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4

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ABSTRACT

I develop a model of trade in final goods and inputs that differ in hi-tech intensity between a developing country –the South– and a developed country –the North–. I show that trade protection is welfare-improving for the South within a setting of incomplete contracts. I employ two standard strands of competing arguments: protection will foster industrial linkages between input producers and distort domestic prices in favor of comparative disadvantage industries. The industrial linkages will increase producers' surplus by shifting profits, but the distortions will reduce consumers' surplus by increasing domestic prices. The former effect will be stronger than the latter effect in industries where the comparative disadvantage of the South is sufficiently low. The range of protected industries and the tech-intensity of the average protected industry will decrease with the overall South's comparative disadvantage.

Keywords: profit-shifting, incomplete contracts, trade protection

JEL Classification: F13-F19

1. INTRODUCTION

The question of whether government intervention in product markets can improve welfare is a centuries-old topic. Two strands of competing arguments have argued in opposite directions. A strand of arguments accentuates that intervention distorts domestic prices in favor of comparative disadvantage industries and worsens welfare (see The World Bank's report, 1993). A different strand stresses that intervention fosters industrial linkages between input producers and improves welfare (see Pack and Westphal, 1986; Okuno-Fujiwara, 1988; and Rodrik, 1996).

I develop a model of trade in final goods and inputs between a developing country –the South– and a developed country –the North– in order to study the welfare consequences of a particular form of government intervention. I show that trade protection is welfare-improving for the South within a setting of incomplete contracts by employing features from the two strands of competing arguments. Trade protection will have a welfare-worsening effect by increasing domestic prices of final goods for which the South has a comparative disadvantage. On the other hand, protection will have a welfare-improving effect by fostering industrial linkages between inputs producers. The welfare-improving effect will be stronger than the welfare-worsening effect in industries where the South's comparative disadvantage in the production of the final good is sufficiently small.

The degree of the South's comparative disadvantage in a given final good will depend on the relative-input intensity in the production of the good. Production of each final good will involve a high-tech input and a low-tech input in the manner of Antras (2005). The production costs of the high-tech input will be smaller in the North, so that the South's comparative disadvantage will be greater for goods using the high-tech input intensively. Protecting the industries of these final goods will not be welfare-improving for the government from the South since it will cause a sufficiently large increase of the domestic price.

An industrial linkage will arise between the two producers involved in the production of inputs for a given final good. The producer of the low-tech input will be assumed to be from the South, but the producer of the high-tech input may be from the South or the North. Each type of producer will make profits that will depend on the investment-level of the remaining producer-type: investment-levels will determine the quality and quantity of the final good, and the sales of the final good will in turn determine profits; the industrial linkage will then arise from the interdependence of the investments decisions. The linkage is fostered as the two inputs producers are from the South so that the profits of Southern producers in a given industry are maximized. I show that it is welfare-improving for the government from the South to promote local production of the high-tech in order to foster the linkage. To this end the government will use trade protection to change the free-trade equilibrium outcome arising from the strategic interaction of firms.

The interaction of firms is summarized in two stages, the first stage being the entry stage. At the entry stage a firm from the North and a firm from the South will decide on entering the market and producing the high-tech input. Following Antras the producer of the high-tech input (the successful entrant) will be thought of as outsourcing the low-tech

input and supplying the final good.[1] The potential entrant from the North will threaten the potential entrant from the South with entering and initiating a price-war. Since production costs of the high-tech input will be smaller in the North, the producer from this country can always set a lower price for the final good. Thus, the threat will be credible and the producer from the South will never enter the market and produce the high-tech input under free-trade. However, the government may turn the threat into a non-credible threat by protecting the domestic market and increasing the price of the final good potentially supplied by the producer from the North. By turning the threat into a non-credible threat the government will induce entry by the producer from the South and alter the free-trade equilibrium outcome. This will foster the industrial linkage between inputs producers and maximize the profits of Southern producers in the protected industry.

The increase in Southern profits occurs at the expense of Northern profits since protection deters market entry by a potential producer from the North. In other words, the Southern government shifts Northern profits to the South by fostering the industrial linkage. The profits-shifting will increase the producer's surplus in the protected industry and have a welfare-improving effect. On the other hand, protection will increase the domestic price of the final good thereby reducing the consumer's surplus and having a welfare-worsening effect. In industries where the comparative disadvantage of the South is low the price increase will be small, and therefore the welfare-worsening effect will be mild. More precisely, the welfare-worsening effect will be milder than the welfare-improving effect, so that trade protection will increase welfare in sufficiently low comparative disadvantage industries.

One contribution of the paper is to harmonize the two strands of competing arguments from the 1980's, when it became evident that the industrial policy of several East Asian countries had been successful. Our model harmonizes the two strands because it shows that protection distorts domestic price in comparative disadvantage industries and fosters linkages between inputs producers. Like the strand arguing in favor of intervention our model shows that protection induces local investment in the South. A difference between this strand and our model is that local investments increase welfare through profits-shifting in our model and not through the solution of an investments coordination failure.[2]

The paper makes a contribution by providing a rationale for trade protection based on profits-shifting, and then relates closely to the literature initiated by Brander and Spencer (1985). They show that trade protection before the market interaction stage provides domestic oligopolies with strategic advantages. Having strategic advantages, domestic firms make higher profits at the expense of foreign firms in the market interaction stage.[3] Our mechanism differs from theirs in that protection does not shift foreign profits because it increases the profits of a fixed number of domestic firms. In our model protection increases Southern profits by inducing market entry of profitable domestic firms. In this

[1] In the framework of this model we could also think of there being a competitive fringe of final good supplier buying inputs from the inputs producers.

[2] This streams shows that investments coordination failures may arise in presence of scale economies and imperfectly tradable inputs: the absence of local production for the imperfectly tradable input makes local production of other inputs not profitable for private agents. However, investments and local production of these inputs may increase social welfare. In this regard, Rodrik (1995) argues that specialized labor services tend to be non-tradable. Along the same lines, Rauch (2000) argues that differentiated products have higher trade costs, supporting the existence of industrial linkages

[3] See Mzrazvova (2010) and Ossa (2011a) for more recent contributions to this literature.

regard, our mechanism relates closely to the profits-shifting channel described in Tobal (2012).[4]

The model relates to the stream of literature showing that incomplete contracting generates sub-optimal investment-levels (see for example that Williamson (1985) and Grossman and Hart (1986)). The model takes some features from Antras (2005) but does not study firms' choice of organizational form. Thus, I study a single form of organization: I do not let the high-tech input producers be vertically integrated like Antras, but instead force these producers to produce the low-tech input in an independent plant.[5] Our focus of study is how trade protection creates industrial linkages between inputs producers in the South, and therefore I constrain the low-tech producers to be from the South but allow the high-tech input producers to be from either country. Antras, on the other hand, allows the former producers to be from either country but constrain the latter producers to be from the North. As a result of our assumptions on firms' nationalities every contract signed by inputs producers will involve a party from the South. Following the evidence provided by Levchenko (2007) that I cite in the next paragraph I will assume that all contracts in this model are incomplete.

Levchenko (2007) shows that developing countries (the South in our model) have a comparative disadvantage in contract-intensive industries that arises from the poor quality of their institutions. Our model differs from the theoretical provided in Levchenko because I consider a source of comparative disadvantage other than institutions: production costs of the high-tech input are greater in the South because I introduce technological differences *à la Ricardo* in the production of this input.

I develop the model in the remainder of this paper. In section 2 I display the model setup, and show that the North specializes in all the contract-intensive goods under free-trade. In section 3 I show that trade protection is welfare-improving for the South, and that both the range of protected industries and its average tech-intensity depends on the comparative disadvantage degree.

2. MODEL SETUP AND FREE-TRADE EQUILIBRIUM

I introduce a model of trade between the developed and the developing country. Goods are produced in contract-intensive industries, and production involves the two types of inputs and producers from Antras. The North is shown to produce hi-tech inputs in every industry. This result is in line with Levchenko where only the North specializes in contract-intensive goods under free-trade.

2.1 Model Setup

I consider a world with two countries, the North and the South, and indicate the variables concerning the former with a superscript n, and the variables concerning the latter with a

[4] Note that if we considered the case of vertically integrated firms, mentioned firms would be expand their business in a profitable manner instead of entering the market.

[5] We could consider vertically integrated firms that manufacture in the South instead of firms that contract independent manufacturers, and all results of the paper would still hold. This would represent better the South Korean situation but worse the Taiwanese case as understood from footnote 1.

superscript s. The wage w is assumed to be greater in the North, and then the North-to-South wage ratio is written as $\omega = w^n/w^s > 1$.

There is a continuum of contract-intensive goods y_z of a length normalized to 1, which should be thought of as the institutionally intensive good from Levchenko. I focus on Southern consumers as I will study trade protection of the Southern market. These consumers' demand for a good y_z is written as follows

$$y_z = \lambda p_z{}^{-1/(1-\alpha)}, \qquad 1 < \alpha < 0, \qquad 0 \leq z \leq 1, \tag{1}$$

where p_z is the good's price, and producers take the parameter λ as given.

Production of good y_z involves the two types of inputs and producers from Antras: a research center produces the hi-tech input x_h, and a manufacturing plant produces the low-tech input x_l. The research center must contract an independent plant for the provision of the low-tech input. Incomplete contracts apply in the South, the country with the poorest quality of institutions: if either the research center or the manufacturer is from the South (or both), the parties cannot contract on the quality or the quantity of the inputs.

Inputs can be of a good or bad quality. If any input is of a bad quality, output equals zero. If both inputs are of a good quality, output is written as follows

$$y_z = \mu_z x_h^{1-z} x_l^z, \qquad \mu_z = z^{-z}(1-z)^{-(1-z)}. \tag{2}$$

Final goods differ in tech-intensity: high values of z denote low intensity.

Any input of a bad-quality can be produced at zero costs. Production of the hi-tech input may occur in the North or the South; research centers may be from either country. However, production costs differ across countries as stated in the following.

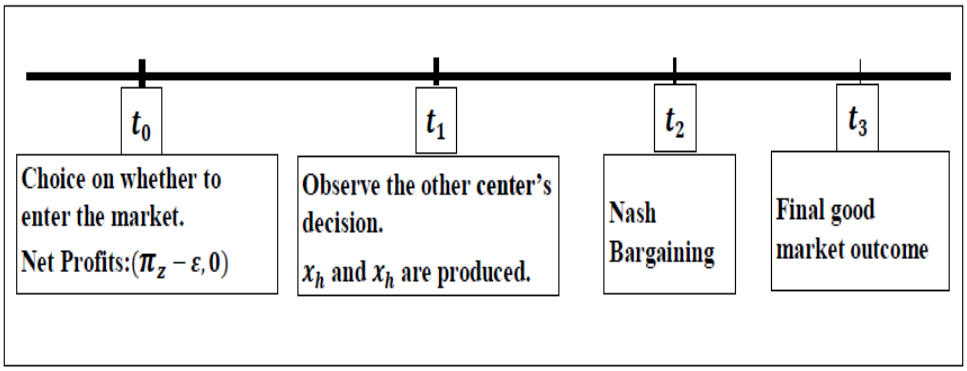
Assumption. *One unit of a good-quality hi-tech input requires one unit of labor in the North, and a^s units in the South. The parameter a^s is assumed to exceed the North-to-South wage so that the South has a comparative disadvantage in the production of the hi-tech input. More formally, I assume: $a^s > \omega > 1$.*

On the other hand production of the low-tech input is assumed to occur only in the South; manufacturers are only from this country. Specifically, one unit of a good-quality low-tech input requires one unit of Southern labor. As all manufacturers are from the South every contract is signed by at least one Southern party. Hence, all contracts considered in the paper will be incomplete.

A research center from each country decides whether to enter the market and contract a Southern manufacturer; the research centers from both countries decide simultaneously. A market entrant faces a small cost ε, reflecting the monetary and non-monetary costs of matching with a plant and signing a contract. Contract incompleteness implies that the parties do not specify the quality or quantity of inputs. Contracts only specify the lump-sum transfer T that the research center receives from the plant; the transfer makes the manufacturer break even like in Antras so that the research center keeps all industry-profits π_z. Anticipating this, the research center will contract the manufacturer and enter the market if and only if profits cover the contracting costs associated with entry -$\pi_z > \varepsilon$.

Once the research center enters the market, it observes the decision made by the other center. Then the center and the manufacturer have an interaction *à la Antras:* the parties make relationship-specific investments, and bargain *à la Nash* ex-post over the quasi-rents. Like Antras I consider the symmetric solution so that each party is left with half of the quasi-rents. In this paper the key is that quasi-rents depend on the sales of the final product, and therefore investments are zero when no rents are expected. Figure 1 summarizes the timing of events.

Figure 1
Timing of the Events



Notes: There are two research centers that could potentially enter the market.

2.2 Free Trade Equilibrium

The game played by the two research centers and the Southern manufacturing plants is solved by backward induction. The quasi-rents of each relationship depend on the final good market outcome which in turn depends on the market structure. There are four possible market structures: there may be two duos of inputs producers, a single duo formed by a research center from the North, a duo from the South, or no firms in the market. I study the four cases next.

Consider the two market structures in which one of the duos acts as a monopolist. Consumers buy the product at the price set by the monopolist so that the quasi-rents generated by the duo equal its market revenues. The parties anticipate this, and maximize the ex-post profits they are left with when making investment decisions. In the appendix section I show that profits-maximization yields the following price for a duo formed by a research center from the North and for a duo from the South respectively

$$p_z^n = \frac{2(w^n)^{1-z}(w^s)^z}{\alpha}, \tag{3}$$

$$p_z^n = \frac{2w^s(a^s)^{1-z}}{\alpha} \tag{4}$$

where p_z^n is the price of the monopolist duo formed by the research center from the North. The presence of α in (3) and (4) shows that monopolistic prices are higher than marginal costs in the two cases, which is the prediction of any standard monopoly-model. High prices are also due to incomplete contracts that overinflate prices in this model; this effect is present in Antras and represented by the number 2. A novel result is that incomplete contracts have no impact on market prices in a duopoly, as shown below in this paper.

Rolling back in time, Southern manufacturers anticipate that the final good will sell at the price in (3) for the case of a center from the North, and at the price in (4) for the case of a Southern center. Specifically manufacturers anticipate that the quasi-rents of a monopolistic relationship are positive, and thus the transfer T is greater than zero. Furthermore the profits made by the research centers are greater than zero. In the appendix section I show that when the transfers make the manufacturers breakeven profits are given by the following expressions

$$\pi_z^n = \lambda\left(1-\frac{\alpha}{2}\right)(p_z^n)^{\frac{-\alpha}{1-\alpha}}, \qquad (5)$$

$$\pi_z^s = \lambda\left(1-\frac{\alpha}{2}\right)(p_z^s)^{\frac{-\alpha}{1-\alpha}}, \qquad (6)$$

where π_z^n is the profits made by the monopolist duo formed by the Northern center. Profits are greater than contracting costs in both cases so that a research center enters the market when that leads to a monopolistic situation. In other words, a research center enters the market when the research center from the other country does not. Hence a structure with no firms in the market does not occur in the equilibrium path, and the two monopolistic structures are candidates for equilibrium outcomes.

Consider the remaining structure, a duopoly with the two duos of producers simultaneously in the market. Each duo knows that its sales are zero unless its price is the lowest, and therefore the duos get involved into a "price-war." The duo that wins the war is the duo with the lowest marginal cost; specifically, this duo accomplishes input investments so that its price equals the other duo's marginal cost. Marginal costs in industry z are as follows

$$MC_z^n = (w^n)^{1-z}(w^s)^z, \qquad MC_z^s = w^s(a^s)^{1-z}, \qquad (7)$$

where MC_z^n is the marginal cost of the duo formed by the Northern center. This duo has the lowest cost in every industry as the North has a comparative advantage in the hi-tech input $a^s > \omega > 1$. Therefore, the duo formed by the research center from the North wins the price-war by setting a market price equal to $MC_z^s - \hat{\varepsilon}$, where $\hat{\varepsilon}$ shows that he duo formed by the research center from the North "cuts the price" of the other duo. In this scenario, the North obtains positive rents and it earns the profits associated with the market price it sets.

The duo formed by the research center from the South loses the war and obtains zero rents. As both parties anticipate zero rents no party accomplishes input investments, and the final good is never produced. Rolling back in time the manufacturer anticipates this so that the transfer is negative; and then net profits associated with entry are lower than zero -

$\pi_z^s - \varepsilon < 0$. Thus, the research center from the South does not enter the market as the Northern research center does. Hence, a duopoly does not occur in the equilibrium path, and the two monopolistic structures are the only possible equilibrium outcomes.

Turning back to the price-war, the quasi-rents of the duo formed by the research from the North are positive, and thus so is the transfer and the net profits $\pi_z^n - \varepsilon > 0$. Therefore, a research center from the North enters the market even when the Southern the center does. Hence, the only monopolist duo that enters in the equilibrium path is formed by a research center from the North, and this duo charges the price shown in (5). This characterizes the equilibrium path under free-trade.

The free-trade equilibrium is consistent with Levchenko where only the North produces the contract-intensive goods due to poor institutions-quality in the South. Instead of focusing on final products I have focused on intermediate goods. Introducing poor institution-quality in the South and a second dimension of comparative advantage, I have shown that only the North produces hi-tech inputs used for producing contract-intensive goods. These are the only inputs whose local production increases a country's rents, and the only inputs that can be produced by either country in this model.

3. TARIFFS

This section shows that it is welfare-improving for the Southern government to change the equilibrium outcome by setting tariffs. No research center from the South enters the market so that a tariff causing entry has profit-shifting effects relative to free-trade. Profits-shifting is shown to be stronger than the welfare costs on consumers for sufficiently low comparative disadvantage industries. Developing countries whose comparative disadvantage in every industry is lower are shown to protect a wider range of industries.

3.1 Profits-shifting Tariffs

The Southern government sets tariffs before the entry-stage. That is, I add to the timing shown in Figure 1 a first stage where the government protects the market. Among all options, I first study profits-shifting tariffs. To shift profits a tariff must cause entry of a research center from the South as research centers keep all industry-profits. The research center enters the market if it wins the price-war triggered by the virtual entry of the two centers. The following equation determines the ad-valorem tariff causing entry into industry z

$$\tau_z > MC_z^s / MC_z^n = (a^s/\omega)^{1-z}\,, \qquad (8)$$

where τ_z denotes the market-entry tariff. Under tariffs greater than the North-to-South marginal cost, no price allows the Northern center to win the price-war making profits. The North-to-South marginal cost increases monotonically with the tech-intensity of the protected industry. Hence, entry into industries with a larger comparative disadvantage requires stronger trade protection.

Under the tariff the research center from the South wins the war. This research center enters the market independent of the Northern center's action, but the Northern center

enters only as the former center does not. Hence, the Southern center is the only market entrant in the equilibrium path under the tariff.

The Southern center and manufacturer produce inputs so as to maximize the profits they are left with, and thus the price under the tariff is that shown in (4).This price is greater than the price under free trade –shown in (5)– so that protection causes welfare losses for Southern consumers. The welfare loss caused by the tariff in industry z is the difference between the following expressions

$$C_z^{FT} = \int_{p_z^n}^{\infty} \lambda {p_z}^{-1/(1-\alpha)}\, dp_z = \lambda \left(\frac{1-\alpha}{\alpha}\right) (p_z^n)^{\frac{-\alpha}{1-\alpha}}, \qquad (9)$$

$$C_z^{TP} = \int_{p_z^s}^{\infty} \lambda {p_z}^{-1/(1-\alpha)}\, dp_z = \lambda \left(\frac{1-\alpha}{\alpha}\right) (p_z^s)^{\frac{-\alpha}{1-\alpha}}, \qquad (10)$$

where C_z^{FT} and C_z^{TP} are consumer surplus under free-trade and trade protection. Relative to the free trade, the welfare loss is greater in industries where the comparative disadvantage is larger as entry requires into these industries requires stronger protection. Although protection reduces consumer surplus, a profits-shifting tariff fosters a linkage between a research center and a manufacturer relative to free-trade. The profits-shifting generated by the linkage increases producer surplus in the South by an amount that equals the profits made by the research center. Hence, the increase in producer surplus caused by the tariff is shown in (6) for industry z.

If the increase in producer surplus is stronger than the fall in consumer surplus, protection increases welfare. The following Lemma summarizes the result.

Lemma 1. *There is a cutoff industry $\bar{z}^{TP}$ that determines the industry-set for which the welfare effects of profits-shifting are greater than the costs imposed on domestic consumers. Hence, trade protection is welfare-improving for any industry z such that $z \in (\bar{z}^{TP}, 1)$.*

Lemma 1 proposes a rationale for trade protection based on profits-shifting relative to free-trade. This rationale is consistent with Levchenko where free-trade eliminates jobs that create rents in the institutionally intensive sector.

The tariff shown in (8) is preferred over free-trade as profits-shifting more than offsets the effects of the domestic price increase. However, other ad-valorem tariffs may be preferred over the profits-shifting tariff shown in (8). The following Lemma states that no tariff dominates a profits-shifting tariff in terms of welfare.

Lemma 2. *Free-trade and profits-shifting tariffs are welfare–improving relative to tariffs that do not cause market entry by Southern centers; that is, relative to any tariff τ_z such that $\tau_z \leq MC_z^s/MC_z^n$ in industry z. Hence, profits-shifting tariffs are optimal for the set of industries z such that $z \in (\bar{z}^{TP}, 1)$.*

Tariffs not causing market entry only affect welfare through their impact on final goods prices and quantities. Under these tariffs the research center from the North and the Southern manufacturer anticipate a lower demand, and therefore lower quasi-rents for each input production level. As a result, the parties reduce their input investments relative

to free-trade and produce a lower quantity at a higher effective importing price. In the appendix section I prove this result.

Lemma 2 reinforces profits-shifting as a rationale for trade protection: only tariffs that shift rents are preferred over free-trade. The Lemma states that the South is better-off producing goods within the set $(\bar{z}^{TP}, 1)$, for which it does not have a comparative advantage. This result argues against The World Bank's ideas and the comparative advantage argument. However, there is a role for comparative advantage in the model as welfare changes caused by protection decreases monotonically with tech-intensity. In other words, welfare gains are lower –and negative- for industries with a large comparative disadvantage. Hence, the South only protects industries with a sufficiently low comparative disadvantage.

3.2 Countries with Different Overall Comparative Disadvantage

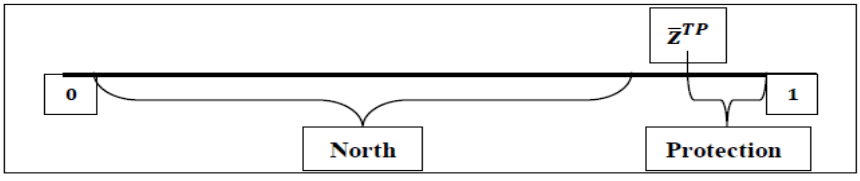
I analyze the link between a developing country's comparative advantage profile and trade protection. The analysis is motivated by two observations. First, that the sectoral configuration of the East Asian economies (Japan, South and Taiwan) shifted to mid-tech industries, but the configurations of other protectionist countries from Latin-America did not. Second, it is motivated by the connection between a country's profile and its success in fostering linkages that was noted by Rodrik. He claims that intervention successfully fostered linkages in East Asia as South Korea and Taiwan had a lower comparative disadvantage in the types of goods produced by rich nations.

To distinguish between countries with a different comparative advantage profile, I run a comparative statics exercise on the term a^s/ω. This term measures comparative disadvantage in the hi-tech input and in the types of goods produced by rich nations. Comparative statics yields the following graphs

Figure 2 depicts the set of protected industries for a developing country with a lower comparative disadvantage in the types of goods produced by rich nations such as South Korea and Taiwan. Figure 3 the analogue for other developing countries such as Argentina or Brazil. Note two main differences between the figures: the protected industries-set and the tech-intensity of the average protected industry are greater for the East Asian case.

Figure 2

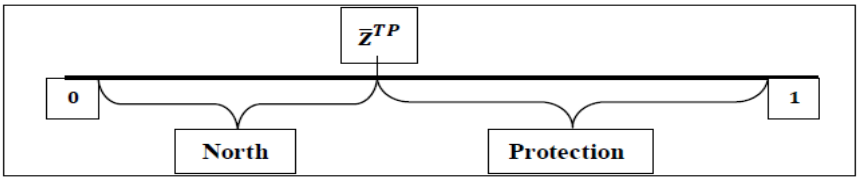
Schedule of Protected Industries for Low Overall Comparative Disadvantage



Notes: As the overall comparative disadvantage of the South is low, this country protects a wider range of industries with a higher average tech-intensity.

Figure 3

Schedule of Protected Industries for High Overall Comparative Disadvantage



Notes: As the overall comparative disadvantage of the South is High, this country protects a smaller range of industries with a lower average tech-intensity.

More formally, I write

Lemma 3. *A country with a lower comparative disadvantage in contract intensive goods protects a wider industry-range with a greater average tech-intensity. I have that* $\frac{d\bar{z}^{TP}}{d(a^S/\omega)} > 0$.

As the value for a^S/ω is smaller the South produces the hi-tech input at lower costs. Lower costs reduce the tariff at which a Southern center enters the market, and therefore the domestic price increase in every industry. Lower costs also increase the profits made by a Southern entrant in every industry. Protection becomes more welfare-improving in every industry so that the indifferent industry shifts to the left as understood from the figures. Thus, a lower a^S/ω value increases the protected-industry set and the tech intensity of its average industry.

Lemma 3 implies that trade protection should be more effective at shifting industrial configurations to mid-tech industries in countries with a lower a^S/ω such as South Korea or Taiwan. These countries should also be successful at fostering linkages in more industries as noted by Rodrik. Interestingly, another implication is that the lower the degree of comparative disadvantage, the more a country is willing to distort its free-market pattern of trade.

4. CONCLUDING REMARKS

The governments of Japan, Korea and Taiwan applied industry-selective interventions to create purposefully profits above free-market levels. These profits played an important role in the rapid economic growth, as they were a necessary condition for the abnormally high savings and investment rates observed in North-East Asia (Akyuz, 1996; Rodrik, 1995).

As firms make profits, profits-shifting is a motivation for setting tariffs as suggested by the evidence provided by Ossa (2011 b). This paper shows that profits-shifting is relevant as it justifies the use of trade protection to foster linkages. This occurs as profits-shifting is stronger than the price-distortions effects predicted by The World Bank and the comparative argument.

Countries with a lower comparative disadvantage, where price distortions created by profits-shifting tariffs are lower, have more incentives to protect the domestic market.

These countries protect a wider range of industries with a higher tech-intensity average. This result is consistent with Rodriks' perception on the North-East Asian economies, and with the fact that other developing and protectionist did not succeed at fostering linkages successfully.

5. APPENDICES

Monopolistic prices

This appendix proves that prices in monopolistic situation are given by (4) and (5), and (6) and (7) respectively.

Consider a monopolist duo from the South in industry z. Employing (2) I obtain market revenues as a function of the market prices, which are written as follows

$$y_z p_z = \lambda (p_z)^{\frac{-\alpha}{1-\alpha}},$$

I will use this expression at the end of the proof. For now let's write revenues in terms of input.

$$y_z p_z = \lambda^{1-\alpha} \mu_z x_h^{\alpha(1-z)} x_l^{\alpha(z)}.$$

In the Nash bargaining symmetric solution parties keep half of the ex-post quasi-rents. Anticipating this and given the expression for market revenues provided above, the research center and the manufacturing plant solve the following maximization problems respectively

$$Max_{x_h}: \frac{\lambda^{1-\alpha} \mu_z^{\alpha} x_h^{\alpha(1-z)} x_l^{\alpha(z)}}{2} - w^s a^s x_h,$$

$$Max_{x_l}: \frac{\lambda^{1-\alpha} \mu_z^{\alpha} x_h^{\alpha(1-z)} x_l^{\alpha(z)}}{2} - w^s x_l.$$

Combining the first order conditions yield by each problem I get

$$x_l = \left[\frac{z}{1-z}\right] a^s x_h.$$

Plugging this into the first order conditions I obtain input usage in equilibrium:

$$x_l = \frac{\lambda z}{(a^s)^{\frac{\alpha(1-z)}{1-\alpha}} (2w^s/\alpha)^{\frac{1}{1-\alpha}}},$$

$$x_h = \frac{\lambda(1-z)}{(a^s)^{\frac{1-\alpha z}{1-\alpha}}(2w^s/\alpha)^{\frac{1}{1-\alpha}}}.$$

I then plug the first two in equation (2) to obtain equilibrium output:

$$y_z = \frac{\lambda}{((a^s)^{1-z}2w^s/\alpha)^{\frac{1}{1-\alpha}}}.$$

Replacing this output value in (78) I obtain

$$p_z^s = \frac{2w^s(a^s)^{1-z}}{\alpha},$$

which is the price shown in equation (5). Let's use this expression along with input usage in equilibrium to obtain total costs

$$w^s x_l + w^s a^s x_h = \lambda \frac{\alpha}{2}(p_z^s)^{\frac{-\alpha}{1-\alpha}}.$$

Given these costs and the revenues expression I obtained above, profits are

$$\pi_z^s = \lambda\left(1-\frac{\alpha}{2}\right)(p_z^s)^{\frac{-\alpha}{1-\alpha}},$$

as shown in (7).

For a monopolist duo formed by a center from the North, the expression for revenues is the same. The maximization program is written as follows

$$Max_{x_h}: \frac{\lambda^{1-\alpha}\mu_z^\alpha x_h^{\alpha(1-z)}x_l^{\alpha(z)}}{2} - w^n x_h$$

$$Max_{x_l}: \frac{\lambda^{1-\alpha}\mu_z^\alpha x_h^{\alpha(1-z)}x_l^{\alpha(z)}}{2} - w^s x_l.$$

Combining first order conditions I get

$$x_l = \left[\frac{zw^n}{(1-z)w^s}\right]x_h$$

Plugging this into the first order conditions I obtain input usage in equilibrium

$$x_l = \frac{\lambda z}{(w^s)^{\frac{1-\alpha(1-z)}{1-\alpha}}(w^n)^{\frac{\alpha(1-z)}{1-\alpha}}(2/\alpha)^{\frac{1}{1-\alpha}}},$$

$$x_h = \frac{\lambda(1-z)}{(w^s)^{\frac{\alpha z}{1-\alpha}}(w^n)^{\frac{1-\alpha z}{1-\alpha}}(2/\alpha)^{\frac{1}{1-\alpha}}}.$$

I then plug the first two in equation (3) to obtain equilibrium output

$$y_z = \frac{\lambda}{(2(w^n)^{1-z}(w^s)^z/\alpha)^{\frac{1}{1-\alpha}}}$$

Replacing this output value in (1) I obtain

$$p_z^n = 2(w^n)^{1-z}(w^s)^z/\alpha,$$

which is the price shown in equation (4). Let's use this expression along with input usage in equilibrium to obtain total costs:

$$w^s x_l + w^n x_h = \lambda \frac{\alpha}{2}(p_z^n)^{\frac{-\alpha}{1-\alpha}}.$$

Given these costs and the revenues expression I obtained above, profits are

$$\pi_z^n = \lambda\left(1 - \frac{\alpha}{2}\right)(p_z^n)^{\frac{-\alpha}{1-\alpha}},$$

as shown in (6).
Q.E.D.

Welfare Enahancing Trade Protection

This appendix proves Lemmas 1 and 3.

A profits-shifting tariff is welfare-improving if and only if the producer surplus increase caused by the entry of the research center from the South more than compensates for consumer surplus decrease. Hence, trade protection is welfare-improving in industry z if the following condition holds

$$\pi_z^S \geq C_z^{FT} - C_z^{TP}.$$

Employing equations (6), (9) and (10) to replace for each term, I get

$$\lambda\left(\frac{1-\alpha^2/2}{\alpha}\right)(p_z^S)^{\frac{-\alpha}{1-\alpha}} > \lambda\left(\frac{1-\alpha}{\alpha}\right)(p_z^n)^{\frac{-\alpha}{1-\alpha}},$$

or

$$\frac{p_z^S}{p_z^n} < \left(\frac{1-\alpha^2/2}{1-\alpha}\right)^{\frac{1-\alpha}{\alpha}}.$$

Replacing the price-ratio for the definitions given in (3) and (4) yields

$$z > 1 - \left(\frac{1-\alpha}{\alpha}\right)\frac{Log\left(\frac{1-\alpha^2/2}{1-\alpha}\right)}{Log(a^S/\omega)}.$$

Therefore, I have

$$\bar{z}^{TP} = 1 - \left(\frac{1-\alpha}{\alpha}\right)\frac{Log\left(\frac{1-\alpha^2/2}{1-\alpha}\right)}{Log(a^S/\omega)} < 1.$$

where the last inequality comes from the assumption that $a^S > \omega > 1$.

This proves Lemma 1.

The derivative of the expression given above for $\bar{z}^{TP}$ with respect to a^S/ω is positive. This proves Lemma 3.

Q.E.D.

Non Rent-shifting Tariffs

This appendix proves Lemma 2.

A tariff not causing entry of a research center from the South only changes the demand and then the quasi-rents of the monopolist duo formed by a research center from the North. As the effective importing price for Southern consumers equals $\tau_z p_z$, the monopolist faces the following demand

$$y_z = \lambda(\tau_z p_z)^{-1/(1-\alpha)}.$$

The quasi-rents of the relationship equal total revenues, which in turn can be written as follows using equation (3)

$$y_z p_z = \lambda^{1-\alpha} \mu_z x_h^{\alpha(1-z)} x_l^{\alpha(z)} {\tau_z}^{-1}.$$

Following the same steps as in a previous appendix I get

$$x_l = \frac{\lambda z}{(w^s)^{\frac{1-\alpha(1-z)}{1-\alpha}} (w^n)^{\frac{\alpha(1-z)}{1-\alpha}} (\tau_z 2/\alpha)^{\frac{1}{1-\alpha}}},$$

$$x_h = \frac{\lambda(1-z)}{(w^s)^{\frac{\alpha z}{1-\alpha}} (w^n)^{\frac{1-\alpha z}{1-\alpha}} (\tau_z 2/\alpha)^{\frac{1}{1-\alpha}}}.$$

I then plug the first two in equation (2) to obtain equilibrium output

$$y_z = \frac{\lambda}{(\tau_z 2 (w^n)^{1-z} (w^s)^z / \alpha)^{\frac{1}{1-\alpha}}}.$$

Replacing this output value in (1) we obtain

$$p_z^n = 2(w^n)^{1-z} (w^s)^z / \alpha,$$

which is the price shown in equation (4).

The price perceived by the research center from the North does not change; however the price paid by consumers equals $\tau_z p_z^n$, and therefore increases.

As the quantity exchanged is lower and we still are on the inverse demand curve we know that the tariff revenue does not compensate, and therefore welfare falls price paid by consumer is greater.

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