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The Employment Consequences of Anti-Dumping Tariffs: Lessons from Brazil*

Gustavo de Souza[†] and Haishi Li[‡]

October 5, 2022

Abstract

Can anti-dumping tariffs increase employment? We compile data on all anti-dumping (AD) investigations in Brazil matching it to firm-level administrative employment information. Using difference-in-differences, we find that, an AD tariff decreases imports and increases employment in the protected sector. Moreover, downstream firms decrease employment, while upstream ones are not affected. To quantify the aggregate effect of these tariffs, we build a model with international trade, input-output linkages, and labor force participation. We show that the Brazilian AD policy increased employment by 0.06%, but they decreased welfare by 2.4%. Using tariffs, the government can increase employment by as much as 2.8%.

Keywords: employment, tariffs, anti-dumping, international trade

JEL Codes: F13, F16

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1 Introduction

With the promise of ‘bringing jobs back’, tariffs are usually advocated as a tool to increase local employment. Despite tariffs’ relevance to policy and their prominence in political debates, economists still do not know how tariffs in general and on particular products affect firms, wages, and employment.

On the one hand, tariffs shift demand for foreign products to those produced in the home market. Therefore, through this shift in demand, the national producer and sectors upstream to it (that is, the sectors that provide inputs to the national producer) could increase production and employment. On the other hand, downstream sectors (the ones that use the tariffed good as an input) face higher costs, which could lead to lower employment among them. Therefore, the final effect of anti-dumping (AD) tariffs on employment will depend on the employment elasticity of the national producer, upstream sectors, and downstream sectors.

In this paper, we ask: What is the effect of tariffs on aggregate employment and wages? And how does the effect of tariffs propagate through the value chain? We use data and a model to show that import tariffs might increase employment, depending on the tariffed product’s position along the value chain.

To answer our questions, we start by collecting information on all anti-dumping investigations initiated by Brazil.¹ Next, we link each investigation to a national producer, an upstream sector, and a downstream sector. For a subset of the investigations, we also get the name of the firm that filed the complaint. This information is then matched to an employer-employee dataset that contains details on wages and employment at the firm level.

To identify the causal effect of tariffs, we implement a difference-in-differences strategy. The treatment group is the set of products whose anti-dumping investigations led to a tariff increase. The control group is the set of products whose anti-dumping investigations did not result in a tariff change.

As usual in difference-in-differences, the identifying assumption is of parallel trends be-

¹Among global economies, Brazil ranks the sixth in terms of the number of anti-dumping (AD) investigations launched, only after the United States, India, European Union, Canada, and Argentina (Bown 2005). Also see <https://www.reuters.com/article/us-brazil-china-wto-idUSKCN11F2MS>.

tween the treatment and control groups. In fact, in our setting, the assumption of parallel trends is supported by anti-dumping regulations. According to World Trade Organization (WTO) regulations, the decision to impose an AD tariff depends on international prices of the investigated product before the investigation. Therefore, conditional on a product being investigated, the decision to impose a tariff and its size are made based on pre-determined variables, which can be teased out with fixed effects. Importantly, AD tariffs should not depend on labor market trends or political connections.

Supporting our identification strategy, we show that political connections cannot predict AD tariffs but international prices can, as stipulated by WTO regulations. We show that treatment and control groups are equally likely to make campaign contributions or to receive procurement contracts, subsidies, tax breaks, or subsidized loans from the government, which shows that AD tariffs are not targeted to protect politically connected sectors. We also show that AD tariffs do not correlate with preferential trade agreements or MFN tariffs. Moreover, we can predict Brazilian AD tariffs with an R-squared above 0.95 using only international prices, which is expected because AD tariffs should be a non-linear function of international prices. Therefore, the data strongly indicates that AD tariffs in Brazil are imposed according to WTO regulations, which supports our identifying assumption.

To further validate our identification strategy, we implement a battery of exercises and robustness checks. First, we show that pre-period parallel trends hold for all the variables we consider. Second, we also show that our results cannot be explained by other major shocks hitting the Brazilian economy, such as the Brazilian trade liberalization or fluctuations in the exchange rate. Third, we implement two placebo tests showing that our results are not driven by sectoral or labor market trends. Fourth, we also found that adding or removing controls from our main specification does not change the results. Fifth, we show that running our main regressions at the region level, instead of the firm level, delivers similar results. Finally, we also find the same results using an instrumented diff-in-diff with pre-period international prices as instrument.

We show that anti-dumping tariffs decrease imports and increase employment in the protected sector without affecting upstream firms. Yet, employment and wages in the downstream firms decrease. When anti-dumping tariffs are imposed on a product, imports of that

product fall. A 100% ad valorem anti-dumping tariff generates a 25% drop in imports. Moreover, in contrast to Flaaen et al. (2019), we do not find any corresponding increase in imports from other locations. Employment increased at the national producer when anti-dumping tariffs are imposed against its foreign competitors. A 100% ad valorem tariff generates a 1.8% employment increase among firms shielded from international competition. Upstream firms are not affected by anti-dumping tariffs. This phenomenon can be explained by an increase in imports of inputs by the national producer. A 100% ad valorem tariff increases imports of inputs used by the national producer by 2.8%. Therefore, local firms do not benefit because the national producer is sourcing its inputs internationally. Downstream firms, as expected, are negatively affected. A 100% ad valorem tariff on all inputs of a firm decreases employment by 3.8%.

The empirical results are informative about firm-level responses to AD tariffs but are silent about aggregate effects. To make aggregate quantitative predictions, we build a small open economy model that features international trade, input-output linkages, and labor force participation. We show that the key parameters from the model can be identified from the estimated reduced-form elasticities. In the model, workers choose to work between different sectors or to stay outside the labor force. To produce, firms use labor and input from all sectors. The sectoral input is supplied by imperfectly substitutable domestic and foreign producers. The Frisch elasticity, the Armington trade elasticity² and the elasticity of substitution across product lines are estimated from the effect that anti-dumping tariffs have on employment and international trade.

From the quantitative model, we conclude that the Brazilian anti-dumping policy increased employment and GDP, but the effect of tariffs on employment depends on the position of the tariffed product along the value chain. We find that the Brazilian anti-dumping policy increased employment and gross domestic product (GDP) by 0.06% and 0.05%, respectively, with a decrease in consumption by 2.43%. Input-output linkages affect these aggregate predictions. A model without the input-output linkages predicts employment and GDP to each rise by 0.15%—these jumps constitute overestimations of 100%. Moreover, the aggregate effect of a tariff depends on the position of the product along the value chain. Imposing tariffs

²The Armington trade elasticity refers to the elasticity of substitution across countries.

that protect computer, electrical and machinery sectors (which are further down the value chain) increases aggregate employment. However, imposing tariffs that protect agriculture and mining sectors (which are relatively upstream in the value chain) decreases aggregate employment. These results indicate that, if the goal of tariffs is to increase employment, they should be targeted at items produced by sectors at the end of the value chain that use inputs from a wide range of sectors.

We show that, if the goal is to maximize employment, tariffs should be higher on products made by downstream sectors than on products made by upstream sectors; i.e., they should follow “tariff-escalation”.³ These tariffs increase aggregate employment by 2.8% but substantially decrease welfare by 15.9%. With this exercise, we highlight the important trade-off between promoting employment and raising consumer welfare that policymakers face when setting tariffs.

This paper contributes to the literature that studies the effect of AD tariffs.⁴ The literature has shown that AD tariffs reduce imports; i.e., they cause trade depression.⁵ But the evidence on trade diversion—the impact of tariffs on the imports of other products and countries—is mixed. Prusa (1997), Bown and Crowley (2006), Bown and Crowley (2007), Baylis and Perloff (2010), and Flaaen et al. (2019) find that AD tariffs increase imports from non-targeted countries, while Konings et al. (2001) and Durling and Prusa (2006) do not find a significant third-country effect. This literature has also found that AD tariffs affect firm performance in the protected sector (Konings and Vandenbussche 2008, Pierce 2011, and Jabbour et al. 2019), as well as employment (Trimarchi 2020, Barattieri and Cacciatore 2020, and Bown et al. 2021).

We make two contributions to this literature on AD tariff effects—with our empirical strategy and with our quantitative model. First, we propose a new identification strategy

³Tariff escalation refers to the fact that tariffs on intermediate goods are generally lower than those on final goods. Travis et al. (1964), Balassa (1965), Bown and Crowley (2016), and Shapiro (2021) document tariff-escalation for most favored nation (MFN) tariffs. Antràs et al. (2022) and Caliendo et al. (2021) explain this pattern with a government that maximizes consumer welfare and the free entry-exit of firms into upstream and downstream sectors. We provide an alternative explanation to it with a government interested in maximizing employment.

⁴For a review of the literature, see Blonigen and Prusa (2016)

⁵See Staiger and Wolak (1994), Lloyd et al. (1998), Prusa (1997), Vandenbussche and Zanardi (2010), Irwin (2014), Besedeš and Prusa (2017), and Sandkamp (2020).

exploiting the institutions of AD regulation. Unlike previous research, this strategy allows us to tease out the effects of uncertainty caused by AD investigations.⁶ Second, we examine more than just the effect of tariffs on trade. To the best of our knowledge, we provide the first general equilibrium analysis of the aggregate employment effect of AD tariffs that takes into account all midstream, upstream, and downstream impacts.⁷

Our paper also contributes to the literature that studies the labor market consequences of international trade. Several papers within this literature have found that import competition leads to a decrease in employment and wages (Trefler 2004, Autor et al. 2013, Autor et al. 2014, Pierce and Schott 2016, Dix-Carneiro and Kovak 2015, Dix-Carneiro and Kovak 2017, and Devlin et al. 2021), and affects employment in upstream and downstream sectors (Acemoglu et al. 2014 and Pierce and Schott 2016). While these empirical works largely agree that tariffs cause employment declines in downstream sectors, they disagree about the impact on the protected sector and its propagation upstream, casting uncertainty on the aggregate effect of tariffs.⁸ Quantitative works, including Caliendo et al. (2019) and Rodríguez-Clare et al. (2020), predict that tariffs can increase total employment, whereas Barattieri et al. (2021) predicts otherwise.

We contribute to this literature studying international trade’s impact on the domestic labor market in the following three ways. First, we develop a new empirical strategy and provide new evidence for the employment effects of trade policies along the supply chain. Second, basing our model on empirical estimates, we find moderate aggregate employment gains from AD tariffs, yet we highlight the importance of the input-output linkages to such

⁶For example, Staiger and Wolak (1994) and Prusa (1997), among others, find that AD investigations can reduce trade even if they do not conclude with tariffs.

⁷Previous works that study the general equilibrium effect of AD tariffs focus on welfare. Using a small open economy model with firm dynamics, Ruhl (2014) finds significant U.S. welfare loss due to AD tariffs. Gallaway et al. (1999) also evaluates the welfare loss from AD tariffs with a computable general equilibrium model.

⁸Flaen and Pierce (2019) and Trimarchi (2020) find that 2018-19 U.S. tariffs weakly increase employment in the protected sectors, but Barattieri and Cacciatore (2020) and Bown et al. (2021) find that anti-dumping tariffs have insignificant employment effect on the protected sectors. Flaen and Pierce (2019), Barattieri and Cacciatore (2020), and Bown et al. (2021) find significant declines in employment in the downstream sectors. Blonigen (2016) studies the impact of industrial policy on downstream firms’ exports. Huang et al. (2019) studies how 2018-19 U.S. tariffs affect the financial market performance of American and Chinese firms in upstream and downstream sectors. Conconi et al. (2018) studies how input requirements by a free trade agreement divert international trade. Handley et al. (2020) finds that 2018-19 U.S. tariffs significantly reduce exports by downstream firms.

an aggregate employment effect. Third, we find that to maximize employment, tariffs should be set higher on goods produced by downstream sectors than on goods produced by upstream sectors and that these tariffs cause a significant loss in consumer welfare.

The rest of the paper proceeds as follows. In Section 2 we go over the WTO AD rules, the practice of AD investigations in Brazil, and the data used in this paper. Then, in Section 3 we explain our empirical strategy. In Section 4 we present the main empirical results. Next, in Section 5 we introduce the model. In Section 6 we describe the procedure to estimate the model. In Section 7 we show the quantitative results. Finally, in Section 8 we state our conclusions.

2 Institutions and Data

2.1 Anti-Dumping Investigations

Dumping is defined as an international price discrimination where the exporter charges a lower price in the destination market than in their home market. According to WTO regulations, the destination market harmed by dumping is allowed to set an AD tariff to exactly offset this price difference. The WTO AD regulations, which Brazil follows, define three steps for the creation of an AD tariff: (1) firms harmed by dumping file a complaint to the Ministry of Economy, (2) the government opens an investigation into whether the foreign competitor engaged in dumping, and (3) the government decides whether to impose the AD tariff and, if so, its size.⁹

The process starts with a domestic firm or a group of domestic firms filing a complaint with the Ministry of Economy. The complaint must show that the sector is harmed by foreign dumping practices. Firms must present evidence that they experience a decrease in profits, sales, or wages, and link this to increased import competition from an international competitor. Moreover, the international competitor must have both an increasing volume of the good it's exporting to Brazil and a decreasing price on that good in Brazil. This suggests that the sales and price of investigated and non-investigated products may have

⁹See the Agreement on Implementation of Article VI of the GATT 1994 (The Anti-Dumping Agreement, https://www.wto.org/english/docs_e/legal_e/19-adp_01_e.htm).

different trends. We discuss this further in Section A.3.

The government, upon receiving the complaint, determines whether it should open an investigation or dismiss the case. This decision is made based on whether there is enough proof that links the national supplier’s decline in economic performance to increased imports from the international competitor. We only consider the cases in which an investigation is opened.

After the government opens an investigation, it identifies the price of the imported product before the investigation in its home market (called the “normal value”) and in Brazil. If the imported product comes from a non-market economy, the normal value is calculated using the pre-investigation price in a third market.¹⁰¹¹¹²

If the government finds that the foreign competitor is involved in unfair trade practices by charging a lower price in Brazil than its normal value, the government will create an AD tariff to equate the Brazilian post-tariff price to the normal value. Therefore, the AD tariff is set based on pre-determined price differences. The AD tariff, once imposed, lasts for five years and is then reevaluated.

2.2 Data

We use four datasets. They contain information on AD tariffs, product-level imports, firm-level employment, and firm-level imports. For information on AD tariffs and investigations, we use the Global Anti-dumping Database (Bown 2005). For each AD investigation in Brazil, the Global Anti-dumping Database contains the product name and classification investigated, the country of origin, the start and conclusion dates of each investigation, and the measures taken. Section A.1 presents a set of summary statistics of AD investigations in Brazil.

Data on imports comes from the Secretary of International Trade of the Ministry of Economy in Brazil. It provides monthly statistics on imports and exports for Brazil at the

¹⁰The Brazilian government considers only China and Vietnam as non-market economies. In those cases, the third country chosen as a reference for the normal value will depend on data availability.

¹¹In general, the normal value in a non-market economy can also be estimated using estimates of the production cost, but this method is not used in Brazil.

¹²See WTO’s Technical Information on Anti-dumping (https://www.wto.org/english/tratop_e/adp_e/adp_info_e.htm).

product level. This is used to understand the effect of tariffs on trade. The third database, RAIS, covers employment information of Brazilian firms. It is a yearly employer-employee matched dataset containing information on wages, hours, occupation, and demographics of workers. It also contains data on the sector and location of the firm. Using a concordance table provided by the Brazilian Secretary of International Trade, we link each AD investigation to its sector. This allows us to study how tariff increases affect employment in domestic sectors.

Throughout the paper, we constrain the analysis to firms with more than one worker that have been active for more than 10 years. The goal is to prevent changes in the composition of firms from driving the results.¹³ We constrain our analysis from 1995 to 2016. We also drop from the empirical analysis the service sector and the government sector.

3 Empirical Strategy

We use difference-in-differences to identify the effect of AD tariffs on trade and employment. The control group is the set of products with AD investigations that did not result in tariff changes. The treatment group is the set of products with AD investigations that led to tariff increases.¹⁴

3.1 Validation

In this section, we show that parallel trends are supported by institutional facts and exogeneity tests. Moreover, AD tariffs do not correlate with other policies implemented in the period, political connections, or sectoral shocks.

¹³One could be worried that this choice could lead to sample selection. Indeed, that would be the case if AD tariffs could lead firms to enter or exit the market. On section A.5.3, we show that results are the same if we keep all the firms on the sample. We also show that AD tariffs did not led to firm entry or exit.

¹⁴Notice that to identify the effect of tariffs, one cannot compare products with AD investigations against products that do not have AD investigations. This happens because of two factors—selection and the effect of tariff uncertainty. The first factor stems from the fact that AD investigations are not random. As Section A.3 shows, investigated products have a lower price and higher volume than non-investigated ones. They are also in a decreasing price and increasing volume trend at the time of the investigation. Furthermore, AD complaints are filed by expanding firms. Therefore, products and sectors undergoing an AD investigation are in a special trend. The second factor is the trade policy uncertainty created by AD investigations. As highlighted by Staiger and Wolak (1994), Prusa (2001), Lu et al. (2013), Besedeš and Prusa (2017), among others, the investigation itself might have effects on trade and employment.

Institutions As discussed in Section 2, conditional on an AD investigation, the decision to impose a tariff is a function of pre-determined characteristics outside of Brazil. Therefore, conditional on an investigation, the probability to be treated should be fully captured by product/firm-level fixed effects. Therefore, sectors that produce goods under AD investigations should have similar labor market trends.

Exogeneity Test In Section A.4.1, as the WTO regulations suggest, we show that prices outside of Brazil can predict tariffs. We can predict Brazilian AD tariffs with an R-squared above 0.95 using the distribution of international prices and AD tariffs imposed by other countries.¹⁵ These results suggest that it is very unlikely that labor trends are affecting the AD policy of the Brazilian government, which supports our assumption of parallel trends.

Placebo Tests To further guarantee that treatment and control groups do not differ in underlying shocks or trends, we implement two placebo tests, as shown in Section A.4.2. First, we show that tariffs do not correlate with employment changes in sectors that are not subject to AD tariffs but have similar employment trends. This placebo test indicates that the results are not driven by sectoral shocks to sectors following a certain employment trend. In our second placebo test, we show that there is no correlation of AD tariffs with employment changes 5 years before the AD tariff is implemented, supporting the notion that the identifying effect is not coming from labor market trends.

Other Policies and Political Connection We also show, in Section A.4.3, that the AD policy does not correlate with political connections, public procurement, subsidies from the government, tax breaks, or other tariffs.

¹⁵As discussed in Section A.4.1, AD tariffs should be a function of the import's price in Brazil and in the home country during the pre-period. But because the price in the home country are not observed, we proxy for this price with the AD tariff of other countries and the distribution of prices of the investigated product. The details of our test can be found in Section A.4.1.

3.2 Empirical Model

3.2.1 Imports

We use the following empirical model to identify the effect of imposing an AD tariff $\tau_{p,c}$ on imports of product p from country c :¹⁶

$$y_{p,c,q} = \theta\tau_{p,c,q} + \beta\mathbb{I}_{p,c,q} \{\text{After AD}\} + \eta_{p,c} + \eta_{q,c} + \epsilon_{p,c,q}, \quad (1)$$

where $y_{p,c,q}$ is the log of total imports of product p from country c in quarter q , $\mathbb{I}_{p,c,q} \{\text{After AD}\}$ is a dummy taking 1 after the beginning of the first investigation, $\tau_{p,c}$ is the ad valorem AD tariff imposed (for the control group, this variable takes the value of zero), $\eta_{p,c}$ is a product-country fixed effect removing any level differences between treatment and control, and $\eta_{q,c}$ is a quarter-country fixed effect. The parameter of interest is θ , which captures the effect of tariff $\tau_{p,c}$. β , which is common to the treatment and control groups, captures the effect of being exposed to an AD investigation. In this regression we constrain the sample to product-destination pairs that have at least one AD investigations.

To test for parallel trends in the pre-period, we use the following specification:¹⁷

$$y_{p,c,q} = \sum_j \theta_j \tau_{p,c,\text{first}} \mathbb{I}_{p,c,q} \{j \text{ Qrt. to AD}\} + \sum_j \beta_j \mathbb{I}_{p,c,q} \{j \text{ Qrt. to AD}\} + \eta_{p,c} + \eta_{q,c} + \epsilon_{p,c,q}, \quad (2)$$

where $\mathbb{I}_{p,c,q} \{j \text{ Qrt. to AD}\}$ is a dummy which takes one if quarter q is j quarters to the beginning of the first AD investigation, $\tau_{p,c,\text{first}}$ is the first AD tariff imposed on product p from country c , and θ_j captures the dynamic effects of the first AD tariff. Parallel trends in the pre-period imply that $\theta_j = 0$ for all $j < 0$.

¹⁶In our analysis each product refers to an 8-digit Nomenclatura Comum do Mercosul (NCM) code. The first 6 digits of the NCM code are the same as those of a Harmonized System (HS) code. The Brazilian government adds two additional digits to improve granularity.

¹⁷In these tests, we consider only the first AD investigation, as is standard in the literature, to ensure that there is no confounding investigation in the pre-period.

3.3 Midstream Firms

We use difference-in-differences to identify the effect of AD tariffs on the national producer, which we also refer to as a midstream firm. The treatment group is the set of firms whose products faced AD investigations that led to tariff increases. The control group is the set of firms whose products never got protection with tariff changes despite being investigated.

The main specification is:

$$y_{i,s,t} = \theta\tau_{s,t}^{mid} + \beta\mathbb{I}_{s,t}\{\text{After AD}\} + X'_{i,s,t}\kappa + \eta_i + \eta_t + \epsilon_{i,t}, \quad (3)$$

where $y_{i,s,t}$ is a labor outcome of firm i in sector s in year t ¹⁸ and where $\tau_{s,t}^{mid}$ is the average of ad-valorem tariffs imposed on products produced by sector s in year t . Firms in the control group have zero tariffs, but for the treatment group the variable $\tau_{s,t}^{mid}$ increases from zero after the decision of the first investigation and keeps changing as AD tariffs are imposed or removed. The variable $\mathbb{I}_{s,t}\{\text{After AD}\}$ is a dummy that takes one after the first AD investigation. It captures the effect of being exposed to an AD investigation and any other trend that leads to the investigation. Finally, η_i is a firm fixed effect and η_t is a time fixed effect.

To test for pre-period parallel trends, we use the following model:

$$y_{i,s,t} = \sum_j \theta_j \tau_{s,first}^{mid} \times \mathbb{I}_{s,t}\{j \text{ Yrs. to AD}\} + \sum_{j=-\bar{q}}^{\bar{q}} \beta_j \mathbb{I}_{s,t}\{j \text{ Yrs. to AD}\} + \eta_i + \eta_t + \epsilon_{i,t}, \quad (4)$$

where $\tau_{s,first}^{mid}$ is the first AD tariff imposed on products of sector s and where $\mathbb{I}_{s,t}\{j \text{ Yrs. to AD}\}$ is a dummy that takes one if year t is j years before the beginning of the investigation that results in the first AD tariff.

3.3.1 Main Downstream Firms

To identify the effect of tariffs on downstream firms, we link each sector protected by an AD tariff to its main consumer. The downstream sector is the one that buys the largest

¹⁸Each sector in Brazil has a 4-digit sector code. There are a total of 297 non-service sectors in Brazil that could be protected against dumping by foreign competitors with tariff increases. See Section A.2 for the detailed definition.

share of the reference sector’s production.¹⁹ By linking each sector to one downstream, we are able to reproduce the same clean identification strategy we use for the midstream sector. The treatment group consists of the firms in the sector whose main supplier had an AD investigation for one of its products that led to a tariff increase, while the control group consists of the firms in the sector whose main supplier never got protection with an AD tariff despite being investigated.²⁰

We chose not to implement a difference-in-differences with all firms downstream to an investigated firm because we would not be able to test for pre-period parallel trends. According to our input-output table, almost all sectors buy inputs from all other sectors. Therefore, every firm is downstream to a treatment firm and downstream to a control firm. In this case, all the firms would be both in the treatment group and in the control group as soon as the first AD tariff is imposed.

For each sector, we create an exposure measure based on the input cost increase caused by the AD tariff. The increase in input costs due to tariff $\tau_{s,t}$ on sector $d(s)$, which is downstream to sector s , is:

$$\tilde{\tau}_{d(s),t}^{down} = \frac{\text{Input Demand of Sector } d(s) \text{ from Sector } s}{\text{Aggregate Input Demand of Sector } d(s)} \times \tau_{s,t},$$

where $\tau_{s,t}$ is the average AD tariff that affects sector s in year t . The main downstream specification is:

$$y_{i,d(s),t} = \theta \tilde{\tau}_{d(s),t}^{down} + \beta \mathbb{I}_{s,t} \{\text{After AD}\} + X'_{i,d(s),t} \kappa + \eta_i + \eta_t + \epsilon_{i,t}, \quad (5)$$

where $y_{i,d(s),t}$ is a labor outcome of firm i in sector $d(s)$ (which buys inputs from sector s),

¹⁹Section A.2 describes how we construct an input-output table at the level of the 4-digit sector code for Brazil and formally defines main downstream (and upstream) sectors. A similar empirical strategy is also employed by Feng and Li (2021) who examine how the impact of climate disasters propagates to main upstream and main downstream countries.

²⁰It is important to notice that, as is usual in difference-in-differences, we are recovering the relative effect of the tariff. All firms are affected through the input-output connections and other general equilibrium effects. Still, firms that are the main consumers of a product with a tariff hike, should be relatively more affected than others. In the sections below, we use a model to match these estimated relative effects by running the same regressions in the model. In this way, we recover the aggregate effect of tariffs common to all firms. In Section A.5.2, we consider a regression that includes all midstream, weighted average upstream, and weighted average downstream tariffs.

$\tilde{\tau}_{d(s),t}$ is the change in input cost caused by an AD tariff in sector s , $X'_{i,d(s),t}$ is a set of controls, η_i is a firm fixed effect, and η_t is a year fixed effect.

To test for parallel trends between the control and the treatment group in the pre-period, we use the following specification:

$$y_{i,d(s),t} = \sum_j \theta_j \tilde{\tau}_{d(s)}^{down} \times \mathbb{I}_{s,t} \{j \text{ Yrs. to AD}\} + \sum_{j=-\bar{q}}^{\bar{q}} \beta_j \mathbb{I}_{s,t} \{j \text{ Yrs. to AD}\} + \eta_i + \eta_t + \epsilon_{i,t}, \quad (6)$$

where $\tilde{\tau}_{d(s)}^{down}$ is the increase in input cost caused by the first AD tariff imposed on a product produced by sector s , and where $\mathbb{I}_{s,t} \{j \text{ Yrs. to AD}\}$ is a dummy that takes one if year t is j years before the beginning that results in the investigation of the first AD tariff.

3.3.2 Main Upstream Firms

We implement the same identification strategy at the main supplier of firms with an AD investigation. We calculate the exposure measure at upstream firms as

$$\tilde{\tau}_{u(s),t}^{up} = \frac{\text{Sales to Sector } s \text{ from Sector } u(s)}{\text{Production of Sector } u(s)} \times \tau_{s,t},$$

where $\tau_{s,t}$ is the average AD tariff affecting sector s in year t . The main model is

$$y_{i,u(s),t} = \theta \tilde{\tau}_{u(s),t}^{up} + \beta \mathbb{I}_{s,t} \{\text{After AD}\} + X'_{i,u(s),t} \kappa + \eta_i + \eta_t + \epsilon_{i,t}, \quad (7)$$

where $y_{i,u(s),t}$ is a labor outcome of firm i in sector $u(s)$ and year t . The other variables are as described earlier. To test for pre-period parallel trends, we use an equation similar to 6.

4 Results

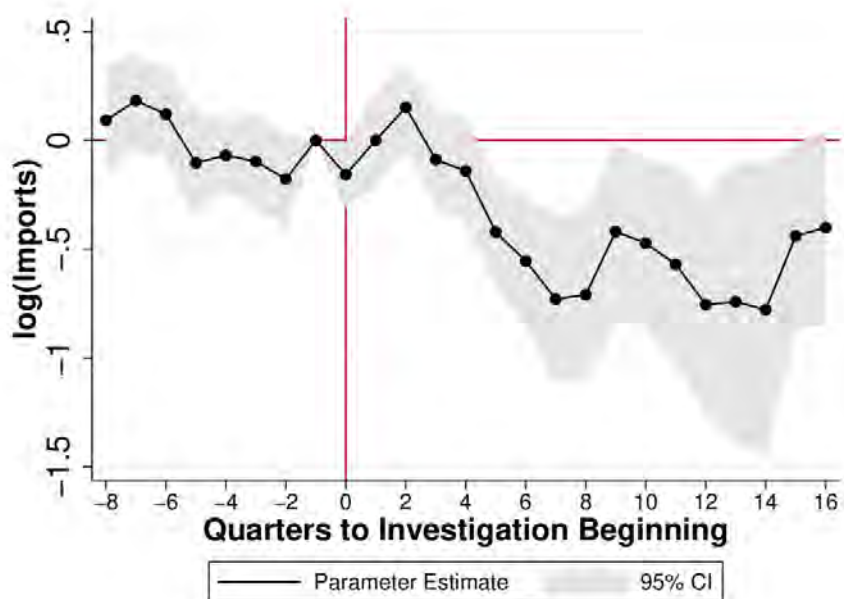
4.1 Imports

According to Figure 1, which shows the dynamic effects of the initial AD tariff on log imports in dollars, AD tariffs cause a drop in imports. In the quarters before the announcement of the tariff increase, the control and treatment groups had a similar import trend. This abruptly

changed when the investigation began; 10 quarters later, a 100% marginal tariff led to a decrease of approximately 50% in imports.

Tariffs cause a drop in the quantity imported but do not affect prices, according to Table 1. Using variation from all AD tariffs, Column 1 of Table 1 shows that a 100% increase in tariffs leads to a drop of 25% in imports. According to columns 2 and 3, which show the effect of tariffs on the quantity imported and on the price of imported goods, the drop can be explained by a decrease in quantity imported. The lack of price effect, displayed in column 3 of Table 1, indicates that Brazilian demand for international goods is too small to have a significant effect on international prices.²¹

Figure 1: Effect of AD Tariffs on Imports



Description: This figure contains the coefficients of the effect of AD tariff on imports using the dynamic model 2 plotted against quarters to the beginning of the investigation in the x-axis. Imports are measured in freight on board (FOB) current dollars at the NCM product code level. Import data is from the Secretary of International Trade of the Ministry of Economy, and AD data is from the Global Anti-dumping Database. The sample is composed of product-origin that had at least one AD investigation. The shaded area contains the 95% confidence interval. Standard errors are clustered at the product-origin level.

We find limited evidence for trade diversion; i.e., firms do not shift imports of the tariffed goods to another country. We run a regression of imports of the tariffed products from countries that are not affected by AD investigations on product-level AD tariff. Table 2

²¹This indicates that we find a complete pass-through of AD tariffs in Brazil. This finding is consistent with Blonigen and Haynes (2002), Sandkamp (2020), and the recent works that study 2018-19 U.S. tariffs (Amiti (2019), Amiti et al. (2020), Fajgelbaum et al. (2020), and Cavallo et al. (2021)).

Table 1: **Effect of AD Tariffs on International Trade**

	(1)	(2)	(3)
	$\log(\text{Value Imports})$	$\log(\text{Quantity Imports})$	$\log(\text{Price})$
$\tau_{p,c,t}$	-0.259*** (0.0811)	-0.273*** (0.0999)	0.0157 (0.0428)
N	20803	20733	20732
R^2	0.635	0.652	0.787
Mean Dep. Var	12.703	11.654	1.077
Mean Ind. Var	.18	.18	.18

Description: This table presents the estimated parameters of model 1. The sample is composed of product-origin that had at least one AD investigation. $\log(\text{Value Imports})$ is the log of FOB current dollars imports at the NCM level. $\log(\text{Quantity Imports})$ is the log of quantity imported, and $\log(\text{Price})$ is the log of price per-unit. Import data is from the Secretary of International Trade of the Ministry of Economy, and AD data is from the Global Anti-dumping Database. The sample runs from 1995 to 2016. Standard errors are clustered at the product-origin level.

shows that AD tariffs do not affect imports from other countries.

We also investigate whether firms shift from importing the tariffed products to importing other products. We run a regression of imports of the products that do not face AD investigations but fall within the same 4-digit sector impacted by the product-level AD tariff. Table 2 shows that imports of similar products from the taxed country are negatively affected by AD tariffs. This is explained by the model in Section 5: tariffs reduce the production of downstream firms by increasing their marginal cost. Due to the production reduction, firms reduce the demand for all the inputs they use, including employment and other imported inputs.

4.2 Midstream Firms

This section shows that an AD tariff increases the wage bill, employment, exports, and imports by the national producer. The effect of AD tariffs on the wage bill is presented in Figure 2. It shows that before the introduction of the tariff, treatment and control groups followed similar trends. But, the introduction of the tariff led to a relative increase in the wage bill of firms protected by the AD tariff. Five years after its introduction, a 100% AD

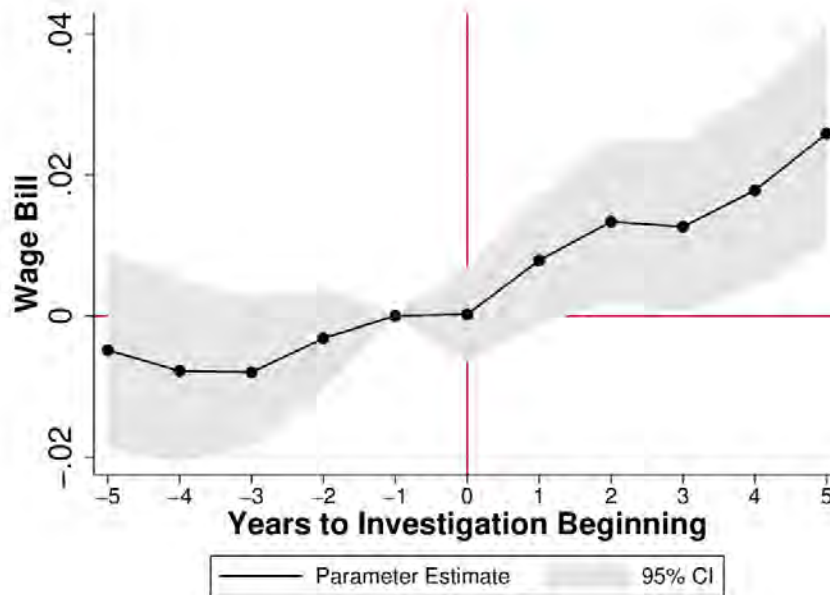
Table 2: Effect of AD Tariffs on Trade Diversion

	(1)	(2)	(3)	(4)
	$\log(\text{Value Imports})$	$\log(\text{Quantity Imports})$	$\log(\text{Value Imports})$	$\log(\text{Quantity Imports})$
AD Tariff	-0.0269 (0.0357)	-0.0575 (0.0489)	-0.0871** (0.0443)	-0.0926* (0.0536)
N	60327	59792	120603	118222
R^2	0.659	0.707	0.694	0.746
Mean Dep. Var	10.832	8.661	10.993	8.952
Mean Ind. Var	.32	.32	.09	.09
Product X Orig. FE	Yes	Yes	Yes	Yes
Time X Country FE	Yes	Yes	Yes	Yes
Specification	Same Product, Other Countries		Same Country, Other Products	

Description: This table shows the effect of the AD tariff on imports of other countries and other products. In columns 1 and 2 we show the coefficient of a regression of average AD tariff at the product level on imports of countries not exposed to AD investigations. Import data is from the Secretary of International Trade of the Ministry of Economy, and AD data is from the Global Anti-dumping Database. In columns 3 and 4 we show the coefficient of a regression of AD tariffs on the imports of other products at the same 4-digit HS code from the same country. Standard errors are clustered at the product-origin level.

tariff increased the wage bill of the national producer by about 3%.

Figure 2: Midstream Wage-Bill



Description: This figure contains the coefficients of the effect of an AD tariff on the log wage bill using the dynamic model 4. The x-axis contains the number of years to the first AD investigation. Wage bill data is from RAIS, and AD data is from the Global Anti-dumping Database. The sample is composed of firms in sectors producing the product under AD investigation. We constrain the sample to the set of firms observed 5 years around the AD investigation. These sample restrictions are made to avoid compositional change. The shaded area contains the 95% confidence interval. Standard errors are clustered at the firm level.

According to results in Table 3, AD tariffs increase employment, wage bill, exports and imports in the national producer. Columns 1 through 2 of Table 3 show the effect of tariffs on employment, and the wage bill. A 100% AD tariff increases employment by 1.8% and the wage bill by 1.9%. Columns 3 and 4 show how the probability of becoming an exporter or importer is affected by tariffs. Column 3 shows that a 100% AD tariff would increase by 0.4% the probability of the national producer of becoming an exporter, while column 4 shows that the same tariff would increase by 0.3% the probability that the same domestic firm would become an importer. Columns 5 and 6 show the effects of AD tariffs on the intensive margin of exporting and importing. Therefore, tariffs affect employment at the national producer, as well as its international trade.

Our estimates are within range of what the literature has found. Flaaen and Pierce (2019) finds that a 100% increase in tariffs leads to 0.8% increase in employment in the protected sector. Bown et al. (2021) finds that tariffs does not increase employment in the protected sector, instead, they significantly decrease employment in downstream sectors.

Table 3: **Effect of AD Tariffs on the National Producer**

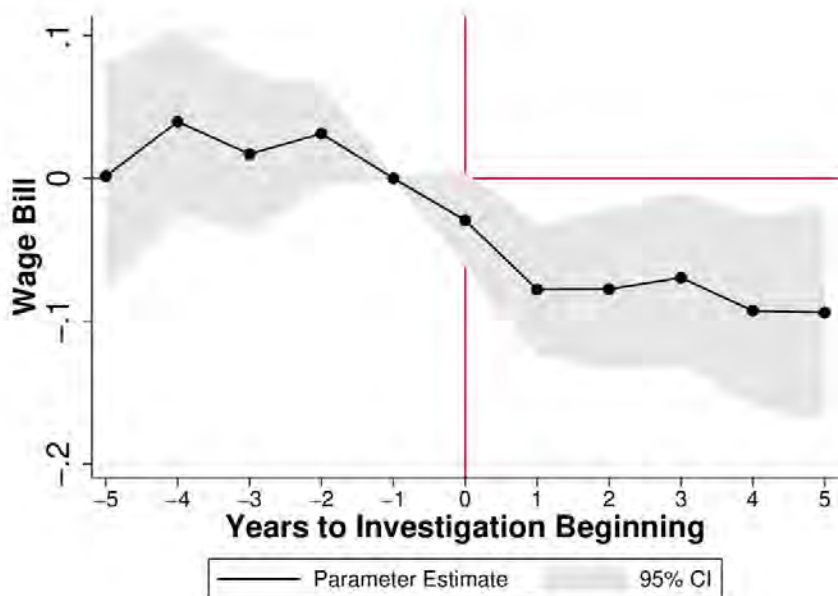
	(1)	(2)	(3)	(4)	(5)	(6)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\mathbb{I}(\text{Exporter})$	$\mathbb{I}(\text{Importer})$	$\log(\text{Exports})$	$\log(\text{Imports})$
$\tau_{s,t}^{mid}$	0.0184*** (0.00359)	0.0186*** (0.00390)	0.00421*** (0.00114)	0.00330*** (0.00119)	0.0133 (0.0107)	0.0286*** (0.00937)
N	119368	119368	132816	132816	17057	24052
R^2	0.829	0.863	0.613	0.635	0.832	0.798
# Firms	6277	6277	6277	6277	1635	2087
Mean Dep. Var	2.68	10.069	.165	.189	12.988	12.806
Mean Ind. Var	1.19	1.19	1.07	1.07	1.07	1.07

Description: This table presents the estimated parameters of model 3. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. $\log(\text{Wage Bill})$ is the log of the firm's total labor expenditure. $\log(\text{Number Workers})$ is the log of the total number of workers in the firm. $\mathbb{I}\{\text{exporter}\}$ is a dummy that takes one if the protected firm exports any product that year, $\mathbb{I}\{\text{importer}\}$ is a dummy taking one if the protected firm imports any product that year, $\log(\text{Imports})$ is the log of expected imports of the firm, and $\log(\text{Exports})$ is the log of expected exports. Expected exports and imports are calculated following de Souza (2021), who describes how expected export and imports are calculated at the firm level. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm. Standard errors are clustered at the firm level.

4.3 Downstream Firms

We now show that the effects of tariffs propagate downstream, decreasing employment and the wage bill. Figure 3 traces the dynamic effects of AD tariffs on downstream firms. Once again, treatment and control firms show similar trends prior to the introduction of the AD tariff and they diverge only after the beginning of the investigation. When tariffs are imposed on the inputs of these firms, employment decreases. A 100% AD tariff on all the inputs of a firm would lead to a drop of 10% in the wage bill 5 years after the beginning of the investigation.

Figure 3: Downstream Wage-Bill



Description: This figure contains the coefficients of the effect of an AD tariff on the log wage bill of firms downstream to a AD tariff using the dynamic model 6. The x-axis contains the number of years to the first AD investigation. Wage bill data is from RAIS, and AD data is from the Global Anti-dumping Database. The sample is composed of firms whose main input is under AD investigation. We constrain the sample to the set of firms observed 5 years around the AD investigation. These sample restrictions are imposed to avoid compositional change. The shaded area contains the 95% confidence interval. Standard errors are clustered at the firm level.

Columns 1 through 2 of Table 4 shows the effect of AD tariffs on the main downstream firms.²² A 100% AD tariff on all the inputs of these firms would lead to a 3.8% drop in employment and a 8.5% drop in wage bill.

The downstream effect of AD tariffs is not limited to the main buyer of an input, according

²²As Figure 3 demonstrates, these firms follow the same trend before the introduction of the tariff.

to results in Table 4. Columns 3 through 4 show the effect of tariffs on all downstream firms. AD tariffs have no significant effect on employment downstream, but they do have an impact on wage bill.

Table 4: **Effect of AD Tariffs on Downstream Firms**

	(1)	(2)	(3)	(4)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$
$\bar{\tau}_{d(s),t}^{\text{down}}$	-0.0383*	-0.0857***	0.000765	-0.0430**
	(0.0221)	(0.0244)	(0.0173)	(0.0191)
Sample	<i>Main Downstream</i>	<i>Main Downstream</i>	<i>All Downstream</i>	<i>All Downstream</i>
N	182790	182790	969619	969619
R^2	0.812	0.833	0.806	0.834
# Firms	8686	8686	55505	55505
Mean Dep. Var	2.412	9.599	2.147	9.313
Mean Ind. Var	.07	.07	.05	.05

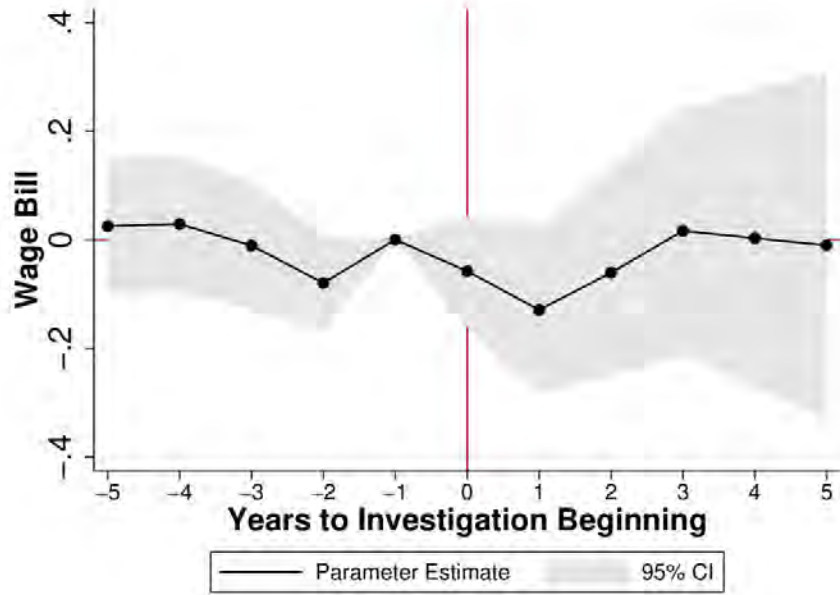
Description: This table presents the estimated parameters of model 5. The sample is composed of firms in sectors downstream to the product under AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. Columns 1 through 3 limit the sample to the main downstream firms. Columns 4 through 6 contain all downstream firms. $\log(\text{Wage Bill})$ is the log of total labor expenditure of the firm. $\log(\text{Number Workers})$ is the log of the total number of workers in the firm. $\bar{\tau}_{d(s),t}^{\text{down}}$ is the average AD tariff imposed on the inputs used by the sector of each downstream firm. Standard errors are clustered at the firm level.

4.4 Upstream Firms

This section shows that AD tariffs do not affect firms upstream, i.e., the firms that sell inputs to the midstream firms, despite increasing employment midstream and the tariffs' effects propagating downstream. Figure 4, which traces the dynamic effects of an AD tariff on the wage bill of the main input provider of the national supplier, indicates that there is no difference between the treatment and control groups before and after the AD tariff is implemented.

Table 5 shows that even using variation from all the AD investigations, we do not find any effect of AD tariffs on employment or the wage bill. Columns 1 through 2 of Table 5 show the effect of AD tariffs on numbers of workers, and the wage bill in the main suppliers of sectors protected by the AD tariff. The estimates identified are not statistically nor economically significant. Columns 3 through 4 show the effect of AD tariffs on all upstream sectors. We

Figure 4: Upstream Wage-Bill



Description: This figure contains the coefficients of the effect of an AD tariff on the log wage bill of firms upstream to a AD tariff using the dynamic model. The x-axis contains the number of years to the first AD investigation. Wage bill data is from RAIS, and AD data is from the Global Anti-dumping Database. The sample is composed of firms whose main input is under AD investigation. We constrain the sample to the set of firms observed 5 years around the AD investigation. These sample restrictions are made to avoid compositional change. The shaded area contains the 95% confidence interval. Standard errors are clustered at the firm level.

do not find any significant effect.

4.5 Robustness

We find that AD tariffs increase employment of the national producer and the effects of these tariffs propagate to downstream firms, thereby lowering their employment, but they do not significantly affect upstream firms. In this section we show that these results are robust to the addition of controls, to different specifications, and to the use of alternative identification strategies.

Controls. Tables A.11 through A.13 in Section A.5.1 show that the effect of AD tariffs on the wage bill is stable across specifications. We show that by adding as a control a 1-digit sector-year fixed effect, a 2-digit sector-year fixed effect, dummies for the number of products investigated, dummies for the number of products with AD tariffs or by controlling for AD

Table 5: **Effect of AD Tariffs on Upstream Firms**

	(1)	(2)	(3)	(4)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$
$\tilde{\tau}_{u(s),t}^{up}$	0.00321 (0.00792)	-0.000384 (0.00809)	0.00680* (0.00379)	0.00637 (0.00401)
Sample	<i>Main Upstream</i>	<i>Main Upstream</i>	<i>All Upstream</i>	<i>All Upstream</i>
N	74735	74735	3238468	3238468
R^2	0.816	0.840	0.807	0.835
# Firms	3694	3694	185354	185354
Mean Dep. Var	2.55	9.8	2.144	9.313
Mean Ind. Var	.29	.29	.05	.05

Description: This table presents the estimated parameters of model 7. The sample is composed of firms in sectors upstream to the product under AD investigation. We limit the sample to the set of firms observed 5 years around the AD investigation. Columns 1 through 3 limit the sample to the main upstream firm. Columns 4 through 6 contain all upstream firms. $\log(\text{Wage Bill})$ is the log of total labor expenditure of the firm. $\log(\text{Number Workers})$ is the log of the total number of workers in the firm. $\tilde{\tau}_{u(s),t}^{up}$ is the average AD tariff imposed on the sectors that each firm sells to. Standard errors are clustered at the firm level.

tariffs upstream and downstream does not change the conclusion that AD tariffs increase the wage bill midstream, decrease it downstream, and has no effect upstream.

All Sectors. Following Acemoglu et al. (2014) and Bown et al. (2021), in Section A.5.2 we run a specification with the exposure of each firm to midstream, downstream, and upstream tariffs. Under this specification, the results are still the same—i.e., AD tariffs increase employment midstream, and their effects propagate downstream, and do not affect upstream firms.

Sectoral Regressions. In Section A.5.3, we study the effect of AD tariffs on sectoral aggregates. We show that the results remain the same: AD tariffs boost employment midstream, and their effects propagate to downstream firms, and do not affect upstream firms.

Instrumental Variable. In Section A.4.1, we show that AD tariffs can be predicted with high accuracy using international prices and the AD policy of other countries. Exploiting this result, we use the AD policy of other countries as an instrument for AD tariffs in Brazil. In

Section A.5.4 we show that tariffs increase employment midstream, propagate downstream, and have no effect upstream.

Regional Variation. In Section A.5.5, we also identify the effect of AD tariffs in local labor markets. Leveraging heterogeneous exposure to the tariffs' effects on account of the heterogeneous sectoral composition of regional labor markets, we find that tariffs increase employment midstream, decrease employment downstream (in particular, by educational attainment group), and have no impact upstream.

Other Shocks In section A.4.4, we show that heterogeneous exposure to aggregate shocks cannot explain our results. We add as controls to our main specifications terms capturing heterogeneous exposure to exchange rate fluctuation and the Brazilian trade liberalization. We still find that tariffs midstream increase employment, while they decrease employment downstream, and have no effect upstream.

5 Model

We have found that AD tariffs increase employment in the protected sector, decrease employment downstream, and do not have an impact upstream. To study the aggregate employment consequence, we build a quantitative model of the Brazilian economy. The model translates the relative employment effects that we identified to aggregate effects, taking into account the general equilibrium forces.

The model has households, firms, and a government. Households supply labor to different sectors and receive an income transfer if they stay outside the labor force. Firms produce using labor and inputs. Inputs come from national producers and from outside of Brazil. The government collects taxes, imposes tariffs, and receives transfers from abroad to finance the payment to non-working households. When the government imposes a tariff, it increases the price of the international good, shifts demand from overseas to the national market, increases production costs downstream, and increases demand for national inputs upstream. In the next section, we use the elasticities we identified on the data to calibrate the important parameters of the model.

5.1 Environment

The model is static. There are $i \in \{0, 1, \dots, N\}$ countries; $i = 0$ denotes Brazil. Brazil has S production sectors and a population with measure L . Households optimally choose to work in one of the S sectors and supply labor to the sector in which they work, or stay out of the labor force. If they work, they earn a sector-specific wage, decide how much labor to supply, and receive a disutility from working. If they do not work, they receive social insurance from the government.

To finance the social insurance, the government generates revenue from three sources: it imposes an income tax on all households, borrows from the rest of the world, and collects tariff revenues.

The product market is competitive.²³ Each production sector has a representative firm. The firm's problem builds on Caliendo and Parro (2015)—it produces tradable output with labor and non-tradeable input from all sectors according to a constant-return-to-scale technology. To make the non-tradeable input, the firm sources tradable output from all sectors and countries. Brazilian tradable output is used domestically and exported.

We assume Brazil is a small open economy in the sense that Brazilian AD tariffs do not affect the ex-tariff foreign price faced by Brazilian importers, an assumption supported by the empirical results (see Table 1).

5.2 Workers

Brazil is endowed with a population of fixed measure L . A representative household ω chooses which sector to work in, the amount of labor to supply in this sector, receive income, and choose their consumption bundle. Labor force in all sectors and those that do not work add up to the total population. Households are heterogeneous in their disutility to work in each sector.

²³We follow Ramondo and Rodríguez-Clare (2013), Caliendo and Parro (2015), and Caliendo et al. (2019) on this assumption. As long as mark-ups are not affected by tariffs, a model with monopolistic competition would deliver the same results.

Consumption Household ω chooses final goods consumption of sector r , $c_r(\omega)$. The preference of households across different sectoral goods is given by

$$C(\omega) = \left(\sum_{r=1}^S (d_r)^{\frac{1}{\theta}} (c_r(\omega))^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}, \quad (8)$$

where d_r is a taste parameter and θ is the consumption elasticity of substitution across sectors.

Income Households working $l^s(\omega)$ at sector s receive wage w^s . If the household chooses to stay out of the labor force, ω receives welfare transfer b from the government. In any case, households pay a fraction δ of their income in taxes.²⁴ The budget constraint is

$$\sum_{r=1}^s P^r c_r(\omega) = \begin{cases} (1 - \delta)w^s l^s(\omega) & , s > 0 \\ (1 - \delta)b & , s = 0 \end{cases}, \quad (9)$$

where P^r is the price index of the final good produced by sector r and $l^s(\omega)$ is the labor supply of household ω to sector s .

Labor Supply Conditional on working in sector s , households decide how much labor to supply. The utility of worker ω , supplying $l^s(\omega)$ to sector s and consuming $C(\omega)$, is given by

$$U^s(\omega) = \begin{cases} C^s(\omega) - \frac{\psi^s}{\psi^s+1} l^s(\omega)^{\frac{\psi^s+1}{\psi^s}} & , s > 0 \\ C^s(\omega) & , s = 0 \end{cases}, \quad (10)$$

where ψ^s , the Frisch labor supply elasticity within sector s , governs the elasticity of substitution between labor and leisure. In some sectors, ψ^s is low and it is costly for workers to adjust their labor supply. In sectors in which ψ^s is higher, the disutility of working does not increase much with the labor supplied. There is no disutility from working for those who do

²⁴This assumption ensures that fiscal policies do not distort the impact of trade shocks on a household's sector choice.

not work: $\psi^0 = 0$.²⁵

Households have to choose between the different sectors. They receive the idiosyncratic preference shock $z^s(\omega)$ for working in sector s . $z^s(\omega)$ follows a Frechet distribution with shape parameter μ : $F(z^s(\omega)) = \exp(-(z^s(\omega))^{-\mu})$. Households also have an exogenous taste preference for working in sector s given by a^s . In the end, the utility of a sector s household is the product of the utility from consumption and leisure, sector taste, and the preference shock:

$$U^s(\omega)a^s z^s(\omega), \quad (11)$$

where $U^s(\omega)$ is given by 10.

Households' Problem Households maximize utility 11, subject to the consumption bundle 8, the budget constraint 9, and the endogenous utility 10.

$$\begin{aligned} \max_{s, \{c_s^r(\omega)\}_{r=1}^S, \{l_s(\omega)\}_{s=1}^S} U^s(\omega)a^s z^s(\omega) \\ \text{s.t. 8, 9, and 10} \end{aligned} \quad (12)$$

Heterogeneous Labor Supply Elasticity The solution to the households' problem implies that the sectoral labor supply, L^s , is heterogeneous across sectors. To demonstrate that, notice that the labor supplied to sector s equals:²⁶

$$L^s = \begin{cases} \frac{\tilde{a}^s \left(\frac{w^s}{PC}\right)^{\lambda^s}}{\sum_{s=1}^S \tilde{a}^s \left(\frac{w^s}{PC}\right)^{\lambda^s} + \tilde{a}^0 \left(\frac{b}{PC}\right)^\mu} L & , s > 0 \\ \frac{\tilde{a}^0 \left(\frac{b}{PC}\right)^\mu}{\sum_{s=1}^S \tilde{a}^s \left(\frac{w^s}{PC}\right)^{\lambda^s} + \tilde{a}^0 \left(\frac{b}{PC}\right)^\mu} L & , s = 0 \end{cases}, \quad (13)$$

²⁵We assume that a household's labor supply problem is governed by the Greenwood et al. (1988) (GHH) preference for tractability. The GHH preference focuses on the substitution between leisure and consumption as it mutes the income effect. Cravino and Levchenko (2017) and Bonadio et al. (2021) also assume that a representative household supplies labor to each sector following GHH preferences. However, they abstract from the household's sector choice problem and their self-selection into the non-working sector.

²⁶See Section B.1 for the proof.

where $\lambda^s = \mu(1+\psi^s)+\psi^s$ denotes the Frisch elasticity. An increase in a sector's s wage causes an increase in the sector's labor supply through two channels. First, more households choose this sector to work in (governed by μ). Second, each household in this sector supplies more labor (governed by ψ^s). With $\psi^s > 0$, the second channel creates heterogeneous sectoral labor supply elasticities. If $\psi^s = 0, \forall s$, then the labor supply problem will be reduced to a discrete choice problem where households only choose sectors, and the labor supply elasticity will be the same (and equal to the Frechet shape parameter μ) for all sectors.

5.3 Government

The social insurance system is financed by three sources of government revenue. The first is the income tax δ . The second is borrowing from the rest of the world through a Trade Deficit (TD).²⁷ The third is the Tariff Revenue (TR).²⁸ With the fiscal revenues, the government pays each non-working household a fixed social insurance income b . The government budget constraint is given by:

$$bL^0 = \delta \left(\sum_{s=1}^S w^s L^s + bL^0 \right) + TD + TR, \quad (14)$$

where bL^0 is the total government transfer to households outside the labor force.

5.4 Firms

Intermediate Goods Each sector s contains a representative competitive firm. Firms use labor and a composite bundle from other sectors to produce. The production function is given by:

$$Y^s = A^s \left((e^s)^{\frac{1}{\rho}} (L^s)^{\frac{\rho-1}{\rho}} + \sum_{s'=1}^S (f^{ss'})^{\frac{1}{\rho}} (M^{ss'})^{\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}},$$

²⁷This is a common property of static models of international trade: the value of foreign borrowing equals the trade deficit.

²⁸The tariff revenue is a function of import values and the tariffs imposed on these imports, which we specify below.

where A^s is the total factor productivity (TFP), L^s is the labor demand by sector s and $M^{ss'}$ is the quantity of sector s' output used by sector s . ρ denotes the elasticity of substitution across inputs. e^s and $f^{ss'}$ are labor- and input-augmenting technology parameters.²⁹

A firm's profit maximization problem implies that Brazilian firms set prices, P_0^s , that are equal to the marginal cost:

$$P_0^s = \frac{1}{A^s} \left(e^s (w^s)^{1-\rho} + \sum_{s'=1}^S f^{ss'} (P^{s'})^{1-\rho} \right)^{\frac{1}{1-\rho}}, \quad (15)$$

where w^s denotes the sector s wage and where $P^{s'}$ denotes the price of input from sector s' .³⁰

Sector s producer's expenditure share on input from sector s' equals the following:

$$s_M^{ss'} = \frac{f^{ss'} (P^{s'})^{1-\rho}}{e^s (w^s)^{1-\rho} + \sum_{s'=1}^S f^{ss'} (P^{s'})^{1-\rho}}.$$

And sector s producer's expenditure share on labor equals the following: $s_L^s = 1 - \sum_{s'=1}^S s_M^{ss'}$.

Composite Intermediate Goods Firms use inputs from different countries. Inputs are aggregated at the sector level according to a Dixit-Stiglitz style technology (Dixit and Stiglitz 1977). Therefore,

$$Q^s = \left(\sum_{i=0}^N (g_i^s)^{\frac{1}{\sigma^s}} (Y_i^s)^{\frac{\sigma^s-1}{\sigma^s}} \right)^{\frac{\sigma^s}{\sigma^s-1}},$$

where Q^s denotes the quantity of the non-tradable input bundle, g_i^s is a preference shifter for inputs from sector s and country i , and σ^s is the Armington trade elasticity (the elasticity of substitution across countries).³¹ Y_i^s denotes the quantity of sector s tradable goods imported from foreign country i . Y_0^s is the quantity of Brazilian tradable output used in Brazil.³²

²⁹These parameters allow us to match the factor shares observed in the data.

³⁰Following Caliendo and Parro (2015), we assume that the non-tradable input is used as a production input and is also consumed. Thus, the sector s consumption goods price faced by consumers equals the sector s input price faced by firms, and both are equal to P^s .

³¹Like many works in the trade literature, including Broda and Weinstein (2006) and Caliendo and Parro (2015), we let the trade elasticity differ across sectors.

³²Therefore, the rest of Brazilian sector s output, $Y^s - Y_0^s$, is exported.

Profit maximization and competitive markets imply that Brazilian sector s has the following expenditure function for country i :

$$x_i^s = \frac{g_i^s (P_i^s)^{1-\sigma^s}}{(P^s)^{1-\sigma^s}} X^s \quad (16)$$

where P_i^s is the price of a composite good of sector s from country i , $x_i^s = P_i^s Y_i^s$ denotes the expenditure by sector s on country i , and $X^s = P^s Q^s$ denotes the total expenditure by sector s . We further denote the country-sector level expenditure share: $s_i^s = \frac{P_i^s Y_i^s}{P^s Q^s}$.³³ The relationship between the sectoral input price and the sector-origin-level output price can be established as follows:

$$(P^s)^{1-\sigma^s} = \sum_{i=0}^N g_i^s (P_i^s)^{1-\sigma^s}. \quad (17)$$

We assume that Brazilian exporters face the same Armington trade elasticity σ^s . Foreign demand for Brazilian sector s output can be written as:

$$Y_{F0}^s = (P_0^s)^{-\sigma^s} E_F^s,$$

where E_F^s is a function of foreign income and price. Because we assume that Brazil is a small open economy, E_F^s can be treated as being exogenous to Brazilian AD tariffs. We denote the Foreign expenditure on Brazilian output: $E_{F0}^s = P_0^s Y_{F0}^s$.

Product Lines. Sector-origin-level import, Y_i^s , which is produced by combining different product lines, is denoted by the following:³⁴

$$Y_i^s = \left(\sum_{l \in \Omega_i^s} (h_{il}^s)^{\frac{1}{\zeta^s}} (y_{il}^s)^{\frac{\zeta^s-1}{\zeta^s}} \right)^{\frac{\zeta^s}{\zeta^s-1}},$$

where Ω_i^s denotes the set of product lines that Brazil imports from country i in sector s , y_{il}^s denotes the quantity of imports in product line l of sector s from country i , h_{il}^s is a

³³The demand function for sectoral tradable output from individual countries is $Y_i^s = \frac{(P_i^s)^{-\sigma^s}}{(P^s)^{-\sigma^s}} Q^s$.

³⁴Fajgelbaum et al. (2020) uses a similar technology that aggregates products to sectors.

preference parameter for products, and ζ^s is the elasticity of substitution across product lines. We allow the product-line-level elasticity of substitution to be heterogeneous across sectors and to differ from country-level substitution.

Brazil imposes tariffs τ_{li}^s on the product lines. The ex-tariff import price of product line l is denoted with p_{li}^s . As mentioned before, we assume that Brazil is a small open economy. Therefore, p_{li}^s can be treated as exogenous to Brazilian AD tariffs.³⁵ The competitive market and the profit maximization assumption imply the following expenditure function on product line l of sector s from country i :

$$x_{il}^s = \frac{h_{il}^s (p_{il}^s t_{il}^s)^{1-\zeta^s}}{(P_i^s)^{1-\zeta^s}} x_i^s, \quad (18)$$

where $t_{il}^s = 1 + \tau_{li}^s$. We denote the product l 's share in the expenditure on sector s of country i : $s_{il}^s = \frac{p_{il}^s t_{il}^s y_{il}^s}{P_i^s Y_i^s}$.³⁶ The sector-origin-level output price, P_i^s , can be written as a function of product-line-level prices and tariffs:

$$(P_i^s)^{1-\zeta^s} = \sum_{l \in \Omega_i^s} h_{il}^s (p_{il}^s t_{il}^s)^{1-\zeta^s}. \quad (19)$$

Market Clearing The market clearing condition for Brazilian sector s output is:

$$Y^s = (P_0^s)^{-\sigma^s} \left(\frac{1}{(P^s)^{-\sigma^s}} Q^s + E_F^s \right). \quad (20)$$

On the right-hand side, $\frac{(P_0^s)^{-\sigma^s}}{(P^s)^{-\sigma^s}} Q^s$ denotes the domestic demand for Brazilian output. The rest, $Y_{F0}^s = (P_0^s)^{-\sigma^s} E_F^s$, denotes the foreign demand.

The sectoral input, Q^s , is used for both consumption and the production of tradable output. Thus, the market clearing condition is:

$$Q^s = \sum_{s'=1}^S M^{s's} + C^s, \quad (21)$$

³⁵We do not find that the AD tariff affects import prices, despite the fact that there is a large drop in demand for the imported good. This supports our assumption that Brazil is a small open economy.

³⁶The demand for product line l of sector s imports from country i is denoted by the following: $y_{il}^s = \frac{(p_{il}^s t_{il}^s)^{-\zeta^s}}{(P_i^s)^{-\zeta^s}} Y_i^s$.

where $M^{s's}$ is the quantity of composite goods from sector s and used by sector s' and C^s refers to total consumption by all households of sector s composite good:

$$P^s C^s = \alpha^s (1 - \delta) \left(\sum_{s=1}^S w^s L^s + bL^0 \right),$$

Labor is hired to produce the tradable output. The market clearing condition for labor equates the labor supply to labor demand in each production sector:

$$L^s = \frac{1}{w^s} s_L^s P_0^s Y^s. \quad (22)$$

We finally relate the trade deficit and tariff revenue. Trade deficit equals total imports minus total exports:

$$TD = \sum_{s=1}^S \sum_{i=1}^N \sum_{l \in \Omega_i^s} p_{il}^s y_{il}^s - \sum_{s=1}^S (P_0^s)^{1-\sigma^s} E_F^s.$$

And the tariff revenue equals tariff import values multiplied by tariffs:

$$TR = \sum_{s=1}^S \sum_{i=1}^N \sum_{l \in \Omega_i^s} p_{il}^s y_{il}^s \tau_{il}^s.$$

Equilibrium Given the government's fiscal and tariff policy, $\{\delta, b, \{\tau_{il}^s\}_{i,l,s}\}$ and foreign prices and demand, $\{\{p_{il}^s\}_{i,l,s}, \{E_F^s\}_s\}$, the equilibrium is defined as a set of sectoral input prices, $\{P^s\}_s$, and sectoral wages, $\{w^s\}_s$ such that the following hold:³⁷

1. Firms maximize profit (equation 15);
2. The price index satisfies equations 17 and 19;
3. The goods markets clear, satisfying equations 20 and 21;
4. The labor market clears, satisfying equation 22;
5. Government budget constraint (equation 14) holds.

³⁷The equilibrium also depends on fundamentals, $\{\{\tilde{a}^s\}_s, \{d^s\}_s, \{A^s\}_s, \{e^s\}_s, \{f^{ss'}\}_{s,s'}, \{g_i^s\}_{i,s}, \{h_{il}^s\}_{i,l,s}\}$.

To compute counterfactuals, we rewrite the model in changes, which we present in Section B.2.³⁸ We also present in Section B.2 the equilibrium definition for the model in changes.

6 Identification of Model Parameters

In this section we identify, in five sequential steps, the parameters of the model using the elasticities we identified in Section 3. First, we calibrate a set of parameters targeting moments in the Brazilian economy. Second, we estimate the elasticity of substitution across product lines, taking into account the effect of anti-dumping tariffs on product-level imports. Third, we estimate the elasticity of substitution across countries, taking into account the effect of anti-dumping tariffs on country-level imports. Fourth, we estimate the labor supply elasticity, taking into account the effect of anti-dumping tariffs on employment and wages. And finally, we identify the elasticities of substitution across inputs (ρ) and the consumption elasticity across sectors (θ) from the effect of tariffs on midstream and downstream employment.

6.1 Calibration

The baseline economy is calibrated to Brazil in 1995, which is the initial year of our database. We let each sector $s \in \{1, 2, \dots, S - 1\}$ refer to a Classificação Nacional de Atividades Econômicas (CNAE) 2.0 4-digit goods sector in agriculture, livestock, extractive industry, and manufacturing. $s = S$ represents the combined service sector. The input-output coefficient, $s_{M}^{ss'}$, is taken from the input-output table. We let each product line l represent a Harmonized System (HS) 6-digit product. With a concordance table between HS codes and CNAE 2.0 4-digit sectors from the IBGE (the Brazilian Institute of Geography and Statistics), we calculate the sector-level exports E_{0F}^s . We get the Brazilian population and the share of population that is not working from the IPEA database—a macroeconomic, social, and regional database maintained by the Brazilian government.³⁹ We compute the sector population share κ^s with RAIS and total population. We further compute both

³⁸Doing so we eliminate the economic fundamentals that are exogenous to tariff changes and are difficult to calibrate or estimate.

³⁹The link to the IPEA database can be found here.

the sector-level consumption expenditure share α^s and the labor and input shares in gross output, s_L^s and s_M^s , from the estimated input-output table. We calibrate the expenditure shares on countries and products, s_i^s and s_{il}^s , by merging the estimated input-output table with sector- and product-level imports data. We calibrate the social insurance tax rate to the variable “government transfer rate” (“Renda de transferências governamentais”) in the IPEA’s database, which equaled 10.3% in 1995. Using the government budget constraint (as denoted by equation 14), we calibrate social insurance b to be 668.54 (Brazilian Real).⁴⁰ We calibrate the elasticity of the non-working population with respect to the social insurance to the estimated value in the literature that studies the cost of public funds (Kleven and Kreiner 2006) and set it to 0.2.

6.2 Elasticity of Substitution across Product Lines

To estimate the elasticity of substitution across product lines, ζ^s , we study the effect of anti-dumping tariffs on the import of products from a particular destination. ζ^s captures how easily the importer can switch product lines within sector-origin-level imports, and it governs the impact of AD tariffs on sector-origin-level prices.

Table 6: **Concordance between Broad Sectors and CNAE 2.0 2-digit sectors**

No.	Broad Sector Name	2 Digit CNAE 2.0 Sectors
1	Agriculture, Mining, Food and Textile	1-14
2	Leather, Wood and Paper	15-18
3	Petrochemicals	19-21
4	Mineral and Metal products	22-25
5	Computer, Electrical and Machinery Equipment	26-28
6	Automobiles and Transportation Equipment	29-33
7	Service	35-97

Description: This table presents the concordance between (a) the broad sectors on which level we estimate the trade and labor supply elasticities and (b) the CNAE 2.0 2-digit sectors.

We show that the elasticity of substitution across product lines, ζ^s , which captures how easily the importer can switch product lines, can be identified from the effect of anti-dumping tariffs on imports. Taking the log of equation 18 and adding controls as in our specification

⁴⁰More specifically, the unit of value for this amount is 1995 Brazilian Real per annum.

in equation 1, we have:

$$\log(x_{i,l,t}^s) = (1 - \zeta^s) \log(t_{i,l,t}^s) + \beta_2^s \mathbb{I}_{i,l,t}^s \{\text{After AD}\} + \beta_3^s \mathbb{N}_{i,l,t}^s \{\text{No. of AD}\} + \Phi_{i,t}^s + \eta_{i,l}^s + \epsilon_{i,l,t}^s,$$

where $x_{i,l,t}^s$ are the imports of product l from country i in quarter t ; $1 - \zeta^s$ is the effect of AD tariffs on imports; $\Phi_{i,t}^s$ summarizes the sector-origin-quarter-level price index, the sector-origin-level expenditure, and other factors that are common to all products in the same sector from the same origin (see equation 18); and $\eta_{i,l}^s$ denotes the origin-product-level fixed effect. To address the potential correlation between the error term and tariffs, we implement a difference-in-differences, as before, adding $\mathbb{I}_{i,l,t}^s \{\text{After AD}\}$ (a dummy that takes value one after the first AD investigation) and $\mathbb{N}_{i,l,t}^s \{\text{No. of AD}\}$ (the number of AD investigations) as the control. We constrain our sample to the set of products under investigation. The identification assumption is that conditional on AD investigations, shocks to the origin-product-level consumer preference and the international price (including non-tariff trade barriers) are not correlated with contemporaneous AD tariff changes.

Although we allow ζ^s to vary across sectors, to ensure that there are sufficient variations in AD tariffs, we classify CNAE 2.0 sectors into 6 broad sectors based on their definitions, and we estimate ζ^s for each broad sector.⁴¹ Table 6 presents the concordance between the broad sectors and CNAE 2.0 2-digit sectors.

Table 7: **Elasticity of substitution across product lines**

Sector name	ζ^s	Standard Err.
Agriculture, Mining, Food and Textile	8.005	(2.514)
Wood and Paper	2.185	(0.801)
Petrochemicals	1.547	(0.435)
Minerals and Metals	1.152	(0.451)
Computer, Electrical and Machinery Equipment	5.062	(1.714)
Automobiles and Transportation Equipment	1.808	(0.601)
All Sectors	1.633	(0.338)

Description: This table presents the elasticity of substitution across product lines for CNAE 2.0 4-digit sectors. The elasticities are assumed to be the same within each broad sector but to vary across broad sectors. Standard errors are clustered at the product-origin-level.

Table 7 shows the estimates of ζ^s . The implied elasticities of substitution across product

⁴¹That is, we assume that ζ^s is heterogeneous across the broad sectors but remains the same within each broad sector.

lines range from 1.152 for mineral and metal sectors to 8.005 for agriculture, mining, food, and textile sectors. These results are consistent with our intuition that products in primary sectors (harvesting and extracting natural resources) are more substitutable than those in secondary sectors (manufacturing and processing). The cross-sector average elasticity of substitution across product lines equals 1.633. This low estimate is consistent with the insignificant trade diversion to other products that we discovered, as noted in Section 4.1.

6.3 Elasticity of Substitution across Countries

In this section, we estimate the Armington trade elasticity, σ^s , which captures how easily sector-level imports can be substituted across different countries. We show that σ^s can be identified from the effect of anti-dumping tariffs on imports at the country level.

Taking logs of equation 16 and adding controls, we have:

$$\log(x_{i,t}^s) = (1 - \sigma^s) \log(t_{i,t}^s) + \beta_2^s \mathbb{I}_{i,t}^s \{\text{After AD}\} + \beta_3^s \mathbb{N}_{i,t}^s \{\text{No. of AD}\} + \Phi_t^s + \eta_i^s + \epsilon_{i,t}^s,$$

where $x_{i,t}^s$ are imports of sector s from country i in quarter t ; $t_{i,t}^s$ is the average AD tariffs at the country-sector-quarter level;⁴² $1 - \sigma^s$ captures the effect of AD tariffs on country level imports; Φ_t^s is a sector-quarter fixed effect capturing the sectoral import price index, expenditure, and other factors that are common to all origin countries (see equation 16); η_i^s is an origin-sector fixed effect; $\mathbb{I}_{i,t}^s \{\text{After AD}\}$ is a dummy taking the value of one after the first AD investigation happens in sector s and targets country i ; and $\mathbb{N}_{i,t}^s \{\text{No. of AD}\}$ counts the number of AD investigations that target country i and sector s in quarter t . The identification assumption is that conditional on AD investigations, shocks to the origin-level consumer preference and international price (including non-tariff trade barriers) are not correlated with contemporaneous AD tariff changes.

Table 8 shows the estimates of the elasticity of substitution across countries, σ^s . Estimates range from 1.339 for the petrochemical sector to 5.158 for the computer, electrical, and machinery sectors. For all sectors except the agriculture, mining, food, and textile

⁴²Formally, $t_{i,t}^s = \sum_{l \in \Omega_i^s} s_{i,l,t-1}^s t_{i,l,t}^s$, where $s_{i,l,t-1}^s$ denotes the share of product l in sector s imports from country i in year $t - 1$.

sector and the petrochemicals sector, the cross-country elasticity is higher than the cross-product elasticity. This suggests that within each non-primary 4-digit sector, imports are more homogeneous across countries than across products. The cross-sector average elasticity of substitution across countries equals 1.633, which is consistent with the limited trade diversion to other countries that we reported in Section 4.1.

For most sectors, our estimates are much lower than what Caliendo and Parro (2015) find. For example, their estimates are all above 10 for the computer, electrical, and machinery equipment sector. A notable difference in their estimation procedure from ours is that Caliendo and Parro (2015) do not account for the impact of trade policy uncertainties as we do. These findings are hence consistent with the predictions in Handley and Limão (2017) that accounting for these uncertainties can significantly reduce trade elasticity estimates.

Table 8: **Elasticity of substitution across countries**

Sector name	σ^s	Standard Err.
Agriculture, Mining, Food and Textile	2.044	(0.260)
Wood and Paper	3.060	(0.414)
Petrochemicals	1.339	(0.176)
Minerals and Metals	2.338	(0.171)
Computer, Electrical, and Machinery Equipment	5.158	(1.147)
Automobiles and Transportation Equipment	2.248	(0.350)
All Sectors	2.054	(0.091)

Description: This table presents the elasticity of substitution across countries for CNAE 2.0 4-digit sectors. The elasticities are assumed to be the same within each broad sector but to vary across broad sectors. Standard errors are clustered at the CNAE 2.0 4-digit sector level.

6.4 Labor Supply Elasticity

The labor supply elasticity, λ^s , governs the effects of tariffs on employment. We show that λ^s can be identified from the effects of anti-dumping tariffs on wages and employment.

Equation 13 shows the relation between sectoral employment and wages. Taking the log of that equation and adding controls, we get:

$$\log(w_{i,t}^s) = \frac{1}{\lambda^s} \log(L_{i,t}^s) + \beta_2^s \mathbb{I}_{i,t}^s \{\text{After AD}\} + \beta_3^s N_{i,t}^s \{\text{No. of AD}\} + \eta_i + \Psi_t^s + \epsilon_{i,t}^s,$$

where $w_{i,t}^s$ is wages at firm i in sector s in year t ; $L_{i,t}^s$ is employment at firm i in sector s in

year t ; η_i is a firm fixed effect; and Ψ_t^s is a year fixed effect. We again implement the same identification strategy and control for exposure to an AD investigation with $\mathbb{I}_t^s \{\text{After AD}\}$.

We instrument employment at the firm, $L_{i,t}^s$, with AD tariffs in sector s , t_t^s .⁴³ Employment is an endogenous choice of firms and correlates with other shocks affecting the firm. To deal with that, we instrument $L_{i,t}^s$ with AD tariffs imposed on products made by sector s .⁴⁴ As we discussed before, AD tariffs affect employment at the firm level, satisfying the relevance condition, and are unlikely to correlate with firm-level shocks, satisfying the exogeneity condition.

We present our estimates in Table 9. Labor supply elasticities are heterogeneous across sectors, ranging from 0.678 to 1.666. Our estimates are higher than the micro estimates (see Chetty et al. 2011), but lower than the macro elasticities. Our numbers are close to Eckert (2019), who studies the elasticity of workers' sector choice to sector income and finds an elasticity of around 1.1 to 1.5.⁴⁵

Table 9: **Labor Supply Elasticity**

Sector name	Implied λ^s	Standard Err.
Agriculture, Mining, Food and Textile	1.009	(0.199)
Wood and Paper	0.678	(0.354)
Petroleum and Chemicals	0.771	(0.572)
Minerals and Metals	1.666	(0.242)
Computer, Electrical and Machinery Equipment	1.592	(0.251)
Automobiles and Transportation Equipment	0.943	(0.123)
All Non-service Sectors	1.115	(0.083)
Service	0.431	(0.038)

Description: This table presents the labor supply elasticity for CNAE 2.0 4-digit sectors. The elasticities are assumed to be the same within each broad sector but to vary across broad sectors. Standard errors are clustered on the firm level.

We show how the estimated product, trade, and labor supply elasticities are associated with the position of the sector in the value chain. We measure how upstream a sector is by taking advantage of the procedure in Fally (2011), Antràs et al. (2012), and Antràs and Chor (2013). The upstreamness measure computes the average number of sectors that one

⁴³Formally, $t_t^s = \sum_{i=1}^N s_{i,t-1}^s t_{i,t}^s$, where $s_{i,t-1}^s$ denotes the share of country i in sector s imports in year $t-1$ and $t_{i,t}^s$ denotes country-sector level tariffs.

⁴⁴Because the service sector has no product that is subject to AD tariff, we instrument service sector employment with upstream tariffs, as discussed in Section 3

⁴⁵Eckert (2019) assumes labor supply elasticity is the same across all sectors but is heterogeneous across worker skill groups.

dollar of a sector’s output passes through to arrive at final demand (we present more details in Section B.5). Figure B.1 shows that relatively downstream sectors have larger elasticity of substitution across products and across countries, but they have weakly lower labor supply elasticities.

6.5 Indirect Inference

We estimate ρ , the elasticity of substitution across labor and materials, and θ , the demand elasticity across sectoral products, by indirect inference. ρ governs how much demand for workers increases out of an increase in the demand for the final product. Because of that, we choose a value for ρ to approximate the effect of AD tariffs on midstream employment. θ governs how much the demand of the final consumer changes from a change in prices. Because of that, we choose a value for θ to approximate the effect of AD tariffs downstream. The greater is the elasticity of substitution across sectoral final consumption, θ , the larger the decline in demand downstream firms will face because of their increase in production costs.

We run our estimation algorithm as follows. We guess a set of parameters, $\{\rho, \theta\}$, and we provide annual tariffs, $\{\tau_{i,t}^s\}$, to the model. For each year, we solve the counterfactual equilibrium with the model in changes (see Section B.2). Then we run the same panel regression in the model as in the data. We target the effects of anti-dumping tariffs on employment at midstream firms and at the main downstream firms. We present the detailed procedures in Section B.3.

Table 10: **Estimated elasticities and targeted moments**

Parameters	Targeted moments	Parameter Value
Elasticity of substitution across inputs ρ	Elasticity of midstream employment with respect to midstream tariffs	0.6694 (0.5960,0.7428)
Elasticity of final demand θ	Elasticity of main downstream employment with respect to midstream tariffs	4.4082 (4.3790,4.4374)

Description: This table presents the elasticities that are estimated in the model—i.e., the of substitution between labor and inputs ρ and the elasticity of final demand θ . The values presented in parentheses are the lower and upper bounds of the 95% confidence interval of the estimated parameters. Standard errors are calculated by bootstrapping.

Table 10 shows the estimated parameters and their confidence intervals. Labor and ma-

terials are complements, with an elasticity of substitution equal to 0.67. Final goods are substitutes, with an elasticity of substitution of 4.41. These values fall within the estimated range in Oberfield and Raval (2021), who find that across different specifications and industries, the elasticity of substitution across inputs falls between 0.6 and 1.0 and the final demand elasticity varies between 3.0 and 7.0.⁴⁶

6.6 Model Validation

In this section, we show that the model can approximate well both targeted and non-targeted moments. Table 11 displays a series of elasticities that we identified with data in Section 3 alongside their model-generated counterparts. As expected, the model matches exactly the targeted moments—i.e., the effects of tariffs on midstream employment and on downstream employment at main downstream firms. The second panel shows the model performance on a set of non-targeted moments. The model performs reasonably well.⁴⁷ In particular, we did not find any upstream effects in the model, as we have not found in the data. In Table B.1, we show how the distribution of trade elasticities contribute to this null effect of tariffs upstream.

6.7 Different Model Specifications

In this section we study how different model specifications impact their ability to match non-targeted moments. In this way we understand how each model assumption helps the model match to the data. We consider the following alternative models and present the results in Table B.1.

Same Input and Final Demand Elasticity In Column 3 of Table B.1, we require that the input elasticity equals the final demand elasticity ($\rho = \theta$). We target midstream employment with both ρ and θ . We estimate that both parameters equal 2.01. This overestimates the input elasticity and underestimates the final demand elasticity, and thus substantially

⁴⁶Su (2017) also finds that inputs are complements, while outputs are substitutes.

⁴⁷The model predicts a small negative effect of tariffs on midstream exports, while the data in Table 3 shows a positive effect; that said, the positive effect documented in the data is insignificant.

Table 11: **Targeted and non-targeted moments, data and model**

		Data	Model
<i>Targeted Moments</i>			
1	Midstream employment	0.0184	0.0184
2	Main downstream employment	-0.0383	-0.0383
<i>Non-targeted Moments</i>			
3	Main upstream employment	0.0032	0.0029
4	Midstream wage bill	0.0186	0.0218
5	Main downstream wage bill	-0.0857	-0.0769
6	Main upstream wage bill	-0.0003	0.0037
7	Exports by midstream firms	0.0133	-0.0061
8	Imports by midstream firms	0.0286	0.0224
<i>Employment Elasticity with Respect to Average Tariffs</i>			
9	Midstream tariffs	0.009	0.0117
10	Upstream tariffs	-0.0158	-0.0276
11	Downstream tariffs	-0.009	-0.0021

Description: This table presents the targeted and non-targeted moments in the data and in the model. Moments 1-8 refer to the elasticity of midstream, main downstream, and main upstream employment and wage bill, as well as exports and imports with respect to midstream tariffs. Moments 9-11 refer to the joint impact of midstream, average downstream, and average upstream tariffs (see Section A.5.2). The data moments (Column 1) refer to the corresponding estimated coefficients that are presented in the empirical section. The model moments refer to those estimated with model-simulated data and equations B.13 and B.14. The employment elasticity with respect to average tariffs refers to the joint impact of own sector, average upstream, and average downstream tariffs that we document in Table A.14.

understates the negative employment consequences for downstream sectors.

Heterogeneous Elasticity of Substitution across Inputs In Column 4 of Table B.1, we consider a model where the elasticity of substitution across inputs differs across sectors. To reduce the number of parameters to estimate, we assume that the input elasticity is log linear in sector upstreamness: $\rho = \exp(\beta_0 + \beta_1 \cdot U)$, where U denotes sector upstreamness (see Section B.5 for a detailed description of how we compute the sector upstreamness). We target the employment response in midstream, main upstream, and downstream sectors to midstream tariffs with β_0 , β_1 , and θ . We find that the elasticity of substitution across inputs weakly decreases in sector upstreamness (labor and inputs are less substitutable with each other in more upstream sectors). However, the estimated slope coefficient β_1 (2.5e-3) is close

to zero and thus, compared with the baseline, this model does not significantly improve in matching the upstream employment effect of tariffs and other non-targeted moments.

Homogeneous Labor Supply Elasticity In Column 5 of Table B.1, we assume that all sectors have the same labor supply elasticity. We set them to their estimated economy-wide values that we presented in Table 9. We find that this model overestimates the midstream wage response. This suggests that it underestimates the labor supply elasticity associated with the average midstream sector and overestimates the labor supply elasticity associated with the average downstream sector; thus, a much larger wage increase midstream and a smaller wage decrease downstream are required to achieve the same midstream employment response.

Homogeneous Trade Elasticity In Column 6 of Table B.1, we assume that all sectors have the same trade elasticity. We set them to their estimated economy-wide values that we presented in Tables 8. We find that the model with homogeneous trade elasticity overestimates the upstream employment effect by about 100%, suggesting that this model underestimates the trade elasticity for an average upstream sector such that foreign inputs substitute less with domestic labor. This is also supported by the small increase in imports by midstream firms in this model.

No Input-output Linkages In Column 7 of Table B.1, we present the model that does not have input-output linkages. To estimate this model, we target the midstream employment effect with θ . Similar to the model that sets input and final demand elasticity to be the same, the model without input-output linkages underestimates the final demand elasticity and the magnitude of the downstream employment effect.

Cobb-Douglas Technology and Preference In Column 8, we investigate the case in which both the production function and final demand are Cobb-Douglas ($\rho = \theta = 1$). The Cobb-Douglas model has been widely used in the international trade literature that takes into account input-output linkages (for instance, Caliendo and Parro 2015, Ossa 2015, and Caliendo et al. 2019, among others). However, Column 8 shows that this model substantially

misrepresents the employment and trade consequences of tariffs. As this model ignores that the increasing sector price due to tariffs can cause final demand to substitute away from that sector, it understates the negative impact on downstream employment and exaggerates the impact on midstream and upstream employment. Because this model does not consider that tariffs lead to cross-sector substitution in inputs, it also underestimates the magnitude of the tariff effects on both imports and exports.

7 Quantitative Results

7.1 Brazilian Anti-Dumping Policy

Table 12 shows the effect of Brazil’s anti-dumping policy on its economy.⁴⁸ The Brazilian anti-dumping policy increased employment by 0.06%. Tariffs shift the demand for protected goods from overseas to the national market, which increase employment at the national producer and decrease it at downstream firms. However, because the downstream effect is not strong enough, aggregate employment and GDP both increase.

The Brazilian anti-dumping policy decreased real income by 1.3% and welfare by 2.4%. To achieve a comparable metric of welfare, we calculate it in consumption-equivalent terms; that is, we hold the labor-leisure decision constant and we determine the percent change in consumption that makes households indifferent between a world with and without an AD policy.⁴⁹ Tariffs increase producers’ marginal cost and final prices to consumers. As a consequence, the real income of workers and consumption both go down, even though there are more workers. These two effects together—the decrease in consumption and the increase in labor supply—contribute to a decrease in welfare by 2.4%.

It is important to consider the input-output relationship of firms. Column 3 of Table

⁴⁸We call the Brazilian anti-dumping policy the cumulative anti-dumping tariffs implemented by the Brazilian government. In Section B.7, instead of looking at the overall anti-dumping policy, we study the impact of AD tariffs that Brazil imposed each year.

⁴⁹In Section B.4 we define precisely the equation that calculates the welfare change in consumption-equivalent terms. Since Lucas (1987), consumption-equivalent terms often have been used to measure the welfare change. Our equation transforms non-consumption terms that enter the utility, e.g., leisure, into consumption, such that they can be compared to other real economic variables, e.g., GDP and employment (Jones and Klenow 2016). Because our model has a household labor-leisure choice within sectors, we use the change in consumption-equivalent terms as our preferred measure of the welfare change.

Table 12: **Aggregate Effect of Brazilian AD Policy**

Variable	Baseline Model	No Input-output
Employment	0.06%	0.15%
GDP	0.05%	0.14%
Real income	-1.32%	-0.75%
Welfare	-2.43%	-1.53%

Description: This table shows the effect of Brazilian anti-dumping policy on aggregate employment, GDP, real income, and welfare. For each of the variables of interest, we calculate the percentage change between the equilibrium with the Brazilian anti-dumping policy and the benchmark equilibrium in which no anti-dumping tariff is imposed. These aggregate variables are defined in Section B.4. The Brazilian AD policy refers to each sector’s maximum AD tariff of all years. We show the effect predicted by the baseline model and a model that does not have input-output linkages.

12 shows the aggregate effect of the Brazilian anti-dumping policy according to a model without an input-output connection between firms. Without this connection, the predicted effect on employment is almost twice as large, while the welfare cost is lower. The model without input-output connections fails to take into account that anti-dumping tariffs decrease employment downstream and, consequently, overstates the positive impact on overall employment from anti-dumping tariffs.

7.2 Propagation Through Input-Output Linkages

The aggregate effect of anti-dumping tariffs depends on the position of the protected sector in the value chain. To show this, we plot on the y-axis of Figure 5 the effect of a 200% anti-dumping tariff on each CNAE 2.0 4-digit sector. We further take the average of all 4-digit sectors within each broad sector (defined in Table 6). We plot on the x-axis the average upstreamness of each broad sector, i.e., the average number of sectors that one dollar of a sector’s output passes through to reach final demand.⁵⁰

Figure 5a shows that the impact of sector-level tariffs on employment is strongly negatively correlated with sector upstreamness.⁵¹ There are two empirically relevant channels:

⁵⁰In Section B.5, our concept of upstreamness is more precisely defined.

⁵¹The negative correlation is robust to sector characteristic controls, including broad sector fixed effects,

the direct effect on the national producer and the downstream propagation.⁵² When a sector is downstream in the value chain (i.e., when it has low upstreamness), few sectors are downstream to it. Therefore, the negative employment effect in downstream sectors is smaller and the positive employment effect on the national producer dominates. Yet, for a sector that provides inputs to several other sectors, the tariff’s negative employment effect downstream is larger and, as a consequence, the effect of the tariff on overall employment is weaker. For example, Figure 5a indicates that imposing tariffs on products made by the petrochemicals sector and the agriculture, mining, food, and textile sector decreases aggregate employment. However, protecting products made by the computer, electrical and machinery equipment sector can raise it.⁵³

Figure 5b shows that the impact of sector-level tariffs on welfare is not correlated with sector upstreamness and is negative for almost all sectors. The tariff affects economic welfare through two main channels: prices and wages. Taxing downstream sectors substitutes more imports with domestic labor, which increases domestic prices. Higher prices imply lower real income and, therefore, welfare decreases. On the other hand, taxing upstream sectors decreases employment in more downstream sectors by cutting their wages, and this, too, leads to lower nominal income and welfare.⁵⁴

7.3 Optimal Import Tariff Policy

If the goal of the government is to maximize employment, how should it choose tariffs? To answer this question, we study the choice of tariffs that maximize employment conditional on keeping the government’s budget constant.⁵⁵ We formally present this optimal tariff problem in Section B.6.

Figure 6a shows that the input-output linkages are an important factor for the choice of value added shares in GDP, employment shares, import shares, and trade elasticities (see Table B.3).

⁵²As discussed in the empirical section and supported by the model in B.1, there is no propagation of the tariff effects upstream.

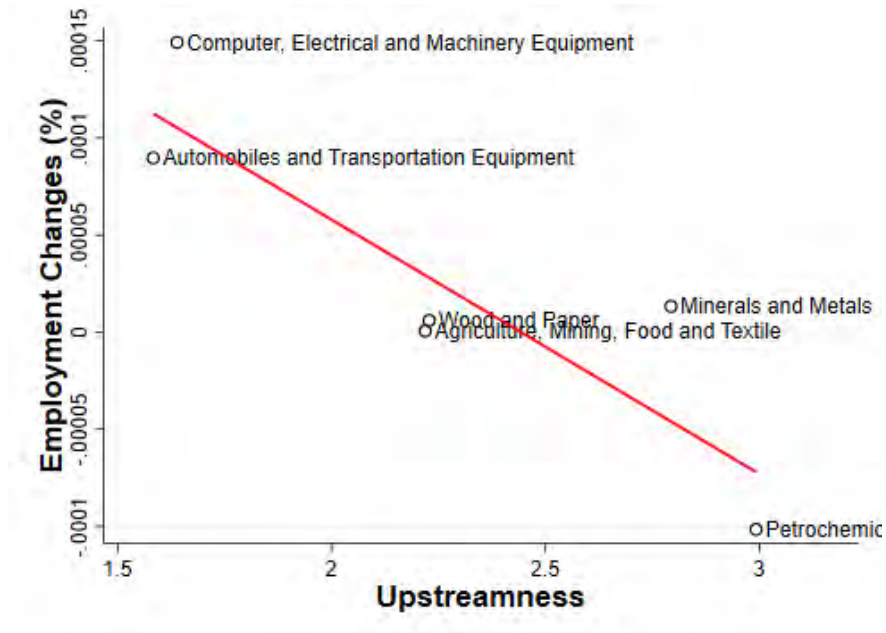
⁵³In Section B.7.2 we show the aggregate consequences of imposing 200% sector-level tariffs on each 4-digit sector, without taking their means for broad sectors.

⁵⁴Figure B.4 confirms this intuition, which shows that the impact of sector-level tariffs on both the nominal income and consumer price are negatively correlated with sector upstreamness.

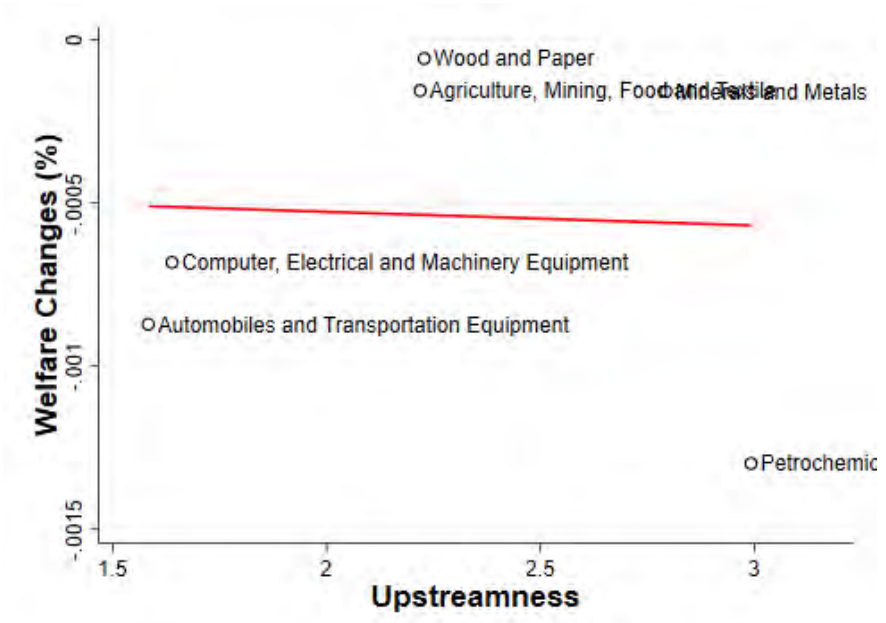
⁵⁵For tractability, we require tariffs to be below 1000%. We also experimented with setting the AD tariff upper bound to 900%. Our findings are robust to the bounds.

Figure 5: Effect of a 200% Sectoral Import Tariff on Employment and Welfare

(a) Employment and Sector Upstreamness



(b) Welfare and Sector Upstreamness



Description: These figures show the effect of sectoral, 200% anti-dumping tariff on aggregate employment and welfare. For each large sector, the x-axis plots the average upstreamness, which measures the average number of sectors that one dollar of a sector's output passes through to reach final demand. In Section B.5, we present more details about how we measure sector upstreamness. The y-axis of Figure 5a plots the change in employment caused by a 200% anti-dumping tariff. The y-axis of Figure 5b plots the effect of a 200% tariff on welfare. To avoid cluttering the figure, we average the effect within large sectors.

employment-maximizing tariffs.⁵⁶ Figure 6a plots on the x-axis the average upstreamness of each large sector and on the y-axis the average tariff that maximizes employment, conditional on keeping the government’s revenue constant. It shows that if the government’s goal is to maximize employment, tariffs should be large (an average of 373%) and strongly negatively correlated with sector upstreamness. Given that the effects of tariffs only propagate downstream, the government should minimize the negative employment effect downstream by setting higher tariffs on sectors selling directly to the final consumer.

Figure 6b shows that the optimal tariffs that maximize welfare should be low (an average of 7.8%) and positively correlated with sector upstreamness.⁵⁷ Imposing higher tariffs on goods produced by downstream sectors reallocates more production from abroad to domestic labor than imposing them on goods produced by upstream sectors. That, in turn, contributes to higher consumer prices, which further reduces welfare by more.

Antràs et al. (2022) and Caliendo et al. (2021) find that tariffs are larger in downstream sectors, a phenomenon that they call “tariff escalation”. Our findings suggest a new mechanism for tariff escalation. We show that a policymaker whose goal is to maximize employment will also increase tariffs less in upstream sectors because they negatively impact employment in other sectors. This suggests that “bringing jobs back” may also be the motivation for tariff escalation.⁵⁸

According to Table 13, a government that uses tariffs can increase employment by at most 2.8%, but it precipitates a 15.9% decrease in welfare.⁵⁹ If, instead, the government chooses tariffs to maximize welfare, employment will increase by 0.01% but welfare should decrease only by 1.46%.⁶⁰ These findings highlight the trade-offs that policymakers face: the

⁵⁶In Section B.7.3 we show the optimal tariffs that maximize employment, GDP, real income and welfare on each 4-digit sector, without taking their means for broad sectors.

⁵⁷See Section B.6 for this government’s problem.

⁵⁸Antràs et al. (2022) and Caliendo et al. (2021) explain tariff escalation with a model in which a government chooses sectoral tariffs to maximize consumer welfare and firms freely enter and exit sectors. In these models, protecting downstream sectors leads to more entries in upstream sectors, thus alleviating the pressure of tariffs on downstream prices. Protecting upstream sectors, on the other hand, leads to more exit in downstream sectors, which further increases the consumer price and causes more welfare loss.

⁵⁹The real income loss from optimal tariffs that maximize employment is comparable to the real income loss from autarky for Brazil that is described in the literature. Using an input-output table that has 251 sectors, Ossa (2015) shows that the Brazilian gains from trade equal 9.8%. This translates into a 8.9% real income loss.

⁶⁰Compared with the baseline equilibrium where no AD tariff is imposed, the optimal tariffs that maximize real income and welfare still reduce real income and welfare because of the fiscal constraint: the government

tariffs that increase employment are likely to harm consumer welfare.

Table 13: **Optimal Import Tariff Policy**

Effect on	Optimal tariffs that maximize				Baseline tariffs
	Employment	GDP	Real income	Welfare	
Employment	2.82%	2.46%	0.03%	0.01%	0.06%
GDP	2.32%	2.49%	0.07%	-0.10%	0.05%
Real income	-7.97%	-6.64%	-0.87%	-1.02%	-1.32%
Welfare	-15.85%	-14.63%	-1.77%	-1.46%	-2.43%

Description: This table shows the optimal tariff according to different objectives of the government and its effect on aggregate variables. The change in outcomes is made from the equilibrium without tariffs.

8 Conclusion

In this paper we study how the impacts of AD tariffs propagate along the value chain and their aggregate consequences. We compile detailed data on AD investigations, trade, and the input-output table, and we match them to firm-level administrative employment data in Brazil. Using a difference-in-differences strategy, we find that AD tariffs reduce imports but do not significantly divert trade to the imports of similar products from other foreign countries. AD tariffs significantly increase employment in the protected sector and strongly decrease employment in downstream sectors, but do not significantly increase employment in upstream sectors.

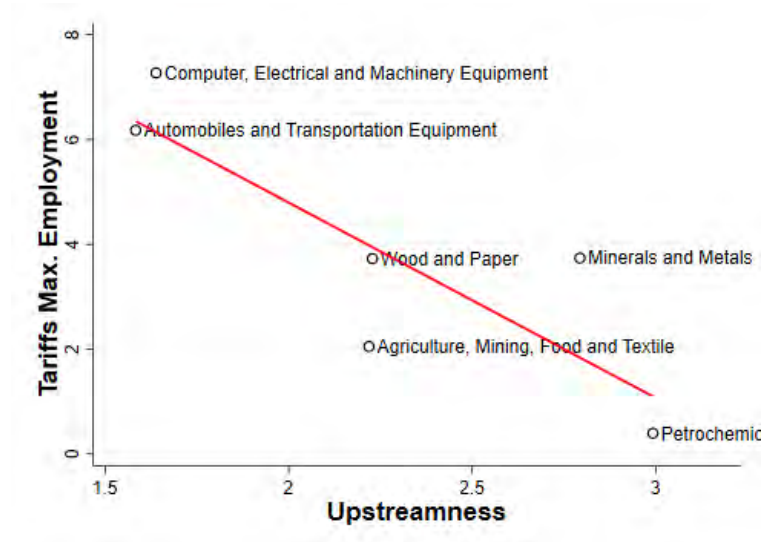
To quantify the aggregate, general equilibrium effects of these tariffs, we build a small open economy model of Brazil that takes into account international trade, input-output linkages and labor force participation. The model can reproduce the micro-elasticities we found and it matches the aggregate moments of the Brazilian economy.

We find that Brazilian AD policy weakly increases aggregate employment but decreases consumer welfare. On average, protecting downstream sectors increases aggregate employment more than it protects upstream sectors. A government whose objective is to maximize

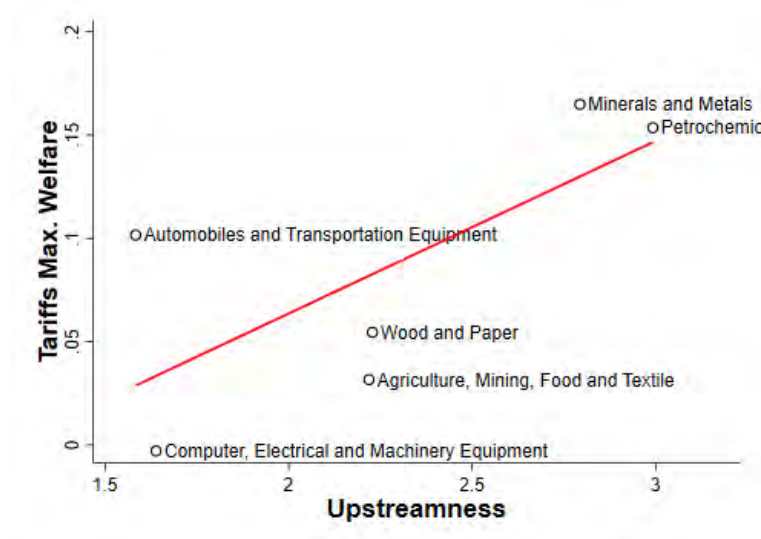
is required to collect the same AD tariff revenue as it collects from the benchmark tariffs. If tariffs are set low for some sectors, they have to be high for other sectors to ensure the fiscal constraint holds. These tariffs raise welfare relative to the incumbent Brazilian AD policy.

Figure 6: Tariffs to Maximize Employment and Welfare

(a) Tariffs that Maximize Employment



(b) Tariffs that Maximize Welfare



Description: These figures show the sectoral optimal tariffs that maximize employment and welfare as well as the Brazilian AD policy. The optimal tariffs solve a problem that maximizes the respective aggregate variable, subject to the equilibrium constraints and the additional constraint that the government collects the same tariff revenue as it collects from the benchmark tariffs (see Section 7.3). The Brazilian AD policy refers to each sector's maximum AD tariff in all years. The x-axis plots the average upstreamness of each broad sector, which measures the average number of sectors that one dollar of a sector's output passes through to reach final demand. In Section B.5, we present more details about how we measure sector upstreamness. The y-axis plots the tariff that maximizes employment (Figure 6a) and welfare (Figure 6b).

employment has strong incentives to increase tariffs, especially for downstream sectors. This moderately increases aggregate employment but substantially undermines consumer welfare.

From our exercise, policymakers can learn that when setting tariffs, they face an important trade-off between increasing employment and promoting domestic welfare. Strong WTO rules, trade agreements, and domestic political institutions could prevent the policy makers from creating jobs by raising tariffs without limits—an act that imposes excessive harm on consumer welfare.

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A Empirical Evidence

A.1 Statistics of Anti-Dumping Investigation in Brazil

In this section we discuss the anti-dumping measures and investigations taken by Brazil between 1989 and 2017. Table A.1 has the number of investigations, different products and countries. Treated are the product-country pair that had an AD tariff applied or price adjustment. Figure A.1a show the AD investigations by year. In 1994 the Brazilian government

Table A.1: **Statistics of Brazilian AD Investigations**

	Treated	Control	All
# Investigations	393	183	576
# Products	155	108	227
# Countries	50	45	65
Avg. Tariff	0.35	0	0.24

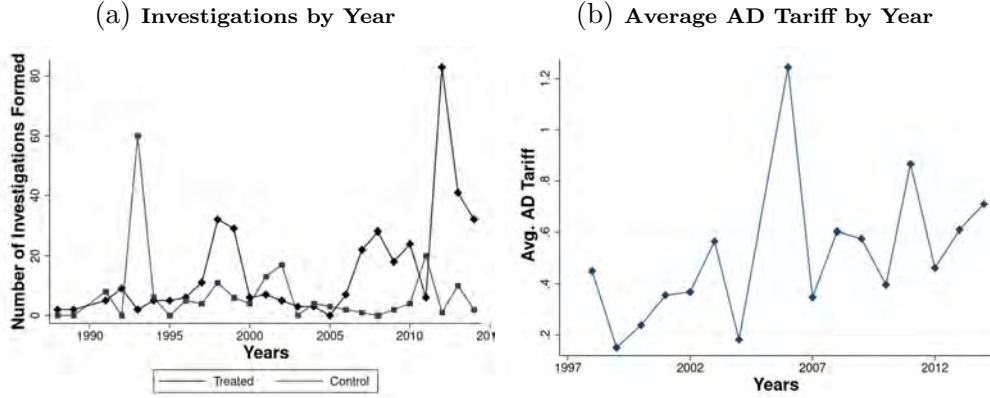
Notes: This table presents the statistics of Brazilian anti-dumping investigations between 1989 and 2017. Each investigation is a product-country pair. The average tariff is calculated using the imposed ad-valorem tariff. In case the tariff is per-unit, we calculate the corresponding ad-valorem value using trade data of the preceding year.

filed a broad complaint that covered 124 types of artificial and synthetic fabric from South Korea. Because we count investigations on the product level and not on the complaint level, we observe the large spike that year. The complaint was rejected in all products. Except for this spike, the treatment and control groups are evenly distributed over time.

Table A.2 show the top 5 countries with the most investigations. China is the leader, and 80% of the investigations on China end with a tariff increase or price adjustment. Moreover, there is large variation on the tariff imposed.

While AD tariffs target specific products and countries, they can lead to significant price changes on the sector level. Figure A.2 and Table A.3 show the average AD tariff that each CNAE 2.0 4-digit sector faces. Figure A.2a shows, for each CNAE 2.0 4-digit sector, the AD tariff faced by the average product-country pair that received an AD tariff. Figure A.2b shows, for each CNAE 2.0 4-digit sector, the AD tariff faced by the average product-country

Figure A.1: Brazilian Anti-Dumping Policy Over-Time



Description: Figure A.1a shows the average number of AD investigations per year at the product level. Figure A.1b shows the average AD tariff at the product level conditional on an AD being imposed.

Table A.2: Statistics of Brazilian AD Investigations

Country	# Investigations	% Treated	Avg. Tariff
China	113	0.850	0.782
South Korea	63	0.317	0.336
United States	58	0.638	0.581
India	34	0.588	0.324
Taiwan	25	0.800	0.445
Germany	22	0.773	0.388

Notes: This table presents the number of products investigated for dumping between 1989 and 2017 in Brazil against different countries. The data source is the Global Antidumping Database.

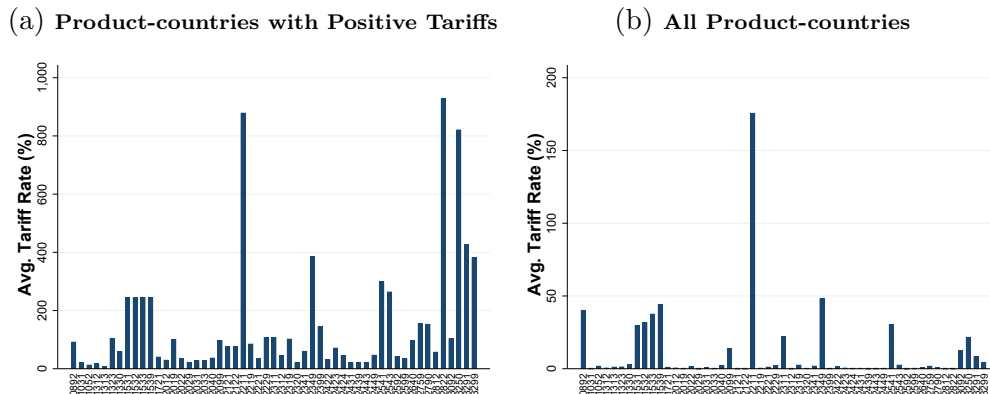
pair taking into account the product-country pairs that never faced AD tariffs.⁶¹ Even if we include into the average the product-country pairs that never had AD tariff changes, for some sectors, the average AD tariff is as high as 30%. These figures show that AD tariffs can lead to substantial price variations across sectors, even if only a subset of products and countries in each sector were hit by AD tariffs.

Table A.3 shows the summary statistics of AD tariffs by broad sectors. In Section 6, we estimate cross-product and cross-country elasticities of substitution for the same set of

⁶¹In Figure A.2, we only show the 4-digit sectors that received AD tariffs. To compute the average AD tariff for each sector, first, we compute the imports in each product from each country in an average year during the sample period. Then we compute the weighted average of the maximum of product-country pair specific AD tariff during the sample period, using these product-country level imports as weights.

broad sectors. Within each broad sector, some 4-digit sectors received an AD tariff. In the aggregate, about 20% of all 4-digit sectors (53 out of 297) were protected. Taking into account the 4-digit sectors that never received an AD tariff, the average AD tariff per 4-digit sector is 1.94%, is the highest for wood and paper sector (5.4%) and is the lowest for computer, electrical and machinery equipment sector (0.1%). Among the 4-digit sectors that received AD tariffs, the average AD tariff per 4-digit sector is 10.5%, is the highest for wood and paper sector (29.0%) and is the lowest for computer, electrical and machinery equipment sector (0.77%). The percentiles of the tariffs also show that within each broad sector, some 4-digit sectors face large tariffs.

Figure A.2: Anti-Dumping Tariff by Sector



Description: Figure A.2a shows, for each CNAE 4-digit sector, the average AD tariff of all product-countries that face positive AD tariffs. Figure A.2b shows, for each CNAE 4-digit sector, the average AD tariff of all product-countries that face positive AD tariffs. To compute the average AD tariff for each sector, first, we compute the imports in each product from each country in an average year during the sample period. Then we compute the weighted average of the maximum of product-country pair specific AD tariff during the sample period, using these product-country level imports as weights. When computing the average tariff, Figure A.2a only includes the product-countries that had positive AD tariffs, and Figure A.2b includes all product-countries.

Table A.3: Statistics of AD Tariff by Sector

Sector Name	No. of 4-digit Sectors	No. with Positive AD	Uncond. Mean (%)	Cond. Mean (%)	Cond. p50	Cond. p95
Agriculture, Mining, Food and Textile	100	7	0.49	6.96	1.37	40.31
Wood and Paper	37	5	5.36	28.95	31.77	44.37
Petrochemicals	41	14	4.89	14.32	0.86	175.73
Minerals and Metals	40	18	2.82	6.27	0.39	48.34
Computer, Electrical and Machinery Equipment	47	5	0.08	0.77	0.78	1.90
Automobiles and Transportation Equipment	32	4	1.47	11.74	10.43	21.78
All Sectors	297	53	1.94	10.52	1.27	44.37

Notes: This table presents summary statistics of AD tariff by broad sectors. The same set of broad sectors is used in Section 6, where we estimate the cross-product and cross-country elasticities of substitution. The *Uncond. Mean* refers to, for each sector, the AD tariff faced by an average 4-digit sector when we account for the 4-digit sectors that never received an AD tariff. *Cond. Mean* refers to, for each sector, the AD tariff faced by an average 4-digit sector that received an AD tariff. *Cond. p50* and *Cond. p95* shows the 50th percentile and 95th percentile of the AD tariffs faced by 4-digit sectors within each broad sector.

A.2 Input-Output Table

A.2.1 Estimating an Input-Output Table

We base our sectoral findings on CNAE 2.0 4-digit level (CNAE4 level) sectors.⁶² There are a total of 297 goods (agriculture, mining, and manufacturing) sectors and 375 service sectors. As there is no AD tariff variation on service sectors, we combine all service sectors into one single sector. In order to identify a sector’s main upstream and downstream sectors, and to compute the weighted average upstream and downstream tariffs, we need to know a input-output table for Brazil that has information about a sector’s input expenditure on all sectors and from both domestic and foreign sources. We call such a table the **complete input-output table**. However, the most disaggregated complete input-output table for Brazil that is readily available is tabulated on a different sector classification–Niv, which has only 67 broad sectors (among the Niv sectors just 36 are goods and the rest are service).⁶³ To acquire complete input-output information on CNAE4 level, we take advantage of the following datasets: a CNAE4 level imports table (details described below), CNAE4 level gross output and expenditure on input, as well as Niv level complete input-output table. We then apply a generalized-RAS (GRAS) estimation algorithm (Temursho et al. 2021) on these databases to estimate the desirable input-output matrix.

We proceed in the following steps. We start with a unique database that we acquire from the Secretary of International Trade of the Ministry of Economy on sector-product level imports–the value of each HS 6-digit product that is imported by a domestic sector. Using a concordance table between HS 6-digit products and CNAE4 sectors from Secretary of International Trade, we construct the input-output table for imports, i.e., CNAE4 level imports by each domestic CNAE4 sector. We call it the **imports table**. A few works in this literature, for example, Flaaen and Pierce (2019), Handley et al. (2020), use the imports table directly to compute domestic sectors’ exposure to upstream tariffs. However, due to the home bias, the IO coefficients calculated with the imports table may not equal to those calculated

⁶²See <https://cnae.ibge.gov.br/> for the background information about this sector classification.

⁶³Muendler (2002) discusses the relationship between CNAE sectors and Niv sectors. The Niv level complete input-output table is available from IBGE (the Brazilian Institute of Geography and Statistics). As the Niv level input-output table is only available for 2015, we fix all other datasets to the same year.

with the complete input-output table, which includes both domestic sales and imports.⁶⁴ Using only the imports table may miss the sectors in which the domestic producers are main upstream and downstream to the protected sectors but do not import or export extensively. Therefore, we need to update the imports table with domestic input-output information.

In the third step, we apply the GRAS estimation algorithm on these datasets to estimate a CNAE4 level complete input-output table. RAS (Leontief 1949, Stone 1961) is an estimation algorithm that has widely been used to estimate input-output tables. The algorithm minimizes the weighted distance between the unknown matrix and an initial guess of it, subject to constraints on the row- and column-sums of the unknown matrix (sectoral gross output and total input expenditure in our setting). The GRAS algorithm (Günlük-Şenesen and Bates 1988, Junius and Oosterhaven 2003) extends RAS. It imposes additional constraints such that the unknown matrix, once aggregated to a set of broad sectors, is consistent with a known input-output matrix at the same broad sectoral. The GRAS algorithm is recommended by the Brazilian government to estimate the national input-output table when such a table is not available for the current year (Guilhoto et al. 2010b), and to estimate the regional input-output table using region-sectoral gross output, total input, and the national level input-output table (Guilhoto et al. 2010a). In our setting, the initial guess is the “normalized” imports table, where we multiply each entry in the imports table with the ratio of total input expenditure (the sum of all entries in the Niv level input-output table) to total imported intermediate input (the sum of all entries in the imports table).⁶⁵ Our constraints are the data on CNAE4 level gross output, input expenditure, and the Niv level input-output table. Following Temursho et al. (2021), we set up the problem as:

⁶⁴For example, an upstream sector’s share in other sectors’ domestic expenditure can be different from its share on other sectors’ imports. Similarly, a downstream sector’s share in the sales of other sectors’ domestic producers may not equal to its share in other sectors’ foreign producers.

⁶⁵Consequently, total expenditure in the “normalized” imports table, as we add up all elements in the matrix, equals total input expenditure in the Brazilian economy.

$$\min_{\{z_{ij}\}} f(\mathbf{Z}) = \sum_{i=1}^{S+F} \sum_{j=1}^S |x_{ij}^O| z_{ij} \log(z_{ij}) \quad (\text{A.1})$$

$$\text{s.t.} \quad \sum_{j=1}^S x_{ij}^O z_{ij} = u_i, \forall i \in \{1, \dots, S\} \quad (\text{A.2})$$

$$\sum_{i=1}^{S+F} x_{ij}^O z_{ij} = v_j, \forall j \in \{1, \dots, S\} \quad (\text{A.3})$$

$$\sum_{i \in \Omega_I} \sum_{i \in \Omega_J} x_{ij}^O z_{ij} = w_{IJ}, \forall I \in \{1, \dots, M\}, J \in \{1, \dots, M\}, \quad (\text{A.4})$$

where $\{i\}_{i=1}^S, \{j\}_{j=1}^S$ denotes CNAE4 sectors. $i = F$ denotes the final sector (final demand and exports). I, J denotes Niv sectors, Ω_I, Ω_J denotes the CNAE4 sectors in Niv sectors. Niv sectors do not overlap— $\Omega_I \cap \Omega_J = \emptyset, \forall I \neq J$, and $\cup_{I=1}^M \Omega_I = \{1, \dots, S\}$. $\{x_{ij}^O\}_{i=1, j=1}^{i=S, j=S}$ —the initial guess—represents the normalized imports table—imports of sector j output by sector i . x_{Fj}^O denotes sales by sector j to the final sector.⁶⁶ z_{ij} represents the distance between the normalized imports table and the unknown, complete input-output table. u_i denotes sector i total input expenditure. v_j denotes sector j supplies (imports and domestic products). w_{IJ} denotes Niv sector J total output used by Niv sector I . The objective function minimizes the weighted distance between the imports table and the complete input-output table. The complete I-O table is consistent with the following information in the data: CNAE4 level total input expenditure according to constraint A.2, CNAE4 level gross output according to constraint A.3, and the cross-sector flows in the complete input-output table on the Niv level according to constraint A.4. Junius and Oosterhaven (2003), Miller and Blair (2009) and Temursho et al. (2021) show that the solution to this problem is unique, and Temursho et al. (2021) provides an iterative solver that can give the solution.

Armed with the solved $\{z_{ij}\}$, we recover the complete input output table with $x_{ij} = z_{ij} x_{ij}^O$. We can then get the input-output coefficients. We define the sector expenditure share, $\gamma_{ij} = \frac{x_{ij}}{u_i}$, as the share of input that sector i spends on sector j . The numerator denotes the input demand of sector i from sector j and the denominator denotes aggregate input

⁶⁶This initial guess is set to sector j 's gross output plus this sector's imports minus $\sum_{i=1}^J x_{ij}^O$.

demand of sector i . We define the sector output share, $S_{ij} = \frac{x_{ij}}{v_j}$, as the share of output that sector j sells to sector i . The numerator denotes the sales to sector i from sector j and the denominator denotes the production of sector j . With these two sets of market shares, we can construct the main upstream and downstream sectors as well as average downstream and upstream tariffs.

A.2.2 Main upstream and downstream

For each sector i , we define its main upstream sector $j(i)$ as the sector that sells the largest share of output to sector i :

$$j(i) = \arg \max_j S_{ij}.$$

For each sector j , we define its main downstream sector $i(j)$ as the sector that spends the largest share of input on sector j :

$$i(j) = \arg \max_i \gamma_{ij}.$$

In the event studies we focus on non-service main upstream and downstream sectors.

A.3 Endogeneity of AD Tariffs

In this section, we show that products and sectors that are targeted by an AD investigation are not similar to the ones that are not investigated. Products investigated have higher trade volume and lower prices. Moreover, they have an increasing trend in trade volume and a decreasing trend in prices. Sectors investigated have higher employment and wage, and have a decreasing trend in wage. These findings suggest that one cannot compare investigated products to non-investigated ones, because one cannot tease apart the effect of AD tariffs from product level trends.

We use the following model to calculate the probability of investigation:

$$\mathbb{I}_{p,o,t} \{\text{Investigation}\} = \beta_0 \log(\text{Imports}_{p,o,t-1}) + \beta_1 \log(\text{Price}_{p,o,t-1}) + \mu_{p,o} + \mu_{t,o} + \epsilon_{p,o,t}, \quad (\text{A.5})$$

where $\mathbb{I}_{p,o,t} \{\text{Investigation}\}$ is a dummy taking one if there is an AD investigation against product p , from destination o , in year t ; $\text{Imports}_{p,o,t-1}$ are imports of product p , from origin o , in year $t - 1$; $\mu_{p,o}$ is a production-origin fixed effect, and $\mu_{t,o}$ is a time-origin fixed effect.

Column 1 and 2 of Table A.4 show that AD investigations are more likely to target higher volume and lower price product-destinations. Column 3 and 4 show that investigations are more likely to target product-destinations in a increasing volume and decreasing price trend. Columns 5 and 6 show that AD tariffs are also more likely to be implemented on higher volume and lower price product-destinations, and Columns 7 and 8 show that they are also implemented on products in a decreasing price and increasing volume trend. Given that AD tariffs should be implemented on lower price producers, it is expected that they are in an increasing volume and decreasing prices trend. As that investigated products are not in the same trend as non-investigated ones, a comparison between them would deliver a biased estimate—one cannot tease apart the effect of an AD tariff from a pre-existing trend.

Table A.4: **Probability of Dumping Investigation and Anti-Dumping Tariff**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\mathbb{I}\{\text{Investigation}\}$	$\mathbb{I}\{\text{Investigation}\}$	$\mathbb{I}\{\text{Investigation}\}$	$\mathbb{I}\{\text{Investigation}\}$	$\mathbb{I}\{\text{AD Tariff}\}$	$\mathbb{I}\{\text{AD Tariff}\}$	$\mathbb{I}\{\text{AD Tariff}\}$	$\mathbb{I}\{\text{AD Tariff}\}$
$\log(\text{Imports}_{t-1})$	0.000121*** (0.000)	0.000120*** (0.000)	0.000108*** (0.000)	0.000111*** (0.000)	0.0000983*** (0.000)	0.0000972*** (0.000)	0.0000924*** (0.000)	0.0000941*** (0.000)
$\log(\text{Price}_{t-1})$	-0.0000746*** (0.000)	-0.0000750*** (0.000)	-0.0000168** (0.033)	-0.0000181** (0.023)	-0.0000575*** (0.000)	-0.0000589*** (0.000)	-0.0000201*** (0.003)	-0.0000207*** (0.002)
N	1542747	1542747	1509536	1508929	1542747	1542747	1509536	1508929
R^2	0.001	0.001	0.087	0.090	0.001	0.001	0.090	0.093
Year FE		X	X			X	X	
Product-Destination FE			X	X			X	X
Year-Country FE				X				X

Notes: This table shows the estimated parameters of model A.5. $\mathbb{I}\{\text{Investigation}\}$ is a dummy taking one if that product-destination has an AD investigation starting at that year. $\mathbb{I}\{\text{AD Tariff}\}$ is a dummy taking one if a product had a AD investigation starting that year. $\log(\text{Imports}_{t-1})$ the lagged FOB imports in dollars, and $\log(\text{Price}_{t-1})$ is lagged prices. Trade data is from the the Secretary of International Trade of the Ministry of Economy in Brazil and AD data is from the Global Anti-dumping database. Standard errors, cluster at the origin-product level, are in parenthesis.

Table A.5 studies the relationship between AD investigations and firm-level labor market outcomes. Column 1 and 2 show that investigations are more likely to start on sectors that have higher wage, higher employment, and smaller number of establishments. Column 3 shows that investigations are more likely to start in sectors that have increasing wage, increasing number of workers, and decreasing number of establishments trends. Column

4-6 show that the same relationship holds between AD tariffs and firm-level labor market outcomes.

Table A.5: **Probability of Dumping Investigation and AD Tariff**

	(1)	(2)	(3)	(4)	(5)	(6)
	$\mathbb{I}\{Investigation\}$	$\mathbb{I}\{Investigation\}$	$\mathbb{I}\{Investigation\}$	$\mathbb{I}\{AD\ Tariff\}$	$\mathbb{I}\{AD\ Tariff\}$	$\mathbb{I}\{AD\ Tariff\}$
$\log(Avg. Wage_{t-1})$	0.000102*** (0.000)	0.000335*** (0.000)	0.0000146 (0.191)	0.0000770*** (0.000)	0.000294*** (0.000)	0.0000130 (0.236)
$\log(N. Workers_{t-1})$	0.000358*** (0.000)	0.000333*** (0.000)	-0.00000987** (0.027)	0.000343*** (0.000)	0.000319*** (0.000)	-0.00000676+ (0.122)
$\log(N. Establishments_{t-1})$	-0.000503*** (0.000)	-0.000529*** (0.000)	-0.0000349** (0.034)	-0.000489*** (0.000)	-0.000516*** (0.000)	-0.0000363** (0.025)
N	36677266	36677266	33294706	36677266	36677266	33294706
Year FE		X	X		X	X
Sector FE			X			X

Notes: This table shows the estimated parameters of a regression of AD policy and firm level characteristics. $\mathbb{I}\{Investigation\}$ is a dummy taking one if that product-destination has an AD investigation starting at that year. $\mathbb{I}\{AD\ Tariff\}$ is a dummy taking one if a product had a AD investigation starting that year. $\log(N. Workers_{t-1})$ is lagged employment and $\log(N. Establishments_{t-1})$ is lagged number of establishments. Trade data is from the the Secretary of International Trade of the Ministry of Economy in Brazil and AD data is from the Global Anti-dumping database. Standard errors, cluster at the origin-product level, are in parenthesis.

A.4 Validation

A.4.1 Predicting Tariffs

According to the WTO regulation, AD tariffs should be equal to the price exporters charged in their home country minus the price they charged in Brazil. Therefore, if we had international data in prices we could test if WTO regulations are being followed with

$$\tau_{p,c} = \beta \frac{\pi_{p,c,c} - \pi_{p,c,BR}}{\pi_{p,c,BR}} + \epsilon_{p,c},$$

where $\tau_{p,c}$ is the AD tariff imposed against product p from country c , $\pi_{p,c,c}$ is the price charged by the exporter of product p , from country c , in country c , $\pi_{p,c,BR}$ is the price of product p , from country c , in Brazil. If WTO regulations are being followed, $\beta = 1$.

But, life is not so easy. We do not observe the price charged by the exporter in their home market. Instead, we approximate that with the distribution of prices and the AD policy of other countries. The idea is that the distribution of prices of good p from country c and the AD tariffs imposed against product p from country c contain indirect information

on the price charged in country c . We use the specification:

$$\tau_{p,c} = \beta_1 \tau_{p,c}^{avg} + \beta_2 \tau_{p,c}^{median} + \beta_2 \tau_{p,c}^{p25} + \beta_2 \tau_{p,c}^{p75} + \beta_2 \tau_{p,c}^{max} + \beta_2 \tau_{p,c}^{min} + X'_{p,c} \theta + \epsilon,$$

where $\tau_{p,c}^{avg}$ is the AD tariff if the price charged in country c and product p was the average price charged from imports of product p from country c across all countries in the world except for Brazil. Similarly, $\tau_{p,c}^{median}$, $\tau_{p,c}^{p25}$, $\tau_{p,c}^{p75}$, $\tau_{p,c}^{max}$, and $\tau_{p,c}^{min}$ uses the tariff that would have been implemented if the price charged by the supplier in its home country were the median, the 25th percentile, the 75th percentile, the maximum price, or the minimum price, respectively. $X_{p,c}$ is a set of fixed effects for the number of countries imposing AD tariff against pair (p, c) or imposing AD an investigation against (p, c) .

A.4.2 Placebo Tests

In this section, we discuss the results of two placebo tests. First, we evaluate if the results are driven by sectoral shocks. To do that we match each sector that received an AD tariff, to another sector that did not receive an AD tariff but was in a similar trend before the introduction of the tariff. We take these matches as the fake treatment group and compare it to the same control group as in the main specification. Second, we evaluate if the results are driven by sectoral trends. To do that we implement the difference-in-differences strategy pretending that the AD tariff was implemented 5 years before its de-facto implementation. These placebo tests support that results are not driven by sectoral shocks or trends.

To test if results are driven by sectoral shocks, we match each sector that faces an AD investigation to a sector that belongs to the same large sector group, had similar employment and international trade trends but did not face an AD investigation. More specifically, for each 4-digit sector i that has an AD investigation, we match it to sector q that is in the same 1-digit sector and had a similar level of employment and wage bill in the three years before the beginning of the AD investigation. Then, we treat each firm at sector q as if they had been affected by the investigation and reproduce regression 4. If a sectoral shock that affected sectors in a particular trend is behind the results identified, AD tariffs should also correlate with employment movements at sector q .

Table A.6: AD Tariffs and the Distribution of Prices

	(1)	(2)	(3)	(4)
	AD tariff	AD tariff	AD tariff	AD tariff
$\tau_{p,c}^{avg}$	0.731*** (0.0511)	0.550*** (0.0593)	0.101* (0.0554)	-0.0400 (0.0992)
$\tau_{p,c}^{median}$	-0.237*** (0.0622)	-1.095*** (0.153)	0.0316 (0.117)	0.112 (0.0931)
$\tau_{p,c}^{p25}$	3.676*** (0.407)	2.732*** (0.442)	-0.183 (0.190)	-0.0272 (0.232)
$\tau_{p,c}^{p75}$	-0.752*** (0.0647)	0.0735 (0.164)	0.0000453 (0.00457)	0.00163 (0.00319)
$\tau_{p,c}^{max}$	-0.000000196*** (5.01e-08)	0.000000238 (0.000000241)	2.98e-08 (5.61e-08)	0.00000379*** (0.000000562)
$\tau_{p,c}^{min}$	-5.787*** (0.639)	-4.072*** (0.722)	-0.0230 (0.219)	-0.282 (0.483)
Level	Product X Origin	Product X Origin	Sector	Sector
Sample	All	Positive Tariff	All	Positive Tariff
N	129	100	62	49
R^2	0.800	0.904	0.830	0.972
adj. R^2	0.680	0.828	0.390	0.853

Notes: This table shows the estimated parameters of a regression of AD policy on different values of predicted tariffs. $\tau_{p,c}^{avg} = \frac{\pi_{p,avg} - \pi_{p,c,BR}}{\pi_{p,c,BR}}$ where $\pi_{p,c,avg}$ is the average price charged by country c for good p to all other countries except Brazil, $\tau_{p,c}^{median} = \frac{\pi_{p,median} - \pi_{p,c,BR}}{\pi_{p,c,BR}}$ where $\pi_{p,median}$ is the median price charged by country c for good p to all other countries except Brazil, $\tau_{p,c}^{p25} = \frac{\pi_{p,p25} - \pi_{p,c,BR}}{\pi_{p,c,BR}}$ where $\pi_{p,p25}$ is the 25th percentile of prices charged by country c for good p to all other countries except Brazil, $\tau_{p,c}^{p75} = \frac{\pi_{p,p75} - \pi_{p,c,BR}}{\pi_{p,c,BR}}$ where $\pi_{p,p75}$ is the 75th percentile of prices charged by country c for good p to all other countries except Brazil, $\tau_{p,c}^{max} = \frac{\pi_{p,max} - \pi_{p,c,BR}}{\pi_{p,c,BR}}$ where $\pi_{p,max}$ is the maximum price charged by country c for good p to all other countries except Brazil, and $\tau_{p,c}^{min} = \frac{\pi_{p,min} - \pi_{p,c,BR}}{\pi_{p,c,BR}}$ where $\pi_{p,min}$ is the minimum price charged by country c for good p to all other countries except Brazil. *ADtariff* is the AD tariff imposed at the product level. Trade data is from the the Secretary of International Trade of the Ministry of Economy in Brazil and the United Nations Comtrade, and AD data is from the Global Anti-dumping database. Standard errors, cluster at the origin-product level, are in parenthesis.

The results of the placebo test are presented in Figure A.3a. It indicates that there is no correlation between employment in sectors that did not receive an AD tariff but had a similar trend in employment and the wage bill, and AD tariffs. We conclude that results are not driven by sectoral shocks affecting sectors with similar employment characteristics.

We also test if results are driven by sectoral trends. To do so we implement regression 4 but we pretend that the investigation started 5 years before its de-facto implementation. Figure A.3b shows that, as expected, we don't find any difference in the wage bill between treatment and control five years before the introduction of the tariff.

A.4.3 Political Connection and Other Policies

We show that AD tariffs are not correlated with political engagement or other policies. If firms protected by a tariff are also targeted by other policies, we will not be able to tease apart the effect of tariffs from the effect of these other policies. Table A.7 tests that for a series of prominent policies in Brazil. It shows that AD tariffs do not correlate with signing a procurement contract with the federal government (Column 2) nor with receiving a subsidized loan (Column 3).

During the 2000s, the Brazilian government implemented policies facilitating access to the stock market, reducing taxes, and privatizing state-owned firms. Columns 4 to 7 show that these policies do not correlate with AD tariffs.

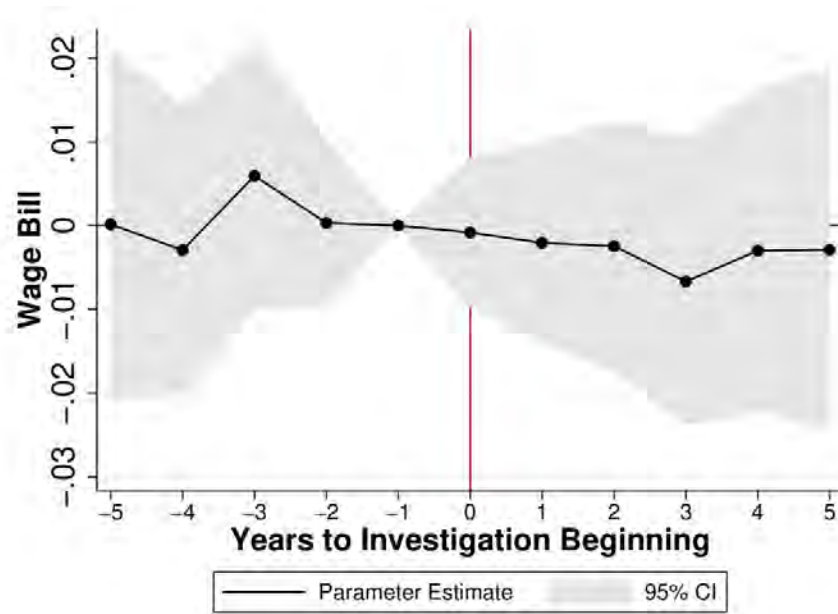
There is no correlation between tariffs and campaign contributions, according to A.7. Therefore, this result indicates that it is unlikely that firms targeted by AD tariff are systematically lobbying for other blessings from the government.

AD tariffs do not correlate with other international trade policies. Columns 8 and 9 show that treatment and control groups are equally exposed to changes in MFN tariffs and preferential tariffs.

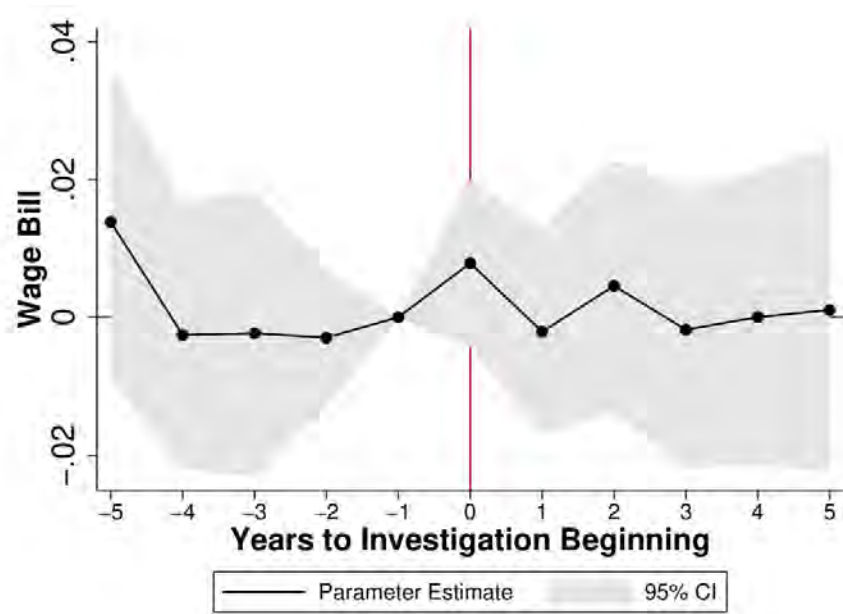
A.4.4 Other Shocks

In this section, we show that heterogeneous exposure to aggregate shocks cannot explain our results. In particular, we focus on important shocks to the Brazilian economy in the past years – the exchange rate fluctuation and trade liberalization, discussed in Dix-Carneiro and

(a) Placebo Test with Fake Investigated Sectors



(b) Placebo Test with Fake Investigation Year



Description: Figure A.3a shows the coefficients of regression 4 but using placebo firms. For each sector with an AD investigation, we match it to a sector in the same 4-digit classification that had similar employment and wage-bill in the 3 years before the investigation. Then, we treat the matched sector as if it was subject to the AD investigation and tariff. Figure A.3a shows the coefficients of regression 4 pretending that the AD investigation started 5 years before it actually did.

Table A.7: **AD Tariffs are not Correlated with Political Connection and Other Policies**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	I{Campaign Contribution}	I{Gov. Demand}	I{Subsidize Loan}	I{Publicly Traded}	I{Public}	I{Multinational}	I{Simples}	MFN Tariff	Tariffs
$\tau_{s,t}$	-0.000709 (0.00101)	0.000937* (0.000507)	-0.0000218 (0.000140)	-0.000324 (0.000306)	-0.0000105 (0.000181)	-0.00000956 (0.0000106)	-0.000561 (0.00130)	0.0871 (0.104)	0.0435 (0.0940)
N	20857	81134	154641	154591	154636	154639	108408	154641	142808
R^2	0.501	0.516	0.174	0.536	0.193	0.085	0.751	0.947	0.945
# Firms	7108	7109	7111	7111	7111	7111	7111	36	36
Mean Dep. Var	.013	.019	.001	.006	.004	0	.525	17.65	17.919
Mean Ind. Var	.96	.96	.96	.96	.96	.96	.96	.96	.96
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

This table presents the estimated parameters of model 3. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. I{Campaign Contribution} is a dummy taking one if the firm has made a campaign contribution in the past election, I{Gov. Demand} is a dummy taking one if the firm has won a government procurement, I{Subsidize Loan} is a dummy if the firm has collected a subsidized loan from the government, I{Publicly Traded} is a dummy if the firm is publicly traded, I{Public} is a dummy if the firm is owned by the government, I{Multinational} is a dummy if the firm is part of a multinational corporation, I{Simples} is a dummy if the firm is part of the Simples plan, which is a plan with lower taxes and simplified tax filing, MFN Tariff is the most favored nation tariff, i.e., the tariff imposed by Brazil to other WTO member, and Tariffs is the tariff imposed by Brazil excluding AD. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm. Standard errors are clustered at the firm level for columns 1 to 7 and at the sector level for columns 8 and 9. We cluster tariffs at the sector level because they do not vary at the firm level.

Kovak 2015 and Dix-Carneiro and Kovak 2017.

To control for heterogeneous exposure to exchange rate fluctuation, we use the following model:

$$y_{i,s,t} = \theta\tau_{s,t}^{mid} + \beta\mathbb{I}_{s,t} \{\text{After AD}\} + \alpha_s E_t + X'_{i,s,t}\kappa + \eta_i + \eta_t + \epsilon_{i,t} \quad (\text{A.6})$$

where α_s is a parameter capturing the correlation of exchange rate fluctuation E_t and sector s labor outcomes. Equivalently, we write similar specification for the effect of AD tariffs upstream and downstream. Tables A.8, A.9, and A.10 shows that AD tariffs increase employment at midstream firms, decreases it downstream, and has no effect upstream, as we have found on the main specification.

One could be worried that we are capturing reminiscences of the Brazilian trade liberalization experience. To test if this is the case, we use the following functional form

$$y_{i,s,t} = \theta\tau_{s,t}^{mid} + \beta\mathbb{I}_{s,t} \{\text{After AD}\} + \alpha_t Lib_s + X'_{i,s,t}\kappa + \eta_i + \eta_t + \epsilon_{i,t} \quad (\text{A.7})$$

where Lib_s is the tariff change between 1995 and 1990 calculated by Dix-Carneiro and Kovak 2017. α_t is an year-specific parameter. Tables A.8, A.9, and A.10 shows that AD tariffs increase employment at midstream firms, decreases it downstream, and has no effect upstream, as we have found on the main specification.

Table A.8: **Effect of AD Tariffs on Midstream Firms Controlling for Shocks**

	(1)	(2)	(3)	(4)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$
$\tau_{s,t}^{mid}$	0.0215*** (0.00378)	0.0225*** (0.00412)	0.0227*** (0.00557)	0.0232*** (0.00617)
Control:	Exchange Rate	Exchange Rate	Trade Liberalization	Trade Liberalization
N	132816	132816	128745	128745
R^2	0.811	0.846	0.808	0.843
# Firms	6277	6277	6098	6098
Mean Dep. Var	2.684	10.062	2.684	10.062
Mean Ind. Var	1.07	1.07	1.07	1.07
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

This table presents the estimated parameters of model 3. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. $\mathbb{I}\{\text{Campaign Contribution}\}$ is a dummy taking one if the firm has made a campaign contribution in the past election, $\mathbb{I}\{\text{Gov. Demand}\}$ is a dummy taking one if the firm has won a government procurement, $\mathbb{I}\{\text{Subsidize Loan}\}$ is a dummy if the firm has collected a subsidized loan from the government, $\mathbb{I}\{\text{Publicly Traded}\}$ is a dummy if the firm is publicly traded, and $\mathbb{I}\{\text{Public}\}$ is a dummy if the firm is owned by the government. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm. Standard errors are clustered at the firm level.

Table A.9: **Effect of AD Tariffs on Downstream Firms Controlling for Shocks**

	(1)	(2)	(3)	(4)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$
$\tau_{s,t}^{down}$	-0.0263 (0.0220)	-0.0336 (0.0242)	-0.0553* (0.0286)	-0.1000*** (0.0312)
Control:	Exchange Rate	Exchange Rate	Trade Liberalization	Trade Liberalization
N	182790	182790	128745	128745
R^2	0.813	0.834	0.808	0.843
# Firms	8686	8686	6098	6098
Mean Dep. Var	2.412	9.599	2.684	10.062
Mean Ind. Var	.07	.07	1.07	1.07
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

This table presents the estimated parameters of model 3. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. $\mathbb{I}\{\text{Campaign Contribution}\}$ is a dummy taking one if the firm has made a campaign contribution in the past election, $\mathbb{I}\{\text{Gov. Demand}\}$ is a dummy taking one if the firm has won a government procurement, $\mathbb{I}\{\text{Subsidize Loan}\}$ is a dummy if the firm has collected a subsidized loan from the government, $\mathbb{I}\{\text{Publicly Traded}\}$ is a dummy if the firm is publicly traded, and $\mathbb{I}\{\text{Public}\}$ is a dummy if the firm is owned by the government. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm. Standard errors are clustered at the firm level.

Table A.10: **Effect of AD Tariffs on Upstream Firms Controlling for Shocks**

	(1)	(2)	(3)	(4)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$
$\tau_{s,t}^{up}$	0.0106 (0.00864)	0.00966 (0.00849)	0.000974 (0.0109)	-0.000780 (0.0120)
Control:	Exchange Rate	Exchange Rate	Trade Liberalization	Trade Liberalization
N	74735	74735	67536	67536
R^2	0.821	0.844	0.823	0.846
# Firms	3694	3694	3352	3352
Mean Dep. Var	2.55	9.8	2.55	9.8
Mean Ind. Var	.29	.29	.29	.29
Firm FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes

This table presents the estimated parameters of model 3. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. $\mathbb{I}\{\text{Campaign Contribution}\}$ is a dummy taking one if the firm has made a campaign contribution in the past election, $\mathbb{I}\{\text{Gov. Demand}\}$ is a dummy taking one if the firm has won a government procurement, $\mathbb{I}\{\text{Subsidize Loan}\}$ is a dummy if the firm has collected a subsidized loan from the government, $\mathbb{I}\{\text{Publicly Traded}\}$ is a dummy if the firm is publicly traded, and $\mathbb{I}\{\text{Public}\}$ is a dummy if the firm is owned by the government. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm. Standard errors are clustered at the firm level.

A.5 Robustness

A.5.1 Controls

Table A.11: **Robustness of the Effect of AD Tariffs on the National Producers**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$
$\tau_{s,t}$	0.0111*** (0.00211)	0.0156*** (0.00358)	0.0121*** (0.00417)	0.0186*** (0.00390)	0.0130*** (0.00423)	0.0191*** (0.00397)	0.0156*** (0.00446)
N	119368	119368	119368	119368	119368	119368	119368
R^2	0.863	0.863	0.865	0.863	0.865	0.863	0.863
1 Digit Sector FE		X		X		X	X
2 Digit Sector FE			X		X		
# Product Invest.				X	X	X	X
# Product AD Tariffs						X	X

Description: This table presents the estimated parameters of model 3. The sample is composed of firms in sectors producing the product under AD investigation. we constrain the sample to the set of firms observed after and before the AD investigation, that have more than 10 observations and more than one worker. These sample restrictions are made to avoid compositional change and special firms. $\log(\text{Wage Bill})$ is the log of total labor expenditure of the firm. $\log(\text{Number Workers})$ is the log of the total number of workers of the firm. $\log(\text{Monthly Earnings})$ is the average monthly earnings of workers at that firm. $\log(\text{Establishments})$ is the log of number of establishments of the firm. $\mathbb{I}\{\text{exporter}\}$ is a dummy taking one if the exported any product that year and $\mathbb{I}\{\text{importer}\}$ is a dummy for importing. AD tariff is the average AD tariff imposed against products produced by the sector of each firm. The sample goes from 1995 to 2016.

Table A.12: Effect of AD Tariffs on Downstream Firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$
<i>Sample: Main Downstream</i>							
$\tau_{s,t}$	-0.118*** (0.0239)	-0.0957*** (0.0247)	-0.0124 (0.0327)	-0.0857*** (0.0244)	-0.0142 (0.0330)	-0.0820*** (0.0250)	-0.0998*** (0.0373)
N	182790	182790	182790	182790	182790	182790	182790
R^2	0.831	0.832	0.836	0.833	0.836	0.833	0.833
<i>Sample: All Downstream</i>							
$\tau_{s,t}$	-0.0738*** (0.0181)	-0.0270 (0.0190)	-0.0217 (0.0220)	-0.0430** (0.0191)	-0.0249 (0.0221)	-0.0372* (0.0192)	-0.0362* (0.0208)
N	969621	969619	969611	969619	969611	969619	969619
R^2	0.833	0.834	0.835	0.834	0.835	0.834	0.834
1 Digit Sector FE		X		X		X	X
2 Digit Sector FE			X		X		
# Product Invest.				X	X	X	X
# Product AD						X	
Tariffs							X

Description: This table presents the estimated parameters of model 3. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. $\log(\text{Wage Bill})$ is the log of the firm's total labor expenditure. Column 2 adds a 1 digit sector interacted with year as control, column 3 has a 2 digit sector interacted with year as control, column 4 has a 1 digit sector-year FE with dummies for the number of product investigated, column 5 has a 2 digit sector-year FE with dummies for the number of product investigated. column 6 has as control a 1 digit sector-year FE, number of product investigated, and number of products with AD. column 7 has as control a 1 digit sector-year FE, number of product investigated, and tariff upstream and downstream. $\tau_{s,t}$ is the average AD tariff downstream. Standard errors are clustered at the firm level.

Table A.13: Effect of AD Tariffs on Upstream Firms

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$	$\log(\text{Wage Bill})$
<i>Sample: Main Upstream</i>							
$\tau_{s,t}$	0.00985 (0.00602)	-0.00219 (0.00707)	-0.0114 (0.0257)	-0.000384 (0.00809)	-0.0156 (0.0244)	-0.00320 (0.00826)	-0.00364 (0.00902)
N	74735	74735	74713	74735	74713	74735	74735
R^2	0.844	0.844	0.845	0.844	0.845	0.844	0.844
<i>Sample: All Upstream</i>							
$\tau_{s,t}$	0.0174*** (0.00386)	0.00833** (0.00395)	0.0115** (0.00569)	0.00637 (0.00401)	0.0114** (0.00576)	0.00486 (0.00403)	0.00283** (0.00122)
N	3238468	3238468	3238468	3238468	3238468	3238468	3238468
R^2	0.834	0.835	0.835	0.835	0.835	0.835	0.835
1 Digit Sector FE		X		X		X	X
2 Digit Sector FE			X		X		
# Product Invest.				X	X	X	X
# Product AD						X	
Tariffs							X

Description: This table presents the estimated parameters of model 7. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. $\log(\text{Wage Bill})$ is the log of the firm's total labor expenditure. Column 2 adds a 1 digit sector interacted with year as control, column 3 has a 2 digit sector interacted with year as control, column 4 has a 1 digit sector-year FE with dummies for the number of product investigated, column 5 has a 2 digit sector-year FE with dummies for the number of product investigated. column 6 has as control a 1 digit sector-year FE, number of product investigated, and number of products with AD. column 7 has as control a 1 digit sector-year FE, number of product investigated, and tariff upstream and downstream. $\tau_{s,t}$ is the upstream tariff. Standard errors are clustered at the firm level.

A.5.2 All Connected Sectors

In this section, we identify both the effects of tariffs on firms and their propagation. Following Acemoglu et al. (2014) and Bown et al. (2021), our specification is given by

$$y_{i,s,t} = \theta\tau_{s,t} + \theta^{up}\tilde{\tau}_{s(u),t}^{up} + \theta^{down}\tilde{\tau}_{s(d),t}^{down} + X'_{i,s,t}\kappa + \eta_i + \eta_t + \epsilon_{i,t}, \quad (\text{A.8})$$

where $\tau_{s,t}$ is the average AD tariff against sector s , $\tilde{\tau}_{s(u),t}^{up}$ is the average exposure of firm i in sector s to upstream tariffs, $\tilde{\tau}_{s(d),t}^{down}$ is the average exposure of firm i in sector s to downstream tariffs. $X'_{i,s,t}$ is a set of controls, which include a 1-digit sector fixed effect interacted with year, and a dummy for the number of investigations. We run this regression on all firms—not only the ones exposed to AD investigation as we studied before.

This specification has two drawbacks. The first one is that to identify the causal effect of tariffs we have to assume that all sectors are in parallel trends. Given that we expect sectors with AD investigations to be in a declining trend due to the institutions of AD investigations discussed in Section 2, this is a strong assumption. A second drawback is that we cannot test if sectors were in similar trends before the introduction of the tariffs.

Still, despite the drawbacks, Table A.14 confirms the result that AD tariffs increase employment at midstream firms and do not significantly affect upstream firms.

A.5.3 Sectoral Regressions

In this section we study the effect of AD tariffs on sector-level aggregate variables. First, we show that AD tariffs do not lead to the entry or exit of firms. Second, we show that, even on the sector level (without exploiting firm-level variations as we did before), we find that AD tariffs lead to an increase in employment midstream, and it decreases wages downstream.

AD tariffs do not lead to the entry or exit of firms or establishments, according to results in Table A.15. Column 1 of Table A.15 shows the effect of tariffs on the number of firms in the midstream, main downstream, and main upstream sectors. In none of these specifications we find that tariffs lead to more or less firms in the sector. In column 2 of Table A.15 shows the effect of tariffs on the total number of establishments. Once again, we find that AD tariffs do not lead to more establishments midstream, downstream, or upstream.

Table A.14: **Effect of AD Tariffs through the Input-Output Connection**

	(1)	(2)	(3)	(4)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\mathbb{I}\{Exporter\}$	$\mathbb{I}\{Importer\}$
$\tau_{s,t}^{mid}$	0.00910*** (0.00163)	0.00958*** (0.00184)	0.00325*** (0.000494)	0.00294*** (0.000503)
$\tilde{\tau}_{d(s),t}^{up}$	-0.00965* (0.00510)	-0.00588 (0.00550)	-0.00445*** (0.00105)	-0.00551*** (0.00106)
$\tilde{\tau}_{d(s),t}^{down}$	-0.0158 (0.0106)	-0.0551*** (0.0116)	0.0206*** (0.00234)	0.0250*** (0.00234)
N	3142280	3142280	3142280	3142280
R^2	0.814	0.840	0.586	0.600
# Firms	180618	180618	180618	180618
Mean Mid. Tariff	.1	.1	.1	.1
Mean Up. Tariff	.05	.05	.05	.05
Mean Down. Tariff	.05	.05	.05	.05

Description: This table presents the estimated parameters of model 3. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. $\log(\text{Wage Bill})$ is the log of the firm's total labor expenditure. $\log(\text{Number Workers})$ is the log of the total number of workers in the firm. $\mathbb{I}\{\text{exporter}\}$ is a dummy that takes one if the protected firm exports any product that year, $\mathbb{I}\{\text{importer}\}$ is a dummy taking one if the protected firm imports any product that year, $\log(\text{Imports})$ is the log of expected imports of the firm, and $\log(\text{Exports})$ is the log of expected exports. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm, $\tau_{s,t}^{up}$ is the AD tariff upstream and $\tau_{s,t}^{down}$ is the AD tariff downstream. Standard errors are clustered at the firm level.

The fact that AD tariffs do not cause entry or exit of firms is important for two reasons – the identification of elasticities and our modeling assumptions. First, it guarantees that our estimates of the effect of AD are not biased. If AD tariffs lead to the entry/exit of firms, our estimates should be conditional on surviving. Second, in Section 5, based on the fact that AD tariffs do not affect entry or exit, we build a model without this margin.

We also find that AD tariffs increase employment midstream and it decreases wages downstream using sectoral aggregate data, as shown in Table A.15.

Table A.15: **Effect of AD Tariffs on Firms using Sectoral Aggregates**

	(1)	(2)	(3)	(4)
	$\log(N. Firms)$	$\log(N. Establishments)$	$\log(N. Workers)$	$\log(Wage Bill)$
Midstream				
$\tau_{s,t}^{mid}$	0.0141 (0.00877)	0.0139 (0.00918)	0.0265*** (0.00839)	0.0334** (0.0128)
N	1079	1079	1079	1079
R^2	0.978	0.974	0.927	0.877
Downstream				
$\tilde{\tau}_{d(s),t}^{down}$	0.0304 (0.100)	0.0735 (0.125)	0.0717 (0.111)	0.00376 (0.0999)
N	1134	1134	1134	1134
R^2	0.979	0.977	0.936	0.905
Upstream				
$\tilde{\tau}_{d(s),t}^{up}$	-0.00812 (0.0121)	0.000793 (0.0168)	-0.0136 (0.0196)	0.0198 (0.0238)
N	944	944	944	944
R^2	0.988	0.981	0.970	0.964

Description: This table presents the estimated parameters of model 3 aggregated at sector level. The sample is composed of sectors that produce the product under an AD investigation. $\log(Wage Bill)$ is the log of the sector's total labor expenditure. $\log(\text{Number Workers})$ is the log of the total number of workers in the sector. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm, $\tau_{s,t}^{up}$ is the AD tariff upstream and $\tau_{s,t}^{down}$ is the AD tariff downstream. Standard errors are clustered at the sector level.

A.5.4 Instrumental Variables

Exploiting the institutional setting discussed in Section A.4.1, we propose an instrument for AD tariffs. We instrument AD tariffs in Brazil with the AD tariffs imposed other countries. The rationale for that is the following. A supplier exporting with low prices to Brazil is likely to export with low prices to other countries as well. Therefore, if a supplier meets the requirements for an AD tariff in Brazil due to its low prices, it is also likely to meet these requirements in other countries. Since the AD policy outside of Brazil is unlikely to directly affect the Brazilian labor market, the instrument is exogenous to Brazilian employment.

We instrument $\tau_{s,t}$, the average AD tariff on products of sector s , with a set of dummies for the number of investigations and tariffs imposed against products of sector s in year t in all other countries except Brazil. The first stage is

$$\tau_{s,t} = \sum_o \beta_o^I \mathbb{I}_t \{o \text{ Countries Investigated Sector } s\} + \sum_o \beta_o^T \mathbb{I}_t \{o \text{ Countries Imposed AD Tariff on Sector } s\} + X'_{s,t} \kappa + \epsilon_{s,t}, \quad (\text{A.9})$$

where $\mathbb{I}\{o \text{ Countries Investigated Sector } s\}$ equals one if countries except Brazil conduct o AD investigations on sector s in year t . $\mathbb{I}\{o \text{ Countries Imposed AD Tariff on Sector } s\}$ equals one if countries except Brazil impose o AD tariffs on sector s in year t . We instrument the exposure to tariffs downstream and upstream similarly.

Results in Table A.16 confirm the finding that AD tariffs increase employment midstream, propagates downstream, but do not affect upstream firms. Column 1 and 2 of Table A.16 show the effect of AD tariffs on midstream firms using as instrument the AD policy of countries outside Brazil. As in the baseline model, we limit the sample to the firms that faced AD investigations. We find that imposing a 100% AD tariff causes a 3% increase in employment. Column 3 and 4 shows the effect of tariffs downstream. It shows that a 100% AD tariff on all the inputs of a firm causes a 60% decrease in employment. This is an order of magnitude larger than what we found in the main regressions. An instrument variable regression identifies the effect of AD tariffs on compliers, i.e., on the set of sectors that were targeted by both tariffs in Brazil and those outside of Brazil. These sectors are not necessarily representative of the set of sectors targeted by tariffs in Brazil. Columns 5 and 6 show that there is no effect of tariffs upstream.

A.5.5 Regional Variation

In this section we study the effect of AD tariffs on local labor markets. We exploit heterogeneous sectoral composition across regions to create a measure of heterogeneous exposure of regions to AD tariffs. We find that midstream tariffs significantly increase employment but the propagation of tariffs through the input-output connection of firms is not significant.

Table A.16: **Effect of AD Tariffs with Instruments**

	(1)	(2)	(3)	(4)	(5)	(6)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$
τ	0.0319*** (0.00669)	0.0316*** (0.00744)				
τ^{down}			-0.590*** (0.194)	-0.819*** (0.243)		
τ^{up}					0.0319 (0.0425)	0.0685 (0.0479)

Sample	Investigated Sectors	Investigated Sectors	Main Downstream	Main Downstream	Main Upstream	Main Upstream
N	132816	132816	31748	31748	41424	41424
R^2	0.809	0.844	0.831	0.843	0.818	0.838
# Firms	6277	6277	1458	1458	2063	2063
Mean Dep. Var	2.684	10.062	2.412	9.599	2.55	9.80
Mean Ind. Var	1.07	1.07	.07	.07	.29	.29

Description: This table presents the estimated parameters of model 3. The sample is composed of firms in sectors that produce the product under an AD investigation. We limit the sample to the set of firms observed 5-years around the AD investigation. $\log(\text{Wage Bill})$ is the log of the firm's total labor expenditure. $\mathbb{I}\{\text{exporter}\}$ is a dummy that takes one if the protected firm exports any product that year, $\mathbb{I}\{\text{importer}\}$ is a dummy taking one if the protected firm imports any product that year, $\log(\text{Imports})$ is the log of expected imports of the firm, and $\log(\text{Exports})$ is the log of expected exports. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm, $\tau_{s,t}^{up}$ is the AD tariff upstream and $\tau_{s,t}^{down}$ is the AD tariff downstream. Standard errors are clustered at the firm level.

Denote $\tau_{s,t}$ the AD tariff impose against sector s in year t . The exposure of region r to tariff $\tau_{s,t}$ equals:

$$\tau_{r,t}^{reg} = \frac{\sum_s \text{Employment}_{s,t-1} \tau_{s,t}}{\sum_s \text{Employment}_{s,t-1}},$$

where $\text{Employment}_{s,t-1}$ is employment and $\tau_{r,t}^{reg,mid}$ is the exposure of region r to midstream tariffs. Similarly, we can calculate the exposure of region r to downstream tariffs, $\tau_{r,t}^{reg,down}$, and to upstream tariffs, $\tau_{r,t}^{reg,up}$.

The regional specification is the following:

$$y_{r,t} = \theta^{mid} \tau_{r,t}^{reg,mid} + \theta^{down} \tau_{r,t}^{reg,down} + \theta^{up} \tau_{r,t}^{reg,up} + X'_{r,t} \kappa + \epsilon_{r,t} \quad (\text{A.10})$$

where $y_{r,t}$ is the log of a labor outcome in region r and year t and $X_{r,t}$ is a set of controls containing the weighted number of investigations, pre-period log employment interacted with year, and pre-period log wage interacted with year.

Table A.17 shows the main results of this section. Column 1 and 2 show that midstream tariffs have a large impact on employment and wage bill in local labor markets. We also find that exposure to downstream tariffs has a large point estimate but it is not significant. Columns 3 to 5 show that downstream tariffs decrease employment of workers with high

Table A.17: **Effect of AD Tariffs on Regional Labor Markets**

	(1)	(2)	(3)	(4)	(5)
	$\log(\# \text{ Workers})$	$\log(\text{Wage Bill})$	$\log(\# \text{ HS Dropout})$	$\log(\# \text{ HS Complete})$	$\log(\# \text{ More HS})$
$\tau_{s,t}^{mid}$	0.343*** (0.106)	0.312** (0.126)	0.244** (0.115)	0.312** (0.126)	0.341** (0.159)
$\tau_{d(s),t}^{down}$	-0.901 (0.859)	-1.428 (1.023)	0.259 (0.937)	-3.476*** (1.024)	-6.269*** (1.296)
$\tau_{d(s),t}^{up}$	-0.101 (0.141)	-0.0998 (0.167)	0.155 (0.153)	0.269 (0.168)	-0.0884 (0.212)
N	14367	14367	14364	14358	14341
R^2	0.982	0.981	0.977	0.979	0.975
# Regions	558	558	558	558	558
Mean Midstream Tariff	.01	.01	.01	.01	.01
Mean Downstream Tariff	0	0	0	0	0
Mean Upstream Tariff	.01	.01	.01	.01	.01
Mean Ind. Var	9.452	16.806	8.831	8.177	7.144

Description: This table presents the estimated parameters of model A.10. $\log(\# \text{ Workers})$ is the log of total employment in the region, $\log(\text{Wage Bill})$ is the log of total wagebill in the region, $\log(\# \text{ HS Dropout})$ is the log of high-school dropouts in the region, $\log(\# \text{ HS Complete})$ is the log of employment of workers with high-school complete, and $\log(\# \text{ More HS})$ is the log of employment of workers with more than high-school. $\tau_{s,t}^{mid}$ is the average AD tariff imposed on products produced by the sector of each firm, $\tau_{s,t}^{up}$ is the AD tariff upstream and $\tau_{s,t}^{down}$ is the AD tariff downstream. Standard errors are clustered at the firm level.

school complete and more than high school but do not affect employment of workers with less than high school. Finally, once again we find that tariffs do not propagate downstream.

B Model Appendix

B.1 Model

Proof of Equation 13: Conditional on a sector, the household's optimal sectoral consumption $c_r^s(\omega)$ and labor supply $l^s(\omega)$ are independent from their utility shocks $z^s(\omega)$. Dropping ω , the within-sector problem implies that the household's sectoral consumption equals the following:

$$P^r c_r^s = \begin{cases} \frac{d^r(P^r)^{1-\theta}}{(PC)^{1-\theta}}(1-\delta)w^s l^s & , s > 0 \\ \frac{d^r(P^r)^{1-\theta}}{(PC)^{1-\theta}}(1-\delta)b & , s = 0. \end{cases}$$

We denote the sectoral consumption shares with $\alpha^r = \frac{d^r (P^r)^{1-\theta}}{(PC)^{1-\theta}}$, and the consumer price index with PC :

$$PC = \left(\sum_{r=1}^S d^r (P^r)^{1-\theta} \right)^{\frac{1}{1-\theta}}.$$

Within a production sector s , we solve the household optimal labor supply which increases in the sector's real wage. The supply elasticity equals ψ^s :

$$l^s = \left(\frac{w^s}{PC} \right)^{\psi^s}. \quad (\text{B.1})$$

Plugging Equation 9 and B.1 into Equation 10 gives the nonrandom component of welfare associated with staying in sector s :

$$U^s = \begin{cases} (1 - \delta - \frac{\psi^s}{1+\psi^s}) \left(\frac{w^s}{PC} \right)^{1+\psi^s} & s > 0 \\ \frac{(1-\delta)b}{PC} & s = 0. \end{cases}$$

The elasticity of a household's welfare in sector $s > 0$ with respect to the sector's real wage equals $1 + \psi^s$, and is greater than that of the outside sector's welfare with respect to the social insurance (which is 1). Real wage increase leads to higher labor supply for the households that work in the sector and greater-than-unity increase in total real income and thus welfare of staying in the sector.

With the familiar property of the Frechet distribution, we can solve for the probability that a household chooses each sector, π^s :

$$\pi^s = \begin{cases} \frac{\tilde{a}^s \left(\frac{w^s}{PC} \right)^{\eta^s}}{\sum_{s=1}^S \tilde{a}^s \left(\frac{w^s}{PC} \right)^{\eta^s} + \tilde{a}^0 \left(\frac{b}{PC} \right)^\mu} & , s > 0 \\ \frac{\tilde{a}^0 \left(\frac{b}{PC} \right)^\mu}{\sum_{s=1}^S \tilde{a}^s \left(\frac{w^s}{PC} \right)^{\eta^s} + \tilde{a}^0 \left(\frac{b}{PC} \right)^\mu} & , s = 0, \end{cases}$$

where $\eta^s = \mu(1+\psi^s)$, $\tilde{a}^s = \left(a^s \left(1 - \delta - \frac{\psi^s}{1+\psi^s} \right) \right)^\mu$, $s > 0$ and $\tilde{a}^0 = (a^0(1 - \delta))^\mu$ are parameters.

The population in all sectors adds up to the total population:

$$\sum_{s=0}^S \pi^s l^s = L. \quad (\text{B.2})$$

This implies that the share of population in each sector, i.e. sectoral labor supply L^s , equals the following:

$$L^s = \frac{\pi^s l^s}{\sum_{s=0}^S \pi^s l^s} L = \begin{cases} \frac{\tilde{a}^s \left(\frac{w^s}{PC}\right)^{\lambda^s}}{\sum_{s=1}^S \tilde{a}^s \left(\frac{w^s}{PC}\right)^{\lambda^s} + \tilde{a}^0 \left(\frac{b}{PC}\right)^{\mu}} L & , s > 0 \\ \frac{\tilde{a}^0 \left(\frac{b}{PC}\right)^{\mu}}{\sum_{s=1}^S \tilde{a}^s \left(\frac{w^s}{PC}\right)^{\lambda^s} + \tilde{a}^0 \left(\frac{b}{PC}\right)^{\mu}} L & , s = 0. \end{cases}$$

Using properties of the Frechet distribution, we also show that a household's expected welfare equals the following:

$$W = \left(\sum_{s=0}^S (\tilde{a}^s U^s)^\mu \right)^{\frac{1}{\mu}} = \left(\sum_{s=1}^S \tilde{a}^s \left(\frac{w^s}{PC}\right)^{\lambda^s} + \tilde{a}^0 \left(\frac{b}{PC}\right)^{\mu} \right)^{\frac{1}{\mu}}. \quad (\text{B.3})$$

B.2 Model in Changes

In order to compute counterfactuals, we rewrite the model in changes. By doing so we eliminate the economic fundamentals that are often difficult to calibrate or estimate directly. These fundamentals include productivity, foreign price, country and product preference, among others. We use V' to denote the value of an ex-post (after a tariff shock) variable V , and $\hat{V} = \frac{V'}{V}$ to denote the variable in changes.

First, the change in sectoral labor supply equals the following:

$$\hat{L}^s = \begin{cases} \frac{\left(\frac{\hat{w}^s}{\hat{P}^C}\right)^{\lambda^s}}{\sum_{s=1}^S \kappa^s \left(\frac{\hat{w}^s}{\hat{P}^C}\right)^{\lambda^s} + \kappa^0 \left(\frac{1}{\hat{P}^C}\right)^\mu} & , s > 0 \\ \frac{\left(\frac{1}{\hat{P}^C}\right)^\mu}{\sum_{s=1}^S \kappa^s \left(\frac{\hat{w}^s}{\hat{P}^C}\right)^{\lambda^s} + \kappa^0 \left(\frac{1}{\hat{P}^C}\right)^\mu} & , s = 0, \end{cases} \quad (\text{B.4})$$

where $\kappa^s = \frac{L^s}{L}$ denotes the population share in sector s in the baseline equilibrium. κ^0 denotes the fraction of population that does not work.

The change in sectoral Brazilian output price is the following:

$$\hat{P}_0^s = \left(s_L^s (\hat{w}^s)^{1-\rho} + \sum_{s'=1}^S s_M^{ss'} (\hat{P}^{s'})^{1-\rho} \right)^{\frac{1}{1-\rho}}. \quad (\text{B.5})$$

The change in input-output shares equals:

$$\hat{s}_M^{ss'} = \frac{(\hat{P}^{s'})^{1-\rho}}{(\hat{P}_0^s)^{1-\rho}}.$$

Therefore, the ex-post input-output shares equal: $s_M^{ss'} = \hat{s}_M^{ss'} s_M^{ss'}$.

The change in sector s expenditure shares on country i equals:

$$\hat{s}_i^s = \frac{(\hat{P}_i^s)^{1-\sigma^s}}{(\hat{P}^s)^{1-\sigma^s}},$$

where the change in sectoral input price equals:

$$(\hat{P}^s)^{1-\sigma^s} = \sum_{i=0}^N s_i^s (\hat{P}_i^s)^{1-\sigma^s}. \quad (\text{B.6})$$

The change in expenditure share on product line l in sector s import from country i is:

$$\hat{s}_{il}^s = \frac{(\hat{t}_{il}^s)^{1-\zeta^s}}{(\hat{P}_i^s)^{1-\zeta^s}},$$

where the change in sector-origin level output price equals:

$$(\hat{P}_i^s)^{1-\zeta^s} = \sum_{l \in \Omega_i^s} s_{il}^s (\hat{t}_{il}^s)^{1-\zeta^s}. \quad (\text{B.7})$$

Ex-post market clearing condition for sector s labor equates labor demand with labor supply:

$$\frac{1}{w^{s'}} s_L^{s'} \left(s_0^{s'} X^{s'} + E_{F0}^s (\hat{P}_0^s)^{1-\sigma^s} \right) = L^{s'} = \hat{L}^s L^s. \quad (\text{B.8})$$

Similarly, ex-post market clearing condition for sector s input is the following:

$$X^{s'} = P^{s'} C^{s'} + \sum_{s'=1}^S s_M^{s' s'} \left(s_0^{s'} X^{s'} + E_{F0}^{s'} (\hat{P}_0^{s'})^{1-\sigma^{s'}} \right), \quad (\text{B.9})$$

where ex-post consumption:

$$P^{s'} C^{s'} = \alpha^{s'} (1 - \delta) \left(\sum_{s=1}^S w^{s'} L^{s'} + b L^{0'} \right),$$

in which $\alpha^{s'} = \alpha^s \hat{\alpha}^s$ is the ex-post consumption expenditure share, and the expression for $\hat{\alpha}^s$ is the following:

$$\hat{\alpha}^s = \frac{(\hat{P}^s)^{1-\theta}}{(\hat{P}^C)^{1-\theta}},$$

where $(P^C)^{1-\theta} = \sum_{s=1}^S \alpha^s (\hat{P}^s)^{1-\theta}$.

The ex-post budget constraint for the government:

$$b L^{0'} = \delta \left(\sum_{s=1}^S w^{s'} L^{s'} + b L^{0'} \right) + T D' + T R', \quad (\text{B.10})$$

in which the ex-post trade deficit and ex-post tariff revenue equal:

$$T R' = \sum_{s=1}^S \sum_{i=1}^N \sum_{l \in \Omega_i^s} X^{s'} s_i^{s'} s_{il}^{s'} \frac{\tau_{il}^{s'}}{t_{il}^{s'}}, \quad (\text{B.11})$$

$$TD' = \sum_{s=1}^S \sum_{i=1}^N \sum_{l \in \Omega_i^s} X^{sl} s_i^{sl} s_{il}^{sl} \frac{1}{t_{il}^{sl}} - \sum_{s=1}^S (\hat{P}_0^s)^{1-\sigma^s} E_{F0}^s. \quad (\text{B.12})$$

The change in a household's expected welfare equals the following:

$$\hat{W} = \left(\sum_{s=1}^S \frac{L^s}{L} \left(\frac{\hat{w}^s}{\hat{P}^C} \right)^{\lambda^s} + \frac{L^0}{L} \left(\frac{1}{\hat{P}^C} \right)^{\mu} \right)^{\frac{1}{\mu}}.$$

Equilibrium in changes Given government's fiscal and tariff policy, $\{\delta, b, \{\tau_{il}^s\}_{i,l,s}\}$, base-line export, $\{E_{F0}^s\}$, market shares, $\{\kappa^s, \alpha^s, s_L^s, s_M^{s'}, s_i^s, s_{il}^s\}$, elasticities $\{\lambda^s, \mu, \theta, \rho, \sigma^s, \zeta^s\}$, the equilibrium is defined as a set of changes in sectoral input prices, $\{\hat{P}^s\}_s$, and changes in sectoral wages, $\{\hat{w}^s\}_s$ such that

1. Firms maximize profit (equation B.5);
2. The price index satisfied equations B.6 and B.7;
3. The goods market clear in the counterfactual equilibrium, satisfying equation B.9;
4. The labor market clears in the counterfactual equilibrium, satisfying equation B.8;
5. Government budget constraint in the counterfactual equilibrium (equation B.10) holds.

B.3 Calibration

We use the following algorithm to estimate the parameters. We guess a set of parameters, $\{\rho, \theta\}$ and we provide sector-level annual tariffs, $\{\tau_t^s\}$, to the model.⁶⁷ For each year, we solve the counterfactual equilibrium with the model in changes (Section B.2). Then we run the same panel regression in the model as in the data:⁶⁸

$$y_{s,t}^u = \beta^u \tilde{\tau}_{s,t}^u + \eta_s^u + \eta_t^u + \epsilon_{s,t}^u, u \in \{mid, down, up\}. \quad (\text{B.13})$$

⁶⁷We construct the sector-level tariffs with the country-sector-product level tariffs, $\{\tau_{il}^s\}_{i,l,s}$, as we discussed in Section 6.

⁶⁸As AD tariffs are the only shock in this counterfactual exercise, parallel trends between treatment and control group in the model simulated data is naturally guaranteed. Therefore, we do not control the investigations in these regressions with model simulated data.

On the left-hand side, $y_{s,t}^u$ denotes the sectoral variable of interest in the targeted and non-targeted moments. They include employment, the wage bill, imports, and exports in the midstream, main upstream and main downstream sectors (all in logs). On the right hand side, $\tilde{\tau}_{s,t}^u$ denotes the exposures to midstream, downstream and upstream tariffs:

$$\tilde{\tau}_{s,t}^u = \begin{cases} \tau_{s,t}, & u = mid \\ \frac{\text{Input Demand of Sector } d(s) \text{ from Sector } s}{\text{Aggregate Input Demand of Sector } d(s)} \times \tau_{s,t}, & u = down \\ \frac{\text{Sales to Sector } s \text{ from Sector } u(s)}{\text{Production of Sector } u(s)} \times \tau_{s,t}, & u = up. \end{cases}$$

η_s^u denotes the sector fixed effect and η_t^u denotes the time fixed effect.

We also include in the non-targeted moments the elasticity of sectoral employment with respect to midstream, average upstream, and average downstream tariffs when the three tariffs enter the right-hand side of the regression at the same time. We apply the following specification to model simulated data:

$$y_{s,t} = \beta_1 \tau_{s,t}^{mid} + \beta_2 \tilde{\tau}_{s,t}^{up} + \beta_3 \tilde{\tau}_{s,t}^{down} + \eta_s + \eta_t + \epsilon_{s,t}, \quad (\text{B.14})$$

where $\tilde{\tau}_{s,t}^{up}$ denotes the downstream tariffs faced by upstream firms and $\tilde{\tau}_{s,t}^{down}$ denotes the upstream tariffs faced by downstream firms. Similarly to how we construct them in the empirical section, they equal the following:

$$\tilde{\tau}_{s,t}^{up} = \sum_k \frac{\text{Sales of Sector } s \text{ to Sector } k}{\text{Aggregate Sales of Sector } s} \times \tau_{k,t},$$

$$\tilde{\tau}_{s,t}^{down} = \sum_k \frac{\text{Input Demand of Sector } s \text{ from Sector } k}{\text{Aggregate Input Demand of Sector } s} \times \tau_{k,t}.$$

With the model moments computed with model simulated data and these regressions, we search for the parameters that minimize the sum of squared normalized distance between these targeted moments in the model and in the data:

$$\min_{\rho, \theta} \left(\frac{\beta_{\text{data}}^{\text{mid,emp}} - \beta_{\text{model}}^{\text{mid,emp}}}{\beta_{\text{data}}^{\text{mid,emp}}} \right)^2 + \left(\frac{\beta_{\text{data}}^{\text{down,emp}} - \beta_{\text{model}}^{\text{down,emp}}}{\beta_{\text{data}}^{\text{down,emp}}} \right)^2$$

s.t. Equilibrium constraints in Section B.2.

To compute the standard errors of the estimated parameters, we bootstrap the AD tariffs on the year level—that is, for each bootstrapped sample, we randomly draw years (with replacement) from the original database and we impose all sectoral tariffs in that year.⁶⁹ By doing so, we ensure that every sector in the bootstrapped sample faces the factual midstream, upstream and downstream tariffs in the year when the sample is drawn. With the standard errors we can compute the 95% confidence interval of our estimates.

In Table B.1, we present how the model matches the targeted and non-targeted moments. We also show how we calibrate alternative model specifications and their ability to match these moments. We find that the baseline model performs better than alternative models in matching most of the non-targeted moments.

Table B.1: Targeted and Non-targeted Moments, Data and Model

Moment names	(1) Data	(2) Baseline Model	(3) Same Input and Final Elasticity	(4) Sector-specific Input Elasticity	(5) Same Labor Supply Elasticity	(6) Same Trade Elasticity	(7) No Input-output	(8) Cobb-Douglas Input and Final Demand
Elasticity with respect to midstream tariffs								
1 Midstream employment	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0184	0.0898
2 Main downstream employment	-0.0383	-0.0383	-0.0045	-0.0383	-0.0383	-0.0383	-0.0019	-0.0084
3 Main upstream employment	0.0032	0.0029	-0.0019	0.0029	-0.0004	0.0074	0.0006	0.0167
4 Midstream wage bill	0.0186	0.0218	0.0272	0.0218	0.0349	0.0311	0.0259	0.1632
5 Main downstream wage bill	-0.0857	-0.0769	-0.0087	-0.0769	-0.0727	-0.0747	-0.0051	-0.0104
6 Main upstream wage bill	-0.0003	0.0037	-0.0057	0.0037	-0.0008	0.0147	0.0013	0.032
7 Midstream firm exports	0.0133	-0.0061	-0.0103	-0.0061	-0.0099	-0.0123	0.0009	-0.0186
8 Midstream firm imports	0.0286	0.0167	-0.0585	0.0165	-0.0229	0.001	NA	0.0085
Employment elasticity with respect to average tariffs								
9 Midstream tariffs	0.009	0.0117	0.0106	0.0117	0.0125	0.012	0.0109	0.0513
10 Upstream tariffs	-0.0158	-0.0256	-0.0039	-0.0256	-0.0221	-0.0268	-0.0042	-0.0123
11 Downstream tariffs	-0.009	-0.0093	-0.0076	-0.0093	-0.0159	0.0016	-0.0069	0.0059
Targeted Moments		1.2	1	1.2,3	1.2	1.2	1	NA
Estimated Parameter Values		$\rho = 0.6694$ $\theta = 4.4082$	$\rho = \theta =$ 2.0127	$\rho = 0.6757 \exp(-2.5e - 3 \cdot U)$ $\theta = 4.4020$	$\rho = 1.1097$ $\theta = 3.3340$	$\rho = 0.4674$ $\theta = 3.8915$	$\theta = 2.1734$	NA

Description: This table presents the targeted and non-targeted moments in the data and in the model. Moments 1-8 refer to the elasticity of midstream, main downstream and main upstream employment, wage bill, exports and imports with respect to midstream tariffs. Moments 9-11 refer to the joint impact of midstream, average downstream and average upstream tariffs (see Section A.5.2). The data moments (Column 1) refer to the corresponding estimated coefficients that are presented in the empirical section. The model moments (Column 2-8) refer to those estimated with model simulated data and Equations B.13 and B.14. Row "Targeted Moments" show the moments that the models target to estimate the parameters, whose values are reported in Row "Estimated Parameter Values". Specifically, Column 4 assumes sector-specific elasticity of substitution across inputs is log linear in sector upstreamness. The employment elasticity with respect to average tariffs refers to the joint impact of own sector, average upstream, and average downstream tariffs that we document in Table A.14.

⁶⁹See Blume et al. (2008) a survey of indirect inference and bootstrap methods used in macroeconomics.

B.4 Changes in aggregate variables

The change in aggregate employment equals a weighted average of changes in sectoral employment. The weights are sector employment shares in total employment:

$$\hat{L}^e = \sum_{s=1}^S \frac{L^s}{\sum_{s=1}^S L^s} \hat{L}^s.$$

AD tariffs that protect a sector draw additional labor from the pool of nonworking population and from other sectors. As a result, the protected sectors observe an increase in employment. With many sectors that buy from and sell to to each other, we need to solve the counterfactual equilibrium to sign and quantify the aggregate effect.

The change in real GDP can also be written as a weighted average of the changes in sectoral employment. However, different from the aggregate employment effect, the weights are sector value-added shares in nominal GDP:

$$\widehat{rGDP} = \sum_{s=1}^S \frac{w^s L^s}{\sum_{s=1}^S w^s L^s} \hat{L}^s. \quad (\text{B.15})$$

Proof: A country's nominal GDP equals the product of real GDP and a price index of the real GDP. Alternatively, it can be written as the difference between the country's gross output and total intermediate input used.

$$\text{GDP} = P^{\text{rGDP}} \text{rGDP} = \sum_{s=1}^S \left(P_0^s Y^s - \sum_{s'=1}^S P^{s'} M^{ss'} \right),$$

where P^{rGDP} is the price index for real GDP. Consider the first-order approximation of changes in real GDP while holding fixed the prices P^{rGDP} , P_0^s and P^s :

$$d \log(\text{rGDP}) = \sum_{s=1}^S \frac{P_0^s Y^s}{\text{GDP}} d \log(Y^s) - \sum_{s'=1}^S \frac{P^{s'} M^{ss'}}{\text{GDP}} d \log(M^{ss'}).$$

Note that the first-order approximation of the production function equals:

$$d \log(Y^s) = d \log(A^s) + s_L^s d \log(L^s) + \sum_{s'=1}^S s_M^{ss'} d \log(M^{ss'}).$$

As tariffs are the only exogenous shock to the model, we set $d \log(A^s) = 0$. Further note that $P^{s'} M^{ss'} = s_M^{ss'} P_0^s Y^s$ and $w^s L^s = s_L^s P_0^s Y^s$. These imply:

$$d \log(rGDP) = \sum_{s=1}^S \frac{w^s L^s}{GDP} d \log(L^s).$$

Taking the equation to discrete time leads to Equation B.15.

We measure real income (real GNI) with the ratio of nominal income (the sum of labor income, foreign transfer and tariff revenue) to the consumer price index. Writing it in terms of changes:

$$\widehat{rGNI} = \frac{\sum_{s=1}^S w^s L^s + TD + TR}{\widehat{P}}.$$

Extending Caliendo and Parro (2015) by considering varying aggregate labor supply, the first order approximation of changes in real GNI equals the following:

$$\widehat{rGNI} = \overbrace{\sum_{s=1}^S \frac{w^s L^s}{GNI} \widehat{L}^s}^{\text{Employment effect}} + \overbrace{\frac{1}{GNI} \left(\sum_{s=1}^S \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} T_{il}^{ts} t_{il}^s \widehat{T}_{il}^s - \sum_{s=1}^S E_{F0}^s \widehat{Y}_{F0}^s \right)}^{\text{Terms of trade effect}}. \quad (\text{B.16})$$

On the right hand side, the employment effect summarizes changes in real income associated with sector employment changes. This term is identical to changes in real GDP. The only difference is that the denominator for changes in real GNI is nominal GNI, whereas the denominator for changes in real GDP is nominal GDP.

While sectoral employment changes are sufficient to summarize changes in real GDP (and aggregate employment), the terms of trade effect indicates that tariffs contribute to real GNI through not only the employment effect but also changes in foreign and domestic prices. In this term $T_{il}^s = p_{il}^s y_{il}^s$ denotes product-country level import value before tariffs, $t_{il}^s = 1 + \tau_{il}^s$

where τ_{il}^s denotes tariffs, E_{F0}^s denotes the value of sectoral exports, and Y_{F0}^s denotes its quantity. Lower import prices are associated with more import and higher export prices are associated with less export. Both cases imply improvements in the terms of trade and an increase in real GNI.

Proof: First order approximation of nominal GNI equals the following::

$$d \log(rGNI) = \sum_{s=1}^S \frac{w^s L^s}{GNI} (d \log(w^s) + d \log(L^s)) + \frac{dT D}{GNI} + \frac{dTR}{GNI} - d \log(P^C). \quad (\text{B.17})$$

The change in trade deficit equals:

$$dT D = \sum_{s=1}^S \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} T_{il}^s d \log(T_{il}^s) - \sum_{s=1}^S E_{F0}^s (1 - \sigma^s) d \log(P^s).$$

Changes in tariff revenue equal:

$$dTR = \sum_{s=1}^S \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} \tau_{il}^s T_{il}^s d \log(T_{il}^s) + \sum_{s=1}^S \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} T_{il}^s t_{il}^s d \log(t_{il}^s).$$

Changes in consumer price equal:

$$d \log(P^C) = \sum_{s=1}^S \alpha^s d \log(P^s), \quad (\text{B.18})$$

in which changes in sectoral input prices equal:

$$d \log(P^s) = s_0^s d \log(P_0^s) + \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} s_i^s s_{li}^s d \log(t_{il}^s).$$

Now we substitute final expenditure share in Equation B.18. Note that:

$$X^s = P^s C^s + \sum_{s'=1}^S s_M^{s's} P_0^{s'} Y^{s'},$$

where $P_0^s Y_0^s$ denotes sector s output. Therefore,

$$\alpha^s = \frac{P^s C^s}{GNI} = \frac{1}{GNI} \left(X^s - \sum_{s'=1}^S s_M^{s's} P_0^{s'} Y^{s'} \right).$$

Plug this into Equation B.18:

$$d \log(P^C) = \sum_{s=1}^S \frac{X^s}{GNI} \left(s_0^s d \log(P_0^s) + \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} s_i^s s_{li}^s d \log(t_{il}^s) \right) - \frac{1}{GNI} \sum_{s=1}^S \sum_{s'=1}^S s_M^{s's} P_0^{s'} Y^{s'} d \log(P^s).$$

We can simplify the last term:

$$\begin{aligned} \sum_{s=1}^S \sum_{s'=1}^S s_M^{s's} P_0^{s'} Y^{s'} d \log(P^s) &= \sum_{s'=1}^S P_0^{s'} Y^{s'} (d \log(P_0^{s'}) - s_L^{s'} d \log(w^{s'})) \\ &= \sum_{s'=1}^S P_0^{s'} Y^{s'} d \log(P_0^{s'}) - \sum_{s'=1}^S w^{s'} L^{s'} d \log(w^{s'}). \end{aligned}$$

Plug these into Equation B.17:

$$\begin{aligned} d \log(rGNI) &= \sum_{s=1}^S \frac{w^s L^s}{GNI} d \log(L^s) + \sum_{s=1}^S \frac{w^s L^s}{GNI} d \log(w^s) \\ &\quad + \sum_{s=1}^S \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} T_{il}^s d \log(T_{il}^s) - \sum_{s=1}^S E_{F0}^s (1 - \sigma^s) d \log(P_0^s) \\ &\quad + \frac{1}{GNI} \sum_{s=1}^S \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} \tau_{il}^s T_{il}^s d \log(T_{il}^s) + \frac{1}{GNI} \sum_{s=1}^S \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} X^s s_i^s s_{li}^s d \log(t_{il}^s) \\ &\quad - \sum_{s=1}^S \frac{X^s}{GNI} \left(s_0^s d \log(P_0^s) + \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} s_i^s s_{li}^s d \log(t_{il}^s) \right) \\ &\quad + \frac{1}{GNI} \sum_{s=1}^S P_0^s Y^s d \log(P_0^s) - \frac{1}{GNI} \sum_{s=1}^S w^s L^s d \log(w^s). \end{aligned}$$

Collecting terms we get:

$$d \log(rGNI) = \sum_{s=1}^S \frac{w^s L^s}{GNI} d \log(L^s) + \frac{1}{GNI} \sum_{s=1}^S \sigma^s E_{F0}^s d \log(P_0^s) + \frac{1}{GNI} \sum_{s=1}^S \sum_{i \in \Xi_F} \sum_{l \in \Omega_i^s} t_{il}^s T_{il}^s d \log(T_{il}^s).$$

Note that $d\log(Y_{F0}^s) = -\sigma^s d\log(P_0^s)$. Plug in and take the equation to discrete time we get Equation B.16.

We can compute changes in household welfare based on Equation B.3. This is a known variable after we solve for \hat{w}^s and \hat{P}^C with the equilibrium conditions in changes:

$$\hat{W} = \left(\sum_{s=1}^S \frac{L^s}{L} \left(\frac{\hat{w}^s}{\hat{P}^C} \right)^{\lambda^s} + \frac{L^0}{L} \left(\frac{1}{\hat{P}^C} \right)^{\mu} \right)^{\frac{1}{\mu}}.$$

Now consider the consumption equivalent of these welfare changes. We let leisure/labor decision should remain the same as the baseline equilibrium, and we compute the percentage change in consumption that the resulting welfare change equals \hat{W} . Use C^s and \tilde{C}^s to denote consumption of a sector s household before and after the change. The household budget constraint and labor supply decision, Equations 9 and B.1, imply that:

$$l^s = \left(\frac{C^s}{1 - \delta} \right)^{\frac{\psi^s}{1 + \psi^s}}.$$

With this we can rewrite the baseline welfare in consumption terms:

$$W = \left(\sum_{s=1}^S \left(\left(1 - \frac{1}{1 - \delta} \frac{\psi^s}{1 + \psi^s} \right) C^s \right)^{\mu} \right)^{\frac{1}{\mu}}.$$

The welfare when consumption becomes \tilde{C}^s but leisure remains the same as before, equals:

$$\tilde{W} = \left(\sum_{s=1}^S \left(\tilde{C}^s - \frac{1}{1 - \delta} \frac{\psi^s}{1 + \psi^s} C^s \right)^{\mu} \right)^{\frac{1}{\mu}}.$$

Taking the ratio and set it to \hat{W} :

$$\hat{W} = \frac{\tilde{W}}{W} = \left(\sum_{s=1}^S s_L^s \left(\frac{1 - \delta}{1 - \delta - \frac{\psi^s}{\psi^s + 1}} \tilde{C}^s - \frac{\frac{\psi^s}{1 + \psi^s}}{1 - \delta - \frac{\psi^s}{\psi^s + 1}} \right)^{\mu} \right)^{\frac{1}{\mu}}.$$

In the end we solve \tilde{C}^s , which is the consumption-equivalent welfare changes.

B.5 Sector upstreamness

We follow the procedure in Fally (2011), Antràs et al. (2012), and Antràs and Chor (2013) to compute the sector upstreamness. Upstreamness measures the average number of sectors that one dollar of a sector's output passes through to reach final demand. If a sector's output is only used for final demand, the sector's upstreamness equals 1. If a sector sells to other sectors, its upstreamness will be greater than 1. The greater is the upstreamness measure, the greater share of output the sector sells to other sectors and the more upstream is the sector.

To compute the fraction of a sector's output used in other sectors, we rely on the input-output coefficients $s_M^{ss'}$. Following the approach in the literature, we adjust the coefficients to take into account imports and exports with $\tilde{s}_M^{ss'} = s_M^{ss'} \frac{P_0^s Y_0^s}{P_0^s Y_0^s - E_{F_0}^s + X^s(1 - s_0^s)}$, where $P_0^s Y_0^s$ denotes gross output, $E_{F_0}^s$ denotes total export in sector s and $X^s(1 - s_0^s)$ denotes sector s total import. The denominator is thus total domestic absorption of sector s output. Finally, the sector upstreamness equals:

$$\vec{U} = (I - \tilde{\Gamma}')^{-1} \vec{Y} ./ \vec{Y},$$

where $./$ denotes element-wise division, the $s - s'$ element of $\tilde{\Gamma}$ is $\tilde{s}_M^{ss'}$, and I is an identity matrix.

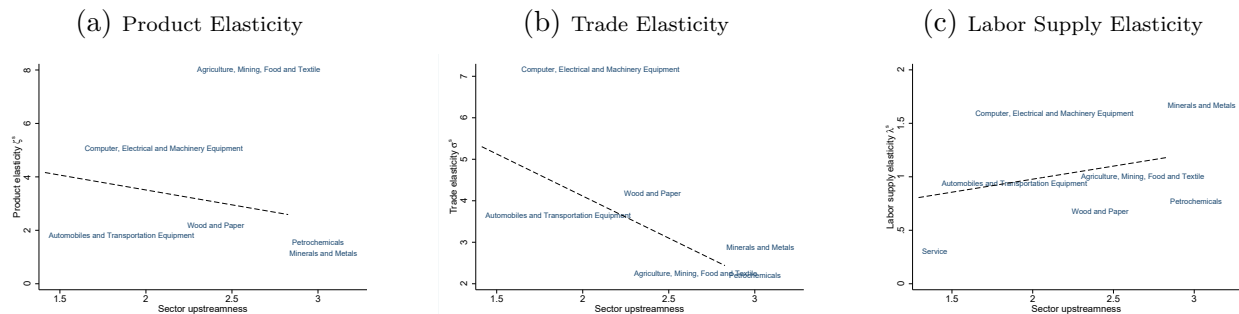
In Figure B.1 we plot the correlations between the estimated elasticity of substitution across products, trade elasticity, and labor supply elasticity, against sector upstreamness.

B.6 Optimal tariffs problem

A country's policy maker maximizes changes in the following aggregate variables (defined in Section B.4):

1. Total employment: \hat{L}^e , or
2. GDP: \widehat{rGDP} , or
3. Real income: \widehat{rGNI} , or

Figure B.1: Correlation between product, trade and labor supply elasticities and sector upstreamness



Description: This figure shows the correlation between the estimated elasticity of substitution across products, trade elasticity, and labor supply elasticity, with sector upstreamness. To measure sector upstreamness on the broad sector level—the same level on which the elasticities are estimated, we first compute the upstreamness measure on CNAE2.0 4-digit sector level with the input-output table and sectoral imports and exports (see Section B.5 for details). Then we calculate the weighted average upstreamness for each sector for which the weight equals a CNAE2.0 4-digit sector’s share in the broad sector.

4. Welfare: \hat{W}

subject to the following equilibrium constraints: changes in prices summarized in Equations B.5, B.6, B.7, market clearing conditions B.8 and B.9, as well as government budget constraint B.10. Furthermore, the government satisfy the additional fiscal constraint that the government collects the same tariff revenue as from the benchmark tariffs:

$$TR' = TR'^{\text{benchmark}},$$

where TR' follows Equation B.11 and $TR'^{\text{benchmark}}$ equals the value of TR' under benchmark tariffs.

B.7 Quantitative Results

B.7.1 Impact of Brazilian Annual AD tariffs

We calculate the AD tariffs imposed on each sector in each year by combining product-country level AD tariffs and with Equations B.6 and B.7. We simulate the model with these yearly tariffs and compute changes in the following aggregate variables: employment, real GDP, real income (GNI), and welfare. We present the formulas for these variables in Section B.4.

Figure B.2 shows that in all years and in all years except 2004-2006, AD tariffs cause moderate aggregate employment gains and GDP gains. This indicates that the positive midstream employment effect outweighs the decline in downstream employment. However, AD tariffs cause larger annual real income and welfare losses. This indicates that the increase in consumer price due to more expensive imports dominates the rise in nominal income. Table B.2b shows that in an average year, Brazil gains from all AD tariffs 0.03% employment, 0.02% GDP, but loses 0.49% real income, and 0.92% welfare.

Figure B.2: **Aggregate Consequences of AD Tariffs**

(a) **Each Year**



(b) **Annual Average**

Aggregate statistics	Employment	GDP	Real income	Welfare
Annual average	0.03%	0.02%	-0.49%	-0.92%
95% Confidence interval	0.02%	0.01%	-0.58%	-1.06%
Confidence interval	0.03%	0.04%	-0.40%	-0.78%

Description: Figure B.2a shows the impact of AD tariffs imposed in each year on aggregate employment, GDP, real income and welfare. Table B.2b shows the annual average of these aggregate consequences and the 95% confidence intervals of the means.

Alternative Model Specifications In Table B.2 we show that alternative models (except the one with sector-specific input elasticity) substantially misunderstand the aggregate effects of Brazilian AD policy.

Table B.2: **Aggregate Consequences of Brazilian AD Policy in Different Model Specifications**

Aggregate Consequence	(1) Baseline Model	(2) Same Input and Final Elasticity	(3) Sector-specific Input Elasticity	(4) Same Labor Supply Elasticity	(5) Same Trade Elasticity	(6) No Input-output	(7) Cobb-Douglas Input and Final Demand
Employment	0.06%	0.15% (126.97%)	0.06% (-2.35%)	-0.08% (-230.40%)	0.08% (22.02%)	0.15% (124.86%)	0.02% (-63.99%)
GDP	0.05%	0.11% (149.07%)	0.04% (-2.88%)	-0.13% (-377.84%)	0.12% (156.29%)	0.14% (199.65%)	0.08% (71.23%)
Real income	-1.32%	-1.35% (-2.48%)	-1.33% (-0.57%)	-1.54% (-16.45%)	-1.35% (-2.10%)	-0.75% (42.95%)	-1.36% (-3.08%)
Welfare	-2.43%	-2.40% (1.20%)	-2.44% (-0.58%)	-2.65% (-8.90%)	-2.68% (-10.13%)	-1.53% (37.10%)	-2.36% (2.83%)

Description: This table shows the impact of Brazilian AD policy in different model specifications. The value outside the bracket refers to the level of the effect, and the value inside the bracket refers to the percentage difference of the impact predicted by the alternative model relative to the absolute value of the impact predicted by the baseline model. The Brazilian AD policy refers to, for each sector, the maximum AD tariff of all years.

B.7.2 Impact of sectoral Tariffs

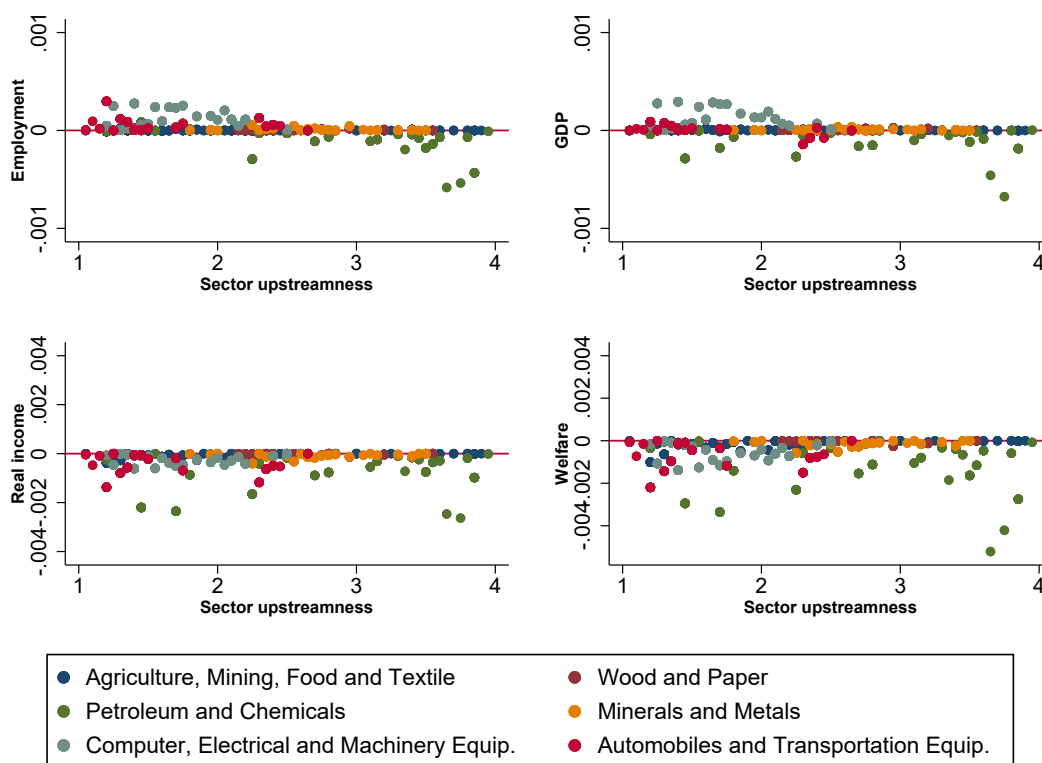
In Figure B.3a we plot the aggregate consequences of 200% sectoral tariffs imposed on every CNAE 2.0 4-digit sectors. We plot them against how upstream the sectors are. While the average impact of sectoral is small,⁷⁰ imposing tariffs on downstream sectors, for example, automobiles and transportation equipment, as well as computer, electrical and machinery equipment, can significantly raise aggregate employment and GDP. On the other hand, tariffs on upstream sectors, for example, petroleum and chemicals, significantly reduce aggregate employment and GDP. Table B.3b shows that the associations between aggregate employment and GDP effects of sectoral tariffs with sector upstreamness are negative (-0.3513 and -0.3193) and significant at 1% confidence interval. The negative correlations are robust to sector characteristic controls. In Table B.3, Column 1 we show the simple regression of the aggregate employment effects of sectoral tariffs on sector upstreamness. Column 2 and 3 control 2-digit sector fixed effects and broad sector fixed effects, respectively. Column 4 to 6 show that protecting the sectors that are smaller, import a larger share from abroad and have larger elasticity of substitution between domestic and foreign output, can also lead to larger aggregate employment gains. Across all specifications the negative correlation between aggregate employment effect and sector upstreamness is negative and significant.

⁷⁰There are 297 CNAE 2.0 4-digit, non-service sectors. Therefore, the average share of each of these sectors in the economy is small.

In contrast, the impact of sectoral tariffs on real income and welfare is negative for almost all sectors. The associations between real income and welfare consequences of sectoral tariffs with sector upstreamness are weakly positive. Taxing downstream sectors substitutes more imports with domestic labor, increases domestic prices, and harms domestic welfare. On the other hand, taxing upstream sectors decrease employment in more downstream sectors by cutting their wages and lead to lower nominal income. Both forces contribute to lower real income and welfare.

Figure B.3: **Aggregate Consequences of 200% Sectoral Tariffs**

(a) **Aggregate Consequences**



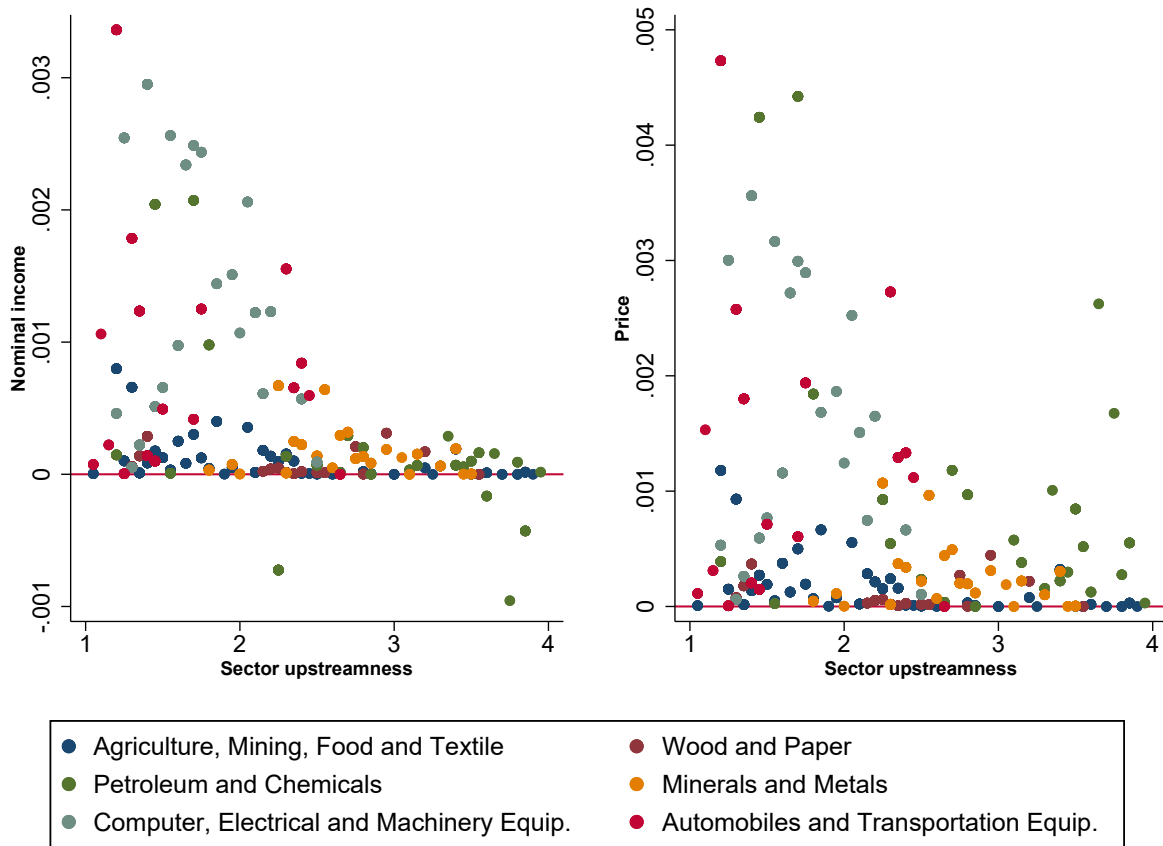
(b) **Correlation with Sector Upstreamness**

Aggregate statistics	Employment	GDP	Real income	Welfare
Correlation	-0.3513***	-0.3193***	0.0499	0.0350

Description: This figure shows the aggregate consequences of 200% sectoral tariffs imposed on every CNAE 2-digit sector. Panel (a) plots the employment, GDP, real income and welfare effects on the vertical axis, and sector upstreamness on the horizontal axis. Each dot in the figure represents the average value in each 0.05 bin of sector upstreamness. Panel (b) shows the correlation between the aggregate consequences of sectoral tariffs and the upstreamness of the sector. *, **, and *** represent significance on the 0.1, 0.05, and 0.01 level.

To understand the sources of low correlation between the impact of sectoral tariffs on real income with sector upstreamness, in Figure B.4 we show that both the impact of these tariffs on nominal income and on consumer price are negatively correlated with sector upstreamness. Protecting downstream sectors leads to greater increase in nominal income like the increase in total employment and GDP. However, it also increases the consumer price more. The two forces offset each other for real income, as it equals the ratio of nominal income to consumer price. Figure B.5 shows that the relationship also holds when we take the average of CNAE 2.0 4-digit sectors for each broad sector.

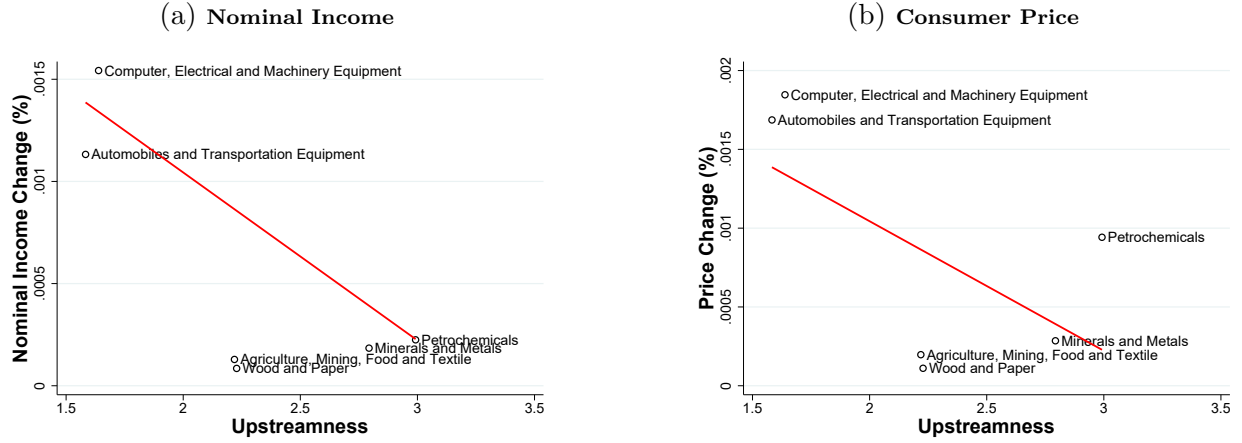
Figure B.4: **Consequences of 200% Sectoral Tariffs on Nominal Income and Consumer Price**



Description: This figure shows the impact of 200% sectoral tariffs imposed on every CNAE 2.0 4-digit sector on nominal income and consumer price. Changes in nominal income and consumer price due to the tariff changes are plotted on the vertical axis, and sector upstreamness is plotted on the horizontal axis.

In Table B.2 we present the aggregate implications of Brazilian AD policy predicted by

Figure B.5: Consequences of 200% Sectoral tariffs on nominal income and consumer price, broad sector average



Description: This figure shows the impact of 200% sectoral tariffs imposed on every CNAE 2.0 4-digit sector on nominal income and consumer price. Changes in nominal income and consumer price due to the tariff changes are plotted on the vertical axis, and sector upstreamness is plotted on the horizontal axis. Averages are taken on the broad sector level.

Table B.3: Correlation between Aggregate Employment Consequence of sectoral Tariffs and Sector Characteristics

VARIABLES	(1) Employment	(2) Employment	(3) Employment	(4) Employment	(5) Employment	(6) Employment
Upstreamness	-6.55e-05*** (1.01e-05)	-5.61e-05*** (1.97e-05)	-2.75e-05** (1.18e-05)	-6.59e-05*** (1.02e-05)	-4.09e-05*** (1.04e-05)	-4.11e-05*** (1.04e-05)
Employment share				-0.000133 (0.000207)		-3.84e-05 (0.000196)
Import share					4.38e-05 (3.85e-05)	4.35e-05 (3.86e-05)
Trade elasticity					3.97e-05*** (7.27e-06)	3.96e-05*** (7.29e-06)
Observations	298	295	297	298	298	298
R-squared	0.123	0.356	0.260	0.125	0.225	0.225
Fixed effect	NA	2-digit	Broad sector	NA	NA	NA
Standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						

Description: This table shows the correlation between the aggregate employment consequence of sectoral tariffs and sector characteristics including sector upstreamness, employment share in the economy, share of import, and trade elasticity.

alternative model specifications. We find that these alternative models (except the one with heterogeneous elasticity of substitution across inputs) lead to incorrect conclusions about the effects of Brazilian AD policy.

B.7.3 Optimal AD Tariff Policy

Figure B.6a shows CNAE 2.0 4-digit sectoral optimal tariffs that maximize employment and GDP. They should be high for many downstream sectors in automobiles, transportation equipment, as well as agriculture, mining, food and textile. Sometimes they even exceed 900%. Those on upstream sectors should be lower. For example, the employment-maximizing tariffs on petroleum and chemical sectors should be negative, which means that to increase employment Brazil should decrease their MFN tariffs for these sectors. In contrast, optimal tariffs that maximize real income or welfare never exceed 100% and they should be set negative for many sectors.

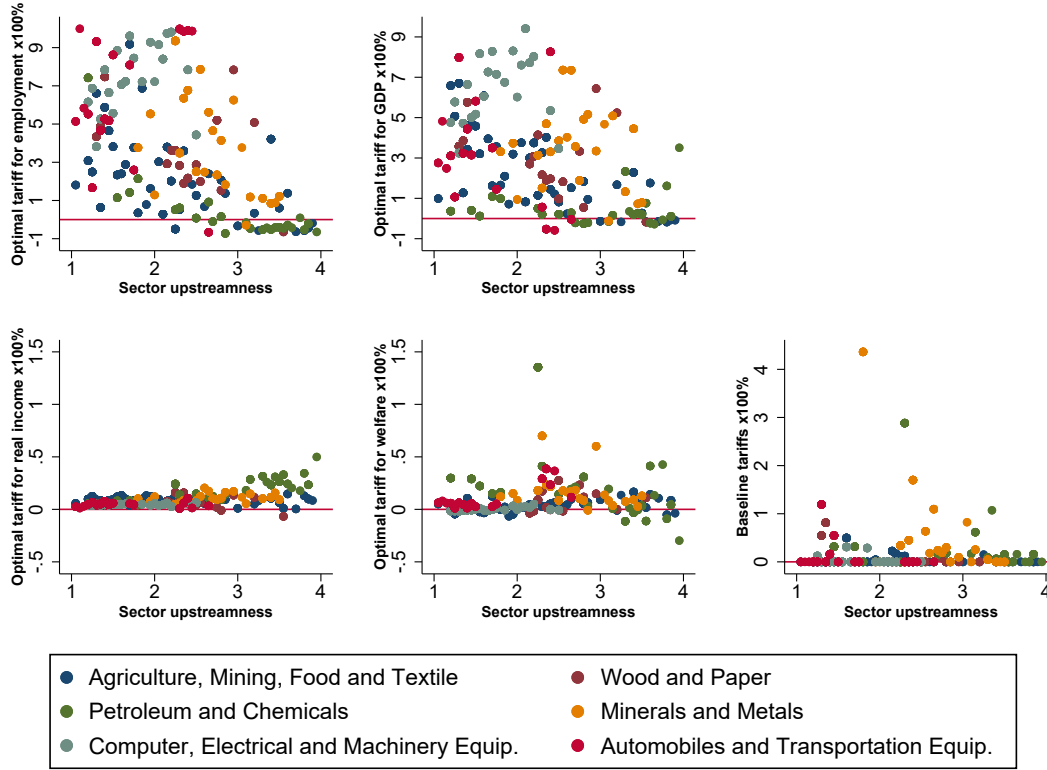
Table B.6b shows that employment- and GDP-maximizing tariffs strongly negatively correlate with sector upstreamness, whereas real income- and welfare-maximizing tariffs positively correlate with it. These findings are consistent with Sections B.7.2 and 7.2 which find that compared to upstream sectors, imposing higher tariffs on downstream sectors increases employment and GDP but decreases real income and welfare.

In Table B.4 we present the correlations of these optimal tariffs with one another, with the benchmark tariffs and with sector upstreamness. Employment-maximizing tariffs are strongly positively correlated with GDP-maximizing tariffs and negatively correlated with real-income-maximizing tariffs. They weakly positively correlated with welfare-maximizing tariffs.

Table B.6b also shows that the benchmark, factual Brazilian tariffs are negatively associated with sector upstreamness, which suggests that employment may be a strong motivation that drives AD tariffs. However, the levels of all actual tariffs stay below 500% (see bottom right panel of Figure B.6a). This suggests that either the Brazilian government is prevented by WTO rules, bilateral/multilateral trade agreements, and domestic political institutions from increasing tariffs further, or they are concerned that raising tariffs may impose additional harm on welfare.

Figure B.6: Optimal Tariffs

(a) Sectoral Optimal Tariffs that Maximize Employment, GDP, Real Income and Welfare



(b) Correlations of Sectoral Optimal Tariffs with Sector Upstreamness

Correlation	Optimal tariffs that maximize				Benchmark tariffs
	Employment	GDP	Real income	Welfare	
Sector upstreamness	-0.4979***	-0.4486***	0.4520***	0.1978***	-0.3381***

Description: This figure shows the sectoral optimal tariffs that maximize employment, GDP, real income and welfare. The optimal tariffs solve a problem that maximize the respective aggregate variable, subject to the equilibrium constraints and the additional constraint that the government collects the same tariff revenue as from the benchmark tariffs (see Section 7.3). The benchmark tariffs refer to, for each sector, the sector’s maximum AD tariff of all years. Panel (a) plots these optimal tariffs against sector upstreamness, and Panel (b) presents the correlations.

Table B.4: Correlations of Sectoral Optimal Tariffs

Optimal tariffs that maximize	Optimal tariffs that maximize				Benchmark tariffs	Sector upstreamness
	Employment	GDP	Real income	Welfare		
(1) Employment	1.0000					
(2) GDP	0.6754***	1.0000				
(3) Real income	-0.3807***	-0.1054*	1.0000			
(4) Welfare	0.0484	-0.2998***	-0.0936	1.0000		
(5) Benchmark tariffs	0.2575**	0.1250	-0.1912	0.2005	1.0000	
(6) Sector upstreamness	-0.4979***	-0.4486***	0.4520***	0.1978***	-0.3381***	1.0000

Description: This table shows the correlation of optimal tariffs that maximize employment, GDP, real income, welfare, as well as benchmark tariffs and sector upstreamness. The optimal tariffs solve a problem that maximize the respective aggregate variable, subject to the equilibrium constraints and the additional constraint that the government collects the same tariff revenue as from the benchmark tariffs (see Section 7.3) The benchmark tariffs refer to, for each sector, the the sector’s maximum AD tariff of all years.