c_0, c_1, c_2, ...\}$ be the optimal path under $f = \{f_1, f_2, ..., f_i, f_{i+1}, ...\}$, where c_0 is the initial condition.

In (c), we show that, if the pro-competitive effect prevails in period i, then $c_i' > c_i$; if the direct dominates in period i, then $c_i' < c_i$.

From result (a), this implies that if the pro-competitive effect prevails in period i, then $c_j' > c_j;\ \forall t=1,2,...$. Conversely, if the direct effect prevails in period i, then $c_t' > c_t;\ \forall t=1,2,...$.

(c) From the conditions of maximization we obtain (c1) and (c2) -- (c1) states that under $\underline{f'}$, c' yields a higher profit than c, i.e. c' is profit maximizing under $\underline{f'}$, while (c2) states that under $\underline{f}$, c yields a higher profit than c',

(5.3.1)

$$\sum_{t>0,\, t\neq i} \beta^t\, \Pi(c_t',f_t) - \beta^{t-1}\, \omega(c_{t-1}'/c_t' - 1) + \beta^t\, \Pi(c_i',\mathbf{f_i'}) - \beta^{i-1}\, \omega(c_{i-1}'/c_i' - 1) > \sum_{t>0,\, t\neq i} \beta^t\, \Pi(c_t,f_t) - \beta^{t-1}\, \omega(c_{t-1}/c_t - 1) + \beta^t\, \Pi(c_i,\mathbf{f_i'}) - \beta^{i-1}\, \omega(c_{i-1}/c_i - 1)$$

(5.3.2)

$\sum_{t>0,\, t\neq i} \beta^t \Pi(c_t,f_t) - \beta^{t-1}\, \omega(c_{t-1}/c_t - 1) + \beta^t \Pi(c_i,\mathbf{f_i}') - \beta^{i-1}\, \omega(c_{i-1}/c_i - 1) >$

$\sum_{t>0,\, t\neq i} \beta^t \Pi(c_t',f_t) - \beta^{t-1}\, \omega(c_{t-1}'/c_t' - 1) + \beta^t \Pi(c_i',\mathbf{f_i}) - \beta^{i-1}\, \omega(c_{i-1}'/c_i' - 1)$

Since: a>b ; c>d $\Rightarrow$ a-d > b-c, we obtain (5.3.3)

(5.3.3) $\Pi(c_i',\mathbf{f_i'}) - \Pi(c_i',\mathbf{f_i}) > \Pi(c_i,\mathbf{f_i'}) - \Pi(c_i,\mathbf{f_i}') \quad \Leftrightarrow$

(5.3.3') $\Pi(c_i',\mathbf{f_i'}) - \Pi(c_i,\mathbf{f_i'}) > \Pi(c_i',\mathbf{f_i}) - \Pi(c_i,\mathbf{f_i}')$

Taking $c_i' - c_i \approx 0$, we can linearize $\Pi(c_i',\mathbf{f_i})$ around c: $\Pi(c_i',\mathbf{f_i}) = \Pi(c_i,\mathbf{f_i}) + \Pi_c(c_i,\mathbf{f_i})(c_i' - c_i)$. Recall, from the envelope theorem that: $\Pi_c(c_i,\mathbf{f_i}) = - x^*(A_i,\mathbf{f_i})$. Performing the same linearization for $\Pi(c_i',\mathbf{f_i'})$, we can substitute in (5.3.3').

After some manipulation, we obtain (5.3.4)

(5.3.4) $\{ x^*(c_i,\mathbf{f_i'}) - x^*(c_i,\mathbf{f_i}) \} (c_i' - c_i) < 0$

Equation (5.3.4) proves our claim. Since $f'_i > f_i$, (e.g. the imposition of a tariff), then:

I. if the direct effect prevails in i, $x^*(c_i,\mathbf{f_i'}) > x^*(c_i,\mathbf{f_i})$ and, from (5.3.4), $c_i' < c_i$.

II. if the pro-competitive effect prevails in i, then $x^*(c_i,\mathbf{f_i'}) - x^*(c_i,\mathbf{f_i}) < 0$ and $c_i' > c_i$.

6. References

Balassa B. (1988), „Interest of Developing Countries in the Uruguay Round“; *The World Economy* 11, 39-54

Baldwin, R. (1992), „On the Growth Effects of Import Competition“, NBER Working Paper # 4045

Barro, R. and Sala-I-Martin (1995), „ Economic Growth“, McGraw-Hill

Cohen, W. (1995), „Empirical Studies of Innovative Activity“; in: *Handbook of the Economics of Innovation and Technological Change*, Paul Stoneman ed.: Basil Blackwell Ltd.

Corbo, V. and De Melo, J. (1985), „Scrambling for Survival. How Firms Adjusted to the Recent Reforms in Argentina, Uruguay and Chile“; Corbo and De Melo eds., World Bank Staff Working Papers #764, The World Bank, Washington DC.

Devarajan, S. and Rodrik, D. (1991), „Pro-Competitive Effects of Trade Reform. Results from a CGE Model of Cameroon“, *European Economic Review*, 35, 1157-1184.

Grossman, G. and Helpman, E. (1992), *Innovation and Growth in the Global Economy*; MIT Press

Harrison, A. (1994), „Productivity, Imperfect Competition and Trade Reform. Theory and Evidence“; *Journal of International Economics*, 36, 53-73.

Helpman, E. and Krugman, P. (1989), *Trade Policy and Market Structure*; MIT Press

Krishna, P and Mitra, D. (1994), „Trade Liberalization, Market Discipline and Productivity Growth: New Evidence from India“; manuscript, Columbia University

Levinshon, J. (1993), „Testing the Imports-As-Market-Discipline Hypothesis“; *Journal of International Economics*, 35, 1-22

Miyagiwa, K. and Ohno, Y. (1995), „Closing the Technology Gap Under Protection“; *American Economic Review*, Vol. 85, No 4, September 1995

Nishimizu, M. and Page, J.M. (1991) „Trade Policy, Market Orientation and Productivity change in Industry“; in: J de Melo and A. Sapir, eds., *Trade theory and economic reform: essays in honor of Bela Balassa*. Cambridge, MA: Basil Blackwell.

Roberts, M. and Tybout, J. (1991) ‘Size Rationalization and Trade Exposure in Developing Countries’, in: R. Baldwin ed., *Empirical Studies of Commercial Policy* Chicago: U. Chicago Press for the NBER

Rodrik, D. (1992a), „The Limits of Trade Policy Reform in Developing Countries“; *Journal of Economic Perspectives*, Vol. 6, N. 1, 87-105

Rodrik, D. (1992b), „Closing the Productivity Gap: Does Trade Liberalization Really Help?“ in: G. Helleiner, ed., *Trade Policy, Industrialization and Development*. Oxford: Clarendon Press

Rodrik, D. (1995), „Trade And Industrial Policy Reform In Developing Countries: A Review Of Recent Theory And Evidence“ in: *Handbook of Development Economics*, Vol. III, North-Holland

Smith, A. (1994), „ Imperfect Competition and International Trade“ in *Surveys in International Trade*, David Greenaway and L. Alan Winters, Eds.   Basil Blackwell Ltd, 1994

Stokey, N.; Lucas, R. and Prescott E. (1989), *Recursive Methods in Economic Dynamics*; Harvard University Press.

Tybout, J. (1992), „Linking Trade and Productivity“; *The World Bank Economic Review* 6, 189-211

Tybout, J.; De Melo, J. and Corbo, V. (1991), „The Effects of Trade Reforms on Scale and Technical Efficiency. New Evidence from Chile“; *Journal of International Economics* 31, 231-250

Tybout, J. and Westbrook, D. (1995), „Trade Liberalization and the Dimensions of Efficiency Change in Mexican Manufacturing Industries“; Journal of International Economics 39, 53-78