Import-competition, Market Power and the Infant-Industry Argument.

Daniel A. Traca\textsuperscript{*}
traca@econ.insead.fr

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Abstract

This paper addresses the impact of import-competition on the investment in R&D of a domestic monopolist, in a developing country, that competes with technologically advanced world producers. For an infant-industry, with a high productivity gap, the monopolist chooses to concede, whereas for mature industries, with a low productivity gap, import-competition stimulates productivity growth. Temporary protection sways an infant-industry to fight and catch-up, and is welfare increasing, due to the distortion from the firm’s market power. In the long-run, free-trade is the optimal policy. Hence we integrate the ‘old’ argument for the temporary protection of infant-industries, with the notion that import-competition fosters innovation and productivity.

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\textsuperscript{*}INSEAD, Bd de Constance, 77300 Fontainebleau, France.
1 Introduction

The conventional wisdom that foreign competition increases productivity and technical efficiency has by now permeated the policy debate, lying at the root of developing countries’ efforts to liberalize import controls (Balassa, 1988). Yet, an old argument in development economics pertained that domestic industries succumb, if open to foreign competition too early in their life, but “if given time to grow competitiveness and close the productivity gap in protected markets, they are likely to respond by expanding innovation and productivity” (Krueger, 1984).

This paper addresses the impact of import-competition on the investment in R&D of a domestic monopolist, in a developing country, that competes with technologically advanced world producers. It integrates the ‘old’ argument for the temporary protection of infant-industries, with the notion that import-competition fosters innovation and productivity. For a developing country, the questions are: Does a lagging, research intensive industry react to import-competition by expanding R&D, fighting to catch up to the world frontier? or, Does it simply concede to foreigners, re-allocating resources to traditional, low-growth sectors? In the latter case, can protection be used to sway the firm to fight? And if yes, does it make sense from a normative point of view?

The main contribution of this paper is to show that, in an endogenous growth framework, the likelihood that the industry concedes increases with the productivity gap, and that the presence of domestic market power, a pervasive distortion in developing countries, constitutes a normative and positive justification for the temporary protection of infant-industries, when the government can precommit.

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1 R&D stands here for all those costly learning activities that enhance productivity. For a discussion of the role of R&D in productivity growth in developing countries, see Evenson and Westphal (1995). Alternative interpretations of the inputs in the process of productivity growth include the effort of managers, the purchase of new blueprints, or the investment in new, more modern machinery.

2 The case for the assistance of infant-industries is as old as economics itself (see Irwin (1999) for the evidence on infant-industry protection in the US, in the late nineteenth century). In the neo-classical literature, one main justification has been the presence of learning-by-doing, although in a competitive environment this argument requires some additional distortion such as capital-market imperfections or externalities (Baldwin, 1969). Recently, strategic pro-.t-shifting in oligopolistic industries has expanded the role for trade policy, when the government can precommit (for a survey, see Brander, 1995).
The link between trade, innovation and growth has long been submitted to the scrutiny of endogenous growth theory. Unfortunately, Schumpeterian models do not provide an appropriate framework to study the role of import-competition, since their leap-frogging properties either bring down import-competing sectors, if the domestic rm looses the patent race, or turn them into export sectors, if the rm wins the race or imitates foreigners at lower production costs (Grossman and Helpman, 1991; Baldwin, 1992). In a non-Schumpeterian model, Rodrik (1992) shows that import-competition affects R&D through its scale effects: investment in R&D increases only if import pressure expands the rm's output.

In this paper, we take an infinite horizon non-tournament model of in-house R&D, and focus on the catch up process of a domestic producer in a small open economy, whose technology lags behind the best practice of foreign competitors. The rm faces no domestic competitors, thus mirroring the market concentration in technologically intensive sectors in developing countries (Rodrik, 1988). We assume also that its cost disadvantage from foreign competitors precludes the possibility that it will be competitive in export markets, at least in the foreseeable future. Since exports are precluded and the domestic market is a negligible share of world sales, foreign producers pay no strategic attention to the home rm, and focus their strategies on global markets. Following the literature on R&D-based models of endogenous growth, we take as given a steady-state equilibrium where foreign rms

\footnote{Drawing extensively on the models of Grossman and Helpman (1991) and Romer and Rivera-Batiz (1991a,b), this literature has mainly analyzed how openness affects innovation by (a) expanding the knowledge pool, (b) re-allocating factors across sectors and activities (e.g. between research and production), and (c) affecting the market for innovations through imitation. See Grossman and Helpman (1995), for a survey, and Bardhan (1995), for a critical review of the contributions to the policy debate on trade and growth. For a political economy approach, see Holmes and Schmitz (1995).}

\footnote{Looking at the steady-state of a symmetric domestic oligopoly, Smulders and Van der Klundert (1995) argue that international competition expands innovation (through scale effect), because the decline in profit margins leads to exit and increases the output of surviving rms. See Cohen (1995) for a survey of the literature on the role of scale (i.e. size, output) in R&D and innovation.}

\footnote{This can be due, for example, to the comparative advantage of the country in traditional, less-technologically intensive goods. Such setting depicts the conditions of certain non-traditional, import-competing sectors in developing countries, where the ability to tailor production to the specific needs of domestic consumers makes domestic producers competitive with more efficient foreign producers. In fact, our analysis generalizes the case for infant-industry protection to import-competing sectors.}
invest in R&D to expand productivity, yielding a falling price for the foreign good. This is exogenous to the domestic monopolist, who then decides on the price and investment in R&D that maximize profits.

The main results of this paper are as follows. First, we show that the productivity gap to the world frontier determines the domestic firm's decision to concede or fight. When the productivity gap is high, the home producer occupies a small share of the market, and therefore the scale effects are too small to encourage the R&D necessary to catch up with foreigners. Hence the domestic firm concedes. And since the foreigners themselves are investing in R&D, the domestic industry eventually shuts down. When the productivity gap is low, the domestic firm chooses to fight foreign competition, and openness brings about an increase in R&D, as the domestic firm catches up to the world technological frontier.

Second, for an infant-industry, that concedes under free-trade due to a high productivity gap, protection sways the firm to fight and catch up. The reason is that a tariff expands the firm's output, thus yielding scale effects that promote R&D. Moreover, assuming that the government can commit to a future liberalization, there is always a policy of temporary protection (with free-trade in the long-run) that succeeds in swaying the domestic firm to survive.

Third, the presence of domestic market power makes protection of infant-industries welfare increasing, at the margin. Rodrik (1988) has shown that protection improves static efficiency, when it increases the output of a firm.

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6 See, for example, Grossman and Helpman (1991), for Schumpeterian models, and Smulders and Van der Klundert (1995) or Peretto (1996), for models of in-house R&D.

7 Taking credibility as endogenous in a sequential stationary game, Matsuyama (1990) shows that the equilibrium where the government makes a credible commitment to liberalize once the industry matures is not renegotiation proof. However, he suggests several ways in which the government can commit, with the help of a third party. In a two period model, Leahy and Neary (1999) examine the implications of precommitment for strategic trade policy.

8 Although we model oligopolist markets and market power, our arguments are quite different in spirit from the strategic trade policy literature. The absence of strategic interaction in our model voids profit-shifting arguments for protection, while taking an exogenous the foreign price means that the terms-of-trade argument is also not present. Moreover, in spite of learning-by-doing in the R&D sector, a primordial component of endogenous growth models, our argument is also not related to this feature, since we assume that the domestic firm internalizes this effect. In fact, our arguments are closer to the literature on protection and domestic market power, reviewed in Helpman and Krugman (1989, ch.2).
with market power. Here, we add that the ensuing increase in R&D, due to scale effects, increases dynamic efficiency. Investment in R&D is socially sub-optimal because, given the wedge between price and unit cost, the firm undervalues the social benefits of its output (Beath, Katsoulacos, and Ulph, 1995). Hence, a (small) tariff that increases output and R&D, and thus sways the firm to fight instead of conceding, i.e. an infant-industry tariff, enhances welfare.

Finally, fourth, stressing the temporary nature of the case for infant industry protection, free-trade is the best policy in the long run. Contrary to an infant-industry, in a mature industry, a tariff hinders investment in R&D and aggravates the (market power) distortion, due to its pro-competitive effect, i.e. its impact on the firm’s market power (Helpman and Krugman, 1989). Through the pro-competitive effect, a lower tariff brings down the domestic firm’s price and increases its output, which, due to scale effects, expands R&D, thus improving welfare. Hence, the conventional wisdom that import-competition enhances productivity and welfare finds essence on the R&D expanding pro-competitive effect.

The next section describes a general equilibrium model, setting up the stage for the analysis of the investment path of a domestic monopolist in section three. Section four looks at the positive and normative impact of protection on the adjustment path. Section five concludes.

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9 Looking at trade liberalization episodes in Turkey and the Ivory Coast, respectively, Levinshon (1994) and Harrison, (1994) find evidence of the pro-competitive effect, captured in lower mark-ups.

10 As the lower tariff also shifts demand toward imports, there is a conflicting effect that decreases output and R&D, which dominates when the productivity gap is high (i.e. for an infant-industry). But, as the domestic firm catches up with its foreign competitors, its market power increases, and the pro-competitive effect becomes of first-order. Devarajan and Rodrik (1991), in a simulation model of trade liberalization in Cameroon, obtain that the pro-competitive effect leads (in equilibrium) to an expansion of the output of each firm.

11 Baldwin (1969) argued that market power might justify protection, but that this did not validate the infant-industry argument, because such protection should endure even after the monopoly had passed its infant-stage. In our model, the scope for trade policy instruments disappears, as the firm catches-up, due the pro-competitive effect, even if the domestic firm’s market power (i.e. the distortion) actually increases.
2 The model

This section describes a dynamic model of a small open economy which can freely lend to and borrow from the rest of the world. There are two sectors: first, a traditional competitive sector with an homogeneous good, with no potential for productivity growth and, second, a growth generating, modern sector. Labor is the only factor of production.

Comparative advantage, not explicitly modelled here, yields that the home economy exports from the traditional sector and imports goods in the modern sector. However, it produces also an import-competing modern good, differentiated from the foreign good, which has no potential to penetrate export markets. In the modern sector, the domestic good is produced by a single domestic firm (the domestic monopolist), mirroring the lack of competitive conditions in developing countries (Rodrik, 1988), while the foreign good is produced by an international oligopoly, and is imported competitively.

The traditional sector is competitive. Good $y$ is produced at home and abroad, with identical, linear technologies, $y = l_y$, where $l_y$ is the amount of labor. The price of the traditional good, $p_y$, is given from world markets, where domestic producers export part of their production to. Taking the foreign wage as the numeraire, the labor market condition in sector $y$ abroad implies that $p_{y(l)} = 1; B_l$. Hence the competitiveness of domestic firms in export markets implies that the domestic wage is also unitary ($w_{l(l)} = 1; B_l$).

In the modern sector, there are a foreign and a domestic good, $x_f$ and $x_h$, respectively, that are imperfect substitutes. The domestic good is produced by the monopolist to serve only the home market. The production function is given by:

$$x_h = A_{l(l)} l_{h(l)}$$

where $A_{l(l)}$ is the productivity parameter and $l_h$ is the amount of labor allocated to the production of the home good. Since $w_{l(l)} = 1$, the linear technology above implies that the monopolist’s unit cost ($c_h$) is given by $c_{h(l)} = 1=A_{l(l)}$.

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There are several reasons why a domestic firm may be competitive in domestic markets, while unable to penetrate export markets. For example: transport costs, which foreign firms can overcome due to lower production costs; differences in tastes, that render the home good inappropriate for foreign markets; or insufficient domestic supply of a specific factor.
The main feature of this sector is that it entails growth, contrary to the traditional sector. Here, we assume that domestic growth arises from in-house R&D of the monopolist\(^{13}\), where labor can be hired to work in R&D to expand productivity according to:

\[
A_{(t+1)} = A_{(t)} \times i^{1} \times l_{R&D}
\]

(2)

where \(l_{R&D}\) is the amount of labor employed in R&D, and \(i^{1}\) is the inherent productivity of the R&D department. The term \(A_{(t)}\) on the right-hand side displays how the research department draws on information and insights from past experience to expand the productivity of its workers, thus ensuring that, dynamically, there are no decreasing returns to investment in R&D. This assumption is of course essential to allow for endogenous growth.

Given that \(w_{(t)} = 1\), the monopolist’s R&D decision can be modeled as choosing the rate of growth, \(\hat{\gamma}_{(t)}\), to be obtained from a total investment in R&D given by \(\hat{\gamma}_{(t)}\), which represents the wage bill in the monopolist’s research department. Henceforth, we call \(\！”\) the cost of productivity growth.

The foreign good is produced by an oligopoly of foreign rms. We have in mind a sector where multinationals fight for leadership in global markets. Since the domestic economy is small and the domestic monopolist is shut from exporting, foreign oligopolists are oblivious to the events in the home economy, in their decisions on pricing and investment in R&D. Hence, the equilibrium of the world oligopoly is exogenous to the home economy.

Thus, let \(p^{w}_{(t)}\) be the world price of the foreign good, which can be written as: \(p^{w}_{(t)} = m^{f}_{(t)} \times c^{f}_{(t)}\), where \(m^{f}_{(t)}\) is the equilibrium mark-up of the foreign oligopoly and \(c^{f}_{(t)}\) is their unit cost. Taking the rest of the world in steady-state, we follow the results from R&D-based models of endogenous growth to make the following assumptions about the equilibrium of the world oligopoly\(^{14}\). First, we take \(m^{f}_{(t)}\) as constant and exogenous. Second, foreign rms invest in R&D, yielding a constant rate of productivity growth abroad,

\(^{13}\)The entry costs of R&D expenditure render plausible our assumption of a single domestic producer.

\(^{14}\)Grossman and Helpman (1991), Smulders and Van der Klundert (1995) and Peretto (1996), for example, provide models where competition sustains a constant mark-up with a positive rate of growth in steady-state. Our assumption of a small open economy implies that the home economy may be viewed as a technologically lagging competitive fringe of these models.
denoted by \( \hat{\Delta} \). Since the foreign wage is unitary, this implies that \( c_f(\hat{t}) \) falls at rate \( \hat{\Delta} \), i.e. \( c_f(\hat{t}) \cdot c_f(\hat{t} + 1) = c_f(\hat{t}) \hat{\Delta} \). These two assumptions imply that the world price of the foreign good falls at rate: \( \Delta \).

Finally, competitive importers bring the foreign good across the border at its world price, adding a tariff to be set by the home authorities, \( - p_f(\hat{t}) \cdot p_f(\hat{t}) \circ \hat{e} \); where \( p_f(\hat{t}) \) is the domestic price of the foreign good, and \( \circ \) is the tariff factor (i.e. one plus the ad-valorem tariff rate). And thus, the domestic monopolist takes as given the domestic price of the foreign good.

Turning to the demand side, there are two types of agents, an entrepreneur and workers. Workers obtain income from supplying labor in the different sectors. We normalize the size of the labor force to one. Workers’s preferences are given by:

\[
U_w \left(1 + \frac{1}{2} t \right) \log D(\hat{t})
\]

where \( \frac{1}{2} t \) is the rate of intertemporal discount and \( D(\hat{t}) \) represents the instantaneous utility function, given below:

\[
D = x_f^{1 - \frac{1}{\alpha_f}} + x_h^{1 - \frac{1}{\alpha_h}} y^{\frac{1}{\alpha_y}} 0 < \frac{1}{\alpha_y} < 1
\]

In (4), \( y, x_h \) and \( x_f \) denote the consumption of the traditional, the home and the foreign goods, respectively, while \( \alpha \) is the elasticity of substitution between the home and the foreign goods in the modern sector.

Letting \( E_{w(\hat{t})} \) denote the workers’ expenditure at \( \hat{t} \), since \( p_y = 1 \), the workers’ demand for each of the three goods at time \( \hat{t} \) can be written:

\[
y^d = (1 \cdot \frac{1}{\alpha} E_{w(\hat{t})})
\]

\[
x_f^d = \frac{p_f^{\alpha_f}}{p_f^{\alpha_f} + p_h^{\alpha_h}} \frac{1}{\alpha_f} E_{w(\hat{t})}
\]

\[
x_h^d = \frac{p_h^{\alpha_h}}{p_f^{\alpha_f} + p_h^{\alpha_h}} \frac{1}{\alpha_h} E_{w(\hat{t})}
\]

where \( p_h \) is the price of the home good. (5), (6) and (7) imply that the workers’ consumption index in (4) is given by:

\[
D(\hat{t}) \cdot E_{w(\hat{t})} \cdot p_f^{\alpha_f \circ \hat{e}}(\hat{t}) + p_h^{\alpha_h \circ \hat{e}}(\hat{t})
\]

\[8\]
Substituting in (3), we can optimize in order to $E_{w(\ell)}$. With the world interest rate at $R$, the Euler equation that determines the path of $E_{w(\ell)}$ can be written

$$\frac{E_{w(\ell+1)}}{E_{w(\ell)}} = \frac{1 + R}{1 + \frac{1}{2}}$$

If the foreign and domestic rates of intertemporal discount are identical, then the equilibrium world interest rate is: $R = \frac{1}{2}$, which yields $E_{w(\ell)} = E_w; \delta_{\ell}$. Now, for workers: $E_w = RW$, where $W$ is the net present value of the economy's wage bill. Given that the labor supply is normalized at one and $w(\ell) = 1$, we get: $W = R^{-1}$, which yields $E_w = 1$.

The entrepreneur owns the monopolistic firm that produces the home good in the modern sector. Her income consists of the monopoly profits plus the potential tariff revenues, which are transferred in a lump-sum fashion from the government. She consumes only the good in the traditional sector, and her preferences are given by:

$$U_e = \sum_{\ell=t}^{\infty} \left(1 + \frac{1}{2} \delta_{\ell+1}^t \right) \log y(\ell)$$

(8)

Letting $E_{e(\ell)}$ denote the expenditure of the entrepreneur at $\ell$, her demand for the traditional good is given by $y_d^e = E_{e(\ell)}$. Since $R = \frac{1}{2}$ the Euler equation yields: $E_{e(\ell)} = E_{e^*}; \delta_{\ell}$. Given her income, we obtain that $E_e = R (V + TR)$, where $V$ is the value of the domestic firm operating in the modern sector and $TR$ is the net present value of the tariff revenue.

15 Assume that, similarly to the home economy, the constant foreign rate of productivity growth implies that the employment in R&D abroad is constant. Then, given that the foreign wage is unitary, taking a constant foreign mark-up implies that foreign profits are constant, in the steady-state. Hence, provided that the foreign labor force is constant, the income in the foreign economy (wages plus profits) is also constant. Now, given that the foreign economy is, for all practical purposes, a closed economy, this means that foreign expenditure is also constant. Therefore, assuming that the foreign rate of intertemporal substitution is unitary (log preferences) and the foreign rate of intertemporal discount is $\frac{1}{2}$ as in the home economy, the Euler equation for foreign expenditure implies: $R = \frac{1}{2}$
3 The domestic monopolist

Since $E_w(\omega) = 1$, (7) implies that the intertemporal demand schedule facing the domestic monopolist is given by

$$x_d^h(\omega) = \frac{p_{h(\omega)}^*}{p_{h(\omega)} + p_{f(\omega)}} \gamma_4$$

(9)

Taking as given the path of the home price of the foreign good ($p_{f(\omega)}$), the domestic monopolist chooses the paths for the price of the home good and for the investment in R&D, to maximize the value of the firm, $V$, i.e. the net present value of profits.

Now, for any path of $c_{h(\omega)}$, the pricing decision corresponds to a sequence of static decisions that take $c_{h(\omega)}$ and $p_{f(\omega)}$ as given. Hence, without loss of generality, we take on the monopolist’s dynamic problem in two steps. First, we look at the decision on the path for the price of the home good as a sequence of independent static problems. Second, we look at the intertemporal decision to invest in R&D, to determine the optimal path of the unit cost.

3.1 Profits, mark-up and output

At period $\omega$, given $c_{h(\omega)}$ and $p_{f(\omega)}$, the monopolist charges the price that maximizes her static profit, $\eta$, as given by the difference between sales revenues and production costs:

$$\eta^*(\omega) = \max_{p_{h(i)}} p_{h(i)} c_{h(\omega)} x_d^h p_{h(\omega)} p_{f(\omega)},$$

where $x_d^h$ is given in (9).

$$\gamma_4^*(\omega) = \frac{1}{m(\omega)} \mu_1 \frac{1}{\eta}$$

(10)

Because an explicit solution for the profit function is unattainable, equation (10) shows the static profit ($\gamma_4$) in terms of an auxiliary variable which denotes the optimal mark-up of the domestic firm ($m$), defined as the ratio of the profit maximizing price over the unit costs: $m(\omega) = \frac{p_{h(\omega)}}{c_{h(\omega)}}$. The optimal mark-up is given implicitly by

\footnote{This unorthodox set up differs from standard models of strategic trade with differentiated goods, because we fail to make the assumption of infinitesimal firms that generates monopolistic competition, where mark-ups are determined solely by the elasticity of substitution (Helpman and Krugman, 1989). The reason is that, as we will see, the dynamics of the mark-up is crucial to understand the dynamics of the productivity gap, - a point raised in Bardhan (1995).}
\[ \hat{\lambda}_{(\ell)} = \frac{m_{(\ell)}}{m_f} \hat{m}_{(\ell)}(\hat{\theta}_{1}; \frac{\hat{\alpha}}{1+\hat{\alpha}}) \quad \hat{\lambda} \geq 0; \quad \lambda_{(\ell)} \geq 0 \]  

where \( m_f \) is the equilibrium (steady-state) mark-up of the foreign oligopoly and \( \hat{\lambda}_{(\ell)} \) is addressed as the cost-ratio. \( \hat{\lambda} \) measures the effective proximity between the firm's technological capabilities and the world frontier, deflated by the tariff.

Letting \( M \) denote explicitly the function defining the mark-up in terms of the cost-ratio \( (m \hat{\lambda}) \), implicitly defined in (11), it can be shown that \( M \) is an increasing, convex function \( (M_0 > 0; M_{00} > 0) \). The lower quadrant of Figure one sketches the function \( M \). Moreover, letting \( \hat{\phi} \) denote explicitly the expression for static profits in terms of the cost-ratio \( (\hat{\phi} \hat{\lambda}) \), obtained by substituting \( M \) in (10), it can be shown that \( \hat{\phi} \) is an increasing and concave function, with \( \hat{\phi}[0] = 0 \).

Finally, equation (12) denotes the profit maximizing output of the monopolist, again as a function of the optimal mark-up. The expression for \( X \) yields a bell-shaped function, with \( \lim_{m \to \infty} X = \lim_{m \to 0} X = 0 \), as sketched in the upper quadrant of Figure one.

**Remark 1** \( X[m] \) is the expression for the firm's total production cost.

**Proof.** Multiply both sides of equation (12) by the firm's unit cost, \( c_{(\ell)} \), to obtain the total cost in the RHS.

**Pro-competitive effects**

Now, we analyze the impact of a decline in the domestic price of imports, arising from an increase in foreign productivity or a decline in the tariff. Here, it means a decline in \( \hat{\lambda} \), which from (10) and (11) brings down profits and the mark-up of the domestic firm. Thus we capture the intuitive notion that the competitive pressure from imports reduces the domestic monopolist's
market power. Following Helpman and Krugman (1989), we refer to this as the pro-competitive effect. It implies that a decline in the price of imports increases the price-elasticity of demand for the domestic good.

However, the bell-shape of the function $X$ implies that the impact of a decline in the price of imports on the firm’s output depends on the cost-ratio. This ambiguity arises from the presence of two conflicting effects of the decline in import prices, namely: the direct effect and the pro-competitive effect. On the one hand, the direct effect describes how a decline in the price of imports decreases the demand for the home good, as consumers substitute toward imports, thus inducing a lower output and market share for the domestic firm. On the other, the decline in the mark-up, due to the pro-competitive effect, implies a decline in the price of the home good, which expands output when the demand curve is negatively sloped.

In the case of the function $X$, when $m$ is small (i.e. $\hat{A}$ is small) the direct effect dominates, since the small mark-up implies that the pro-competitive effect, which relies on the decline of mark-ups, is of second order. Consequently, a decline in the price of imports reduces output, and $X$ is increasing ($X^0 > 0$). As $m$ increases (i.e. $\hat{A}$ grows), the role of the pro-competitive effect strengthens. When $m$ is large enough, the pro-competitive effect becomes the first-order effect, whereupon an increase in output arises when the price of imports falls, i.e. $X$ is decreasing ($X^0 < 0$). Thus we obtain the bell shape of the $X$ function, which is crucial for the results in this paper.

### 3.2 Investment in R&D

Now we analyze the dynamic decisions of the domestic monopolist to obtain the path of investment in productivity. For now, we assume that the tariff is constant, i.e. $\theta(\ell) = \theta; \forall \ell$. Hence, we can write the Bellman equation for the firm’s program as:

$$V \begin{bmatrix} \hat{A}(\ell) \\ \hat{\hat{A}}(\ell) \end{bmatrix} = \max_{\hat{A}(\ell)} \left( \begin{bmatrix} \hat{A}(\ell) \\ \hat{\hat{A}}(\ell) \end{bmatrix} \right)^T \begin{bmatrix} \ell \\ \ell \end{bmatrix} + (1 + R)^{\ell} V \begin{bmatrix} \hat{\hat{A}}(\ell+1) \\ \hat{\hat{\hat{A}}}(\ell+1) \end{bmatrix}$$

(14)

where $V$ denotes the market value of the domestic firm, i.e. the present discounted value of the monopolist’s net stream of profit. Since the tariff is constant, the motion of the cost-ratio, $\hat{A}(\ell)$, is given by

$$\hat{\hat{A}}_{\ell+1} = \frac{1 + \ell}{1 + \hat{A}} \hat{A}_{\ell}$$

(15)
Lemma 1 The value function \( V[\bar{A}] \) is increasing, continuous, differentiable and strictly concave.

Proof. We can decompose \( V(\cdot) \) as follows:

\[
V(\cdot) \equiv A(\cdot) + (\lambda + R) \max_{\bar{A}_{(\cdot + 1)}} \bar{A}_{(\cdot + 1)} \quad \text{satisfies the strictest conditions in Section 4.2 in Stokey et al. (1989),}
\]

which implies that these are also properties of \( V(\cdot) \). Hence, they apply also to \( V(\cdot) \).

The first-order and envelope conditions that characterize the solution to the monopolist’s problem, can be written:

\[
\left( \lambda + R \right) V^0 \bar{A}_{(\cdot + 1)} \bar{A}_{(\cdot + 1)} = 0 \quad \text{if} \quad \lambda(\cdot) > 0 \quad (16)
\]

\[
V^0 \bar{A}_{(\cdot + 1)} \bar{A}_{(\cdot + 1)} = \lambda(\cdot) V^0 \bar{A}_{(\cdot + 1)} \bar{A}_{(\cdot + 1)} \quad \text{if} \quad \lambda(\cdot) > 0 \quad (17)
\]

Solving for the term: \( \lambda(\cdot) \bar{A}_{(\cdot)} \) in (17), we obtain through the envelope theorem that it is given by \( X[m]\beta \) (i.e. \( X[M]\beta \)), where \( X \) is given in (13). Recall from remark 1 that \( X[m]\beta \) is the expression for the total cost, thus bringing forth the notion that scale effects (i.e. size, output) are a crucial determinant of the incentives for innovation and productivity growth.

3.3 Steady-state

Now, we search for a solution to the set of equations in (16) and (17).

Proposition 2 The solution to the monopolist’s problem yields a stationary path, where \( \lambda(\cdot) \) is a constant, \( \bar{A}_s \), the steady-state, with \( 0 < \lambda \). \( \bar{A}_s < 1 \).

Proof. First, explosive solutions (\( \lambda(\cdot) \to 1 \)) can be ruled out since they will eventually yield negative pro. ts. Second, the possibility of cycles can be precluded since, from (16) and strict concavity of \( V[\bar{A}] \), we have: \( d\bar{A}_{(\cdot + 1)} = d\bar{A}_{(\cdot + 1)} > 0 \) 

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. She may decide to either:
Concede and let its market share be unceasingly corroded by imports or,

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

A corner solution in (16) (denoted by the superscript “_”) embodies the long run aftermath of the strategy of conceding. In this case, the rate of productivity growth (\( \text{\( \Delta \)} \)) and the cost-ratio (\( \text{\( \tilde{\text{\( \Delta \)}} \)} \)) are zero, in the steady-state. This solution is locally stable. That is, if the cost-ratio is in the vicinity of zero, the rate of productivity growth is close to zero (thus smaller than A) which, from (15), implies that the cost-ratio converges to zero. The latter implies that profits (\( \text{\( \bar{\text{\( \Delta \)}} \)} \)) also converge to zero (see equations 10 and 11). Hence, the decision to concede, which happens when the initial cost ratio is sufficiently close to zero, implies that the monopolist will shut down in the long run.

To ...ght is the only decision that allows the domestic monopolist to stay in the market in the long run, competing with imports. If the monopolist decides to ...ght, equation (16) entails interior solutions, denoted by the superscript “~”. The Euler equation characterizing the solution for the monopolist’s problem, when the ...rm opts to ...ght, can be obtained from the manipulation of (15), (16) and (17) and is shown in (18).

\[
(1 + R)^i \frac{X}{m(\xi)} = \frac{1}{\gamma} \frac{1}{1 + \text{\( \tilde{\text{\( \Delta \)}} \)}(1 + R)^i} \frac{1}{1 + \text{\( \tilde{\text{\( \Delta \)}} \)}(1 + R)}
\]  

Equations (15) and (18) constitute a system of non-linear, first order difference equations in \( \text{\( \tilde{\text{\( \Delta \)}} \)} \) and \( \text{\( \tilde{\text{\( \Delta \)}} \)} \), which through (11) can also be seen in terms of \( m(\xi) \). Proposition 2 implies that it converges to a steady-state (\( \text{\( \tilde{\text{\( \Delta \)}} \)} \)), which we address below.

Proposition 3 If the ...rm opts to ...ght, the steady-state rate of growth of domestic productivity (\( \text{\( \tilde{\text{\( \Delta \)}} \)} \)) equals the rate of growth of foreign productivity (\( \text{\( \Delta \)} \)).

Proof. Solving equation (18) for the steady-state, we get: 

\[
\frac{X}{m(\xi)} = R(1 + \text{\( \tilde{\text{\( \Delta \)}} \)}(1 + R)^i) \frac{1}{\gamma} \frac{1}{1 + \text{\( \tilde{\text{\( \Delta \)}} \)}(1 + R)^i} \frac{1}{1 + \text{\( \tilde{\text{\( \Delta \)}} \)}(1 + R)}
\]

If \( \text{\( \tilde{\text{\( \Delta \)}} \)} > \text{\( \tilde{\text{\( \Delta \)}} \)} \), then \( \text{\( \tilde{\text{\( \Delta \)}} \)} \) and \( m(\xi) \) ! 1 and \( \text{\( \tilde{\text{\( \Delta \)}} \)} \) ! 1. If \( \text{\( \tilde{\text{\( \Delta \)}} \)} < \text{\( \tilde{\text{\( \Delta \)}} \)} \), then \( \text{\( \tilde{\text{\( \Delta \)}} \)} \) ! 1 and \( m(\xi) \) ! \( \frac{1}{\gamma} \). From (13) we have: 

\[
\lim_{m \to 1} X[m] = \lim_{m \to 1} \text{\( \tilde{\text{\( \Delta \)}} \)} \frac{1}{\gamma} \frac{1}{1 + \text{\( \tilde{\text{\( \Delta \)}} \)}(1 + R)^i} \frac{1}{1 + \text{\( \tilde{\text{\( \Delta \)}} \)}(1 + R)}
\]

\[\text{\( \Delta \)} \]

In reality, the ...rm will just keep getting smaller. However, if we assume a small ...xed cost, which is otherwise irrelevant, the ...rm will eventually close.
X [m] = 0. Hence, if $s \in \hat{A}$, the condition above becomes: $R (1 + s) ! = \gamma = 0$, in the limit. This condition is impossible for $s > 0$, thus establishing a contradiction. Hence, in any interior solution we have $s = \hat{A}$. □

This proposition implies that, when the rm decides to .ght, the cost ratio $(\hat{A} / (\gamma))$, and thus the mark-up $(m / (\gamma))$, converge to a steady-state where they are constant. We address the values of the cost-ratio and the mark-up in the steady-state as $\hat{A}$ and $m$, respectively. Now, if it exists, $\{\hat{A}; m\}$ is a stationary point of the system comprised of (15) and (18), which implies that $m$ is given by the solution to:

$$
(1 + \hat{A})R! = \gamma = X [m]
$$

Assuming $(1 + \hat{A})R! = \gamma$, the bell-shape of $X [\cdot]$ implies that there are two solutions for equation (19). We denote them by $m_a$ and $m_b$, with $X [m_a] < 0$; $X [m_b] > 0$, and $m_a > m_b$. We can thus obtain $\hat{A}_a = M \hat{2}[m_a]$ and $\hat{A}_b = M \hat{2}[m_b]$, with $\hat{A}_a > \hat{A}_b$ (see .gure one).

On the other hand, stability is also a requirement for $\{\hat{A}; m\}$ to be considered the steady-state, which brings us to the following proposition

Proposition 4 Let $m$ be a stationary point for the domestic monopolist, as given in (19). Then, $\{\hat{A}; m\}$ is a locally saddle-path stable if and only if $X [m] < 0$. If $X [m] > 0$, then the stationary point is locally unstable.

Proof. Let $X_{\cdot}[\hat{A}] \cdot X [M [\hat{A}]]$. The dynamic system in (11), (15) and (18) can thus be simpli..ed to

$$
\mu X_{\cdot}[\hat{A}] = \frac{\hat{A}_a}{\hat{A}} - (1 + R) i \frac{\hat{A}_b}{\hat{A}_a}
$$

where $\mu \cdot (1 + \hat{A})^{1/2} < 1$. The last inequality has to hold, if (19) has a solution. Linearizing around the steady-state de..ned in (19), we obtain

$$
\xi (\gamma + 1) \xi + (1 + R) \xi = 0
$$

where $\xi (\gamma) \xi_\gamma$ and $\xi + 2 + R \mu X_{\cdot}[\hat{A}][\hat{A}] \gamma > 0$. The latter inequality arises from the second order condition of the monopolist’s problem, that ensures that $\hat{A}$ is a maximum, which yields $\frac{\partial^2 X}{\partial \gamma} = X_{\cdot}[\hat{A}] \gamma > 0$. The characteristic roots are given by:

$$
a_1 \gamma \gamma + \hat{A}^2, (1 + R) \xi = \hat{A}_a; \quad a_2 \gamma \gamma + \hat{A}^2, (1 + R) \xi = \hat{A}_b
$$

15
Now, if $0 < \tilde{\lambda} < (1 + R)^{1/2}$, then $a_1$ and $a_2$ are complex roots with modulus $1 + R$, and thus the system is not stable. For $\tilde{\lambda} > (1 + R)^{1/2}$, figure two plots the ‘real’ roots in terms of $\tilde{\lambda}$, - the right-hand side arises from: $a_1 a_2 = 1 + R$. Note that (i) when $\tilde{\lambda} = 2 + R$, then $a_1 = 1 + R$ and $a_2 = 1$, and that (ii) if $\tilde{\lambda} > 2 + R$, then $X_0^0 < 0$; while if $\tilde{\lambda} < 2 + R$, then $X_0^0 > 0$. Hence, we obtain: (a) $(1 + R)^{1/2} < \tilde{\lambda} < 2 + R$ (i.e. $X_0^0[\tilde{\lambda}_s] > 0$) if and only if $a_1 > 1$; $a_2 > 1$ (i.e. the system is not stable); and (b) $\tilde{\lambda} > 2 + R$ (i.e. $X_0^0[\tilde{\lambda}_s] < 0$) if and only if $a_1 > 1$; $a_2 < 1$ (i.e. the system is saddle-path stable).

Since, from proposition 4, $m_0$ is the unique stable stationary point of the system, we obtain that, when it decides to fight, the rm converges to $m_0$, i.e. $m_s = m_a$ (or $\tilde{\lambda}_s = \tilde{\lambda}_a$). The decision to fight is optimal when the initial cost-ratio is in the vicinity of $\tilde{\lambda}_a$, given the local stability of the equilibrium.

Moreover, the proposition establishes a relationship between the slope of $X[m]$, i.e. the impact of foreign prices on domestic output, and the dynamic stability of the equilibrium, when the rm survives. In particular, the stable equilibrium is the one where a decline in the price of imports expands output, i.e. $X_0^0 < 0^{18}$. The intuition is simple. In the stable equilibrium, where it fights to stay alive and maintain competitiveness, the domestic rm has to respond to the increase in the productivity of foreign rms with an equivalent increase 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 the direct effect), near the steady-state.

### 3.4 The critical gap

Two long run solutions are possible: the rm may concede or decide to fight. In the first case, it shuts down in the long run. In the latter, it converges to $\tilde{\lambda}_s$.

Now, the position of $\tilde{\lambda}_b$, an unstable stationary equilibrium between the two stable steady-states, makes it the critical cost-ratio in the rm’s decision between fighting or conceding. On one hand, if the initial cost-ratio is higher

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18It can be shown that the link between (a) the derivative of the home rm’s output to the stationary mark-up (implicitly to the productivity gap) and (b) the local stability of the equilibrium, does not depend on the demand setting (i.e. preferences).
than $\hat{A}_p$, the firm decides to fight and catch-up with its foreign competitors, closing the productivity gap toward $\hat{A}_s$. On the other hand, if the initial cost-ratio is below $\hat{A}_p$, the optimal decision is to concede, and the domestic firm is wiped out of the market following its encounter with foreign producers. We address the latter as infant-industries, whereby although the firm is lucrative in the long-run, once it catches up, the initial technological backwardness renders unprofitable the catch up process. Figure one shows the steady-state and the motion of the mark-up and the cost-ratio.

Since $X [m_{10}]$ is positive, it is straightforward to see from equation (19), that the critical cost-ratio is higher, and thus the domestic firm is more likely to concede, when its cost of innovation ($!$) and the interest rate ($R$) are higher and when the size of the domestic market ($\varphi$) is smaller. Also, the firm is more likely to concede when the competitive pressure, measured by the rate of foreign productivity growth ($\dot{A}$), is higher. To the extent that, in equilibrium, the latter is negatively correlated with the foreign cost of productivity growth, the home firm concedes when the relative efficiency of its R&D sector is lower.

If $R (1 + \dot{A})! \Rightarrow \varphi$ is too large, the existence of an interior steady-state is undermined, since equation (19) 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.

4 Protection

This section analyzes the argument that protection may reverse an infant-industry’s decision to concede, and looks at the welfare consequences of such protection. We assume that the government is able to commit to a tariff path, \( t^*_o \), which the domestic monopolist takes as given, and that governments are interested in domestic welfare. As we will see, in this case the government will commit to a path of temporary protection of infant-industries, with free-trade in the long run.

Now, the assumption that the government can credibly commit to a tariff path that liberalizes once the firm has caught up, has long been criticized, since the firm may act strategically, and cut its investment hoping for a continuation of protection. However, there are several ways in which the government can commit to the future liberalization. First, the government might have an incentive to build a reputation through the ‘demonstration effect’, if, in the future, other industries will be targeted for temporary protection. Second, the government might be able to sign a contract with a third party (perhaps the WTO), to make the costs of delaying liberalization prohibitively high\(^22\). Third, the domestic government might want to ask a foreign government to exert diplomatic pressure to liberalize the domestic market (e.g. World Bank adjustment program, or US/Japan trade disputes) (Matsuyama, 1990).

4.1 Trade policy and productivity

We start by analyzing the impact of protection announced at \( \zeta = 0 \), the time to set policy, on the firm’s productivity growth path.

**Proposition 5** Let \( t^*_\zeta \) be the tariff set for time \( \zeta > 0 \). If \( X [m(\zeta_o)] > 0 \), a (small) increase in \( t^*_\zeta \) expands the equilibrium level of productivity for

---

\(^{22}\)The post Uruguay-Round interpretation of GATT’s special and differential treatment of developing countries, to focus on longer transition periods and technical assistance instead of exemption from reciprocity, can be seen as a new way of establishing the commitment of a strategy of temporary protection.
all upcoming periods: \( @c_{m(\xi)}(\xi_0) < 0; 8\xi > 0 \). If \( X \{ m(\xi_0) \} < 0 \), a (small) increase in \( o(\xi_0) \) reduces the equilibrium level of productivity for all upcoming periods: \( @c_{m(\xi)}(\xi_0) > 0; 8\xi > 0 \).

Proof. See appendix one.

Since an increase or a decline in the productivity level imply an expansion or reduction, respectively, of the rm's investment in productivity growth, proposition 5 brings us back to the role of scale effects in defining the impact of foreign prices on productivity growth. The result obtained shows that a tariff expands the path of investment in R&D when it expands output, i.e. when \( X [m] \) is decreasing. Conversely, when a tariff reduces output, i.e. when \( X [m] \) is increasing, it brings down the investment in R&D. Hence, proposition 5 implies that the link between tariffs and productivity growth depends on the relative weight of the pro-competitive and the direct effects.

Since the catch-up process, if it happens, moves the rm from an area where \( X \) is increasing to an area where it is decreasing (see figure one), proposition 5 implies that tariffs that enhance investment in R&D should take place in the early periods of the rm's life. Moreover, the tariff may actually affect the rm's decision to engage in the catch-up process.

Proposition 6 Let \( A_{0(0)} \) denote the initial productivity gap, such that the rm decides to concede under free-trade, i.e. \( A_{0(0)} < A_{b} \). Then, a permanent tariff: \( \bar{o} = \bar{A}_{b}=A_{0(0)} \) reverses the rm's decision, swaying it to fight and survive in the long run. Moreover, there always exists a tariff schedule, \( o(\xi) \), with \( \lim_{\xi \to 1} o(\xi) = 0 \), that, announced at \( \xi = 0 \), ensures long run survival.

Proof. The rst part of the proposition is immediate, since with \( \bar{o} = \bar{A}_{b}=A_{0(0)} \), the initial cost-ratio rises to \( A_{b} \), and the rm catches up to converge to \( A_{s} \).

For the second part, let \( A_{0(0)} \). Let \( \bar{A} \) denote the path of cost-ratio under that tariff path \( o(\xi) \). Let \( \bar{A} \) be such that \( \bar{A} < \bar{A} \) and \( X [\bar{A}] < 0 \), for \( \bar{A} > \bar{A} \). And nally, let \( \xi_{1} \) be such that \( \bar{A}_{(\xi_{1},o(\xi_{1}))} = \bar{A} \), i.e. \( \xi_{1} \) is the earliest time where the optimal path for the cost-ratio, given the tariff path: \( o(\xi) \), monopolist's satisfies \( X [\bar{A}] < 0 \).

If \( o(\xi) = \bar{A}_{b}=A_{0(0)}; \xi_{0} \), then \( \bar{A}_{(\xi_{1},o(\xi_{1}))} = \bar{A}_{s} \). Now, we construct a tariff path, \( o(\xi) \), entailing long-run free trade, which maintains the rm's willingness to fight. So, let \( o(\xi) = \bar{A}_{b}=A_{0(0)}; \xi_{0} < \xi_{0} < \xi(\xi_{1}) < 0 ; \xi_{1} > \xi_{0} \). From proposition 5, and since \( X [\bar{A}_{0(0)}; o(\xi_{1}) < 0 \), we have that \( \bar{A}_{(\xi_{1},o(\xi_{1}))} = \bar{A}_{s} \), since tariffs
were removed only when \( X^0 < 0 \). The new tariff path, which implies long-run free-trade, yields an increase in the ..rm’s investment in R&D, that speeds up the convergence to \( \bar{A}_s \). Subsequent interactions would yield a tariff path with a shorter protectionist period, that would still sustain the ..rm’s decision to ..ght. ■

Note that proposition 6 not only shows that trade policy may make viable in the long run, a ..rm that would otherwise concede, but that the protection necessary to obtain such long term competitiveness needs to be only temporary. In the long run, we can always obtain a ..rm that is able to survive foreign competition on its own merits.

4.2 Welfare analysis

In this section, we discuss whether the positive arguments made in proposition 6 for the temporary protection of infant industries make sense, from a normative standpoint. To this end, we explore the effect of such policy on welfare, starting from the free-trade benchmark. The status-quo, again, is that the domestic ..rm is in a position where it concedes, under free-trade, i.e. \( \bar{A}_0 < \bar{A}_b \).

We address the normative impact of protectionism by looking at the effect of a change in \( \delta^{(\bar{A}, b)} \), the tariff announced for time \( \bar{\omega} \). Our measure of social welfare assumes that there are lump-sum payments that transfer the impact of protection on the entrepreneur’s income to workers. It is given by

\[
U = \sum_{\bar{\omega} = 0}^{\bar{\omega}} (1 + \Delta)^{\bar{\omega}} \log \frac{B \bar{A}_{(\bar{A}, b)}^{(\bar{A}, b)} \bar{V}(\bar{A}, b; (\bar{A}, b))}{p_{(\bar{A}, (\bar{A}, b))}^{(\bar{A}, (\bar{A}, b))}}
\]

where \( \bar{V}(\bar{A}, b; (\bar{A}, b)) \) denotes the wealth of the entrepreneur under the new tariff, and \( V_0 \) denotes her wealth under the status-quo. Hence, \( \bar{V}_0 \) in (20) captures the discounted value of the lump-sum transfers of income that leave the entrepreneur indifferent to the change in the tariff. Assuming such lump-sum transfers implies that the maximization of the welfare function in (20) identifies the set of pareto-efficient equilibria\(^{23}\).

\(^{23}\)Note that we are implicitly maximizing the welfare of workers, subject to the utility of the entrepreneur. The lump-sum transfers allow us to keep the entrepreneur indifferent,
Looking at the impact of a change in the tariff at \( \zeta_o \), in the neighborhood of \( \zeta_o = 0 \), we obtain equation (21), which sets the welfare differential as the sum of the consumer benefits, the entrepreneur's profits and the tariff revenue.

Equation (22) shows the impact of a tariff on welfare. Now, \( \partial x \triangleright (\zeta_o) = 0 \), \( \partial h(\zeta) = \partial c(\zeta) = 0 \), while from (12), \( \partial h(\zeta) = \partial y \) is positive when \( X \partial [m(\zeta_o)] > 0 \), and negative when \( X \partial [m(\zeta_o)] < 0 \). Moreover, from proposition 5, the sign of \( \partial c(\zeta) = \partial \partial \zeta_o > 0 \) is positive when \( X \partial [m(\zeta_o)] < 0 \), and negative when \( X \partial [m(\zeta_o)] > 0 \). Hence, table one summarizes the signs of the differential terms.
The impact of trade policy here is not trivial because of the domestic firm’s market power\textsuperscript{25}. Now, there are two dimensions of the social efficiency of the equilibrium: static efficiency (I), referring to the pricing/output decision, and dynamic efficiency (II), relating to investment in productivity. The presence of (a) market power and (b) the tariff create distortions that affect both dimensions of the social efficiency.

Market power implies that the levels of output and R&D are below the social optimum. The latter arises because the firm undervalues the social marginal benefit of the output arising from higher productivity, and not due to technological spillovers. Terms (aI) and (aII) denote the impact of protection on the static and dynamic inefficiencies, respectively, created by market power. As the table shows, when $X^{(0)} < 0$, an increase in the tariff increases the inefficiency imposed by market power, by reducing output and, consequently, R&D. Conversely, when $X^{(0)} > 0$, an increase in $\theta$ reduces the distortion imposed by market power, because it expands output and R&D.

Terms (bI) and (bII) measure the distortion introduced by the tariff itself. (bI) shows that due to tariffs, import levels are below the social optimum. Clearly, an increase in the tariff aggravates this static inefficiency. (bII) shows that tariffs cause R&D 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, as captured in (bII). Note that for a small tariff, $\theta_{(c)} < 1$, the terms (bI) and (bII) become negligible.

Equation (22) has implications for the conduct of trade policy.

**Proposition 7** When the firm concedes under free-trade, temporary infant-industry protection that sways the firm to survive, is welfare increasing, if

\begin{table}[h!]
\centering
\begin{tabular}{llll}
\hline
& aI & aII & bI & bII \\
$X^{(m_{(c)})} > 0$ & + & + & i & i \\
$X^{(m_{(c)})} < 0$ & i & i & i & + \\
\hline
\end{tabular}
\end{table}

\textsuperscript{25}Since the distortion arises from the wedge between the price and the unit cost caused by domestic market power, the first-best intervention is a production subsidy that expands the output of the domestic firm to its competitive level. By equating the price to the marginal cost, this would eliminate terms (aI) and (aII) in (22). A second-best intervention is to subsidize R&D directly, which would bring down $\theta$. This would solve the dynamic inefficiency by lowering the critical gap, but would leave the static inefficiency unharmed. Our case for an R&D subsidy is different from the profit-shifting argument in Brander and Spencer (1983).
the initial gap is not too high.

Proof. To see this, take the case where the initial cost-ratio, \( \hat{A}_{(0)} \), is just below \( \hat{A}_{bp} \) such that the firm decides to concede. Then, a very small tariff for a very short time will be enough to sway the firm to fight. Hence, let \( \hat{\xi}_0 = 0 \), in equation (21). Now, if all future tariffs are zero, \( \hat{\delta}_{(\xi)} = 0 \); \( \hat{\delta}_0 > 0 \), so (blI) in (22) collapses to include only the term with the current tariff. Moreover, we are looking at the impact of a small tariff, the distortionary effects are negligible, thus yielding that (blI) and (blII) disappear. Hence, we are left with (blI) and (blII) denoting the impact of the market power distortion. Since we are assuming that without protection the domestic producer concedes, it has to be the case that \( X^{m(0)} > 0 \) which, from table one implies that \( du=d\hat{\sigma}_{(0)} > 0 \). That is, the very small tariff necessary to sway the domestic monopolist to fight is welfare increasing.

Finally, although we do not attempt to establish the features of the optimal policy path, equation (22) allows us to establish the optimal policy in the long run (steady-state). We assume that the tariff has to be non-negative \( \hat{\delta}_{(\xi)} \geq 0 \).

Proposition 8 The optimal path for the protection of infant industries entails free-trade in the long-run.

Proof. The survival of the domestic firm implies that it converges to \( \hat{A}_s \), where \( X^0 < 0 \). Hence, let \( \hat{\xi}_0 \) be a period in the future, where the firm is near the steady-state. Now, if protection in other periods, \( \hat{\xi} \neq \hat{\xi}_0 \) is not very high, (blII) becomes second-order, and an increase in \( \hat{\xi}_0 \) from the free-trade benchmark reduces welfare. Thus the optimal policy for the neighborhood of the steady-state is free-trade.

In the long run tariffs serve only to aggravate the distortion imposed by market-power, because the pro-competitive effect dominates in the vicinity of the steady-state. Hence, the scope for protectionism disappears, and free-trade is the best policy, once the firm matures, even if the distortion that made the case for intervention at earlier stages, i.e. the firm’s market power, is actually stronger, as measured by its mark-up. The proposition brings us one step closer to the classical argument for the use of only temporary protection as a welfare increasing tool to promote infant-industries. Moreover, even if the domestic firm concedes and shuts down, free-trade is the best long-run policy: in this case, a tariff has only the standard distortionary effects, once
the domestic firm shuts down. Thus, despite the possibility of protection in the early stages, to promote innovation, the case for free-trade remains the paradigm for the long run, as the policy that maximizes the benefits from import-competition in improving productivity and making up for the lack of domestic competition.

5 Conclusion

This paper has looked at the impact of import-competition on domestic innovation and growth. It has attempted to integrate the conventional wisdom that international competitive pressure increases domestic productivity, with the old infant-industry argument, that domestic firms are unable to survive the competitive pressure of imports in the initial stage of their lives, even if ‘profitable’ in the long run, and should be protected.

We found that the productivity gap between a domestic firm and its foreign competitors determines whether the firm will invest to increase productivity and catch up, or concede and let imports take over the market. Infant-industries, with a large technological lag concede under free-trade, due to the short term costs of catching up.

Looking at the impact of trade policy, we have formalized the old argument that the protection of infant-industries is welfare increasing, when, early in their lives, they cannot withstand the competitive pressure from more efficient foreign producers. We have shown: (a) that a temporarily protectionist policy can sway the domestic firm to catch up, instead of conceding; (b) that this policy is welfare-increasing, if the level of protection necessary is not too high, because, due to its market power, the firm undervalues the social value of its output and, thus, has too many incentives to exit; and (c) that the optimal policy implies long-run free-trade, since after a period of maturation, protection can and should be withdrawn, without causing the firm to concede. Interestingly, although effective as a second-best policy to reduce the deadweight loss from domestic market power in an infant-industry, the scope for trade policy declines, as the domestic industry matures, even if the distortion itself increases. In fact, the innovation promoting effects of trade liberalization in mature industries provide support to the conventional wisdom that foreign competition increases efficiency, strengthening the case for free-trade.

Finally, difficulties of implementation by imperfect governments, e.g. rent-
seeking, lobbying, or lack of credibility, are frequently used as an argument against the protection of infant-industries. Addressing these, in the context of our analysis, remains a challenge for future research.

6 Appendix

Proposition 5: Let $\bar{\tau}_{(\zeta_0)}$ be the tariff set for time $\zeta_0$, $\zeta_0 > 0$. If $X q[m_{(\zeta_0)}] > 0$, a (small) increase in $\bar{\tau}_{(\zeta_0)}$ expands the equilibrium level of productivity for all upcoming periods: $\delta h_{(\zeta_0)} = \bar{\tau}_{(\zeta_0)} < 0 \Rightarrow \delta \zeta > 0$. If $X q[m_{(\zeta_0)}] < 0$, a (small) increase in $\bar{\tau}_{(\zeta_0)}$ reduces the equilibrium level of productivity for all upcoming periods: $\delta h_{(\zeta_0)} = \bar{\tau}_{(\zeta_0)} > 0 \Rightarrow \delta \zeta > 0$.

Proof. To show this, it is preferable to solve the monopolist’s problem in terms of the unit cost, i.e.

$$V_{\bar{c}_{(\zeta)}}; \bar{p}_{(\zeta)} = \max_{\bar{c}_{(\zeta+1)}} \frac{\bar{c}_{(\zeta)}}{\bar{c}_{(\zeta+1)}} \mu \bar{c}_{(\zeta)} \bar{c}_{(\zeta+1)} 1 \, \bar{c}_{(\zeta+1)} \frac{\bar{c}_{(\zeta+1)}}{1 + R} + \frac{\bar{c}_{(\zeta+1)}}{1 + R} \frac{\bar{c}_{(\zeta+1)}}{1 + R}$$

Let $p_{(\zeta)}$ and $\bar{p}_{(\zeta)}$ denote two paths for the price of the foreign good, with $p_{(\zeta)} = \bar{p}_{(\zeta)} \neq \zeta_0$, and $p_{(\zeta)} \neq \bar{p}_{(\zeta)}$; $\zeta = \zeta_0$. The last inequality arises due to the change in the tariff at $\zeta_0$. And let $c_{(\zeta)}$ and $\bar{c}_{(\zeta)}$ denote the optimal path for the domestic unit cost, under $p_{(\zeta)}$ and $\bar{p}_{(\zeta)}$, respectively. Now, let

$$X \begin{cases} \frac{\bar{c}_{(\zeta)}}{\bar{c}_{(\zeta+1)}} \mu \bar{c}_{(\zeta)} \bar{c}_{(\zeta+1)} 1 \, \bar{c}_{(\zeta+1)} \frac{\bar{c}_{(\zeta+1)}}{1 + R} + \frac{\bar{c}_{(\zeta+1)}}{1 + R} \frac{\bar{c}_{(\zeta+1)}}{1 + R} & \text{if } \zeta > \zeta_0 \neq \zeta \, \bar{X} \, \zeta > \zeta_0 \neq \zeta \end{cases}$$

Since the paths $p_{(\zeta)}$ and $\bar{p}_{(\zeta)}$ are identical, except when $\zeta = \zeta_0$, and from the definition of the optimal paths, we have:

$$X \begin{cases} \frac{\bar{c}_{(\zeta)}}{\bar{c}_{(\zeta+1)}} \mu \bar{c}_{(\zeta)} \bar{c}_{(\zeta+1)} 1 \, \bar{c}_{(\zeta+1)} \frac{\bar{c}_{(\zeta+1)}}{1 + R} + \frac{\bar{c}_{(\zeta+1)}}{1 + R} \frac{\bar{c}_{(\zeta+1)}}{1 + R} & \text{if } \zeta > \zeta_0 \neq \zeta \, \bar{X} \, \zeta > \zeta_0 \neq \zeta \end{cases}$$
and

\[
- \frac{\mu c_{h(\ell_0)}}{(1 + R)\ell_0} \frac{\partial V}{\partial c_{h(\ell_0)}} < 0
\]

Linearizing \( c_h \) around \( c_h \), using the fact that \( \frac{\partial c_{h(\ell_0)}}{\partial x_h} = 1 \), we have:

\[
X \left[ \begin{array}{c}
\frac{\partial c_{h(\ell_0)}}{\partial x_h} \frac{\partial V}{\partial c_{h(\ell_0)}}
\end{array} \right] < 0
\]

This means that if \( X \left[ \frac{\partial c_{h(\ell_0)}}{\partial x_h} \frac{\partial V}{\partial c_{h(\ell_0)}} \right] > 0 \), then \( p_{h(\ell_0)} > p_{f(\ell_0)} \), and \( c_{h(\ell_0)} < c_{h(\ell_0)} \), i.e., a tariff expands investment in R&D, and reduces the unit cost. Conversely, if \( X \left[ \frac{\partial c_{h(\ell_0)}}{\partial x_h} \frac{\partial V}{\partial c_{h(\ell_0)}} \right] < 0 \), then \( p_{h(\ell_0)} > p_{f(\ell_0)} \), and \( c_{h(\ell_0)} > c_{h(\ell_0)} \).

Finally, we conclude the proof by showing that the change in \( c_{h(\ell_0)} \) extends to the entire path for the unit cost. To see this, note that the first order condition of the monopolist’s problem can be written:

\[
\frac{\partial V}{\partial c_{h(\ell_0)}} + (1 + R)\frac{\partial V}{\partial c_{h(\ell_0)}} = 0
\]

Differentiating, and using the envelope condition, we obtain

\[
\frac{dc_{h(\ell_0)}}{dc_{h(\ell_0)}} = \frac{1 + R}{c_{h(\ell_0)}} \frac{\partial V}{\partial c_{h(\ell_0)}} + V_{cc} \frac{\partial c_{h(\ell_0)}}{\partial x_h} c_{h(\ell_0)}
\]

which is positive, given the strict concavity of the profit and the value functions. Hence, the expansion (or decline) in \( c_{h(\ell_0)} \), affects the whole path of the unit cost in the same direction. ■
References


