A Comprehensive Empirical Analysis of Trade Policy with Monopolistic Competition in a Small Country *

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Abstract

A comparative advantages model with monopolistic competition is proposed to perform a comprehensive analysis of the effects of protectionism on competition, economies of scale and resource allocation. Evidence is based on Brazil's period of import substitution industrialization. The foreign economy is a set of (aggregated) developed countries, which both improves the statistical accuracy of measured comparative advantages and increases access to data for computation of fixed costs. Only the period under protection is considered, so that the comparative statics, aimed to identify the above policy effects, are drawn on within-period counterfactuals.

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1 Introduction

We attempt a comprehensive industry-level analysis of trade-policy effects under imperfect competition, building on the efficiency basis of comparative advantages (Deardorff, 1980). Evidence is based on Brazil's import-substitution industrialization (ISI) from the late 1960s to the late 1980s, which offers a rich experience for examining this policy issue.

To assure a robust index of Brazil's revealed comparative advantages (RCA), we define the foreign economy as an aggregate of developed countries, which further helps to reduce biases from characteristics (e.g., trade costs) we cannot not control for. In fact, the geographic basis of trade (Eaton and Kortum, 2002) in this three-country (adding the rest of the world) model makes ample room to define and compute comparative advantages.

In theory, imperfect competition and trade-policy barriers can weaken and even invert comparative-advantage linkages, as given by the negative N-industry correlation between net exports (or *RCA*) and countries' characteristics (Deardorff, 1979, 1980). Yet, to avoid misleading statistical inferences, we both use the aggregate foreign economy and expand the period to the entire ISI era. This long time span also enables us to refrain from disputable statistics experiments with the ensuing trade-openness period, which was largely affected by simultaneous non-trade related reforms in Brazil, making the isolation of trade policy difficult.[1] Our comparative-static exercises are, instead, based on within-sample counterfactuals that also allow simultaneously to address some related development issues over that ISI period.

At the same time, using the pre-1980 years greatly reduced the availability of internationally comparable data. The number of total employees, for instance, is the only direct marginal-cost information available for the seven included countries. This prompted us to develop a latent opportunity-cost variable, based on the impact of unobserved differences in factor proportions. Additionally, given that Brazil's wide-ranging protectionism cannot be adequately characterized by either nominal tariffs or the effective rate of protection (ERP), we attempt a counterfactual based on a more accurate (than RCA) trade-performance measure: the revealed comparative efficiency in manufacturing (RCEM), which provides more conclusive evidence about the trade-policy effect on allocative efficiency.

Underlying the RCA index is the possibility of exporting from sectors without comparative advantages, which we draw from monopolistic competition (i.e., intra-industry trade) model and that additionally introduces a non-price competition argument through product-differentiation. The latter is empirically captured by an industry-level variable proxying changes in world preferences.

Moreover, spatial monopolistic competition (Lancaster, 1984; Schmitt, 1990) also enables, from its non-constant markup pricing, both the scale (productive efficiency) and the pro-competitive effects, which are, respectively, the firm-size and the industry-size effects from protection (Feenstra,

[1] A standard problem in developing countries' reform, as stated by Trefler (2001) and witnessed in Tyler and Gurgel (2008).

1995). In the Chamberlinian monopolistic competition theory (Melitz, 2003), the productive effect stems instead from selection of heterogeneous firms in productivity, as empirically supported by previous studies (Tybout et al, 1991; Tybout, 1993; Head and Ries, 1999), rather than from elimination of homogenous plant.

Unlike these quoted partial-equilibrium empirical analyses based on production function, ours is built upon the transformation function – from its dual (*i.e.*, costs) – that focuses in inter-industry trade as well, similarly to the Chamberlinian analysis by Bernard et al (2007). Having comparative-cost advantages as control for assessing non-observed fixed cost outweighs, to some extent, the inferior technological accuracy of an industry-level analysis.

We consider both corporate and plant fixed costs, proxying the former by a variable expressing each industry's activity in terms of skilled-labor intensity, and the latter by a composite variable of the operative workers input and the average firm size, aimed to express both the activity and firm's scale. The aggregate foreign economy, together with our assumption about these costs, are crucial for assessing these fixed costs, since relevant data are not available for all developed countries.

A derived variable of market structure (the effective rate of protection) proxies the pro-competitive effect, an association that is reinforced by further statistics experiments.

Three policy effects are examined: on allocative efficiency (opportunity cost), on productive efficiency (average cost), and the pro-competitive effect (pricing).[2] The non-price competition term has no definite relationship with policy, as detailed below. It is worth stressing an empirical complementarity in identification: marginal costs help to single out the pricing and fixed cost terms, while the latter reduce the risk of spurious comparative-advantages linkages from trade policy. This is, in fact, a convention in the empirical IO literature for identifying fixed costs and imperfect competition.

The statistics results of both the exploratory and regression analyses vindicate all of these forms of economic inefficiency, showing that Brazil's ISI regime not only caused extreme allocative inefficiency, as already shown in Tyler (1985), but also other inefficiencies related to firms size and market power.

The paper is structured as follows. The models are worked out in Section 2, followed by a description of the empirical variables in Section 3. In Section 4, an exploratory statistical analysis briefly describes Brazil's experience, while Section 5 presents the basic regression results, and Section 6 takes up further statistical experiments. Conclusions follow.

[2]From Melitz and Ottaviano (2008), which rests on a Chamberlinian quasi-linear utility, we draw another comprehensive analysis of international trade upon economic performance.

2 Theory and Empirical Specification

We start with the closed economy, focusing on both market conduct and the temporal change in industry sizes. We then shift to the international-economy model, focusing on relative export sizes, as initially given by both comparative costs and distorted prices, and subsequently by inefficient firm entry.

2.1 Industry Size in Autarky

Consider an economy having a competitive sector, y, produced with unskilled labor, and N manufacturing industries X_i, each producing horizontally differentiated varieties with unskilled and skilled labor under internal increasing returns to scale. Consumers are heterogeneous in their preferences to varieties, as described by this upper-level utility function:

$$U(y, x_i, d_i) = y^{1-\xi}\Sigma_{i=1}^{N} x_i'^{\xi_i}, \qquad \xi = \Sigma_{i=1}^{N}\xi_i < 1, \tag{1}$$

where $x_i' = x_{i\omega}/h(d_{i\omega})$ is the quality-adjusted quantity a specific consumer attains from the most preferred variety, $x_{i\omega}$, after applying the compensating function, $h(d_{i\omega}) \geqslant 1$, in the distance $d_{i\omega}$ from her *ideal variety* (see Lancaster, 1979, 1984). The quality space is in a unit circle, where the n_i firms (varieties) are symmetrically spaced, so that $d_i = 1/n_i$, and the heterogeneous consumers are uniformly distributed. Aggregating those for whom $p_{i\omega}h(d_{i\omega})$ is minimized, one reaches the firm's clientele, whose price-elasticity $\sigma_i(n_i)$ is fully determined by the number of firms[3].

Given (1), the aggregate demand for each manufactured product i, after accounting for the symmetric (in price and size of firms) zero-profit equilibrium, will be

$$X_i = S_i\left(\frac{1}{\theta_i c_i}\right), \qquad i = 1, \ldots, N, \tag{2}$$

where $S_i = \xi_i Y$ is the size of industry i, irrespective of prices, and Y is the available income of the economy. The denominator within brackets is the optimum price (relative to the numeraire y): marginal cost, c_i, times the markup $\theta_i = [1 - 1/\sigma_i(n_i)]^{-1}$.

Normalizing (2) by $Y = X$, yields:

$$x_i = \xi_i\left[\theta_i(\mathbf{w}\mathbf{a_i}(\mathbf{w}))\right]^{-1}, \tag{3}$$

where $x_i = X_i/X$ is the relative sales of manufacturing industry i and w and a_i are, respectively, the factor-price and factor-input vectors in marginal cost.

To cast (3) in a time dimension, we add subscript t to each variable and substitute ξ_i by η_{it} =

[3]This result was noted by Helpman and Krugman (1985, 6.3), and demonstrated by Cinquetti and Balistreri (2010) in a fully specified model, using $h(d)$ as in Lancaster (1984). Other developments of this approach to trade theory are Schmitt (1990) and Vogel (2008), with heterogeneous firms and non-local competition.

$d \log \xi_{it} / d \log Y_t$, yielding:

$$x_{it} = \eta_{it} \left[\theta_{it}(\mathbf{w_t a_{it}}(\mathbf{w_t})) \right]^{-1}. \tag{4}$$

As indicated, the η_{it} terms come from temporal changes in consumer preferences for products.

2.2 Export and Opportunity Cost under Free Trade

Should the world economy be divided into several non-symmetric countries integrated by free international trade in goods, then the share of each country k in the world market of i, x_i^k, follows from (4), adjusting its arguments to country characteristics.

If labor input and prices are the sole available evidence of marginal costs, $\mathbf{w_t^k a_{it}^k}(\mathbf{w_t^k})$, how can we further characterize opportunity costs in each country? The Rybczynski theorem, relating factor-endowment, v_l, and relative output in a small country, gives a clue:

$$\hat{x}_i = R(\hat{v}_l) > 0, \quad \hat{x}_j = R(\hat{v}_l) < 0, \tag{5}$$

where x_i and x_j are sectors intensive and not intensive in v_l, respectively, whereas the transformation function $R(.)$ is controlled for fixed-input requirement in any sector. Similar relationships hold for the foreign economy. Therefore, if $v/v*$ is the ratio of factor endowment of home to foreign countries, its relationship with the vector of relative exports, x^T/x^{T*}, can be traced by the correlation of the latter with the vector of relative output, x/x^*:

$$corr[(x_i^T/x_i^{T*}), x_i(v)/x_i^*(v^*)] = \gamma, \qquad \gamma > 0. \tag{6}$$

Hence, γ indirectly conveys the efficiency relationship between comparative exports and factor proportions (Deardorff, 1980), with the relative size x_i/x_i^* expressing the latent opportunity (or marginal) cost.

If foreign is an aggregate of j developed countries, each having a trade cost τ^j, then $\tau = \sum_j \delta_j \tau^j$, is the average trade cost with the local economy, which may change the modulus of γ, but not its sign (*i.e.*, the comparative advantages). The same applies to adding a third region, the rest of world (ROW), representing the whole world (except for *local*) with endowment $\bar{v}$.

2.3 Fixed Costs, Protection and Comparative Exports

The unit cost function is assumed separable in the marginal and the fixed costs. The latter encompasses both plant and corporate fixed costs, $G_i(q_i)$ and $F_i(q_i)$, which may be associated with fixed input coefficients of unskilled and skilled labor respectively(see Markusen and Venables, 2000):

$$c_i(w^k, q_i) = a_i^k(w^k)w^k + (G_i/q_i)w^k + (F_i/q_i)w_s^k. \tag{7}$$

The technical coefficient of marginal cost, $a_i^k(w^k)$, is irrespective to firm's scale, q_i, whereas $G_i(q_i)$ and $F_i(q_i)$ vary with the unskilled and skilled-labor prices, w^k and w_s^k respectively. Although the technology $G_i(q_i)$ is constant internationally, in a developing country, the corporate fixed cost is mostly related to technology transfer, F_i^h, rather than technology generation, F_i, and $F_i^h < F_i$.

Introducing local's trade-policy barriers (and incentives), T_i, whose impact is limited to the product markets by assumption, then the reduction in foreign supplied goods, through total sales and total varieties as well, causes the following changes in the markup $\theta_i(T_i)$:

$$\theta_i(T_i) = \left(1 - \frac{1}{\sigma_i(N_i^T)}\right)^{-1} > \theta_i = \left(1 - \frac{1}{\sigma_i(N_i)}\right)^{-1}, \tag{8}$$

where $N_i = n_i + n_i^*$ is the number of local and foreign varieties of i sold domestically. Moreover, the reduced quality-arc of foreign-good clientele shifts the monopolistic equilibrium of Section 2.1 to a zero-profit non-symmetric one. If pricing goes similarly to international integrated markets, as further developed in Appendix C, then the higher θ_i will not only ration domestic sales of i, but also exports from local firm. Hence, despite consumer's substitution away from foreign varieties, we can expect that $\dot{n} < |\dot{n}^*| \Rightarrow N^T < N$, corroborating (8) that inversely expresses the pro-competitive effect from international trade (Markusen, 1981).[4]

We may now substitute (6)-(8) into (4), with the latter defined in terms of each country's relative supply (exports) to ROW, x_{it}^T and x_{it}^{T*}. In this international context, S_{it} (and S_{it}^*) must be replaced by its corresponding industry size in the international economy: $S_{it} = \delta_i(n_{it})\xi_t^{\eta_{it}} Y_t^w$, where $\delta_i(n_{it})$ stands for the home economy's share in the world sales of i (there is a similar share for foreign) and Y^w for the world income. Lastly, the transformed equation (4) is rewritten as comparative exports and then linearized into the following stochastic form:

$$x_{it}^T / x_{it}^{T*} = \alpha_i + (\delta - \delta^*)\eta_{it} - \beta_2 \left(\frac{w_t a_{it}}{w_t^* a_{it}^*}\right) + \beta_3 \left(\frac{x_{it}}{x_{it}^*}\right) - \beta_4 \tilde{G}_{it} - \beta_5 \tilde{F}_{it} - \beta_6 T_{it} + \varepsilon_{it}, \tag{9}$$

where α_i stands for unmeasured industry-specific characteristics, ε_{it} for the random error, and the subscript of $(\delta - \delta^*)$ were dropped since these coefficients are constrained to be the same across industries.

In this comparative cost and pricing model, the coefficient $\beta_1 = (\delta - \delta^*)$ stands for performance on non-price competition. Associating the coefficient of η_{it} with international competition through product differentiation rests further on the notion that the size of each regional industry is proportional to the number of competitive varieties[5], and on the set of cost and markup pricing controls as well. The cost controls become more meaningful if $\tilde{F}_{it}$ also contains non-$R\&D$ expenditures (e.g., fixed

[4]The additional scale effect on local firms is discussed next, while this asymmetric monopolistic equilibrium can be referred to Lancaster's (1984) split case, or to Vogel (2008), but based on firms with homogenous technology.

[5]Suppose firms are identical in size, q, so $X_i^k = n_i^k q_i$, where k refers to either home or foreign. we can then rearrange $X_i^k = \delta_i^k \xi_i Y^w / \theta_i^k \mathbf{w}\mathbf{a_i}^k = \delta_i^k \xi_i Y^w / p_i^k$ to

$$\delta_i^k = p_i^k n_i^k q_i (\xi_i Y^w)^{-1},$$

trade costs), so that $\beta_1 \gtrless 0$ could be ultimately related to changes in factor endowments (see Currie et al., 1999).

As dictated in (4), β_2 should be negative, while β_3 should be positive, since (6) gives an inversely written opportunity cost. Policy distortions weaken these comparative-advantage linkages, but a more conclusive identification of *allocative inefficiency*, from the values of both β_2 and β_3, is left to Section 6. Although fixed cost $G_{it}(= G_{it}w^k/q_{it})$ and $F_{it}(= F_{it}w_s^k/q_{it})$ measures only cross-industry differences, as better explained below, their impacts on relative exports are certainly conditioned by factor proportion (or prices), following (7). Lastly, the association of a negative β_6 with pricing distortions is partially granted by the fact that β_2 through β_5 control for cost distortions, yet further analysis is done in Section 6 aiming to decompose it into cost and pricing (market-power) distortions.

2.4 Protection and Productive Efficiency

Since protection affects N_i, it might affect firm size as well, and then average cost (Horstmann and Markusen, 1986; Markusen and Venables, 1988). In fact, with free entry$\theta_i(\bar{T}_i) \cong \psi(\bar{T}_i)$, the measure of economies of scale, so that, given (8):

$$\psi(\bar{T}_i) = \frac{c_i(w, q_i(\bar{T}_i))}{c_{iq}(q_i(\bar{T}_i), w)} > \psi = \frac{c_i(w, q_i)}{c_{iq}(q_i, w)}. \tag{10}$$

Assuming that marginal cost $c_{iq}(w, q_i)$ is constant, or controlled in the empirical model, then higher $\psi_i(T_i)$ can only be explained by inefficient entry that reduces q_i and thus increases average cost $c_i(w, q_i)$. This is observed in some trade-policy analyses with spatial monopolistic competition (Schmitt, 1990; Lancaster, 1984). Ours, however, has a zero-profit non-symmetric equilibrium – Vogel (2008) is the closest reference – with both a small local country and an aggregate foreign economy, for which additional analysis is provided in the Appendix C.

Similar to most developing countries in the analyzed period (see Santos-Paulino, 2002), Brazil's protectionism encompassed a myriad of trade and industrial-policy instruments. Accordingly, if T, which is proxied by the effective rate of protection (or nominal tariffs), captures the pro-competitive effect, then there is a case for including another variable, $\bar{T}_i$, that maps the scale effect.

The best empirical solution is proxying it by an intrinsic variable of market structure that is associated with firms' size (scale). Plant fixed cost, G_{it}, arises as the most natural choice, since its technology coefficient, unlike the F_{it} one, does not change internationally. Taking account of the

making clear the association between δ_i^k and n_i^k, once p_i^k has already been accounted for. Consider now the international form of the normalized temporal equation (4):

$$x_{it}^k = \delta_i^k \eta_{it} (p_i^k)^{-1}.$$

If the inter-period changes in varieties are internationally uneven (e.g., Grossman and Helpman, 1991, ch. 9), then $\dot{n}_i \gtrless \dot{n}_i^* \Rightarrow \delta_i^k(\eta_{it})$, and so $\delta - \delta^* \lesseqgtr 0$ reflects countries' relative positions in this non-price competition.

separability in factor content in (7), the whole imperfectly competitive impact from trade policy can thus be decomposed:

$$\Theta_i(T, \bar{T}) = G_i/x_i[n_i(\bar{T}_i)] + \theta[N_i(Ti)]. \tag{11}$$

With free entry, the average costs effect responds to unobserved instruments $\bar{T}_i$, by means of adjustment in the number of local firms, n_i, whereas market power responds to T_i, by means of adjustment in the number of varieties in the market, N_i.

Replacing the internationally equal G_i by the local G_i^n, model (9) is transformed to:

$$x_{it}^T/x_{it}^{T*} = \alpha'_i + (\delta - \delta^*)'\eta_{it} - \beta'_2\left(\frac{w_t a_{it}}{w_t^* a_{it}^*}\right) + \beta'_3\left(\frac{x_{it}}{x_{it}^*}\right) - \beta'_4 G_{it}^n - \beta'_5 F_{it} - \beta'_6 T_{it} + \nu_{it}. \tag{12}$$

In this counter-factual to (9), the inefficient entry, causing $G_{it}^n > G_{it}$, is identified by the weakening linkage of plant fixed cost with *RCA*. That is, using the true, local-adjusted fixed cost, causes $\beta'_4 > \beta_4$.[6] An exploratory data analysis (not shown) is made to previously identify if local firm size is smaller than average international firm size, so that $G_{it}^n > G_{it}$.

3 Variables and Data

To discuss the empirical specification, let us transform (9) and (12) to a nominal form:

$$\begin{aligned} RCA_{it} &= \alpha_i + \beta_1 WYEL_{it} - \beta_2 CPCOST_{it} + \beta_3 SIZE_{it} - \beta_4 PLANT_{it} - \beta_5 CORPO_{it} \\ &- \beta_6 ERP_{it} + \varepsilon_{it}, \quad i = 1, \ldots, 20 \quad \text{and} \quad t = 1, \ldots, 4 \end{aligned} \tag{13}$$

where RCA$_{it}$ (revealed comparative advantages) = x_{it}^T/x_{it}^{T*}, WYEL$_{it} = \eta_{it}$, CPCOST$_{it} = (w_t a_{it})/(w_t^* a_{it}^*)$, SIZE$_{it} = x_{it}/x_{it}^*$, PLANT$_{it} = G_{it}$, CORPO$_{it} = F_{it}$ and ERP$_{it} = T_{it}$. Alternative to CPCOST is CPROD = (a/a^*) and to PLANT is PLANTBR = G^n. The three-digit twenty manufacturing industries – with some adjustments to available data – are described below, while the four years are 1967, 1973, 1980, and 1987-88 (average, due to the extreme disturbances of these two years), with slight deviations for some variables. Pre-1980 years made the dearth of international compatible data more stringent, the sources of which are described in the Data Appendix.

The then six largest industrialized economies (USA, Japan, Germany, UK, France, and Italy) make up the foreign economy, which assures less-biased RCA$_{it}$ and comparative costs than one built on a single developed country, given their large differences in size and factor endowments[7]. Hence, in the RCA, $x_{it}^* = \Sigma_j \left(X_{it}^{Tj}/X_t^{Tj}\right)$, X_{it}^{Tj} stands for the jth foreign country's exports of i and X_t^{Tj} for

[6] The non-homothetic cost function (7) does not compromise the entailed framework, since the comparative cost relationship does not rely on autarky prices.

[7] This multi-country aggregation is an alternative to the multiple regressions made by Golub and Hsieh (2000), as well as a way to bring back the analysis on trade pattern in world with several production and trade-cost differences as that of Eaton and Kortum (2002).

its total manufactured exports at t.

Variation in i's world-market demand, WYEL$_{it}$, is given by:

$$\eta_{it} = \frac{X^w_{it}/X^w_{i,t-1}}{X^w_t/X^w_{t-1}},$$

where X^w_i and X^w_t are the world's exports of i and total exports (not only manufactured), and the $t-1$ obliges us to take 1963 data. Our associating of η_{it} with the income-elasticity of demand is warranted insofar as the demand structure of tradable goods in the world and in the international markets is nearly the same, but this variable is not really measuring income elasticity in model (13).

Marginal and fixed costs, which are not directly observable, as in most inter-industry studies (Bresnahan, 1989), are taken as distinct components of total labor input. Accordingly, marginal comparative labor costs is given by:

$$CPCOST_{it} = \frac{a_{it}w_t}{a^*_{it}w^*_{it}} = \frac{(l_{it}/x_{it})\,.w_t}{\left(\sum_j l^j_{it}/\sum_j x^j_{it}\right).w^*_{it}},$$

where l/x stands for "total employees/value added", and w and $w*$ are the manufacturing wages in constant US dollars of Brazil and foreign. A pure relative productivity measure, CPROD$_{it}$, is obtained by dropping w_t/w^*_t. The latent opportunity cost, SIZE$_{it}$ $= x_{it}/x^*_{it}$, based on (6), makes room for some cross-time scale (or home-market) effects.

Similarly to Brainard (1997), corporate fixed cost, CORPO$_{it}$(CORPBR$_{it}$), is proxied by the ratio "office labor/total employees" in the US industries, given the assumption of fixed input coefficients. We extend this idea to plant fixed cost, PLANT$_{it}$, proxied by the operative labor input. However, the latter is expanded by a measure of economies of scale, average firm size:

$$PLANT_{it} = \frac{(l^{u*}_{it}/x^*_{it})\,.N^*_{it}}{\bar{G_t}^*} = \frac{l^{u*}_{it}/\bar{x}^*_{it}}{\bar{G_t}^*}$$

where l^{u*}_{it} and x^*_{it} stand, respectively, for operative workers employment and output, and N^*_{it} for the number of firms therein, whereas $\bar{x}_{it}$, in the rightmost fraction, stands for firm's mean size. Hence, the unitary plant fixed cost, PLANT$_{it}$, is given by the operative labor input of the average firm (in size) in each industry, and PLANTBR$_{it}$, plant fixed cost in Brazil, is similarly calculated. The normalization by $\bar{G}^*_t$, the yearly average of the numerator, removes a likely general higher size of foreign firms, so that relative cross-industry difference are the only regional difference. Making them stationary panel data also removes a temporal home-market (size) effect, when comparing PLANT$_{it}$ to PLANTBR$_{it}$.

Our disregarding of output level in CORPO$_{it}$ aims to isolate fixed costs related to a type of economic activity, which is proxied by the intensity of skilled (office) labor, following Antweiler and Trefler (2002). It, accordingly, helps to isolate plant fixed costs, and so the attempted meaning of the comparative impact of PLANT$_{it}$ and PLANTBR$_{it}$.

A derived market-structure variable (Schmalensee, 1989) proxies market power stemming from import tariffs (and export subsidies), ERP$_{it}$: the effective rate of protection in Brazil. The reason is straightforward: the literature makes a direct association between protection and market power. Nonetheless, given the likely impact on higher opportunity costs as well, further regression experiments are performed, in Section 6, to prove that ERP$_{it}$ stands mostly for prices rather costs distortions. Nominal tariffs in Brazil, TNOM$_{it}$, are also tested for robustness. Disregarding the foreign economy, whose correspondent panel data were not available, amounts to assuming its firms operated under conditions of free trade as compared to Brazil – quite reasonable for that period.

Policy endogeneity is not expected to be a problem in (12) on the ground that protection in Brazil was unrelated to sectors' comparative advantages (Gonzaga et al., 2006).

4 Trade Policy in Brazil

A brief overview of Brazil's policy experience is useful and enables us to better grasp of some of our variables. We begin it with a graphical analysis of a centered RCA, as in Benedictis (2005) :

$$b_{it} = \frac{RCA_{it} - 1}{RCA_{it} + 1},$$

with $-1 \leq b \leq 1$, where positive (negative) values, from $RCA > 1$ (< 1), indicate comparative advantages (disadvantages). These b_{it} are further classified into the four technology groups (Lall, 2000): **RB (resources-based)**: food products, beverages, paper & paperboard, rubber, non-metallic minerals, wood & cork; **LT (low technology)**: furniture, leather & furs, clothing & shoes, metals and textiles; **MT (medium technology)**: transport equipment, plastics, printing & publishing, mechanical equipment, chemicals and tobacco[8]; **HT (high technology)**: other chemicals, electrical material and other sectors.

The b_{it} are plotted in the below diagrams, each having the original and final periods on the horizontal and the vertical axes, respectively, so that points below the diagonal indicate industries whose final RCAs were smaller than the original ones. In 1967, Brazil had comparative advantages in only two manufacturing industries, although the concentration of points above the diagonal, in both figures, shows a steady upward movement. However, all seven sectors having comparative advantages by 1987-88 belonged to either the RB or the LT groups.

Figure 1 Figure 2

However, the Brazilian HT and MT industries, whose trade performance improved the least, were among those having the highest output growth, which indirectly suggest the allocative inefficiency of this inward-growth experience.

[8]This manufacturing sector is highly concentrated around few firms due to a high expenditure on advertising.

The whole picture becomes clearer once we consider the evolution of factor endowments. Table 1 below shows that Brazil's proportion of skilled to unskilled labor, relatively to the developed countries, did not change from 1967 to 1980, having even decreased relative to arable land. This slow pace of human capital formation is a key difference between this industrialization strategy and that of the Asian NICs – see UN, *Human Development Report 1999* and World Bank, *World Development Indicators 1998*.

Table 1

Trade protection is another factor to consider, starting with the average (and standard deviation) of the effective rate of protection: 79.7 (45.2) in 1967; 34.1 (32.4) in 1973; 36.0 (53.4) in 1980; and 41.4 (51.6) in 1987-88. The only period of steady and general fall in the ERP, 1967-73, was the very one in which Brazil's GDP and exports grew the most relatively to the world economy. Protectionism resumed strongly afterwards in a very erratic sectoral dynamic, which is witnessed by the slight increase in the average ERP, as in the 1973-80 interval, together with a sharp increase in the standard deviation, on account of negative protection in some industries (see also Tyler, 1985; Savasini, 1983). The uncontrolled consequences of expanding trade barriers, which become less coordinated, is reinforced by the fact that the bulk of the huge export subsidies – the main trait of this new policy – aimed at compensating the anti-export bias of the import-substitution policy (Bruton, 1989; Moreira, 1995).

5 Estimation Results

The main goal of the ensuing regression analysis is estimating the qualitative effects of trade policy. Accordingly, we work with centered variables: $z_i - \bar{z}_i$, where the "within" mean is $\bar{z}_i = \sum_t z_{it}/N$ (number of industries i) which further avoids the scale nature of some variables, and apply a WGLS-White estimator to models (9) and (12), as justified in the Statistical Appendix.

As shown in Table 2, all variables are statistically significant in most of model specifications, in spite of some regressions having low $\bar{R}^2$, which can be attributed to both the small sample and high number of regressors. The two reported fixed effects are average values for each group in models [(i)-(iv)] and [(v)-(ix)], which are, respectively, the models with and without the cost-dummy variables described below. They clearly characterize industries' components of the RCA$_{it}$, whose ordering change only slightly, except for the two sectors (food and wood) defining models (v)-(ix).

The negative WYEL coefficient confirms that Brazil did not thrive in the world's most expansive markets. Given the empirical form of WYEL and all cost and pricing controls, this result suggests that Brazil's firm did not respond well to global non-price competition. Assuming that these demand-expansive sectors were high-tech intensive, the failure in this favored target of the import substitution

(ISI) policy can be explained by Brazil's sluggish human-capital formation (see Bruton, 1989). The assumption that these were high-tech sectors is not necessarily accurate, though.

Table 2

The coefficient of CPCOST is generally lower than that of CPROD and insignificant in some cases. This likely reflects the sudden impact of sizable devaluation in 1987-88 on manufacturing wages in Brazil, relative to the composite foreign economy. CPROD does not contain wages and is simply a comparison of relative (inverse) labor productivity. However, in models (i) to (iv), the positive partial correlation between comparative cost and relative exports stands for an extreme "allocative inefficiency", confirming previous studies of Brazil's ISI (Tyler, 1985; Savasini, 1983; Bruton, 1989). However, a closer look at resource-based sectors, such as Food and Wood, having high CPCOST, suggests that this variable may misrepresent comparative cost advantages because of the unobserved cost advantages from abundance of non-tradable natural resources.

With a cost-dummy variable for both Food and Wood, in models (v)-(ix)[9], CPCOST then become negative. The world is not Ricardian: the comparative advantage linkages (RCA inversely correlated to comparative costs) only show up when other productive factors are taken into account. However, as suggested by the model in column (ix), we cannot rule out that there were significant resource misallocations, which have not been sufficiently controlled by either ERP or TNOM, to the point of inverting the weak linkages in comparative advantage in the sense of Deardorff (1979). [10] We take up this point at the next section.

Since the fixed-cost variable PLANT stands for an input/output rate, whereas CORPO (and CORPBR) refers to factor intensity, their coefficients show that Brazil's RCA partially rested on both plant-level economies of scale and skilled-labor intensive sectors. This coefficient sign of CORPBR is unexpected since Brazil is unskilled-labor abundant, which may reflect Brazil's regional comparative advantages in skilled-labor intensive goods, as happened with Japan's early manufacturing exports (Heller, 1976). If so, CORPO contains (or is correlated with) unobserved fixed trade costs, which are smaller for exports to neighboring countries.

Another possibility is that PLANT, which incorporates only unskilled labor, under-controlled the skilled labor of plant fixed cost. At the same time, it must be stressed that the coefficients of the developed-country corporate fixed costs exceeded those for Brazilian corporate costs in all cases, which confirms the basic theoretical hypothesis around equation (7).

The negative coefficient of ERP fits with our identification of the *pro-competitive effect* of international trade: higher wedges between prices and cost reduce international competitiveness and

[9] In the form of $DCPCOST_{it} = 1 \cdot CPCOST_{it}$, if i= Food, Wood, and $DCPCOST_{it} = 0 \cdot CPCOST_{it}$, for the remaining sectors. The same applies to $DCPROD_{it}$.

[10] Our model rests on weak linkages as his, though with no reference to autarky prices.

sales. Since this negative impact can also reflects the misallocation of resources towards sectors with higher opportunity costs, an additional analysis is carried out in the next section to single them out. Nominal tariffs, TNOM, a less accurate measure of the effects of trade policy on firm's revenues, had a non-definite impact [columns (viii) and (ix)].

The "scale effect" is to be assessed by placing PLANTBR, the plant-fixed cost of the average firm in Brazil, in lieu of PLANT, the counter-factual standing for the world without policy distortions. However, we must make sure that the differences between PLANTBR and PLANT are indeed related to variation in the firm size in the corresponding industries.

A decisive insight is provided in Figure 3, by plotting the ratio "$\text{PLANTBR}_{it}/\text{PLANT}_{it}$" against the equally normalized number of firms per industry, $\frac{N_{it}/\bar{N}_t}{N^*_{it}/\bar{N}^*_t}$, in the vertical axis. The values are in logarithm so as to avoid a large concentration of points around zero and thus attain a more informative diagram. As shown, the cost ratio $\text{PLANTBR}_{it}/\text{PLANT}_{it}$ is highly and positively correlated with $\frac{N_{it}/\bar{N}_t}{N^*_{it}/\bar{N}^*_t}$, which supports the argument that inefficient entry in Brazil decreased (increased) industry-level economies of scale (average cost).

Figure 3

That the variations in $\text{PLANTBR}_{it}/\text{PLANT}_{it}$ are strongly correlated with the relative number of plant, indirectly show how the former is affected by variation in the average firm size, $\bar{x}$. This finding contradicts previous studies (Head and Ries, 1999; Tybout, 1993; Trefler, 2001; Fernandes, 2007, ch. 5) rejecting the scale effect and showing that only plant-selection can explain variation in productivity. The fact that some of these studies focus on free trade agreement, which shrinks firm's domestic market, can in part explain their divergence with our findings.

It must be noticed, that Brazil's legal apparatus for entry (and exit) had no sectoral bias, except for two or three manufacturing sectors in which foreign firms were restricted, which reinforces the role of protectionism – hardly encompassed by ERP alone – behind the above result.

We can now move to the next regression analysis, whose results are shown in Table 3. The substantial increase in the coefficients of PLANTBR shows weaker linkages of fixed-plant cost to comparative (exports) in Brazil, as compared to corresponding model with PLANT in Table 2; the free-trade condition. Given the observed empirical content of these variables, we cannot then reject the hypothesis that the Brazilian industries operated with lower economies of scale.[11] The statistical insignificance of PLANTBR is addressed in the next section.

Table 3

The above quoted empirical analyses around the scale and the selection effects, which are either

[11]This is not a test about the minimum efficiency scale (MES) because monopolistic competition prevents the MES.

based on larger samples or on closer evidence of firm-level data, carry no necessary relationship with comparative advantages under conditions of heterogeneous firms (see Bernard et al, 2007). This simultaneously means having no marginal costs to control for fixed costs (and the entailed economies of scales), as conventional to inter-industry studies in the empirical IO literature (Berry and Reiss, 2007; Bresnahan, 1989). In our case, an additional (corporate) fixed cost helps to isolate plant fixed costs.

6 The Allocative and the Competitive Effects

No definitive evidence about both the allocative and pro-competitive effects has been provided yet. Regarding the former, the negative relationship between comparative cost and trade patterns in Table 2 prevents us from stating any microeconomic inefficiency from this protectionist experience. What remains unanswered, though, is whether unobserved policy instruments weakened the negative partial correlation between *CPCOST* (*CPROD*) and the RCA.

Theoretically, in countries where manufacturing industries heavily rely on trade and industrial-policy instruments, a given export share of the supported industries uses higher input requirements compared to the same-industry exports from a country closer to free trade. Therefore, one possible approach to answering the above question is to replace RCA by a measure of trade performance that captures allocative efficiency more accurately, and then check the new coefficient of comparative marginal costs.[12]

More precisely, if $\tilde{E}$= RCA and E is the alternative vector of trade pattern, then their respective correlation to the vector of comparative opportunity cost (controlled for fixed cost and markup revenues), $\mathbf{c}^p$, are

$$E = b\mathbf{c^p}, \qquad \tilde{\mathbf{E}} = \mathbf{b}'\mathbf{c^p} \quad \Rightarrow \mathbf{b} > \mathbf{b}', \tag{14}$$

Since b' was negative (with the cost-dummies) but close to zero, microeconomic inefficiency pushes b up, so that the $b' < b$ expresses the weaker links of comparative advantages stemming from trade-policy distortions in Brazil – that is irrespective to the role of geography on trade.

A germane (to RCA) and more accurate measure of allocative efficiency is the *revealed comparative efficiency in the manufacturing* industry:

$$RCEM_{it} = \frac{\left(x_{it}^T / x_t^T\right) / \left(x_{it}/x_t\right)}{\left(x_{it}^{*T} / x_t^{*T}\right) / \left(x_{it}^{*}/x_t^{*}\right)}$$

where x_i^T and x_i stand for the exported and total output of i in an economy, respectively. The RCEM index combines information of both production and goods market, and in a way that resembles the

[12]Bernard et al (2003) employ a similar theoretically driven statistical experiment to obtain indirect evidence of trade costs.

efficient partition of the traded and produced output in Deardorff (1980).[13] Note that RCEM uses only exports, rather than net exports. We argue that this is superior to net exports because the latter requires data on imports, which raises questions about consistency with sectoral production (ISIS) and are as distorted by trade policy as exports.

Table 4

Table 4 displays the result of the regression model (13) with RCEM$_{it}$ replacing RCA$_{it}$, which is aimed to identify artificial (costly) export by means of the comparative advantages linkages as held in (14). As shown, the coefficient of CPCOST moved significantly upward, as compared to similar models in Tables (2) and (3). Indeed, in columns (iii)-(vi), the coefficients of comparative costs (and productivity) are positive, which can be coined an extreme microeconomic inefficiency. The significant fall in the coefficient of SIZE, in comparison to the earlier regressions, corroborates this weaker relationship between opportunity cost and trade pattern, when the latter is adjusted for efficient specialization.

We now move to examining the possibility that ERP may contain both a cost distortion, associated with allocative inefficiency, and a pricing distortion (increase in the wedge between prices and costs), associated with rationed sector's size. Insofar as the former effect is partially captured by both CPCOST and SIZE, this would allow us to associate the ERP coefficient with the remaining pro-competitive effect, yet this does not provide a definitive identification of pro-competitive effect.

One way to isolate the above two effects is to examine the implicit function between ERP and opportunity (or marginal) cost CPCOST and SIZE, from one side, and with fixed cost PLANTBR, connected with pricing (market power), form another side. The former implicit function can be referred to cost distortions, while the latter one to price distortions. More to the point, if $\mathbf{x_1}$ stands for marginal costs and x_2 for fixed cost, these functions can be estimated with stepwise regression (Greene, 2000): through elimination of ERP, x_3, from the RCEM model. That is, if $\hat{b}_1$ and $b_{1,3}$ are the partial correlation of $\mathbf{x_1}$ in the restricted and unrestricted models, respectively, then $E[b_1]/E[b_{1,3}] \sim Bias[b_1]$ is the implicit relationship between x_1 and x_3. Similar reasoning applies to $\hat{b}_2$ and $b_{2,3}$, regarding the implicit relationship between market power and trade protection. The latter effect cannot be rejected if the change in this parameter is significant.

This identification can be improved by restricting our attention to the firm-size component in PLANTBR. That is, working with

$$FIRMSZBR_{it} = \frac{(x_{it}\,/N_{it})}{\bar{Z}_t} \tag{15}$$

[13]Though comparative costs do not rely on autarky prices in this framework. Cinquetti and Silva (2008) apply a similar variable to access the relative efficiency of manufacturing industry in a set of developing countries prior to the 1980s debt crisis.

where $\bar{Z}_t$, the year-average of the numerator, is a normalization factor. It can be told that $FIRMSZBR_{it}$ is a less direct measure of plant-fixed costs than $PLANTBR_{it}$. To reduce any resulting bias, we also test DIFIRMSZ$_{it}$ $= log$(FIRMSZBR$_{it}$/FIRMSZ$_{it}$), giving the variation in $FIRMSZBR_{it}$ with respect to the average firm size in the US economy.

Each pair of equations in Table (5) stands for a particular stepwise regression, in which the first is the unrestricted equation (with ERP) and the second is the restricted one. As shown, the coefficient of the most relevant variables changed in the predicted direction: more positive for FIRMSZBR and SIZE, and more negative for CPCOST, meaning that the underlying productive and allocative efficiency effects are magnified in the absence of ERP. In the pair (iii)-(iv), we include TNOM to better single out the wedge from price to cost, which is more consistently expressed by ERP, and, as shown, the impact of removing ERP on FIRMSZBR is far greater than in the set CPCOST and SIZE. Finally, in columns (v)-(vi), replacing FIRMSZBR by DIFIRMSZ, we observe that, besides attaining statistical significance, this new scale variable experience a sizable variation in the restricted models, confirming a strong correlation with ERP.

Table 5

Hence, the weaker correlation of ERP with the marginal-cost variables, as compared to the fixed-cost (markup revenues) variables, supports the idea of a pro-competitive effect underlying ERP, besides a likely allocative effect.

Note, finally, that the three main policy effects, observed in our analysis, sum up to lower income (consumer expenditure) of Brazilian residents, which may be translated in principle into an indirect utility function to study each welfare loss (see Feenstra, 1995).[14] Unfortunately, the many transformations we used in the analysis make it impossible to quantify these welfare effects, which are theoretically complex in any case.

7 Conclusions

This paper investigates the various efficiency impacts of the Brazilian ISI through comparative (export) advantages, in which the spatial monopolistic competition allowed us to draw those policy effects from an industry-level analysis, whereas the enlarged foreign economy overcame several data difficulties, which are common to international comparison over a long (and distant) period.

The *productive (scale) inefficiency* was manifest in the exploratory graphical analysis of PLANTBR, as compared to the counterfactual *PLANT*, and by the weaker partial linkages of the former variable

[14]The same applies to the ignored analysis of demand for varieties, inasmuch as their number do not increase with protection and that the possibility of income gains depends on either no entry or a constant markup (Helpman and Krugman, 1989).

to revealed comparative advantages. The allocative inefficiency was uncovered when replacing RCA by a more accurate trade-pattern measure as to efficiency in resource allocation, RCEM, which drastically weakened the linkages from marginal costs, CPCOST and SIZE.

Lastly, evidence of the *anti-competitive effect* was attested when decomposing the negative impact of the ERP on RCA, which was strongly correlated with average cost terms. This finding supports the notion of a price-driven allocative distortion. The non-cost competition term showed that the country did not thrive in the globally most expanding industries, which suggests that the ISI failed to achieve a key dynamic target.

It would be fruitful to expand this research to a firm-level analysis and to the post openness period as well. However, this is far from trivial, since the former entails a new theoretical model and the latter new procedures for controlling other policy reforms.

A Data Appendix: Sources

RCA_{it}: UNCTAD, Handbook of International Trade and Development Statistics; United Nations, International Trade Statistics Yearbook; IBGE (Brazilian Institute for Geography and Statistics), Anuário Estatístico do Brasil. All in current US dollars.
WYEL_{it}: the same as RCA_{it} and also United Nations, *Commodity Trade Statistics Database*.

CPROD_{it}, CPCOST_{it}, PLANT_{it}, PLANT_{it}, PLANTBR_{it} and SIZE_{it}, CORP_{it}, CORPBR_{it}: UNIDO, *Industrial Statistics Database*; UN, *Yearbook of Industrial Statistics*; IBGE (idem), with value added deflated by the US and Brazil's GDP deflator, respectively. Industry average wages were based on UN, Statistical Yearbook and ILO, LABORSTA Labour Statistics Database, IBGE, Estatísticas Históricas do Século XX, and FIESP (São Paulo State Industry Federation), for Brazil in 1980. Lastly, number of firms in industries: Country Business Patterns for the USA, and IBGE Estatísticas Históricas for Brazil.

Brazil's series of employment and number of establishments was interrupted in 1985, at the beginning of the democratic government, and the level of the new series shifted dramatically, so that their values in 1987-1988 were interpolated according to Cinquetti and Maskus (2012). Briefly, the employment data was interpolated from IBGE's special series for 1985-88, together with those of 1984 and 1988 (in Estatísticas Históricas), while the number of establishments, whose new data started only in 1986 (In "www.sidra.ibge.gov.br/bda/cempre/", collected in 11/03/2009), was interpolated from a mix of statistical forecast, using a class of first-order autoregressive model, up to 1986, and mathematical interpolation from the sample's yearly variation (from 1986 to 1988).
ERP_{it} and TNOM_{it}: Bergsman and Malan (1971); Neuhauss and Lobato (1978); Tyler (1985); Kume (1989).

B Statistical Appendix

We specified the unexplained constant term, α_i, as a group-specific constant (fixed effects, FE), in the regression models, based on evidence (see Table 2) that the parametric differences between cross-sections were associated with industry characteristics, which is likely in a panel data with both time and cross-section dimension like ours (Greene, 2000, p. 615). Another indication was the correlation with the regressors: the variance of the βs increase – most of them lose statistical significance – when running the baseline models either as random effects (RE). A Hausmann test yielded $\chi^2 = 4.79$ (p-value = 0.571), which does not reject the null hypothesis of the RE model, but this test is inadequate for small samples (Hsiao, 2003) like ours, so that we further applied the test of redundance of the fixed effects, yielding $\chi^2 = 174.55$ (p-value = 0.000) that strongly rejects the null hypothesis of redundant FE.

Lastly, the sample size, the usual problems with international data, and cross-time heterogeneity of the sources (for ERP) dictated a WLS-White estimator that corrects contemporaneous cross-equation correlation as well as different error variances in each cross-section (Arellano, 1987).

C Prices, Cost and Trade Policy.

This appendix provides a more detailed analysis about the price and entry strategies associated with the scale and anti-competitive effects.

As shown by Head and Ries (1999), several trade models with monopolistic competition warrant, with free-entry, this relationship between consumers and foreign-producers prices, p and p^*_q respectively:

$$p^*_{qi} = \frac{p_i}{(1 + T_i + \tau)}, \tag{16}$$

where policy T_i is positive if it stands for an import tariff on foreign, and negative if for an export subsidy, which should affect p_i only, under the small-country assumption.

Firms interact on price (first stage) and quality (second stage) strategies. To evaluate how T_i affects p_i, we take the latter at subgame-perfect Nash equilibrium (SPNE). Using (16) this gives:

$$m_i c_i = m^*_i c^*_i (1 + T_i)\tau = \sum_{j=1}^{J} \bar{\delta}_j \left\{ m^j_i(N_i) \left[c^j_i + \tau_j \right] (1 + T_i) \right\}, \quad \Sigma_j \bar{\delta}_j = 1 \tag{17}$$

where $\bar{\delta}_j$, in the rightmost term, is country's j share in the foreign's export. Fixed costs are equal among foreign countries, but marginal production cost, c^j_{iq}, are not. Therefore T_i has its greatest impact on firms from countries with the highest total marginal cost, $c^*_{ij}\tau_j$. In sum, T_i affects local prices directly, as a cost term, and indirectly, through endogenous variation in market structure (N_i) that conditions both m^*_i and m_i. Likewise, increase in the foreign price of local firms, $p(1 + T_i + \tau)$, reduces their exports, either by smaller sales in each foreign market or, in the limit, by forcing exit by those with highest τ^j when profits becomes negative.[15]

Although each trade cost τ_j is decisive in determining which foreign firms (imports) are first eliminated, the aggregate τ is immaterial for trade pattern between local and foreign (as single entity), whose sole reliance on marginal cost is reinforced by the non-unique industry distribution of c_{iq}^j.

Entry, n, defines the quality strategy itself, through SPNE given by[16]:

$$p_i = c_i(w, q_i) \tag{18}$$

Our small country assumption allows us to disregard the corresponding strategic analysis for foreign firms. The exact variation in n_i and thus in q_i, leading to (18), depends on a fully specified theoretical analysis, but the potential for inefficient entry can be easily identified.

From the higher elasticity of substitution between varieties than between products, $\sigma > \xi$, we can predict an increase in domestic sales by local firms $(n_i' x_i' - nx > 0)$ – in their quality arc – despite the rationing in industry sales, from (17). In fact, the higher $m_i(N_i)$ reinforces the potential for inefficient entry, $q_i' < q_i$, for it allows entry of firms with higher average cost c', as follows from substituting (18) into (16):

$$\frac{c_i'}{c_i'^*} = (1 + T' + \tau) \tag{19}$$

with $c_i \geq c_i^*$ before entry.

In spite of (16), this free-entry adjustment, which can be associated with import tariffs, does not completely fit to the traditional integrated markets analysis by Horstmann and Markusen (1986), since foreign sales contract. This difference is due to both the assumption of small economy and a multi-country world, in addition to monopolistic competition.

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[15] As implied in (16), small country under monopolistic competition does not rule out a change in the CIF prices of local firms and thus in their FOB prices as well.

[16] In a discrete entry process, we could have $p_i = c_i(1 + \varphi_i)$, with positive profits if $\varphi_i(N_i' + 1) < 0$, where N_i' is the new number of firms, but this would be conditional to industry and firm size in each equilibrium.

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