Intermediate Inputs and Premature Deindustrialization: An Analysis of the Brazilian Case

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Abstract

Several Latin American countries have engaged in a structural transformation from manufacturing to services. This has reduced their overall economic growth because labor has been reallocated towards low-productivity services instead of high-productivity services, as observed in East Asian countries. Since such transformation happened concurrently with trade reform, this paper conjectures that trade policy via improved access to manufactured intermediate inputs fosters employment in services. This mechanism is formalized in a theoretical model which predicts that a reduction in export tariffs increases employment share whereas a decline in the effective rate of protection has the opposite effect. These predictions are confirmed using a novel dataset and industry-level variation from the 1989–1999 Brazilian trade liberalization episode. More specifically, the manufactured intermediate input channel explains approximately 40% of the change in employment share of services. These results are robust to endogeneity concerns that are addressed using instrumental variable and control function approaches.

Keywords: Brazil; intermediate inputs; services; structural change; trade liberalization.

JEL Codes: F12, F14, F16, O14, O17, O54.

1 Introduction

A salient feature of developing economies is the existence of large productivity differentials across sectors. Thus, labor reallocation between sectors—also called 'structural transformation'—is an important source of overall economic growth. Most of the research on structural transformation has focused on the labor shift from agriculture towards manufacturing. Nevertheless, several developing countries, such as South Korea, Brazil, and Argentina, have already made such a transition. Hence, researchers are turning their attention to the subsequent step in economic development—namely, the reduction in manufacturing employment share in favor of an expansion in high-productivity services, as experienced by developed countries.

In a cross-country study, McMillan and Rodrik (2011) point out that this transition from manufacturing to services has been heterogeneous for developing countries. In some cases, labor has been reallocated towards high-productivity services, while in others towards low-productivity services. The latter hinders economy-wide productivity and slows down economic growth. This phenomenon was called 'premature deindustrialization' by McMillan and Rodrik (2011), who found it to be the case of several Latin American countries, as also confirmed by Timmer and de Vries (2009) and de Vries et al. (2012).[1] McMillan and Rodrik's (2011) findings suggest that comparative advantage in natural resources, overvalued currency, and labor market rigidities are behind Latin America's premature deindustrialization.

Trade liberalization, with its economy-wide shocks, has also been investigated as a potential culprit. Several country-specific studies focusing only on manufacturing—for instance, Ferreira and Rossi (2003), Lopez (2005), and Fernandes (2007)—revealed that trade liberalization led to productivity growth in manufacturing, in part from the trimming of excess labor. And, the cross-country study by Wacziarg and Wallack (2004) found no evidence of labor reallocation between manufacturing industries after a trade reform. Hence, trade liberalization could be a driver of structural transformation since these displaced workers probably switched to either agriculture or services.

In view of these facts, and considering the recent wave of trade liberalization—e.g., the trade agreements signed by the United States with Peru and Colombia in 2006—it is of considerable interest and potentially of great concern for policymakers to understand the determinants of this labor reallocation, in order to design policies to induce labor reallocation towards high- and not low-productivity industries,

[1] McMillan and Rodrik (2011) provided evidence that this was also the case of Sub-Saharan Africa; however, McMillan, Rodrik, and Verduzco-Gallo (2013) used updated data, and their new findings suggest a reversal of this conclusion.

and therefore increase overall economic growth. This concern is illustrated by the Brazilian trade reform of 1989–1999, in which employment in manufacturing declined by approximately 20% (i.e., a million jobs). Interestingly, household survey data indicates a comparable increase in the services employment share, albeit not uniform across service industries. Most of this expansion occurred in low-productivity services. For instance, the construction and retail employment shares grew by less than 10%, whereas personal and non-commercial services increased by more than 25%.

This latter observation motivates this paper. In it, I hypothesize that the Brazilian trade liberalization impacted the service industries' employment shares via increased access to manufactured intermediate inputs. This overlooked channel becomes more transparent when it is noted that manufactured intermediate input constitutes 17% and 9% of low- and high-productivity services output, respectively. Furthermore, the tariffs imposed on such inputs decreased differently across service industries, and the inputs consumed by low-productivity services faced larger tariff cuts.

The first contribution of this paper is a theoretical model designed to capture the impact of trade liberalization—as changes in the effective rate of protection (ERP) and trade partners' import tariffs—on the share of manufacturing and services on overall employment.[2] This model is a small open economy version of the heterogeneous-firm framework developed by Davies and Eckel (2010), which is extended to include a service sector that consumes manufactured intermediate inputs. Three testable predictions are derived from the model. First, a reduction in the ERP leads to a reduction in the manufacturing employment share. In contrast, a decline in the tariffs imposed by trade partners expands the employment share in manufacturing industries. For the service sector, a reduction in the intermediate input tariffs (i.e., an increase in ERP) results in a larger employment.

The second and most substantial contribution is assessing the model's testable predictions using Brazilian data, which have several noteworthy merits. Brazil experienced economically significant changes in both its own and its trading partners' import tariffs during the 1990s. These tariff cuts resulted in changes in Brazilian import and export levels in excess of 60%. Second, in contrast to several other countries, Brazil's labor institutions and its labor market regulations remained stable throughout this period of trade liberalization. This is helpful in identifying the trade-environment–labor-market nexus, which is the central concern of this paper. Third, in addition to a national household survey, this is the first paper, to the best of my knowledge, to employ a worker-level panel dataset covering both formal

[2] Recall that the ERP is increasing in the output import tariff and decreasing in the intermediate input import tariffs.

and informal workers: the 1996 PME special supplement. Panel data encompassing informal workers is extremely rare for developing countries with ubiquitous job informality.[3] In this survey, workers were interviewed in 1996 and asked about their current affiliation and formality status both in 1991 and in 1996. Hence it has no attrition, which is another desirable characteristic usually absent in worker-level panel data.

My empirical results at the industry level indicate that a ten percentage point decline in export tariffs leads to a 0.12 percentage point increase in manufacturing employment share. A similar reduction in ERP decreases employment share by 0.15 and 1.9 percentage points in manufacturing and services, respectively. These estimates are able to explain approximately 20% and 40% of the changes in manufacturing and services employment share, respectively. Most important, the estimated change in services' employment share occurred via the manufactured intermediate input channel. The worker-level panel data provides a more detailed account of the labor reallocation. In this case, export tariff cuts make manufacturing workers less likely to switch to service industries. A fall in ERP has the opposite effect—that is, increasing the odds of a transition to services. More precisely, the switch to low-productivity services is more likely than to high-productivity services even after controlling for workers' characteristics. For workers initially employed in services, an increase in ERP reduces their probability of reallocating to manufacturing. Interestingly, a raise in ERP makes service informal workers more likely to switch to formal jobs in their original industry affiliation. And, it decreases the odds of transitioning into informality for service formal workers. So the formal-informal margin of adjustment in the service industry is affected by trade reform via access to intermediate inputs. This paper's findings still hold after several robustness checks, including a falsification test designed to examine whether pre-existing trends in the data are driving the results.

Surprisingly, there is a dearth of literature that investigates the nexus between trade-policy reform and structural change. The closest papers are Dehejia and Panagariya (2014), Ahsan and Mitra (2013), Firpo and Pieri (2013), and Menezes-Filho and Muendler (2011). Dehejia and Panagariya (2014) investigated the expansion of service industries' employment shares by focusing on the effects of the increased demand for services as an input to the fast-growing manufacturing sector in India. Ahsan and Mitra (2013) analyzed the impact on employment share of trade policy and labor institutions in India by exploiting both tariff and regulatory variation across Indian states. They found that employment in high-productivity

[3] Although employer-employee administrative data is available for Brazil, it covers only formal jobs. These are approximately 80% of the manufacturing jobs, but less than 70% of employment in services.

industries expanded in states more exposed to foreign competition and with pro-business labor regulations. Firpo and Pieri (2013), using Brazilian household data at a high aggregation level, found that economic growth in the 1990s was driven by within-industry productivity gains and that increased trade openness had no effect on labor reallocation. Menezes-Filho and Muendler (2011) investigated the effect of trade liberalization in manufacturing employment utilizing Brazilian administrative and household survey data. Their findings indicate a trade-induced shrinkage in manufacturing employment.

The approach of my paper is complementary to that of Dehejia and Panagariya (2014) and of Ahsan and Mitra (2013) by exploiting industry-level tariff variation and by examining a distinct linkage between manufacturing and services: manufactured intermediate input usage by services. Besides using a new dataset, this paper extends upon Firpo and Pieri (2013) and Menezes-Filho and Muendler (2011) by examining the effect of tariffs on labor flows within and between manufacturing and service industries at a more disaggregated level and according to job formality status.

This paper is linked McCaig and Pavcnik (2013), which found that trade liberalization in Vietnam led to structural transformation from agriculture to manufacturing. It is also related to the empirical studies of Lopez and Alvarez (2012) and of Branstetter, Kovak, and Venancio (2014) that investigates the effects of tariffs and foreign market access on industry- and firm-level employment. Finally, there is a connection with the theoretical literature on structural transformation and labor reallocation that features an important role for international trade as in Sposi (2012), Uy, Yi, and Zhang (2013), Coşar (2013), and Dix-Carneiro (2014).

The remainder of the paper is organized as follows. The next section revisits some stylized facts about Brazil's structural transformation and lays down the theoretical model and its testable predictions. The econometric methodology to assess these predictions is developed in Section 3. The data used in the empirical exercises are described in Section 4. Section 5 reports the estimates and discusses the results. Finally, conclusions are presented in Section 6.

2 Stylized Facts and Theoretical Model

This section begins revisiting and presenting new stylized facts concerning industry-level labor reallocation during the 1989-1999 Brazilian trade liberalization. Next, a simple general equilibrium theoretical model featuring services firms that employ manufactured intermediate inputs is used to derive testable predictions about the effects of trade reform on industry-level employment shares that will guide the empirical approaches described in the subsequent section.

2.1 Stylized facts

Several studies on structural transformation—for instance, McMillan and Rodrik (2011)—utilize the cross-country dataset prepared by Timmer and de Vries (2009). Unfortunately, an inherent feature of this cross-country comparable dataset is its availability only at a high level of aggregation. In fact, it includes only 10 industries, of which the entire manufacturing sector is just one. To access more disaggregated data, this paper relies on Brazilian household surveys, which cover 16 manufacturing and 10 service industries. As will be discussed shortly, looking at a more disaggregated industry classification unveils substantial heterogeneity across industries within manufacturing and services. As a result, it is imperative to first revisit the stylized facts found by McMillan and Rodrik (2011) and de Vries et al. (2012) in order to verify if they are also present in this paper's datasets.

Figure 1 displays the evolution of the employment share in manufacturing (Panel A) and in services (Panel B) for the 1981–1999 period.[4] The share of manufacturing employment after some oscillation in the 1980s presented a downward trend that began by 1990, and the employment share share ends up two percentage points smaller. This means a 20% decline in manufacturing employment, or slightly less than one million jobs. In Panel B, the services share in employment exhibited the opposite pattern, showing an upward trend since the early 1990s. And by the end of the decade the services share was up by approximately two percentage points. Such patterns match the findings of McMillan and Rodrik (2011) and de Vries et al. (2012) of a structural transformation towards the service sector in Brazil. In terms of output, the manufacturing and services shares of the Brazilian GDP over the same period were relatively stable at 33% and 58% respectively. Consequently, the labor reallocation pattern suggests a small decline in the productivity of the service sector, and an increase in productivity in manufacturing. This evidence upholds McMillan and Rodrik (2011) concerns that the trade-reform induced productivity growth in manufacturing by countries like Brazil may not necessarily translate into higher overall-economic productivity.

An important aspect of this labor reallocation towards services is whether former manufacturing workers migrated to high- or low-productivity services. McMillan and Rodrik (2011) consider high-

[4] Agriculture's share of employment remained stable during this period.

productivity services to be public utilities, transportation, communications, financial services, services provided to firms, and real estate services. Low-productivity services are construction, retail and wholesale, public administration, and personal and community services. Figure 2 exhibits the behavior of the low- and high-productivity services employment share. The share of high-productivity services seems flat. In contrast, the low-productivity share increased throughout the 1990s.[5] Hitherto, the results coincide with McMillan and Rodrik's (2011) finding that structural transformation has been heading the wrong way in Brazil. This analysis now turns toward potential explanations for the (premature) structural change in the Brazilian economy.

In a large body of literature in economic growth—for instance, Sposi (2012) and Uy et al. (2013)—structural change results from different total factor productivity (TFP) growth across industries as well as consumers with non-homothetic preferences. Such a mechanism hinges upon robust economic (and therefore income) growth as the engine for structural transformation. Nonetheless, Brazil in the 1980s and 90s experienced dismal economic growth. McMillan and Rodrik (2011) suggest three other factors that lead to structural transformation—appreciated real exchange rate, large natural resources endowment, and labor markets rigidities. To be more specific, these three factors cause labor reallocation towards low-productivity services. Although such factors may be at play in Brazil, a closer look at the industry-level descriptive statistics reported in Table 1 reveals substantial heterogeneity in the industry-level employment share over time, which can be seen in the relatively large ratio between the average and the standard deviation of the employment shares. This suggests that some factors are affecting industries differently, perhaps in addition to those identified by McMillan and Rodrik (2011).

The trade liberalization implemented in Brazil has been identified as one of the causes of the reduction in manufacturing employment and of the skill upgrade experienced by manufacturing as documented by Menezes-Filho and Muendler (2011) and Krishna et al. (2014), *inter alia.* Given that the service sector is comparatively less skill-intensive than manufacturing, this industry seems to be the natural destination of such displaced workers. Nonetheless, this explanation still does not account for the heterogeneity in employment share across service industries. Trade liberalization may have affected services through its linkages to manufacturing, and thus generate such heterogeneity through two channels. The first channel operates through manufacturing purchases of inputs produced by services firms. This is Dehejia

[5] Although manufacturing employment declines by one million jobs, manufacturing employment comprises less than one-third of the services employment. This makes labor reallocation towards services appear as a modest increase.

and Panagariya's (2014) argument that the manufacturing boom in India led to increased demand for services inputs. This does not; however, seem to be case for Brazil because no major expansion was experienced in manufacturing. Furthermore, according to the Brazilian Input-Output (I-O) matrix, the participation of services as manufacturing inputs is smaller than 10% in all manufacturing industries.

The second channel operates through the manufactured inputs purchased by the service industries. There is considerable heterogeneity across service industries in the usage of manufactured intermediate inputs. More specifically, on average, manufacturing intermediate inputs account for approximately 17.2% of the output of low-productivity services, whereas this figure is 9.3% for high-productivity services. Figure 3 exhibits the average ERP for the low- and high-productivity service industries during the Brazilian trade liberalization of the 1990s.[6] The effective protection increased by more than 50% for both industries due to lower tariffs on inputs. Notwithstanding that ERP is always lower for low-productivity services, the difference between high- and low-productivity services ERP decreased over time.[7] Also, at a more disaggregated level, the ERP changes are not uniform across industries. So, the effect of manufactured intermediate input tariff changes on the services employment share merits a careful investigation.

A prominent feature of developing economies is the existence of a large informal labor market that, by not following regulations, is considered more flexible and sometimes a last resort for displaced workers. Because informality in Brazil is more pervasive in services than in manufacturing (Firpo and Pieri, 2013), this could be another explanation for the labor reallocation towards services. The significance of this is that the negative effect on the economy-wide productivity due to the labor shift to services can be further magnified if it took place via the creation of informal jobs, which are usually considered less productive than their formal counterparts.[8]

Although there is no clear-cut definition of informality—see Schneider and Enste (2002) and Henly et al. (2009) for a discussion—in this paper, informal jobs are defined as in de Vries et al. (2012). An informal worker is either self-employed or an employee without a signed labor contract (*carteira assinada*).[9] Panel B of Figure 3 portrays the evolution of the share of informal jobs in the low- and high-productivity services. In both cases, the informality shares have increased, although the expansion

[6]The ERP is negative because the import tariff on services is assumed to be zero. Since the analysis utilizes changes over time, this assumption is inconsequential.

[7]A very similar pattern is revealed by a figure (available upon request) using aggregation by weighted average with employment shares as weights.

[8]See de Vries (2010), de Paula and Scheinkman (2010, 2011), and IADB (2010, Chapter 3) for evidence on this.

[9]The informality definition in Paz (2014) is payroll tax compliance. Thus, this paper's results are not directly comparable to Paz (2014).

is much more pronounced in the high-productivity services.

There are a few aspects that the above discussion cannot address due to the cross-sectional nature of the PNAD-Census data used. Chief among them is the difficulty of following workers as they switch industries and formality status. Existing studies that have tracked workers over time in Brazil—Muendler (2009) and Menezes-Filho and Muendler (2011)—indicate that displaced workers in manufacturing were not absorbed by exporting plants in manufacturing. Moreover, they either moved into the service sector (with no distinction among the service industries) or dropped from the formal labor market. The latter means that unemployment and informal employment cannot be distinguished in their data.

A major impediment of such analysis has been the lack of panel data encompassing both formal and informal workers. Fortunately, to the best of my knowledge, this paper is the first to employ the 1996 PME special supplement survey that provides information on the workers industry of employment and formality status in 1991 and 1996. One of its major strengths is the absence of attrition, which usually plagues panel surveys. Furthermore, it is also the survey with the longest time span that captures both formal and informal workers.

Table 2 presents the transition matrices elaborated with the 1996 PME supplementary survey data. Panel A exhibits the inter-industry and unemployment transitions for all workers regardless their formality status. In line with Muendler's (2009) and Menezes-Filho and Muendler's (2011) findings for formal workers, we can see that the manufacturing workers in 1991 that switched industries in 1996 moved into services. Moreover, approximately 75% of them ended up in the low-productivity service industries. A large part of the workers that were in the low-productivity service sector in 1991 did not switch sectors. Of the workers in the high-productivity services in 1991, approximately one-third moved to low-productivity services. In comparison to PNAD-Census data, the PME data shows a similar reallocation towards low-productivity services, although in the PME data high-productivity services showed a slight increase in size.

Yet, when such transitions are further broken down according to formality status in Panel B of Table 2, approximately 60% of those who switched from manufacturing to low-productivity services ended up in informal low-productivity services, whereas only one-third of those who switched to high-productivity services went to informal jobs. The conclusion here is that several important aspects of labor reallocation mentioned above are definitely left out by overlooking informality. Thus, analyzes using firm-level or administrative data are definitely incomplete. In considering these facts, the focus turns to a theoretical model that can formalize the mechanism through which tariff changes on manufactured inputs affect the employment share in services.

2.2 Theoretical Model

The trade-induced structural transformation mechanism examined in this paper is formalized in a streamlined model, in which access to manufactured intermediate inputs is the only channel affecting the services employment. The model features two countries: Home and Foreign. The term 'domestic' refers to Home, and Foreign variables will be denoted by *. For expositional purposes, the economies in both countries are similar.[10] Home is a small open economy in the same sense as in Flam and Helpman (1987). This means that Home can influence Foreign exports to Home but not the economic environment in Foreign.

Each country produces three goods: A is a final consumption and homogeneous (perhaps, agricultural) good; X is a composite differentiated manufactured good; and S is a homogeneous services good that cannot be exported or imported. The next step is to solve the consumer utility maximization problem in order to derive the demand functions. This is followed by outlining the production side of the economy. Finally, the general equilibrium equations of the model and the comparative statics are presented.

2.2.1 Consumer

The representative consumer is identical in both countries and maximizes an additively separable quasi-linear utility function given by

$$U = \mu_1 \ln(X) + \mu_2 \ln(S) + A, \quad X \equiv \left(\int_{i \in \Omega} x(i)^{\frac{\sigma-1}{\sigma}} di \right)^{\frac{\sigma}{\sigma-1}}, \tag{1}$$

where μ_1 and μ_2 are positive constants. The composite differentiated good exhibits the Dixit-Stiglitz "love for variety" preferences, in which $\sigma > 1$ is the elasticity of substitution across varieties, $x(i)$. The set of varieties available at Home either from imports or domestic production is given by Ω. The representative consumer's budget constraint is given by

$$\int_{i \in \Omega} p(i)x(i)di + P_S S + P_A A \leq I, \tag{2}$$

where $p(i)$ is the price of variety i, P_S and P_A are the prices of goods S and A respectively, and I is the

[10] This assumption can be easily relaxed, but doing so yields no new insights.

aggregate income arising from wages, profits of domestic firms, and the lump-sum transfer of the tariff revenues collected by the government.[11]

It is assumed that all consumers have at least a minimal level of income and parameter values are such that, in equilibrium, goods X , S, and A are consumed in positive amounts. In this case, the quasi-linearity of the utility function implies that total expenditure on the differentiated and on the service goods is constant and equal to μ_1 and μ_2, respectively. This useful property means that any impact on consumers' income—e.g., trade-induced changes in firms profits—affects only the demand for good A. Thus, the non-homothetic demand is not driving changes in the service sector's size and employment level. The solution of the utility maximization problem yields the following demand function for variety i of the differentiated good:

$$x(i) = P^{\sigma-1} p(i)^{-\sigma} \mu_1, \quad P \equiv (\int_{i \in \Omega} p(i)^{1-\sigma} di)^{\frac{1}{1-\sigma}}, \tag{3}$$

where P is the price index for manufacturing goods available at Home, which can be interpreted as the cost of buying one unit of X that comprises the optimal amount purchased of each variety. The demand for services is given by $S = \mu_2/P_S$. With the demand schedules, the production side of the economy is presented next.

2.2.2 Production

Home has a homogeneous labor force of size $\bar{L}$, which is inelastically supplied by the households and is the only factor of production. Populations of Home and Foreign are assumed to be large enough to prevent specialization in any country. As a result, both countries produce A, S, and a positive mass of varieties of good X. The Good A is freely traded with no tariffs or other costs in a perfectly competitive market. It is produced under constant returns to scale, and its measurement unit is normalized to be the amount produced by one unit of labor. Also, it is chosen to be the numeraire good with a unity price, $P_A \equiv 1$. Accordingly, the wage at Home (w) is one as well. These assumptions about A are designed to prevent movements in the wage, exchange rate, and terms of trade due to tariff changes. Furthermore, trade balance will always be in equilibrium due to free trade in A. In sum, trade liberalization affects the size of the service sector solely through the intermediate input mechanism, as explained below.

[11]Home households are assumed to own all domestic firms in equal shares.

The non-tradable service sector comprises identical firms with a constant returns to scale Leontief production function operating in a perfectly competitive market. More specifically, one unit of S requires a unit of labor (L_S) and a unit of materials (M). Note that M is a CES-style composite good comprised of all varieties of the manufacturing good available at Home,

$$S = min\left\{L_S, M\right\}, \ M \equiv \left(\int_{i\in\Omega} m(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right)^{\frac{\varepsilon}{\varepsilon-1}}, \tag{4}$$

where $\varepsilon > 1$ is the elasticity of substitution across intermediate input varieties, $m(i)$. It is assumed that $\varepsilon = \sigma$ for the sake of analytical tractability.[12] As a result, the price paid for each unit of M is P. This formulation captures increased access to imported intermediate input by means of price and variety, since both are reflected in P. And leads to a constant marginal cost, $MC_S = w + P$. Together with the fact that $w = 1$, perfect competition in the services market implies that $P_S = MC_S = 1 + P$. Hence, the demand for materials is given by

$$m_i = P^{\sigma} p_i^{-\sigma}\left(\frac{\mu_2}{1+P}\right). \tag{5}$$

Turning to the varieties produced in the manufacturing sector, the domestic demand for each variety (q_i) is the sum of the final consumer purchase with the inputs acquired by the service sector.

$$q_i = x_i + m_i = p_i^{-\sigma} P^{\sigma-1}\mu, \ \mu \equiv \mu_1 + \left(\frac{P\mu_2}{1+P}\right). \tag{6}$$

The differentiated manufacturing good sector is characterized by a continuum of monopolistically competitive firms, as in the heterogeneous firm model used by Davies and Eckel (2010) to investigate tax competition.[13] Each of these firms produces a different variety indexed by i. To serve the domestic market, firm i incurs a fixed cost of F units of labor. The production of each unit of the differentiated good implies a marginal cost of $a(i)$, with $a(i) \geq 1, a'(i) > 0$. The marginal cost can be interpreted as firm i's labor requirement to produce one unit of output. The firm-specific marginal cost is a random draw from a cumulative distribution function $G(i)$ with associated probability distribution function $g(i)$.

With knowledge of $a(i)$, firm i must choose to serve the Home market, the Foreign market through exports, both, or neither. Since firms' decisions are analogous in both countries, only the Home firm

[12]Relaxing this assumption generates the same qualitative results.

[13]This type of model was also used by Cole and Davies (2011) as well as Bauer, Davies, and Haufler (2014).

results are derived. The firm's profit maximization problem from serving the domestic market is

$$\Pi_{dom}(i) = \max_{p(i)} p(i)q(i) - [a(i)q(i) + F]\,. \tag{7}$$

Using the domestic demand function, equation (6), the solution of the formal profit maximization problem yields the equilibrium price and quantity functions:

$$p_{dom}(i) = \Psi a(i), \quad q_{dom}(i) = (\Psi a(i))^{-\sigma} \mu P^{\sigma-1}, \tag{8}$$

where $\Psi \equiv \sigma(\sigma-1)^{-1}$ is the price mark-up. Note that the quantity (and therefore labor usage) is increasing in the price index and decreasing in the index i.

If firm i chooses to export, it will incur an exporting fixed cost of F_x units of labor. It is assumed that $F_x > F$, which implies that exporters will also serve domestic markets, as was found to be the case by Bernard et al. (2003) for the United States and by Ellery and Gomes (2007) for Brazil.[14] Exporters suffer the incidence of an *ad valorem* exporting trade barrier (τ^*), which is modeled as an iceberg transportation cost for the sake of simplicity.[15] The profit maximization problem for Home exporters is given by

$$\Pi_{\exp}(i) = \max_{p(i)} \{p_i - (1+\tau^*)a(i)\} \mu^* p_i^{*-\sigma} P^{*\sigma-1} - F_x \tag{9}$$

Using the Foreign demand equation, the exporter profit maximization problem solution provides the following equilibrium price and profit, which are the last results needed before solving for the general equilibrium of the model.

$$p_{exp}(i) = \Psi^*(1+\tau^*)a(i), \quad q_{exp}(i) = \mu^* P^{*\sigma^*-1} \Psi^{*-\sigma^*} (1+\tau^*)^{-\sigma^*} a(i)^{-\sigma^*} \tag{10}$$

2.2.3 General Equilibrium

The three endogenous variables that are determined in general equilibrium are the index of the last domestic firm to enter the domestic market (N), the index of the last Foreign firm to enter Home market (λ_x^*), and the manufacturing price index (P). The three equations needed for this are described below.

Free entry implies that the last domestic firm ($i = N$) to enter the Home market is the one making

[14] See Baldwin (2005) for further discussion regarding this assumption in heterogeneous firm models.

[15] This means that the exporter ships $1+\tau^*$ units of the good and only one unit arrives at the destination.

zero profits. Accordingly, N is implicitly obtained by setting the profit from equation (7) equal to zero for $i = N$.

$$\mu P^{\sigma-1}\Psi^{-\sigma}a(N)^{1-\sigma}\{\sigma-1\}^{-1} - F = 0 \tag{11}$$

The last Foreign exporter to enter the Home market also makes zero profits, and its index is implicitly defined by equation (12).

$$\{\Psi-1\}\Psi^{-\sigma}\mu P^{\sigma-1}(1+\tau)^{1-\sigma}[a(\lambda_x^*)]^{1-\sigma} - F_x^* = 0 \tag{12}$$

Finally, using these aforementioned cutoffs, the equilibrium manufacturing price index at Home is:

$$P = \Psi\left(\int_0^N a(i)^{1-\sigma}di + (1+\tau)^{1-\sigma}\int_0^{\lambda_X^*} a^*(i)^{1-\sigma}di^*\right)^{\frac{1}{1-\sigma}} \tag{13}$$

2.2.4 Comparative statics

The effects of changes in the Home and Foreign trade barriers on the number of workers employed in the manufacturing and service sectors are examined in the following propositions. Their proofs are included in the Online Appendix.

Proposition 1. *A marginal reduction in domestic trade barriers decreases the demand for labor in the domestic manufacturing sector.*

The intuition of this result centers on the fact that a decrease in domestic trade barriers increases Foreign firms' profit from exporting to the Home market. Moreover, some Foreign firms that formerly did not find the Home market sufficiently profitable to incur the fixed cost of exporting will now choose to do so. Such increase in the mass of imported varieties that are now cheaper reduces the manufacturing price index at Home. As P falls, so do the output and profits of all Home firms that remain active. This profit reduction compels the least productive firms—i.e., those firms that were just barely covering their costs—to exit the market. Thus, N decreases and the mass of firms shrinks. The amount of labor hired by manufacturing firms decreases because the mass of manufacturing firms shrinks and every surviving manufacturing firm also reduces their labor demand.

Proposition 2. *A marginal decrease in the Foreign trade barriers increases the amount of labor hired in* *the domestic manufacturing sector.*

A reduction in Foreign trade barriers increases the demand for Home-made manufacturing varieties. This expands the domestic exporters' profits from exporting to the Foreign market. In this vein, some domestic firms that formerly did not find the Foreign market sufficiently profitable to incur the fixed cost of exporting will now choose to export. As a result, the employment level of the domestic exporters grows due to the larger output of current exporters and to the larger mass of exporters. The small open economy assumption implies that the only effect of a change in τ^* in the Home economy happens through the domestic exporters.

Proposition 3. *A decrease in the domestic trade barriers levied on the manufactured intermediate inputs consumed by the domestic service sector expands its employment level.*

A reduction in domestic barriers lowers P, which is also the price of the composite input (M). This leads to a decrease in the marginal cost of all services firms, and thereby a reduction in the price of services. Consequently, the demand for services grows, as does the employment in services. This paper now turns to the econometric methodology employed to evaluate these testable predictions.

3 Econometric Methodology

In this paper's empirical exercise, Brazil is considered as the domestic country, while the Foreign country consists of an aggregate of Brazil's trade partners. The Foreign trade barriers consist of the output tariff imposed on Brazilian exports by the Foreign country, hereafter called *export tariff*. The domestic trade barriers are measured as the effective rate of protection faced by Brazilian firms in the domestic market. Besides the protection resulting from output import tariffs, ERP also reflects the increased protection from a reduction in the intermediate input tariffs.[16] Intuitively, the latter gives domestic firms a cost advantage in relation to foreign competitors. Such cost advantage implies a larger output and employment level for Home firms. Note that this conclusion is valid for both manufacturing and services firms.

[16] Although intermediate inputs are found to play an important role in manufacturing—as documented in Schor (2004), Lopez (2006), Amiti and Konings (2007), and Ahsan (2013)—their introduction in the current setup is not analytically tractable on grounds of introducing simultaneity among firms' profit maximization problem, because each manufacturing firm's output will depend on the other manufacturing firms' demand for manufactured inputs.

3.1 Industry-level employment share

The first econometric strategy is designed to use the PNAD-Census industry-level employment share data encompassing both manufacturing and services. It is illustrated by equation (14),

$$\Delta share_{jt} = c + \gamma_1 \Delta ERP_{jt} + \gamma_2 \Delta export\_tariff_{jt} + \Delta\theta_t + \Delta u_{jt}, \tag{14}$$

where $\Delta share_{jt}$ is the change in the share of industry j on the overall employment between years t and $t-1$. Similarly, ΔERP_{jt} is the industry j's change in the effective rate of protection, $\Delta export\_tariff_{jt}$ is the export tariff change faced by industry j's goods sold in foreign markets, $\Delta\theta_t$ represents the change in the year indicator variables, and Δu_{jt} is the change in the error term.

The ERP coefficient is expected to be positive if Propositions 1 and 3 hold because either an output tariff cut or an input tariff increase reduces the ERP, which in turn lowers industry-level employment. Propositions 1 and 3 can be evaluated separately when equation (14) is augmented to incorporate an interaction between ΔERP_{jt} and a service sector indicator variable. Finally, Proposition 2 implies a negative coefficient for export tariff because a drop in export tariffs leads to an expansion in exporters' employment.

Four crucial aspects of the above specification merit discussion. First, the first-difference eliminates any time-invariant industry specific characteristics, such as comparative advantage, proclivity for informality, and natural resource intensity.[17] The latter is one of the three causes of premature deindustrialization suggested by McMillan and Rodrik (2011). The other two are economy-wide causes—namely, labor market rigidities and real exchange rate appreciation, which are accounted for by including year effects in equation (14).

Second, both output import and export tariffs are not defined for the service industries due to their non-tradable nature. Because the specification is in first-difference, this issue is addressed by setting these tariff changes equal to zero for all service industries in all years of the sample.[18] This means that the ΔERP for the service sector will reflect only changes in its input tariffs. Moreover, its coefficient is then identified by the variation in all industries, whereas the export tariff coefficient is identified only by changes in the manufacturing industries. This is the case because equation (14) is in first-difference and

[17] The idea here is that some industries are less likely to hire informal workers because technological constraints make them too large to hide operations (e.g., a steel mill), whereas others (e.g., apparel) can be easily hidden.

[18] Although investigating somewhat different questions, a similar approach is used in McLaren and Hakobyan (2010), Topalova (2010), McCaig (2011), Autor, Dorn, and Hanson (2012), and Kovak (2013).

contains year effects.

The third issue is the possibility of reverse causality between the employment share and ERP.[19] This can occur if the government considers industry characteristics when determining the tariffs, such as size of the industry, skill level, and capital intensity, as discussed in Nunn and Trefler (2010). Those characteristics will then be contained in the error term. These omitted industry-specific factors that determine tariffs are correlated with right-hand-side variables, which leads to inconsistent estimates by Ordinary Least Squares (OLS) as long as they are time-variant. In this case, they are not canceled out by the first difference, and consistent estimates will require the use of the instrumental variable estimator and valid excluded instruments.

The literature has used two types of excluded instruments for the changes in tariffs during the Brazilian trade liberalization. The first type is based on the fact that the change in ERP is negatively correlated with the pre-reform ERP level. In other words, the higher the initial tariff the larger (in absolute terms) the change in tariffs (as can be seen in Figure 6). This instrument was used by Ferreira and Rossi (2003), Pavcnik et al. (2004), and Kovak (2013). Since it does not vary over time, we follow Pavcnik et al. (2004) by using its interaction with the Brazilian real exchange rate as an instrument.[20]

The other type of instrument is motivated by the change in ideology (or economic development strategy) that preceded trade liberalization in several developing countries. For instance, countries that used very protectionist trade policies—perhaps, based on the infant industry argument—found that highly protectionist policies hampered their economic growth when they contrasted East Asian economic performance to their own. For this reason, the resulting ideological change creates a positive correlation in the tariffs across countries that have engaged in trade liberalization.[21] Notwithstanding the decision to decrease tariffs, the magnitude of such cuts may still be subject to lobbies. Paz (2014) pointed out that as long as the manufacturing profiles of two countries are not similar, their lobbies interests will also differ considerably. Moreover, the correlation between tariffs will be solely due to the initial desire of trade liberalization. Thus, the Colombian tariffs during Colombian trade liberalization in the early 1980s

[19] Export tariffs are considered exogenous due to Brazil's very small participation in international trade flows. Section 4 further discusses this issue.

[20] An alternative identification strategy is the use of long differences, which allows the use of pre-reform tariff levels as instruments without the need to interact them with the real exchange rate. This type of approach is used in Kovak (2013) to study a different issue. Unfortunately, this strategy is unfeasible in the context of this paper due to the small number of industries, which renders only 26 observations. The results (available upon request) indicate a similar pattern in terms of coefficient signs; however, none of them are statistically significant, most likely due to the very small number of observations.

[21] The ideological change insight comes from Karacaovali (2011); however, Paz (2014) is the first to use it to build an instrument for tariffs.

could be used to compute an ERP measure to serve as an instrument for Brazilian ERP in the 1990s, because both countries shared this change in ideology and their industrial bases are relatively dissimilar, which means that the industry-specific time-varying factors of Colombia and Brazil are not correlated. Moreover, since the trade flows between these two countries are very small, it is highly unlikely that Colombia took into account Brazil's response when deciding its tariffs in the 1980s.

The last methodological issue with this econometric strategy is its inability to shed light on the role of workers' characteristics in the reallocation patterns. This would make it possible distinguish this paper's intermediate input tariff channel from employment in services as a last resort for the low-skill workers displaced from manufacturing due to skill-upgrade, as found by Krishna et al. (2014). To address this last issue, an econometric strategy using the PME worker-level panel data is developed next.

3.2 Effect of tariffs on worker-level industry reallocation

The second strategy analyzes the effects of tariffs on the worker's likelihood of switching to another industry in 1996 relative to the likelihood of staying in the same industry that he or she was affiliated with in 1991. The reallocation likelihood is modeled as follows. Let K_h be the set of potential outcomes in 1996 for a worker initially exhibiting outcome h in 1991. The likelihood (P_{ihk}) of worker i initially employed in h in 1991 switch to outcome $k \in K_h$ in 1996 is estimated through a multinomial logit specification as described below,

$$P_{ihk} = \frac{\exp(\delta_{1k}\Delta ERP_i + \delta_{2k}\Delta export\_tariff_i + m_i\beta_k)}{\sum_{n \in K_h} \exp(\delta_{1n}\Delta ERP_n + \delta_{2n}\Delta export\_tariff_n + m_i\beta_n)}, \tag{15}$$

where Δ represents the changes between 1996 and 1991, the ΔERP and $\Delta export\_tariff$ represent the change in tariffs in the worker's industry of affiliation in 1991, the latter is only included when the worker was employed in a manufacturing industry in 1991. The vector m_i contains a constant and worker's characteristics. Model identification is achieved by setting all coefficients of the base category ($k = h$) to zero, since $\forall h \sum_{k \in K_h} P_{ihk} = 1$.[22] The workers' characteristics included in the estimated specification are years of education, gender, age, age squared, and state of residence indicators. The latter set of indicators is included to address regional differences in labor regulation enforcement found to be important by Almeida and Poole (2013).

[22] To ensure a sufficient number of observations, the outcomes are an aggregated version of the industries (e.g., manufacturing, low-productivity services, and high-productivity services).

For a worker that is employed in manufacturing in 1991, Proposition 1 implies a negative ERP coefficient in the outcomes other than its affiliation in 1991 (base outcome) since an ERP cut reduces employment in its original industry and thus increases the relative likelihood of switching to other industries. Proposition 2 predicts a positive export tariff coefficient because a decrease in export tariff expands employment in the base outcome, and therefore decreases the relative likelihood of changing to other outcomes. For a worker initially employed in services, Proposition 3 predicts a negative ERP coefficient because a decline in input tariffs (i.e., an increase in ERP) reduces the firms' marginal cost and boosts their sales and employment levels. Thus, the probability of a worker switching to another industry relative to the probability of staying diminishes.

The endogeneity of ERP is also an important concern here. The non-linearity of the multinomial logit complicates matters considerably; however, the control function approach can address this issue.[23] The idea behind this approach is to approximate the effects of the omitted variables, as discussed in Petrin and Train (2010), Liu et al. (2010), Wooldridge (2010, pp. 652), and Kim and Petrin (2011). The control function can be motivated by breaking down the error term (ε_{ik}) that is implicit in equation (15) into two components: $\varepsilon_{ik} = \ell v_i + e_{ik}$.[24] The first is the industry-specific component (v_i) that is correlated to the change in ERP. Although this term is observable by the worker and firms in that industry, it is not by the researcher. The second component is an idiosyncratic error, e_{ik}, assumed to be independent across industries and workers. Since v_i is in the error term, ERP will be correlated with the error term, even after controlling for the other explanatory variables. This leads to inconsistent estimates due to the violation of the weak exogeneity assumption needed to estimate the multinomial logit specification.

Let $\mathbf{X_i}$ be a vector containing $\mathbf{m_i}$ and export tariffs, and let $\mathbf{Z_i}$ be a vector of variables that are not in $\mathbf{X_i}$ but are correlated with ERP and not with ε_{ik}. Making an analogy with instrumental variables, $\mathbf{Z_i}$ would be a vector of excluded instruments. Under certain regularity conditions, the change in ERP can be modeled as a function of all variables taken as pre-determined by the workers at the time of their decision, $\Delta ERP_i = \Delta ERP_i(\mathbf{X_i}, \mathbf{Z_i}, v_i)$.

The control function is built in two steps. The first step comprises a linear regression of the changes in ERP on $\mathbf{X_i}$ and on $\mathbf{Z_i}$, i.e., $\Delta ERP_i = E(\Delta ERP_i|\mathbf{X_i}, \mathbf{Z_i}) + \eta_i$, where $\hat{\eta}_i$ is the estimated residual of the regression and $\hat{\mathbf{\Lambda}}$ is the vector of estimated coefficients of $\mathbf{X}$ and $\mathbf{Z}$. The second step to create the

[23]As shown in Angrist and Pischke (2009), one should never replace the endogenous regressors in nonlinear specifications by their first-stage fitted values.

[24]For the sake of exposition, the index h is dropped since this approach is applied for each h separately.

control function, $f(\hat{\eta}_i, \hat{\mathbf{\Lambda}})$, involves generating a polynomial based on $\hat{\eta}_i$ that is a good approximation of ℓv_i. Then, the multinomial logit specification is augmented to include the control function term, as shown below.

$$P_{ihk} = \frac{\exp(\delta_{1k}\Delta ERP_i + \delta_{2k}\delta export\_tariff_i + m_i\beta_k) + f(\hat{\eta}_i, \hat{\mathbf{\Lambda}}))}{\sum_{n\in K_h}\exp(\delta_{1n}\Delta ERP_n + \delta_{2n}\Delta export\_tariff_n + m_i\beta_n + f(\hat{\eta}_n, \hat{\mathbf{\Lambda}}))} \tag{16}$$

As long as $f(\hat{\eta}_i, \hat{\mathbf{\Lambda}})$ is a good approximation of ℓv_i, there will be no correlation between import tariffs and the new error term, which is now composed of $\ell v_i - f(\hat{\eta}_i, \hat{\mathbf{\Lambda}}) + e_{ik}$. Since the specification has generated regressors, a bootstrap method is required to obtain consistent estimates of standard errors, as explained in Liu et al. (2010). Finally, a joint test of the null hypotheses that control function estimated coefficients in equation (16) are zero can be used as a test of the exogeneity of the import tariff, as suggested by Petrin and Train (2010).

4 Data Description and Historical Background

In this section, the Brazilian household surveys are described first. Next, the sources of the ERP and export tariff data are presented. Details regarding the construction of the variables are available in the Online Appendix.

4.1 Household survey data

The Instituto Brasileiro de Geografia e Estatística (IBGE, Brazilian Bureau of Geography and Statistics) conducts an annual household survey called 'Pesquisa Nacional por Amostra de Domicílios' (PNAD), which covers the entire country, with the exception of Northern rural areas.[25] PNAD is not conducted in census years and was not conducted in 1994 due to lack of funds. For the census year of 1991, Brazilian census microdata from IPUMS-International (Minnesota Population Center, 2013) is used in place of PNAD since it contains the very same questions as the PNAD survey. Along these lines, with the exception of 1994, annual data for the 1989–1999 period is used.[26]

The industry aggregation level used here is dictated by the PNAD industry classification, which consists of 16 manufacturing and 10 service industries. Workers included in the sample are those that are

[25] Together these areas account for less than 5% of the Brazilian population.

[26] The 1994 data gap is circumvented in the first-difference specifications by using the difference between 1995 and 1993 divided by 2.

either employees or self-employed and between the ages of 15 and 65 years. The age cutoff is chosen to exclude those who are too young (the minimum age to work in this period is 14) and those older than 65 that are already receiving social security benefits. The industry-level employment share is calculated as the number of workers in that industry divided by the total number of workers meeting the requirements mentioned above. Note that this calculation employs the sampling weights provided by the surveys. Table 1 provides descriptive statistics at the industry-level for this dataset.

Due to its pooled cross-sectional nature, the PNAD-Census dataset cannot be used to track workers over time. The only panel data available for Brazil covering both formal and informal workers comes from another household survey, the Pesquisa Mensal de Emprego (PME), also used by Menezes-Filho and Muendler (2011). In this survey, each worker is interviewed only twice, and these interviews are one year apart. This interval may be too short to allow the observation of the effects of tariffs changes. Moreover, a major shortcoming of the PME is the sample's large attrition—usually above 10%. This problem becomes more dramatic for workers with unstable jobs (presumably low-productivity services and informal jobs) that are more likely not to be found by the interviewer.[27]

Fortunately, in 1996, the PME questionnaire had a special supplement that asked workers who were at least 20 years of age in 1996 about their employment status and industry of affiliation in 1991. This precludes the important problem of attrition, and this five-year span is also long enough to capture the effects of tariff changes on industry reallocation. The last issue is that the PME covers only the largest metropolitan areas of Brazil. This would be a problem in the case of a major difference in workers' characteristics between metropolitan areas and the rest of the country. In Table 3, which reports industry-level descriptive statistics of PME data, we can see that the industry rankings in terms of employment share are comparable to those from the PNAD-Census dataset reported in Table 1. Even though the sample restrictions in terms of worker's age differ between the PME special supplement and the PNAD-Census datasets, the average of the workers' characteristics are roughly similar.

Few observations are missing from the questions used to determine workers' formality status, accounting for 0.5% of the sample at most. Furthermore, workers have no incentive to lie in these question because the questionnaire is confidential and cannot be used as evidence in court. More importantly, informal workers in Brazil face no penalty if caught by the authorities; in fact, only employers are penalized. Finally, workers are aware of their status since they have to hand in the work card, which contain

[27] Migration can be a source of attrition. See Aguayo-Tellez, Muendler, and Poole (2010) for evidence for Brazil.

the labor contract, to their employer and receive it back after having it signed.

4.2 Historical Background and Tariff Data

Until the end of the 1980s, Brazil followed an import substitution development policy that, in conjunction with a concern for the country's balance of payment deficits, guided the trade policy.[28] The former implied different levels and instruments of protection across industries—for example, large import tariffs and non-tariff barriers (NTBs) on imported goods that had a similar made in Brazil. The concern with balance of payment deficits led to high tariffs across all industries in order to lower imports. In 1988, Brazil unilaterally decided to change its trade policy by reducing its tariffs to a level that still curbed imports, although no changes were made to its NTBs as posited by Kume et al. (2003). In 1990, Brazil's new president drastically reduced NTBs and scheduled nominal tariff reductions to start in 1990 and end in 1994 (see Kovak, 2013). Panel A of Figure 4 shows the behavior of the average Brazilian ERP calculated with tariff data from Kume et al. (2003). Here, we can see a sharp drop in the ERP in the early 1990s as discussed before and a slight increase by 1995 due to the adoption of Mercosur's external common tariff. These tariff cuts ended up not following the planned schedule according to Kume et al. (2003, pp. 15; 2008, pp. 112). Nonetheless, the trade reform had real effects on the economy, as imports of manufactured goods increased by more than 200% and import penetration increased from 5.7% to 11.6%. Most important, the actual decrease in tariffs was not identical across industries, as shown in Figure 5. In particular, the industries with the largest absolute decrease in ERP are automobiles, apparel, textiles, and rubber products. These are also the industries with the largest pre-reform ERP levels.

The 1985 Input-Output table for Brazil from IBGE (2006) is used to calculate the ERP. The original I-O table is aggregated to match the 16 manufacturing and 10 service industries used in the PNAD-Census and PME data. The ERP for service industries is calculated using a zero output import tariff. Hence, it only reflects the input tariffs imposed upon manufactured intermediate inputs purchased by service industries. The I-O matrix is usually considered to be exogenous in the literature. For example, Amiti and Konings (2007) and Schor (2004) simply assume that firms input mix remains stable over time. This assumption seems reasonable because the Brazilian I-O tables for 1985, 1990, and 1995 are very similar. Thus, to prevent any contemporaneous correlation between tariffs and industries input mix reported in the I-O matrix, the 1985 I-O matrix is used.

[28] Kume et al. (2003, 2008) and Moreira (2009) provide a good description of Brazil's trade policy in the 1980s and 90s.

The first excluded instrument for the change in ERP is the ERP level in 1987 interacted with the change in the real exchange rate, from IPEA (2014). The other instrument is an ERP measure constructed with Colombian import tariff data for the 1984–1998 period from the Colombian National Planning Department (DNP).

Brazilian firms' access to foreign markets also changed during the 1989–1999 period for three reasons. First, the GATT Uruguay Round negotiations required the United States, Japan, the European Union, and other developed countries to reduce the tariffs imposed on their trade partners (see, e.g., Finger and Schuknecht, 1999). A paramount aspect of these changes noted by Abreu (1996, pp. 81) is that developing countries had hardly any influence on the agreed tariff cuts to be made by developed countries. Second, starting in 1991, the Mercosur customs union almost completely removed tariffs for the majority of goods traded among its members—namely, Argentina, Brazil, Paraguay, and Uruguay. Third, in order to join the WTO during the 1990s, China decreased its import tariffs, as discussed in Chandra (2014).

The choice of Brazil's trade partners considered here hinges upon data availability. The partner countries are Argentina, China, Japan, the United States, France, Italy, Germany, the United Kingdom, Belgium-Luxemburg, the Netherlands, Portugal, and Spain. They accounted for more than 60% of Brazil's manufacturing exports during the 1989–1999 period.[29] The export tariff variable used in the estimates consists of the simple average of each trade partner's import tariff for each of the 16 manufacturing industries.

These tariff reductions by Brazil's trade partners can be seen in Panel B of Figure 4, and they were accompanied by a 68% increase in Brazil's exports of manufactured goods. The industries with the largest decline in export tariffs are apparel, food and tobacco, textiles, footwear, and automobiles. Notice that tariffs exhibit a small downward trend from 1990 to 1994 due to the decrease in Argentina's import tariffs induced by the Mercosur agreement. After 1994, a pronounced decline in export tariffs takes place due to the Uruguay round tariff cuts. By contrasting Panels A and B of Figure 4, we can see that the changes in import and export tariffs happened at different points in time.[30] This ensures that their effects can be separately identified.

[29] Mercosur is not the major destination of Brazilian exports. In particular, by 1994, the exports to Mercosur countries reached volumes close to the exports to the United States or the European Union.

[30] Once year and industry effects are accounted for, the partial correlation between ERP and export tariffs used is 0.14.

5 Results

The testable predictions from Propositions 1–3 are first evaluated at the industry level using PNAD-Census data. Next, the focus shifts to the estimation of worker-level reallocation likelihood using the PME special supplement data. In both cases, the results obtained support Propositions 1–3, which are also found to be robust to several checks, including a falsification test.

5.1 Industry-level employment share

The effects of tariffs on the industry-level employment share are estimated by means of equation (14). Table 5 reports the results obtained by OLS and Instrumental Variables (IV) for manufacturing-only and manufacturing-plus-services samples. In all specifications, the standard errors are clustered at the industry level. Since the industry-level employment share is a generated variable, the observations are weighted by the inverse of the number of workers used to compute the dependent variable.[31]

Columns (1) and (2) report the estimates obtained using only manufacturing industries. In column (2) the signs of the IV-estimated coefficients are in line with Propositions 1 and 2, and the ERP coefficient is statistically significant at the 5% level. These coefficients can be interpreted as follows. A ten percentage point decrease in export tariffs leads to an increase of 0.06 percentage points in the industry-level share of overall employment. A similar change in ERP decreases employment share by 0.04 percentage points. The magnitude of these figures is not trivial since, for instance, the largest employment share for a manufacturing industry is 4.1 percentage points and the average ERP change is about 30 percentage points.

Moving to the estimates that use both manufacturing and services data, columns (3)–(6), we can see that the IV estimates also portray the expected signs from Propositions 1–3. Interestingly, in columns (3) and (4), none of the coefficients are statistically significant; however, this changes when the ERP coefficient is allowed to vary across industries. Column (5) features an additional endogenous regressor that is the interaction of ERP with a service indicator. This estimated coefficient is positive as predicted by Proposition 3 and statistically significant at the 10% level. Instead of an indicator variable for all service industries, Column (6) specification includes low- and high-productivity service indicators interacted with ERP. Both interactions exhibited positive coefficients, but only the coefficient for low-productivity services

[31] Estimates without weights provide qualitatively similar results.

is significant at the 5% level.

Although the null of exogeneity is not rejected at the 5% level in columns (2), (4), and (5), it is rejected at the 10% level in the preferred specification, column (6). When contrasting the OLS and the IV results, a noticeable feature is the sign reversal of the ERP coefficient. Such reversal can be explained by smaller tariff cuts in industries more inclined to shaving excess labor due to a government aversion to unemployment.

A major concern with IV estimates is the weak instrument problem. In Table 5, the Kleibergen-Paap statistics are always larger than the Stock-Yogo reference levels when the latter exists. The first-stage regressions reported in Table C1 in the Online Appendix indicate that the excluded instruments are statistically significant at the 5% level. Angrist and Pischke (2009) suggested that in the case of more than one endogenous regressor, the Angrist-Pischke F-statistics should be used because it is computed for each first-stage regression separately. Fortunately, such statistics are always above 80 and the null of this test is always rejected at the 5% level. Another check suggested by suggested by Angrist and Pischke (2009) is to re-estimate Table 5 specifications using limited information maximum likelihood. The results are similar and available upon request. These checks indicate that weak instruments are not a concern here.

Even though the IV-estimated coefficients exhibited the expected signs, a few were not statistically significant, still the joint test of significance suggests that they are in some cases statistically different from zero at the 5% level. This constitutes a weakness of this approach, resulting from the small number of observations due to the industry aggregation level. Fortunately, the analysis at the worker level utilizes a larger number of observations and will corroborate the above results as seen below.

5.2 Worker-level specifications

At the worker-level, implications of Propositions 1–3 are evaluated by means of a multinomial logit model used to estimate the effects of tariffs on the likelihood of switching to another industry relative to not switching. The transitions data reported in Table 2 suggest that the formal-informal margin is potentially crucial to understand the effects of tariffs on labor reallocation. To confirm this, the multinomial logit specification is estimated with different sample cuts.

The first sample cut keeps only workers that held a formal job in 1991. Columns (1)–(4) of Table 6 exhibit the estimates using equation (15). Panel A reports the coefficients for workers initially affiliated with manufacturing, in which the base category is having a formal job in the same manufacturing industry. The remaining categories are as follows: employed in a formal job in other manufacturing industries, low-productivity services, high-productivity services, and other. Note that 'other' includes both unemployment and informal employment in any industry.[32] The change in export tariffs is not statistically significant for other manufacturing and 'other'. But, in line with Proposition 2, it is positive and statistically significant for the service industries, columns (2) and (3). This means that a decrease in export tariffs makes the relative probability of switching to services smaller. The prediction of Proposition 1 is not supported because the ERP coefficient is positive and statistically significant for the service industries. The estimated coefficients for years of education imply that highly educated workers are relatively more likely to switch to high-productivity services in relation to staying in manufacturing.

For workers initially employed in low-productivity services, the results in Panel B indicate that the estimated ERP coefficient for 'other' and for manufacturing outcomes is negative, as suggested by Proposition 3. Interestingly, it is positive but not significant for the high-productivity services. Furthermore, specifications using workers that were initially employed in services report only ERP coefficients since an export tariff is not defined for the service sector. The years of education coefficient indicates that having more education increases the relative likelihood of switching to manufacturing and high-productivity services. Panel C results for workers originally employed in high-productivity services exhibit a similar pattern regarding the ERP coefficient. The coefficient of years of education is not statistically significant but is negative in most cases.

Now, to address the endogeneity of ERP, a control function term is included in the econometric specification, as illustrated in equation (16).[33] The estimates are reported in columns (5)–(8). The main differences relative to the results without the control function in columns (1)–(4) are in the estimated ERP and years of education coefficients in Panel A. The ERP coefficients are now negative in all columns, as predicted by Proposition 1, and statistically significant for services outcomes. The coefficient of years of education is positive and significant for both service industries. Accordingly, highly educated workers are relatively more likely to switch to services than to stay in manufacturing. The relevance of the control function term is assessed by a Wald test with a null hypothesis that the control function term coefficient

[32] A weakness of the multinomial logit specification is the assumed independence of irrelevant alternatives. Although there are Hausman-type and Small-Hsiao tests, they perform poorly as discussed in Long and Freese (2006, pp. 243–246). When computed for this papers' specifications, the results (available upon request) were inconclusive.

[33] The estimates of the first step of the control function are available in Table C2 in the Online Appendix. Several polynomials of different orders of the residuals of the regressions in Table C2 were tried. Interestingly, these polynomials led to very similar results. Thus, the first-degree polynomial was chosen to be used in the estimates reported in this paper.

is equal to zero for all outcomes. The null is rejected at the 5% level of confidence for all panels, which confirms that endogeneity is an important matter.

The second sample cut considers both formal and informal workers. The results are reported in Table 7. Columns (1)–(4) contain the estimates without control function, and columns (5)–(8) contain those with control function. Once again, the use of a control function to address the endogeneity of the change in ERP affected mostly Panel A (i.e., manufacturing workers) specifications that exhibited sign reversal for the ERP coefficient in the services outcomes.

The differences in the results obtained through the use of a control function with respect to those in Table 6 merit some discussion. For Panel A, the ERP coefficient for high-productivity services is no longer statistically significant. This can be explained on the grounds of manufacturing informal workers not being likely to switch to high-productivity services. Such conjecture will receive additional scrutiny next, when the outcomes are further disaggregated according to job formality status. The ERP coefficient became positive and significant for unemployment. This suggests that a reduction in protection makes workers relatively less likely to become unemployed. The sign reversal for unemployment is likely to be another result due to the aggregation level of outcomes. Recall that, in Table 5, 'other' included both unemployment and informality; hence, the sign reversal means formal workers are becoming informal rather than unemployed. The results in Panel B of Table 7 are comparable to those in Table 6. Panel C coefficients have a signal similar to those in Table 6, but they are not statistically significant coefficients in the specification with control function. An explanation for this is that informal workers seem to be less inclined to switch to industries other than services, as suggested by Panel B of Table 2.

A new set of estimates is obtained using the second sample cut with a different set of outcomes. More specifically, the previous outcomes are now broken down by formality status.[34] A shortcoming of this new set of outcomes is the lack of sufficient transitions to identify the coefficients for the unemployment outcome, which is then dropped. The estimates using the control function for manufacturing are reported in Table 8, and those for services are displayed in Table 9.

Panel A of Table 8 exhibits the estimates for the formal workers employed in manufacturing in 1991. The export tariff and ERP coefficients for the services outcomes support the predictions of Propositions 1 and 2, while the coefficients for the remaining outcomes are not statistically significant at the 5% level. For

[34] After every multinomial logit estimation, a Wald test was conducted to verify whether some of the categories could be merged together, i.e. if two outcomes are indistinguishable with respect to the explanatory variables in the model. In all cases, the test results (available upon request) indicated at the 5% level of confidence that no categories could be combined.

informal jobs in the same manufacturing industry outcome, both tariff coefficients have the expected sign but are only significant at the 10% level. This means that export tariff decline makes workers relatively less likely to become informal, while a cut in ERP has the opposite effect. The years of education coefficient is positive and statistically significant for the services outcomes. This conveys that high-skill formal manufacturing workers are relatively more likely to switch to services. The estimates in Panel B are for the manufacturing workers that initially held an informal status. The export tariff coefficients are somewhat similar to those in Panel A, except that it is no longer significant for formal low-productivity services. The ERP coefficients are not significant in any services outcome. The estimated coefficient for years of education is always positive but not significant. A closer look at the estimates for the same manufacturing industry formal outcome reveals a negative export tariff and a positive ERP coefficient significant at the 10% level. These estimates mirror those for the same manufacturing industry informal outcome from Panel A. So, there is labor reallocation along the formal-informal margin in manufacturing and it happens within the manufacturing industry, as found by Paz (2014) using PNAD-Census data.

Moving to services, Panel A of Table 9 displays estimates for the formal workers employed in low-productivity services in 1991. As can be seen, a decrease in ERP makes workers more likely to switch to an informal job in manufacturing and to an informal job in the same industry relative to staying in the initial outcome. The latter result indicates that the within-industry formal-informal adjustment margin is also operating here. Unexpectedly, the ERP coefficient for both formal and informal high-productivity services is positive. And the years of education coefficients that are significant are positive for informal manufacturing and negative for high-productivity services. The significance of these results is that an increase in ERP (or input tariff fall) makes high-skill workers more likely to switch to high-productivity service industries than low-skill workers. For informal low-productivity service workers, Panel B results are comparable to those in Panel A, with the exception that the years of education coefficients are now positive for high-productivity services outcomes. This result indicates that those workers who are more educated are relatively more likely to transition to high-productivity services.

Coefficients for formal workers initially employed in high-productivity services in 1991 are reported in Panel C. The ERP coefficient is negative for all outcomes as predicted by Proposition 3. The years of education coefficient is positive for formal manufacturing and negative for the remaining outcomes. It is worth noting that the negative ERP coefficient for informal high-productivity services, column (6), suggests that the formal-informal margin is present in this industry; furthermore, and the negative but statistically insignificant coefficient for years of education implies that, in contrast with informality in low-productivity services, high-productivity informality status is not heavily dependent upon workers' level of education. Finally, Panel D provides estimates for the informal high-productivity services. They are comparable to those for formal high-productivity services and also in line with Proposition 3. Here, the ERP coefficient also affects the formal-informal margin. Note that this time the ERP coefficient is statistically significant at the 10% level for formal manufacturing. As a result, reallocation to these industries is less likely than suggested by Panel C.

5.3 Discussion of the Results

The above estimates are now evaluated in terms of the support they provide to Propositions 1–3, and contrasted to the findings of earlier studies. The industry-level estimates uphold for Propositions 1 and 3 because a reduction in ERP decreases the employment share in both the manufacturing and service sector. In contrast to Wacziarg and Wallack (2004) and Firpo and Pieri (2013), this paper finds that the employment share in manufacturing does respond to changes in trade protection. As expected, the export tariff coefficients were negative. Also, they lacked statistical significance, though the null hypotheses of the joint coefficient tests were rejected at the 5% level. Hence, support for Proposition 2 is scant. This result, together with the strong support for Proposition 1, is consistent with the estimates from the cross-country study of Lopez and Alvarez (2012). Moreover, the mild export tariff effect is not surprising in light of Menezes-Filho and Muendler's (2011) finding that Brazilian exporters did not increase their employment substantially during this period.

Using a back-of-the-envelope calculation, the manufacturing industries faced an average reduction of 8 and 33 percentage points in export tariffs and in ERP, respectively. Multiplied by the estimated coefficients of column (6) in Table 5, this explains the reduction in the manufacturing share of 0.4 percentage points, which accounts for 20% of the observed change of two percentage points. For the service industries, the increase in ERP (induced by a decrease in input tariffs) was approximately 5 percentage points. Using coefficients from column (5) of Table 5, a similar calculation results in an expansion of 0.895 percentage points in services employment share, which represents 55% of the observed increase. Now, using estimates from column (6), the low-productivity services experienced an increase in ERP of four percentage points leading to a growth of 0.708 percentage points—that is 40% of the observed increase in the employment share. The model performs poorly for the employment share in high-productivity services—as suggested by its coefficient's lack of statistical significance—because the sector actually contracted, despite the predicted expansion.

At the worker level, the estimates backed Propositions 1–3. The results of Table 6 are comparable to those in Menezes-Filho and Muendler (2011) in the sense that a decrease in protection makes manufacturing workers relatively more likely to switch to service industries; however, Table 6 implies the novel result that a transition to low-productivity services is more probable than to high-productivity services even after controlling for worker's characteristics. Moreover, the positive coefficient for the worker's years of education indicates that reallocation was less likely for low-skill workers. So, services in general and low-productivity services in particular are not just a last resort for low-skill workers, such as those displaced due to the skill upgrade in Brazilian manufacturing revealed by Menezes Filho and Muendler (2011) and Krishna et al. (2014). For the worker originally employed in service industries, this paper uncovers the important role of intermediate input tariffs on the odds of their labor reallocation: the lower the input tariffs, the lower the likelihood that are the service workers will switch to other industries.

The results of Tables 6 and 7 not only provide support to Propositions 1–3 but also suggest that job informality plays an important role in the labor reallocation. For manufacturing workers, the results of Table 8 are in line with Paz's (2014) findings that an export tariff cut reduces industry-level informality whereas a reduction in protection increases industry-level informality. Moreover, as pointed out by Wacziarg and Wallack (2004) and Firpo and Pieri (2013), changes either in ERP or in export tariff lead to no reallocation between manufacturing industries. The reallocation of informal manufacturing workers towards services is not affected by changes in ERP. One possible explanation is that these workers have a substantial industry-specific human capital that would not be rewarded in the service sector.

Besides backing Proposition 3 in most cases, the estimates for service workers reported in Table 9 review a new result that is the effect of input tariffs (via ERP) on job informality in the service sector. More specifically, an increase in ERP decreases the relatively likelihood of a formal worker in low-productivity services to become informal, and raises the likelihood of an informal low-productivity worker switching to a formal job. Within-industry informality changes also take place in high-productivity services.

In sum, this paper's results confirm that the 1989–1999 Brazilian trade reform led to a shrinkage in manufacturing employment share, and at the same time an expansion in services employment share. And this increase in service industries' employment share was affected by the reduction in the manufactured intermediate inputs tariffs. Moreover, a large informal labor market can confound the identification of such effects if left unaccounted for, since findings reveal a noteworthy number of formal-informal transitions taking place within- and between-industries.

5.4 Robustness exercises

Several checks were conducted to ensure the robustness of this paper's results. Regarding the industry-level estimates, the checks performed consisted of re-estimating Table 5 models using export tariff and ERP lagged by one period to allow for a sluggish response to tariff changes, and ERP calculated using I-O matrices for 1990 and 1995. All of these estimates (available upon request) produced similar results. The export tariff contains Argentina's import tariffs levied on Brazilian goods. Since most of the changes in these tariffs are attributed to the Mercosur Trade Agreement, such tariff levels might be endogenous. To investigate this issue, the Argentinean tariffs were excluded from the calculation of the export tariffs and Table 5 specifications were re-estimated. The new coefficients (available upon request) were very similar to the prior ones.

The validity of the instrument set used in the estimates of Table 5 has been called into question recently in different contexts—for instance, see Karacaovali (2011). To address this relevant concern, the specifications of Table 5 were re-estimated using instruments based on Colombian tariffs, as suggested by Paz (2014). The results are reported in Table C3 of the Online Appendix, and are qualitatively comparable. The coefficients of the interactions between ERP and services indicators are larger, and the interaction between ERP and the high-productivity services indicator is now statistically significant. Additionally, the null of exogeneity of ERP is rejected at least at the 10% level in all columns.

An important question is whether the results obtained are driven by pre-existing trends in the data—e.g., the labor reallocation from manufacturing to services may have already been under way when the trade liberalization took place. A falsification test (i.e., placebo regression) was used to assess this possibility. Table 5 estimates were replicated using industry-level share of employment between 1981 and 1990 instead of between 1989 and 1999. Results are reported in Table 10. Here, we can see that tariffs and their interactions with services indicators are unable to explain the changes in employment share. More precisely, they are not statistically significant at the 5% level. Such results validate this paper's main finding that trade liberalization is one of the drivers of the reallocation of labor from manufacturing to services.

Turning to the worker-level specifications, a number of robustness exercises were also conducted for the specifications from Tables 6–9 (results available upon request). First, the export tariff was replaced by a version that did not include Argentina's tariffs as explained above, and the results were very similar. Second, the changes in export tariffs and ERP were replaced by those between 1995 and 1991. Again, the estimates were comparable. Third, the state indicators were replaced by city indicators, and qualitatively similar results were obtained. Finally, to investigate the possibility that one metropolitan area was driving the results, the specifications were re-estimated excluding one metropolitan area at a time. No significant change was detected in any of the restricted samples used.

6 Conclusions

Structural change is an important component of economic development. It can foster overall economic growth when labor is reallocated from low- to high-productivity industries. Developed countries first exhibited such transformation from agriculture to manufacturing, and then from manufacturing towards high-productivity services. McMillan and Rodrik (2011) pointed out that not all developing countries have followed this track. In contrast to East Asian economies, Latin American countries started the transition from manufacturing to services before the manufacturing sector accounted for a substantial part of their GDP. Hence, McMillan and Rodrik (2011) called this phenomenon 'premature deindustrialization'. Such transition acquires dramatic contours in Latin America because the labor leaving manufacturing is heading to low-productivity services, thereby reducing overall economic growth.

An interesting feature of this phenomenon is that it took place concurrently with major trade policy changes. Such concurrence motivated this paper's investigation of whether trade liberalization affected industry-level employment shares. The focus is on an overlooked channel through which tariff changes affect the access to manufactured intermediate inputs by service industries. A stylized theoretical model was developed to formalize this mechanism. This model predicts that a decrease in the effective rate of protection reduces the employment share of both the manufacturing and service industries. The latter is affected via tariffs on the manufactured intermediate inputs purchased. In contrast, a cut in the tariffs levied by trade partner countries enlarges the manufacturing employment share. Such predictions are taken to the 1989–1999 Brazilian trade liberalization episode using two different datasets based on household surveys.

The results obtained from industry-level data confirm a positive effect of ERP on both manufacturing and services employment share. In fact, these estimates account for approximately 20% and 40% of the observed changes, respectively. Moreover, this estimated change in services took place through the manufactured intermediate input channel. The worker-level panel data provides a sharper picture of the determinants of reallocation. In this case, export tariff cuts makes manufacturing workers less likely to switch to service industries, while a fall in ERP has the opposite effect. For workers initially employed in services, increased access to imported manufacture inputs—i.e., an increase in ERP—reduces their relative likelihood of reallocating to manufacturing. Interestingly, such increase in ERP leads services informal workers to switch towards formal jobs in the same industry. Thus, the formal-informal margin of adjustment is also present in the service industry.

Note that the results found here are complementary to McMillan and Rodrik's (2011) main drivers of premature deindustrialization, including appreciated exchange rate, large natural resources endowment, and labor market rigidity. Thus, an important avenue of future research consists of investigating additional factors that also contributed to this labor reallocation towards low-productivity service, as in the Brazilian case, instead of towards high-productivity services, as in South Korea.

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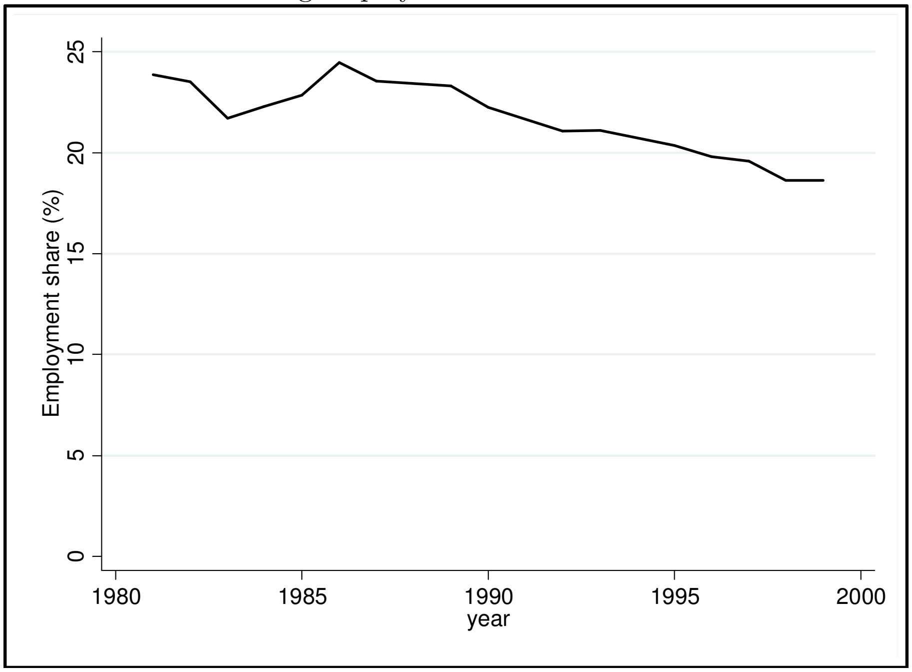
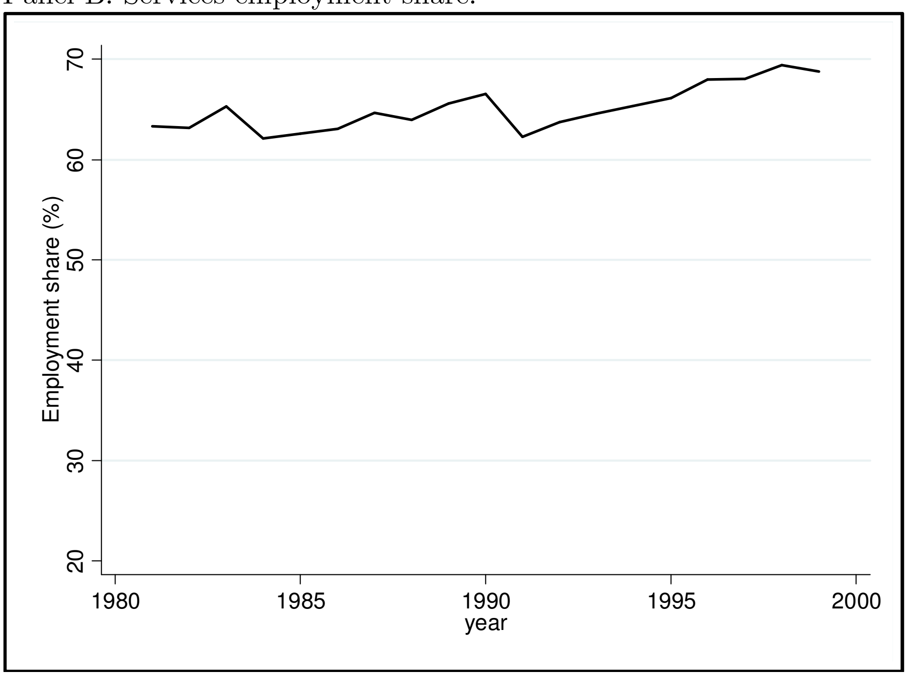
Figure 1- Employment share by sector.

Panel A. Manufacturing employment share.



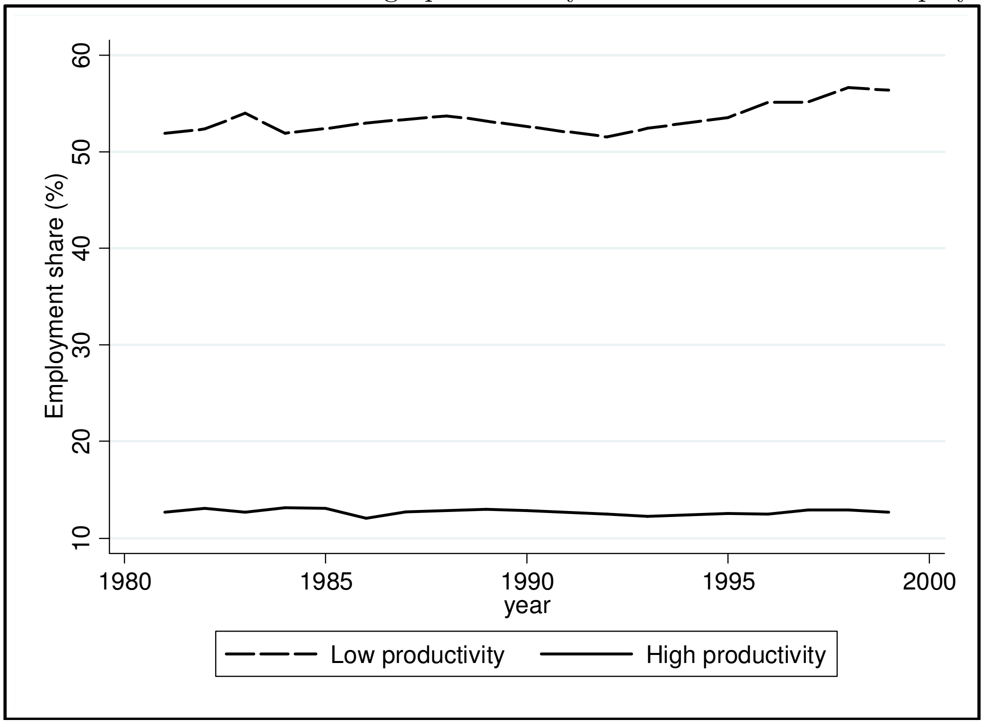
Panel B. Services employment share.



Notes: Workers are restricted to those between the ages of 15 and 65 years. Source: PNAD and Census data.

Figure 2 – Employment in services according to McMillan and Rodrik's (2011) productivity classification.

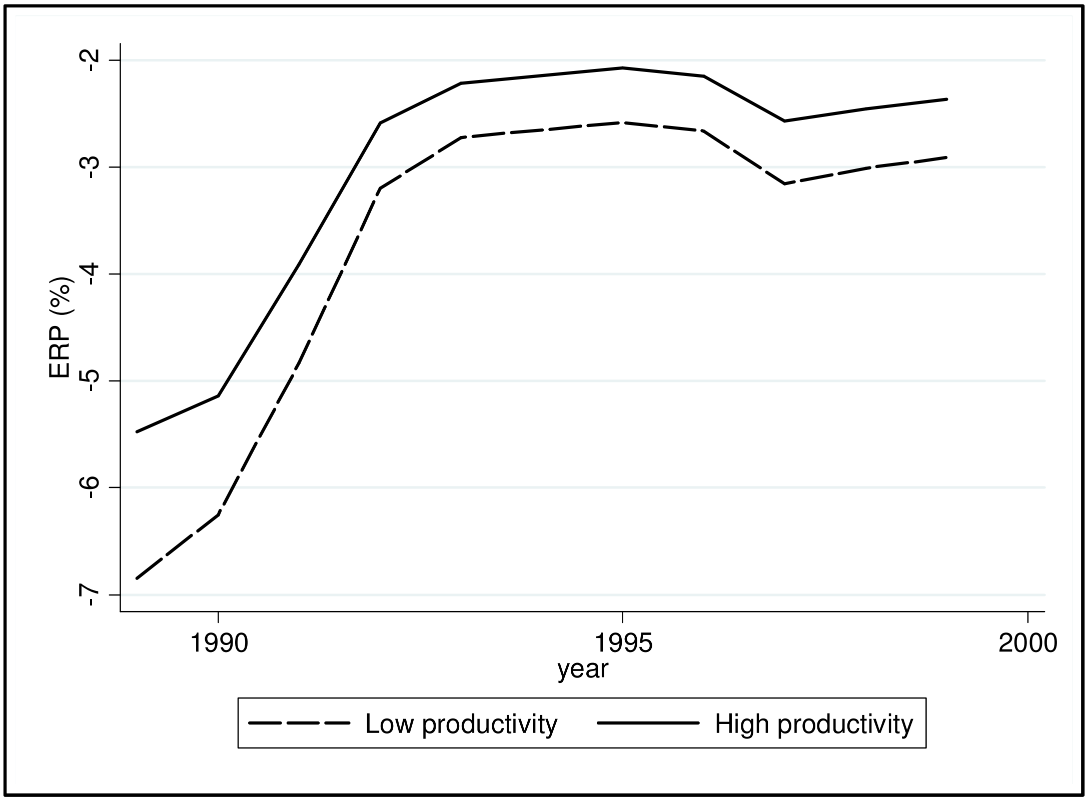
Panel A. Share of low- and high-productivity services in the overall employment.



Panel B. Informal job shares within low- and high-productivity services.

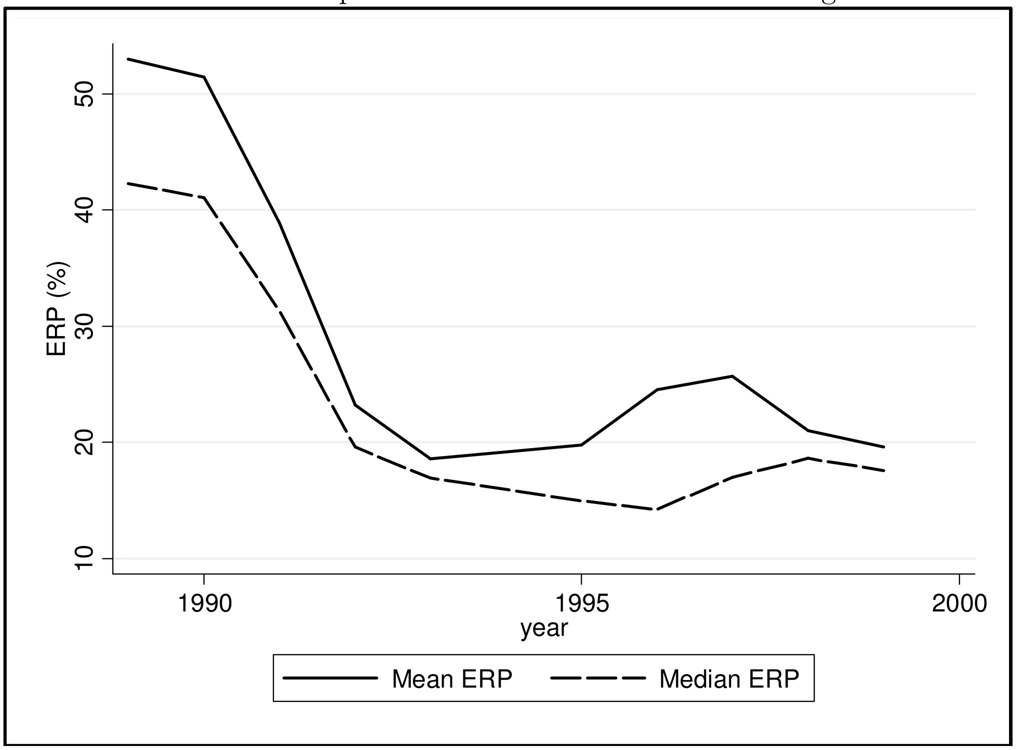
Notes: Workers are restricted to those between the ages of 15 and 65 years. An informal worker is defined as a self-employed worker or one without a signed labor contract. Source: PNAD and Census data.

Figure 3 – Average effective rate of protection (ERP) for low- and high-productivity services industries.



Notes: ERP is calculated using weights from the 1985 Input-Output matrix, and is aggregated into low- and high-productivity industries by simple average.

Figure 4 – Tariffs levied on manufacturing industries.
Panel A. Effective rate of protection for Brazilian manufacturing industries.



Panel B. Export tariffs imposed on Brazilian manufacturing industries.

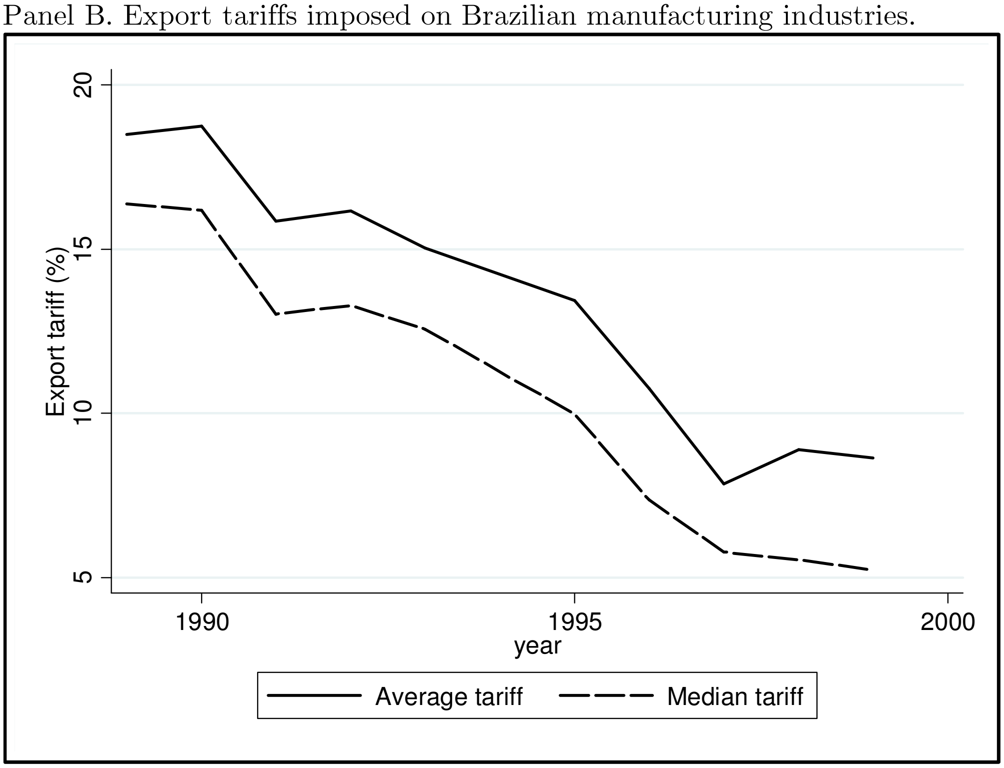
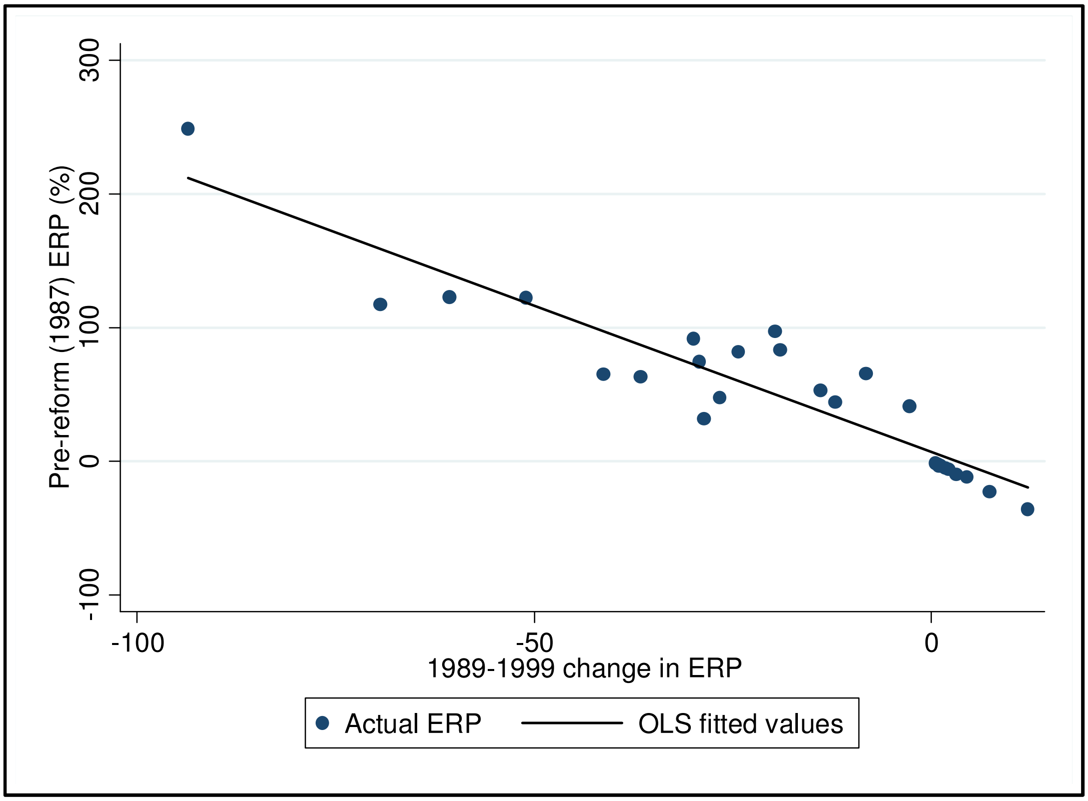


Figure 5 – Industry-level pre-reform (1987) effective rate of protection (ERP) and its 1989–1999 ERP change.



Notes: Correlation between the variables is -0.81. Regression coefficient of the fitted line is -2.19, the standard error is 0.184, and the t-statistic is -11.95.

Table 1 – Industry-level descriptive statistics of the 1989–1999 PNAD-Census dataset.

	Employment share (%)		Age		Years of education		Male share (%)	
Industry	average	std. dev.	average	std. dev.	average	std. dev.	average	std. dev.
Nonmetallic mineral products	1.329	0.148	30.770	0.702	5.126	0.332	89.814	1.678
Machinery, equipment and commercial installation	1.030	0.210	33.252	0.643	7.667	0.417	85.121	2.506
Wood sawing and wood products	1.717	0.112	30.825	0.858	5.233	0.300	89.861	1.372
Pulp and paper production, printing and publishing	1.204	0.146	31.47	0.493	8.084	0.557	75.193	3.345
Rubber products	0.220	0.066	32.552	1.732	7.006	0.492	83.354	3.470
Oil refining and petrochemicals	0.200	0.043	35.015	0.931	9.566	0.327	84.343	2.860
Pharmaceutical, perfumes, detergents and candles	0.375	0.064	32.097	0.974	8.770	0.579	62.570	2.605
Plastics products	0.514	0.07	30.758	0.459	7.028	0.496	68.901	2.153
Textiles	1.107	0.279	31.358	0.830	6.590	0.572	57.686	1.941
Apparel	1.884	0.258	31.792	1.453	6.315	0.464	19.992	1.131
Footwear and leather products	1.044	0.127	29.123	0.799	5.944	0.349	53.479	2.518
Metals production and processing	2.315	0.299	32.581	0.409	7.141	0.336	89.436	1.149
Electrical and electronic equipment	0.878	0.242	30.899	0.602	8.592	0.496	71.845	3.368
Automobile, truck and bus	1.283	0.324	33.599	0.562	7.704	0.698	87.442	1.470
Chemicals and fertilizer	0.825	0.100	33.524	0.840	7.534	0.400	82.294	1.289
Coffee, food, beverages, animal feed and tobacco	3.666	0.492	31.259	0.370	6.129	0.358	73.673	1.424
Other manufacturing industries	0.545	0.076	29.141	0.942	7.324	0.412	58.413	2.850
Public utilities	0.858	0.161	37.164	0.664	8.868	0.278	84.846	1.573
Construction	6.622	0.461	32.588	0.939	4.540	0.244	96.018	1.410
Wholesale and retail	12.449	0.661	29.518	1.050	7.677	0.405	63.669	0.967
Transportation	4.286	0.15	34.724	0.557	6.276	0.359	92.342	0.908
Communications	0.707	0.133	33.674	0.675	10.045	0.302	67.905	2.654
Financial services	2.349	0.472	31.898	0.798	11.560	0.356	56.491	4.317
Personal and non-commercial services by private entities	24.863	4.037	31.824	1.059	5.967	0.338	31.577	2.380
Services provided to firms	3.868	0.725	31.100	0.704	8.959	0.395	67.200	1.330
Real estate services	0.389	0.064	33.257	1.356	9.096	0.955	56.669	7.169
Public administration	10.203	3.984	35.696	0.411	8.487	0.695	40.653	1.430

Table 2 – Workers' inter-industry employment transitions between 1991 and 1996.

Panel A. Aggregate transition matrix.

Status in 1991 / Status in 1996	Unemployed	Manufacturing	Low-prod. services	High-prod. services	Total
Unemployed	3.38%	1.06%	4.59%	0.77%	9.80%
Manufacturing	0.09%	11.95%	6.44%	1.54%	20.02%
Low-prod services	0.19%	3.92%	47.49%	3.66%	55.26%
High-prod services	0.03%	0.98%	4.42%	9.47%	14.91%
Total	3.69%	17.91%	62.95%	15.45%	100.00%

Panel B. Transition matrix disaggregated by formality status.

Status in 1991 / Status in 1996			Manufacturing		Low-prod. services		High-prod. services		
		Unemployed	Formal	Informal	Formal	Informal	Formal	Informal	Total
	Unemployed	3.38%	0.69%	0.37%	1.63%	2.95%	0.52%	0.25%	9.80%
Manufacturing	Formal	0.08%	8.76%	1.12%	2.34%	3.00%	0.90%	0.45%	16.65%
	Informal	0.01%	0.40%	1.67%	0.27%	0.82%	0.11%	0.09%	3.38%
Low-prod. services	Formal	0.09%	1.76%	0.66%	15.43%	9.12%	1.67%	0.62%	29.36%
	Informal	0.10%	0.69%	0.81%	4.11%	18.83%	0.68%	0.69%	25.91%
High-prod. services	Formal	0.03%	0.65%	0.16%	1.63%	1.84%	6.75%	0.81%	11.87%
	Informal	0.00%	0.11%	0.07%	0.26%	0.70%	0.33%	1.57%	3.05%
Total		3.69%	13.05%	4.86%	25.68%	37.27%	10.97%	4.48%	100.00%

Notes: Agricultural workers are virtually non-existent since data covers metropolitan areas. Source: 1996 PME Special Supplement.

Table 3 – Descriptive statistics at the industry level of the 1996 PME special supplement data.

	Employment share (%)		Male		Age		Years of education	
Industry	average	std. dev.	average	std. dev.	average	std. dev.	average	std. dev.
Nonmetallic mineral products	0.600	0.085	0.862	0.344	34.745	10.770	6.318	4.010
Machinery, equipment and commercial installation	0.690	0.028	0.898	0.302	36.227	9.940	8.333	3.922
Wood sawing and wood products	0.865	0.191	0.951	0.214	37.091	11.749	5.868	3.400
Pulp and paper production, printing and publishing	1.375	0.276	0.726	0.446	34.006	10.081	8.57	3.867
Rubber products	0.250	0.028	0.863	0.345	34.01	9.813	7.305	3.602
Oil refining and petrochemicals	0.240	0.014	0.876	0.330	38.495	8.144	11	3.475
Pharmaceutical, perfumes, detergents and candles	0.455	0.134	0.558	0.498	34.638	10.204	9.699	3.712
Plastics products	0.560	0.127	0.659	0.475	32.686	9.282	7.478	3.730
Textiles	0.710	0.028	0.607	0.489	35.169	10.661	7.656	3.821
Apparel	2.340	0.721	0.138	0.345	39.581	11.207	6.385	3.123
Footwear and leather products	0.615	0.021	0.567	0.496	33.102	9.616	5.577	2.663
Metals production and processing	2.600	0.169	0.885	0.318	35.271	10.302	7.160	3.692
Electrical and electronic equipment	0.945	0.092	0.698	0.459	33.131	9.471	9.024	3.633
Automobile, truck and bus	1.615	0.276	0.889	0.314	34.837	9.993	8.007	3.756
Chemicals and fertilizer	0.575	0.064	0.774	0.418	35.323	9.557	9.295	4.149
Coffee, food, beverages, animal feed and tobacco	2.145	0.431	0.631	0.482	33.851	10.186	7.098	3.742
Other manufacturing industries	0.620	0.085	0.547	0.498	35.362	11.049	8.163	3.746
Public utilities[H]	0.605	0.035	0.811	0.391	41.35	9.134	9.761	4.201
Construction[L]	5.755	2.071	0.971	0.165	37.128	10.813	4.867	3.562
Wholesale and retail[L]	11.675	3.259	0.624	0.484	34.867	10.920	7.566	3.803
Transportation[H]	4.305	1.138	0.912	0.282	37.575	10.425	6.972	3.620
Communications[H]	0.695	0.077	0.731	0.444	37.068	9.090	10.682	3.094
Financial services[H]	2.655	0.148	0.571	0.495	33.430	8.729	12.112	2.739
Personal and non-commercial services by private entities[L]	21.36	8.259	0.418	0.493	36.013	11.015	6.495	4.171
Services provided to firms[H]	4.500	1.725	0.682	0.465	33.926	10.616	10.055	4.046
Real estate services[H]	0.480	0.113	0.681	0.467	38.367	11.576	9.862	3.542
Public administration[L]	10.100	2.262	0.440	0.496	38.284	10.230	10.431	4.127

Notes: L and H indicate low- and high-productivity services, respectively. Source: 1996 PME special supplement.

Table 4 – Industry-level tariffs' descriptive statistics.

Industry	Import tariff average	Import tariff std. dev.	Export tariff average	Export tariff std. dev.	Effective rate of Protection average	Effective rate of Protection std. dev.
Nonmetallic mineral products	16.055	8.319	5.324	2.967	26.991	21.234
Machinery, equipment and commercial installation	22.173	8.637	7.202	3.012	28.963	13.154
Wood sawing and wood products	14.491	5.976	7.183	4.273	20.472	12.7
Pulp and paper production, printing and publishing	13.736	5.515	4.588	1.919	19.399	16.033
Rubber products	22.391	13.8	9.3	3.722	40.679	33.866
Oil refining and petrochemicals	9.618	6.054	5.056	2.246	24.467	23.735
Pharmaceutical, perfumes, detergents and candles	15.091	9.747	10.021	4.541	26.264	25.262
Plastics products	22.264	9.503	13.921	4.814	32.873	16.934
Textiles	22.9	11.823	17.059	5.801	47.001	33.439
Apparel	31.918	18.279	22.075	6.967	51.867	34.342
Footwear and leather products	19.891	7.136	11.222	3.123	30.186	22.502
Metals production and processing	12.395	3.649	3.293	1.172	19.635	10.032
Electrical and electronic equipment	24.627	9.687	9.451	3.806	36.461	18.505
Automobile, truck and bus	38.03	12.839	11.454	5.017	132.688	63.043
Chemicals and fertilizer	14.519	6.152	7.921	2.596	21.09	11.309
Coffee, food, beverages, animal feed and tobacco	18.166	5.826	15.552	4.973	30.033	19.831
Other manufacturing industries	22.182	11.197	7.021	3.978	35.271	21.3
Public utilities					-4.118	2.523
Construction					-0.655	0.387
Wholesale and retail					-14.654	8.868
Transportation					-9.475	5.696
Communications					-1.445	0.847
Financial services					-2.32	1.281
Personal and non-commercial services by private entities					-2.726	1.594
Services provided to firms					-5.201	3.063
Real estate services					-0.965	0.592
Public administration					-1.361	0.799

Note: Tariffs expressed in percentage points. Kume (2003) is the source for import tariffs and the effective rate of protection (ERP) for manufacturing. Export tariffs and ERPs for services are from author's calculations.

Table 5 – Impact of the change in tariffs on the industry-level employment share estimated using equation (14) and industry-level PNAD-Census data.

	Dependent variable: Δ employment share					
Technique	OLS	IV	OLS	IV	IV	IV
Independent variables	(1)	(2)	(3)	(4)	(5)	(6)
ΔExport Tariff	-0.008	-0.006	-0.004	-0.004	-0.011	-0.012
	(0.007)	(0.008)	(0.010)	(0.019)	(0.021)	(0.023)
ΔERP	-0.001	0.004**	-0.002	0.017	0.011*	0.015**
	(0.001)	(0.002)	(0.003)	(0.011)	(0.006)	(0.007)
Services × ΔERP					0.179*	
					(0.102)	
Low-productivity Services × ΔERP						0.177**
						(0.059)
High-productivity Services × ΔERP						0.186
						(0.242)
Joint test of all ΔTariff	0.77	4.62*	0.36	0.21	10.63**	28.60**
coefficients equal to zero	[0.481]	[0.099]	[0.702]	[0.901]	[0.013]	[0.000]
Kleibergen-Paap statistic		82.26		141.9	73.32	48.49
Stock-Yogo weak ID test critical values		16.38		16.38	7.03	N.A.
Endogeneity test		0.827		0.020	2.147	6.346*
		[0.363]		[0.887]	[0.342]	[0.096]
Observations	153	153	243	243	243	243
Manufacturing only	X	X				
Manufacturing and Services			X	X	X	X

All tariff variables are expressed in percentage points. Year dummies and a constant are included in all specifications. The first excluded instrument is the 1987 ERP level interacted with the real exchange rate. Additional instruments consist of interactions of the first instrument with services indicator, and with low- and high-productivity services indicators. Standard errors clustered on the industry level are reported in parentheses. p-values are reported in brackets. ** and * indicate statistical significance at the 5% and 10% levels, respectively. The endogeneity test null hypothesis is that ERP is an exogenous regressor. N.A. means that a Stock-Yogo critical value does not exist for the case of three endogenous regressors and three excluded instruments.

Table 6 – Effect of tariffs on worker mobility estimated by means of a multinomial logit based on equations (15) and (16) using only workers with a formal job in 1991.

Employment in 1991 / 1996	(1) Other Manuf.	(2) Low-prod. services	(3) High-prod. services	(4) Other	(5) Other Manuf.	(6) Low-prod. services	(7) High-prod. services	(8) Unemployment or Informality
A. *Manufacturing*								
ΔExport Tariff	-0.061	2.178**	2.342**	0.016	0.190	1.524**	4.479**	0.241*
	(0.125)	(0.432)	(0.472)	(0.119)	(0.168)	(0.251)	(0.306)	(0.144)
ΔERP	-0.017	0.310**	0.241**	0.041	-0.100	-2.907**	-0.699**	-0.035
	(0.036)	(0.117)	(0.112)	(0.034)	(0.066)	(0.477)	(0.183)	(0.054)
Years of Education	0.048	0.017	0.104**	0.016	0.061*	0.274**	0.174**	0.028
	(0.031)	(0.030)	(0.030)	(0.033)	(0.033)	(0.056)	(0.042)	(0.037)
B. *Low-productivity Services*								
ΔERP	-0.197**	Base	0.008	-0.079	-0.974**	Base	0.861	-0.835**
	(0.079)	Outcome	(0.064)	(0.069)	(0.170)	Outcome	(0.976)	(0.164)
Years of Education	0.041**		0.064**	-0.019	0.055**		0.056*	-0.013
	(0.017)		(0.024)	(0.030)	(0.027)		(0.030)	(0.027)
C. *High-productivity Services*								
ΔERP	-0.208**	0.029	Base	-0.075**	-0.625**	0.060	Base	-0.302**
	(0.045)	(0.046)	Outcome	(0.033)	(0.155)	(0.359)	Outcome	(0.144)
Years of Education	0.011	-0.068		-0.016	0.017	-0.066		-0.022
	(0.035)	(0.042)		(0.047)	(0.053)	(0.057)		(0.050)
Control Function	No	No	No	No	Yes	Yes	Yes	Yes

	Without control function			With control function		
Specification	A	B	C	A	B	C
Joint test of all ΔTariff	606.67**	2922**	1807**	226.51**	739.86**	232.71**
coefficients equal to zero	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Joint test of all control function				69.41**	40.30**	160.55**
coefficients equal to zero				[0.000]	[0.000]	[0.000]
Log Likelihood	-5080	-10070	-3911	-4909	-9732	-4778
Pseudo-R^2	0.226	0.068	0.066	0.338	0.099	0.098
Observations	4,065	11,217	3,803	4,065	11,217	3,803

Notes: Status in 1991 is considered the base category. For Panels B and C, the "Other manufacturing" category is interpreted as all manufacturing industries. The "Unemployment or Informality" category includes unemployment and informal employment in any industry. Additional variables that were included in the estimated specifications but omitted in this table: age, age squared, gender, state of residence indicators, and control function (if used). Standard errors are clustered at industry level, and bootstrapped in the specifications including the control function. Control function estimate is reported in Table C2 in the Online Appendix. Sample weights are used.

Table 7 – Effect of tariffs on worker mobility estimated by means of a multinomial logit specification based on equations (15) and (16) using workers with a formal or informal job in 1991.

Employment in 1991 / 1996	(1) Other Manuf.	(2) Low-prod. services	(3) High-prod. services	(4) Unemployment	(5) Other Manuf.	(6) Low-prod. services	(7) High-prod. services	(8) Unemployment
A. *Manufacturing*								
ΔExport Tariff	-0.011	3.762**	3.769**	0.061**	0.350**	2.999**	2.802**	-0.012
	(0.020)	(0.177)	(0.178)	(0.010)	(0.060)	(0.187)	(0.163)	(0.023)
ΔERP	-0.014**	0.939**	0.938**	0.051**	-0.126**	-5.288**	-2.372	0.073**
	(0.005)	(0.450)	(0.452)	(0.003)	(0.018)	(1.390)	(1.566)	(0.006)
Years of Education	0.059**	0.079**	0.201**	0.059**	0.072**	1.041**	0.530**	0.058**
	(0.014)	(0.023)	(0.025)	(0.011)	(0.018)	(0.061)	(0.087)	(0.013)
B. *Low-prod. Services*								
ΔERP	-0.366**	Base	0.024	-0.293**	-1.944**	Base	1.502	-1.935**
	(0.096)	Outcome	(0.094)	(0.103)	(0.034)	Outcome	(1.479)	(0.031)
Years of Education	0.021		0.100**	0.010	0.034		0.087**	0.012
	(0.027)		(0.015)	(0.034)	(0.125)		(0.015)	(0.129)
C. *High-prod. Services*								
ΔERP	-0.352**	-0.001	Base	-0.302**	-0.434	0.126	Base	-0.427
	(0.073)	(0.086)	Outcome	(0.071)	(0.389)	(0.309)	Outcome	(0.589)
Years of Education	-0.036	-0.084**		-0.051	-0.310	-0.077		-0.324
	(0.029)	(0.027)		(0.043)	(0.374)	(0.521)		(0.387)
Control Function	No	No	No	No	Yes	Yes	Yes	Yes

	Without control function			With control function		
Specification	A	B	C	A	B	C
Joint test of all ΔTariff	2114**	3662**	116.02**	3904**	1009**	8.43**
coefficients equal to zero	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.038]
Joint test of all control function				390.70**	125.72**	2.67
coefficients equal to zero				[0.000]	[0.000]	[0.446]
Log Likelihood	-3932	-4924	-2872	-3823	-3233	-2400
Pseudo-R^2	0.523	0.262	0.148	0.536	0.515	0.288
Observations	5,587	15,004	4,072	5,587	15,004	4,072

Notes: Status in 1991 is considered the base category. For Panels B and C, the “other manufacturing” category is interpreted as all manufacturing industries. Additional variables that were included in the estimated specifications but omitted in this table: age, age squared, gender, state of residence indicators, and control function (if used). Standard errors are clustered at industry level, and bootstrapped for the specifications including the control function. Sample weights are used.

Table 8 – Effect of tariffs on worker mobility estimated by means of a multinomial logit based on equation (16) using formal and informal workers with control function for manufacturing.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Employment in 1991 / 1996	Same Manuf. industry	Same Manuf. industry	Other Manuf. industry	Other Manuf. industry	Low-prod. services	Low-prod. services	High-prod. services	High-prod. services
	Formal	Informal	Formal	Informal	Formal	Informal	Formal	Informal
A. *Formal Manufacturing*								
ΔExport Tariff	Base	0.494*	0.760	0.384	4.084**	4.116**	2.459**	2.576**
	Outcome	(0.296)	(0.629)	(0.575)	(0.524)	(0.482)	(0.239)	(0.401)
ΔERP		-0.273*	-0.264	-0.142	-1.049**	-1.047**	-1.870**	-5.343**
		(0.157)	(0.198)	(0.185)	(0.165)	(0.153)	(0.364)	(2.165)
Years of Education		-0.027	0.058*	0.059	1.206**	1.173**	0.567**	0.906**
		(0.037)	(0.033)	(0.045)	(0.196)	(0.184)	(0.149)	(0.194)
B. *Informal Manufacturing*								
ΔExport Tariff	-0.652*	Base	0.996	-0.212	3.332	3.760**	2.874**	-1.135
	(0.375)	Outcome	(1.412)	(0.791)	(2.132)	(0.822)	(0.408)	(0.909)
ΔERP	0.356*		-0.350	0.062	-1.698	-0.086	0.443	0.440
	(0.208)		(0.462)	(0.562)	(1.933)	(0.775)	(0.304)	(0.313)
Years of Education	0.077		0.053	0.099	0.117	0.510	0.207	0.071
	(0.103)		(0.155)	(0.105)	(0.184)	(0.691)	(0.516)	(0.087)

Specification	A	B
Joint test of all ΔTariff coefficients equal to zero	458.10**	43.77**
	[0.000]	[0.000]
Joint test of all control function coefficients equal to zero	99.72**	15.59**
	[0.000]	[0.029]
Log Likelihood	-4097	-262.08
Pseudo-R^2	0.428	0.527
Observations	4,048	1,327

Notes: Status in 1991 is considered the base category. Additional variables that were included in the estimated specifications but omitted in this table: age, age squared, gender, state of residence indicators, and control function. Standard errors are clustered at the industry level and bootstrapped. Sample weights are used. There are very few observations of workers transitioning into unemployment in 1996. Hence, it is impossible to provide estimates for this outcome.

Table 9 – Worker multinomial logit based on equation (16) using formal and informal workers with control function for services.

	(1)	(2)	(3)	(4)	(5)	(6)
Employment in 1991 / 1996	Manuf. industry Formal	Manuf. industry Informal	Low-prod. services Formal	Low-prod. services Informal	High-prod. services Formal	High-prod. services Informal
A. *Formal Low-prod. Services*						
ΔERP	0.011	-1.927**	Base	-1.929**	2.121**	2.063**
	(0.072)	(0.019)	Outcome	(0.023)	(1.035)	(0.337)
Years of Education	-0.027**	0.091**		0.021	-0.138**	-0.078**
	(0.005)	(0.043)		(0.042)	(0.016)	(0.033)
B. *Informal Low-prod. Services*						
ΔERP	0.472*	-1.922**	-1.924**	Base	1.836**	1.621**
	(0.258)	(0.102)	(0.108)	Outcome	(0.278)	(0.534)
Years of Education	0.004	-0.415**	-0.494**		0.644**	0.657**
	(0.011)	(0.091)	(0.102)		(0.090)	(0.173)
C. *Formal High-prod. Services*						
ΔERP	-0.696**	-1.859**	-1.861**	-1.104**	Base	-0.979**
	(0.214)	(0.353)	(0.356)	(0.122)	Outcome	(0.127)
Years of Education	0.091**	-1.091**	-1.192**	-0.010		-0.020
	(0.017)	(0.117)	(0.154)	(0.014)		(0.013)
D. *Informal High-prod. Services*						
ΔERP	-0.366	-3.751**	-1.457*	-1.749**	-0.366	Base
	(0.944)	(1.059)	(0.847)	(0.770)	(0.944)	Outcome
Years of Education	-0.022	-0.033	-0.131**	-0.131**	-0.022	
	(0.059)	(0.097)	(0.066)	(0.047)	(0.059)	

Specification	A	B	C	D
Joint test of all ΔTariff coefficients equal to zero	2001**	4592**	3087**	14.04**
	[0.000]	[0.000]	[0.000]	[0.007]
Joint test of all control function coefficients equal to zero	154.72**	1653**	196.42**	16.48**
	[0.000]	[0.000]	[0.000]	[0.002]
Log Likelihood	-10108	-2708	-4207	-300.26
Pseudo-R^2	0.198	0.214	0.168	0.175
Observations	11,194	3,757	3,783	258

Notes: Status in 1991 is considered the base category. Additional variables that were included in the estimated specifications but are omitted in this table: age, age^2, gender, state of residence indicators, and control function. Standard errors are clustered at industry level and bootstrapped. Sample weights are used. There are very few observations of workers transitioning into unemployment in 1996. Hence, it is not possible to provide estimates for this outcome.

Table 10 – Placebo estimates of the industry-level specification, equation (14), using worker data from 1981–1990 and tariffs for 1989–1999.

	Dependent variable: Δ employment share			
Independent variables	(1)	(2)	(3)	(4)
ΔExport Tariff	0.020	0.011	0.013	0.013
	(0.013)	(0.016)	(0.012)	(0.011)
ΔERP	-0.004	-0.005	-0.024	-0.021
	(0.015)	(0.020)	(0.019)	(0.022)
Services × ERP			0.034	
			(0.183)	
Low-productivity Services × ΔERP				-0.053
				(0.030)
High-productivity Services × ΔERP				0.141
				(0.119)
Joint test of all ΔTariff coefficients equal to zero	2.49	1.81	2.25	1.78
	[0.712]	[0.595]	[0.477]	[0.224]
Kleibergen-Paap statistic	82.26	141.9	73.32	48.49
Stock-Yogo weak ID test critical values	16.38	16.38	7.03	N.A.
Endogeneity test	0.313	0.496	2.126	2.520
	[0.855]	[0.781]	[0.547]	[0.472]
Observations	153	243	243	243
Manufacturing only	X			
Manufacturing and Services		X	X	X

Instrumental Variable estimator used. All tariff variables are expressed in percentage points. Year dummies and a constant included in all specifications. The excluded instruments are: 1987 ERP level interacted with real exchange rate, the previous instrument interacted with services indicator, and with low- and high-productivity services indicators. Standard errors clustered on the industry level are reported in parentheses. *p*-values are reported in brackets. ** and * indicate statistical significance at the 5% and 10% levels, respectively. The endogeneity test null hypothesis is that ERP and its interactions (if included) are exogenous regressors. N.A. means that a Stock-Yogo critical value does not exist for the case of three endogenous regressors and three excluded instruments.

Online Appendix

A. Comparative Statics Proofs

Lemma 1. *A marginal reduction in domestic trade barriers decreases the Home manufacturing price index (P), reduces the index of the last domestic manufacturing firm to enter the Home market (N), and increases the index of the last Foreign manufacturing exporter to enter the Home market (λ_x^*).*

Proof. Define $B(\lambda) \equiv \int_0^\lambda a(i)^{1-\sigma} di$. Let's totally differentiate the system of equations that define the general equilibrium, and define D to be the determinant of such system.

$$\begin{bmatrix} (\sigma-1)P^{-1} + \frac{\mu_2}{\mu(1+P)^2} & 0 & (1-\sigma)a(N)^{-1}a'(N) \\ P^{-1} + \frac{\mu_2}{\mu(1+P)^2} & -a(\lambda_x^*)^{-1}a'(\lambda_x^*) & 0 \\ (\sigma-1)P^{\sigma}\Psi^{1-\sigma} & \frac{\partial B(N)}{\partial N} & (1+\tau)^{1-\sigma}\frac{\partial B(\lambda_x^*)}{\partial \lambda_x^*} \end{bmatrix} \begin{bmatrix} dP \\ d\lambda_X^* \\ dN \end{bmatrix}$$
$$= \begin{bmatrix} 0 \\ (1+\tau)^{-1} \\ (\sigma-1)(1+\tau)^{-\sigma}B(\lambda_X^*) \end{bmatrix} d\tau$$

$$\begin{aligned} D = &-a(\lambda_x^*)^{-1}a'(\lambda_x^*)[(\sigma-1)P^{-1} + \frac{\mu_2}{\mu(1+P)^2}](1+\tau)^{1-\sigma}\frac{\partial B(\lambda_x^*)}{\partial \lambda_x^*} \\ &-(\sigma-1)a(N)^{-1}a'(N)P^{-1}\frac{\partial B(N)}{\partial N} - \\ &(\sigma-1)a(N)^{-1}a'(N)a(\lambda_x^*)^{-1}a'(\lambda_x^*)(\sigma-1)P^{\sigma}\Psi^{1-\sigma} < 0 \end{aligned}$$

From the Cramér rule, the derivatives with respect to τ are

$$D\frac{dP}{d\tau} = \begin{vmatrix} 0 & 0 & -(\sigma-1)a(N)^{-1}a'(N) \\ (1+\tau)^{-1} & -a(\lambda_x^*)^{-1}a'(\lambda_x^*) & 0 \\ (\sigma-1)(1+\tau)^{-\sigma}B(\lambda_X^*) & \frac{\partial B(N)}{\partial N} & (1+\tau)^{1-\sigma}\frac{\partial B(\lambda_x^*)}{\partial \lambda_x^*} \end{vmatrix}$$

$$\begin{aligned} D\frac{dP}{d\tau} = &-(\sigma-1)a(N)^{-1}a'(N)(1+\tau)^{-1}\frac{\partial B(N)}{\partial N} \\ &-(\sigma-1)a(N)^{-1}a'(N)a(\lambda_x^*)^{-1}a'(\lambda_x^*)(\sigma-1)(1+\tau)^{-\sigma}B(\lambda_X^*) < 0 \end{aligned}$$

Further, with respect to the Foreign export threshold

$$D\frac{d\lambda_X^*}{d\tau} = \begin{vmatrix} (\sigma-1)P^{-1} + \frac{\mu_2}{\mu(1+P)^2} & 0 & -(\sigma-1)a(N)^{-1}a'(N) \\ P^{-1} + \frac{\mu_2}{\mu(1+P)^2} & (1+\tau)^{-1} & 0 \\ (\sigma-1)P^{\sigma}\Psi^{1-\sigma} & (\sigma-1)(1+\tau)^{-\sigma}B(\lambda_X^*) & (1+\tau)^{1-\sigma}\frac{\partial B(\lambda_x^*)}{\partial \lambda_x^*} \end{vmatrix}$$

$$\begin{aligned} D\frac{d\lambda_X^*}{d\tau} &= [\sigma-1)P^{-1} + \frac{\mu_2}{\mu(1+P)^2}](1+\tau)^{-\sigma}\frac{\partial B(\lambda_x^*)}{\partial \lambda_x^*} \\ &- (\sigma-1)a(N)^{-1}a'(N)(\sigma-1)(1+\tau)^{-1}P^{-1}[\{\frac{P\mu_2}{\mu(1+P)^2}\}(1+\tau)^{1-\sigma}B(\lambda_X^*) - B(N)] > 0 \end{aligned}$$

Note that all terms multiplying $B(\lambda_X^*)$ are smaller than 1, hence $D\frac{d\lambda_X^*}{d\tau} > 0$ and $\frac{d\lambda_X^*}{d\tau} < 0$.

For the last firm (N)

$$D\frac{dN}{d\tau} = \begin{vmatrix} (\sigma-1)P^{-1} + \frac{\mu_2}{\mu(1+P)^2} & 0 & 0 \\ P^{-1} + \frac{\mu_2}{\mu(1+P)^2} & -a(\lambda_x^*)^{-1}a'(\lambda_x^*) & (1+\tau)^{-1} \\ (\sigma-1)P^{\sigma}\Psi^{1-\sigma} & \frac{\partial B(N)}{\partial N} & (\sigma-1)(1+\tau)^{-\sigma}B(\lambda_X^*) \end{vmatrix}$$

$$\begin{aligned} D\frac{dN}{d\tau} &= -a(\lambda_x^*)^{-1}a'(\lambda_x^*)\left[(\sigma-1)P^{-1} + \frac{\mu_2}{\mu(1+P)^2}\right](\sigma-1)(1+\tau)^{-\sigma}B(\lambda_X^*) \\ &- \left[(\sigma-1)P^{-1} + \frac{\mu_2}{\mu(1+P)^2}\right](1+\tau)^{-1}\frac{\partial B(N)}{\partial N} < 0 \end{aligned}$$

□

Proposition 1. *A marginal reduction in domestic trade barriers decreases the demand for labor in the domestic manufacturing sector.*

Proof. Differentiating the demand for each manufacturing variety with respect to τ yields

$$\frac{dq_i}{d\tau} = \mu\Psi^{-\sigma}a(i)^{-\sigma}(\sigma-1)P^{\sigma-2}\frac{dP}{d\tau} + \frac{\mu_2 P^{\sigma-1}\Psi^{-\sigma}a(i)^{-\sigma}}{(1+P)^2}\frac{dP}{d\tau} > 0.$$

□

Proposition 2. *A marginal decrease in Foreign trade barriers increases the amount of labor hired in the domestic manufacturing sector.*

Proof. The index of last domestic firm that enters the Foreign market (λ_x) indicates the firm that makes zero profit from exporting. Hence, its variable profits from exporting are equal to the fixed cost of exporting, as illustrated by equation (17).

$$\{\Psi^* - 1\}\Psi^{*-\sigma^*}\mu^* P^{*\sigma^*-1}(1+\tau^*)^{1-\sigma^*}a(i)^{1-\sigma^*} - F_x = 0 \tag{17}$$

The small economy assumption implies that N^* is fixed. And, using the analogous of equation (11) for Foreign, we can see that if N^* is fixed, then so is P^*. From the consumer utility maximization and the firm profit maximization problems, we obtain the following demand for the exported varieties and its derivative with respect to τ^*.

$$q_i^* = \mu^* P^{*\sigma^*-1}\Psi^{*-\sigma^*}(1+\tau^*)^{-\sigma^*}a(i)^{-\sigma^*}$$
$$\frac{dq_i}{d\tau^*} = -\sigma^*\mu^* P^{*\sigma^*-1}\Psi^{*-\sigma^*}(1+\tau^*)^{-\sigma^*-1}a(i)^{-\sigma^*} < 0$$

□

Proposition 3. *A decrease in domestic trade barriers levied on the manufactured intermediate inputs consumed by the domestic service sector expands its employment level.*

Proof. Differentiating the demand for services with respect to τ provides

$$\frac{dS}{d\tau} = -(1+P)^{-2}\mu_2\frac{dP}{d\tau} < 0$$

□

B. Data Construction

The industry aggregation level used is dictated by the household surveys' industry classification, which originally consisted of 16 manufacturing industries and 11 service industries. Two service industries—personal services and non-commercial services by private entities—had to be merged because they exhibit large and sudden changes in the employment share. Since the employment share change in one industry mirrors the change in the other, this seems to be a classification problem, which is addressed by merging the two industries.

Workers younger than 15 years of age and older than 65 were excluded from the sample. If a worker had multiple jobs, only information about the main job was used. The employment share in industry j in year t consists of the average of the industry affiliation indicator weighted by the sample weights provided by the PNAD and the census. In the PME special supplement data, those workers who were between the ages of 20 and 65 in 1996 were kept in the sample. The age cut is different because the panel structure of the data requires workers to be in the labor force (i.e., at least 15 years of age) in 1991. Records with missing age, gender, and education were dropped from the sample. Observations for employed workers that had missing industry affiliation were also excluded.

The 1989–1999 Brazilian import tariff and the effective rate of protection (ERP) data come from Kume et al. (2003), and these series were originally aggregated by industry value-added at IBGE's Nível 50 industry classification. Using industry value-added as weights, the data were further aggregated into the 16 manufacturing industries and 10 service industries in the case of ERP.

Data on Argentina's import tariffs on Brazilian goods for the 1991–1999 period come from Freund et al. (2008) and were at the 4-digit ISIC level. The 3-digit ISIC level data for 1990 come from Liftschitz (1991). I used 1990 data for 1989 because no data were available for this year. Then, I aggregated the data into my 16-industry manufacturing classification by simple average. The US data come from Feenstra et al. (2002) at Standard International Trade Classification (SITC). The import tariff on Brazilian goods is calculated as the ratio between import duties and customs value, which I further aggregated to my 16-manufacturing industry classification via simple average.

For the remaining countries, the source is the 1974–2006 Trade, Production, and Protection (TPP) data at the 3-digit ISIC level from Nicita and Olarreaga (2006). Each trade partner's import tariff is the simple average tariff rate in percentage points that must be paid for the good at the border of the importing country by a most-favored nation (tar_savg_mfn). Each partner's export tariff data is aggregated by simple average into the 16-industry manufacturing classification. There are no data for China for the 1989–1991 period, so the same tariff level is assumed for these years as that which was in effect in 1992.

References

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Nicita, A. and M. Olarreaga (2006). Trade, Production and Protection 1976–2004. Mimeo.

Table C1 – First-stage regressions for Table 5 Instrumental Variable estimates.

Dependent variable	ΔERP				Services × ΔERP	Low-prod. Services × ΔERP	High-prod. Services × ΔERP
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Excluded instruments							
RER × 1987 ERP	-0.0004**	-0.0004**	-0.0004**	-0.0004**	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Services × RER × 1987 ERP			0.000		-0.0003**		
			(0.000)		(0.000)		
Low-prod. Services × RER × 1987 ERP				0.000		-0.0003**	0.000
				(0.000)		(0.000)	(0.000)
High-prod. Services × RER × 1987 ERP				0.000		0.000	-0.0003**
				(0.000)		(0.000)	(0.000)
Angrist-Pischke multivariate	82.26**	141.86**	143.48**	142.48**	3486**	41000**	1053**
F test	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Observations	153	243	243	243	243	243	243
Manufacturing only	X						
Manufacturing and Services		X	X	X	X	X	X

ERP and RER mean effective rate of protection and real exchange rate, respectively. All tariff variables are expressed in percentage points. Year dummies, Δ Export tariffs, and a constant included in all specifications. Standard errors clustered at the industry level are reported in parentheses. *p*-values are reported in brackets. ** and * indicate statistical significance at the 5% and 10% levels, respectively. Sample weights are used.

Table C2 – Control function estimates used in the multinomial logit specification, equation (16), reported in Table 6.

Dependent variable: ΔERP	(1)	(2)	(3)
Regressors / Table 5 specification	A	B	C
1987 ERP	0.111**	-0.110**	-0.085**
	(0.036)	(0.008)	(0.014)
ΔExport Tariff	3.725**	0.002	0.007
	(0.448)	(0.009)	(0.017)
Years of Education	0.140*	-0.074**	-0.046
	(0.068)	(0.035)	(0.050)
Age	0.118	0.001**	0.000
	(0.091)	(0.000)	(0.001)
Age squared	-0.001	0.839**	0.616**
	(0.001)	(0.094)	(0.187)
Male	1.336	-0.110**	-0.085**
	(0.875)	(0.008)	(0.014)
F test	3547**	41.70**	20.14**
	[0.000]	[0.000]	[0.000]
R-squared	0.723	0.353	0.262
Observations	4,065	11,217	3,803

State indicators and a constant are also included in all specifications. Export tariffs and ERP are expressed in percentage points. Standard errors are reported in parentheses. They are clustered on the industry level for column (1) and robust for columns (2) and (3) due to a small number of clusters. *p*-values are reported in brackets. ** and * indicate statistical significance at the 5% and 10% levels, respectively. Sample weights are used.

Table C3 – Industry-level employment share estimates of equation (14) obtained by instrumental variables using a different instrument set.

	Dependent variable: Δ employment share			
Independent variables	(1)	(2)	(3)	(4)
ΔExport Tariff	-0.003	-0.007	-0.003	-0.005
	(0.010)	(0.021)	(0.016)	(0.016)
ΔERP	0.007**	0.020	0.011*	0.012**
	(0.004)	(0.015)	(0.006)	(0.006)
Services × ΔERP			0.484***	
			(0.140)	
Low-productivity Services × ΔERP				0.447**
				(0.092)
High-productivity Services × ΔERP				0.721**
				(0.364)
Joint test of all ΔTariff coefficients equal to zero	5.06*	1.97	13.03**	25.19**
	[0.080]	[0.379]	[0.005]	[0.000]
Kleibergen-Paap statistic	16.553	25.17	21.13	15.64
Stock-Yogo weak ID test critical values	16.38	16.38	7.03	N.A.
Endogeneity test	4.429**	4.515**	5.447*	6.837*
	[0.035]	[0.034]	[0.066]	[0.077]
Observations	153	243	243	243
Manufacturing only	X			
Manufacturing and Services		X	X	X

All tariff variables are expressed in percentage points. Year dummies and a constant are included in all specifications. The excluded instruments are an ERP calculated using Colombian import tariffs and 1985 Brazilian I-O matrix, and its interactions with services, low-productivity and high-productivity services indicator variables. Standard errors clustered at the industry level are reported in parentheses. *p*-values are reported in brackets. ** and * indicate statistical significance at the 5% and 10% levels, respectively. The endogeneity test null hypothesis is that ΔERP is an exogenous regressor. N.A. means that a Stock-Yogo critical value does not exist for the case of three endogenous regressors and three excluded instruments. In all first-stage regressions, the null hypotheses of the Angrist-Pischke multivariate F test of excluded instruments were rejected at the 5% level. Sample weights are used.