Import Competition, Foreign Inputs, and Wage Inequality: Evidence from Colombian Liberalization

Preliminary and Incomplete

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Abstract

This paper examines the impact of trade liberalization on wage inequality in developing economies. We study a new mechanism that may amplify or lessen the inequality effect of trade. In particular, we include different degrees of substitutability between labor and intermediate inputs across sectors into a dynamic quantitative trade model. We use administrative data from Colombia and exploit exogenous tariff variation to estimate the key elasticities of the model through an indirect inference approach. We find complementarities between labor and intermediate inputs in the non-tradable sector and substitutability in the manufacturing and agricultural sectors. Armed with the estimates, we compute the gains from the trade reform, finding that different substitutabilities in the production function amplify the wage inequality effects.

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1. Introduction

A classic question in the international trade literature is what are the distributional effects of trade. Tariff reductions may affect labor markets directly by increasing import competition and indirectly by reducing intermediate inputs' costs. Multiple studies find that import competition induced by trade liberalization, has detrimental effects on labor markets among low and high-income countries.[1] Such negative effects are mostly explained by declines in manufacturing employment, although more recent studies also show that import competition can have positive spillovers on other economic sectors, especially among non-tradable goods.[2]

Most of these results do not account for the potential effects on the labor market due to reductions in the prices of foreign inputs, even though access to imported intermediate inputs have shown to foster economic development.[3] This seems to be a relevant channel as input linkages affect both tradable and non-tradable sectors thereby affecting a larger share of the economy compared to import competition, which exclusively affects the tradable goods sector.[4] Furthermore, foreign inputs can be particularly useful for developing economies, which can leverage lower prices to import cheaper or higher-quality intermediate goods, increase productivity, and benefit from foreign technologies. For these reasons many developing countries have adopted policies over recent decades to increase trade with advanced economies. For instance, the United States have signed multiple free trade agreements with developing countries to induce a more dynamic trade.

Foreign inputs may affect labor outcomes by either decreasing marginal costs (leading to firm expansions), i.e., *marginal cost* effect, or by complementing or substituting workers depending on the elasticity of substitution between labor and intermediate inputs, i.e., *substitution* effect.[5] Previous trade models, including those that add input-output linkages (Adão, Carrillo, Costinot, Donaldson, and Pomeranz, 2020; Caliendo, Dvorkin, and Parro, 2019), assume no substitutability between labor and intermediate inputs ignoring these effects.[6] However, this effect can be very relevant in an environment in which foreign technologies can substitute or complement local labor.

In this paper, we analyze the impact of import competition and foreign inputs on the Colombian labor market. In contrast to previous work, (such as D. H. Autor, Dorn, and Hanson (2013) or

[1]For the effects of trade liberalization see: Dix-Carneiro and Kovak (2017); Hanson and Harrison (1999); Attanasio, Goldberg, and Pavcnik (2004); and Erten, Leight, and Tregenna (2019). For effects among Chinese imports on high-income countries, see D. H. Autor, Dorn, and Hanson (2013), D. H. Autor, Dorn, Hanson, and Song (2014), Bernard, Jensen, and Schott (2006) and Pierce and Schott (2016). For the effects of Chinese imports among low-income countries, see: Jenkins, Peters, and Moreira (2008); Moreira (2007); and Wood and Mayer (2011).

[2]See: Bloom, Handley, Kurman, and Luck (2019); and Costa, Garred, and Pessoa (2016).

[3]See, for instance, Blaum, Lelarge, and Peters (2018), Goldberg, Khandelwal, Pavcnik, and Topalova (2010); Edmonds and Pavcnik (2006); Topalova and Khandelwal (2011); Amiti and Konings (2007); Bustos (2011); and Halpern, Koren, and Szeidl (2015).

[4]For instance, in Colombia, the tradable sectors (agriculture, mining, and manufacturing) account for 14 percent of formal employment. Even in more developed countries, such as France, the tradable sectors represent only 23 percent of employment (Frocrain and Giraud, 2018).

[5]The marginal cost effect only affects tradable sectors.

[6]These models assume Cobb-Douglass production functions that imply an elasticity of substitution equal to one.

Dix-Carneiro and Kovak (2017)) that focuses mostly on import competition, we analyze the impact of import competition and intermediate foreign inputs in a joint framework. Moreover, we derive our main specification from a model with imperfect substitutability between labor and intermediate inputs. We focus in a setting in which imports from a high-income country affect the labor market of a lower-income country, highlighting the role of trade liberalization in economic development. To assess the trade reforms' aggregate welfare and distributional impacts, we extend the model from Caliendo et al. (2019) to allow heterogeneous degrees of substitutability by sector between labor and intermediate inputs. Our work reveals great complexity, showing that the effects of imports within emerging economies are highly heterogeneous, just as several theoretical papers have suggested. (Stolper and Samuelson, 1941).

From an empirical perspective, previous literature has struggled to analyze the effect among developing economies of import competition and inputs prices coming from high-income countries due to two impediments. First, data restrictions have limited the ability to link input and competition measures. This issue has particularly hindered the analysis among developing countries where data quality is usually lower. To surmount such limitation, we use detailed administrative imports registers to compute the baseline share of foreign inputs by industry. The industry-level input shock is the sum of tariff cuts in inputs, weighted by their baseline share.[7] We combine the foreign input shock with a traditional measure of import competition, and link them with the universe of formal employer-employee administrative records from the social security registry and household surveys. Merging all these data sources allows us to analyze changes in overall employment and earnings and contrast our results across different data sets.

Second, empirical difficulties have impeded the identification of import shocks coming from high-income countries. We isolate these effects by exploiting the exogenous variation induced by two unexpected tariff reductions in Colombia. The first reduction, implemented in 2010, unilaterally reduced tariffs charged on the prices of intermediate foreign inputs after a change in the National Government. The second, which took effect in 2012, decreased the tariffs charged on imports from the United States, as part of the implementation of a free trade agreement between the two countries. Neither of the reforms affected Colombian exports, making it possible for us to isolate the effect of imports from that of exports. Both tariff reforms exclusively increased imports from the United States, leaving those from other countries mainly unaffected. Therefore, most of the identifying variation comes from changes in imports from a high-income country.

Our empirical strategy uses across state and industry variation that combines the unexpected timing of the reductions in tariffs in 2010 and 2012 with their exogenous magnitudes in a differences-in-differences framework that provides reduced form estimates of the effects of import competition

[7] Our main specification uses industry inputs weights based solely on imported inputs to better exploit the granularity of the data. We compute an alternative measure of foreign inputs shock based on the nationwide input-output matrix, finding similar results.

and foreign inputs. We use dynamic event-study estimates to test the common-trends assumption, finding balanced point estimates before 2010 in most cases. We also present robustness of our specification to address potential threats stemming from the definition of the treatment, its timing, and potential heterogeneous treatment effects (Callaway and Sant'Anna, 2021; de Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2020).

We find that the Colombian tariff reductions increased imports coming almost exclusively from the United States, and raised mainly the inflow of capital (including construction goods) and consumption goods. We find no detectable effects on raw materials. Overall, the tariff reductions increased import competition among agricultural and manufacturing industries, but additionally benefited manufacturing and services firms, who profit from the situation to access cheaper foreign inputs.

Our main empirical finding suggests that a one-percentage-point reduction in Colombian tariffs (i.e., an increase in import competition) *decreases* Colombian employment by an estimated 2.0 percent. In contrast, a one-percentage-point reduction in the prices of foreign inputs *increases* employment by an estimated 0.8 percent. While our estimated competition effects are similar to those found in previous studies, we show that the reduction in foreign inputs prices has employment effects of similar magnitude. These results are in line with previous evidence on employment reallocation across industries (Bloom, Handley, Kurman, and Luck, 2019; Costa, Garred, and Pessoa, 2016). We explore heterogeneity by sector and find complementarities in the service sector and substitutability in the manufacturing and agricultural sectors.

By exploiting exogenous variation, we furthermore estimate the main model parameters and analyze the effect of trade on labor market outcomes. We estimate different counterfactuals to study the aggregate and distributional impacts of the trade reform, finding that considering how foreign inputs can affect labor due to complementarities or substitutability may amplify the inequality effects of trade across space. The findings suggest that including this mechanism can mitigate the discrepancies between the impacts from quantitative spatial models and the income dispersion we observe in the data from trade shocks (Adão, Arkolakis, and Esposito, 2019; D. Autor, Dorn, and Hanson, 2021).

The paper contributes to the literature in at least two specific ways. First, our paper contributes to a large literature on international trade that uses quantitative trade models to measure the distributional effects of trade. We extend the recent dynamic trade GE models allowing for different degrees of substitutability between labor and intermediate inputs. We also show how to solve the model without knowing economic fundamentals. Classic studies such as Caliendo et al. (2019); Galle, Rodríguez-Clare, and Yi (2022); Rodriguez-Clare, Ulate, and Vasquez (2022) studied the impact of the China shock on the US economy by calibrating sectoral productivity shock that matches Chinese import penetration in the United States. These studies find that China has contributed enormously to wage inequality in the US. Similarly, other papers such as Adão et al. (2020) collect very rich microdata to study the inequality effects of trade in Ecuador. Consistent with our framework, they find that input shocks explain a significant fraction of the impacts of trade on inequality. We contribute to this literature by allowing different degrees of substitution between labor and intermediate inputs across sectors finding that this mechanism can reconcile the wage dispersion observed in the data with the ones from the QSM (Adão et al., 2019; D. Autor et al., 2021). We believe our estimates can also be used as a benchmark to other studies that aim to study the effect of "shocks" on labor market outcomes.

Second, we quantify the effects of the decreases in the prices of foreign inputs, and contrast them with the effects of import competition. Most of the existing empirical literature emphasizes on import competition, which not only limits the analysis to a restricted number of sectors in manufacturing and agriculture, but also omits a key mechanisms through which trade liberalization affects productivity and employment.

Third, we study how imported products from high-income countries affect developing economies. Most of the existing empirical research has focused on analyzing the effects of import competition from developing countries, such as China and Mexico, on high-income countries in North America and Europe.[8] The papers studying the effect of trade in developing countries, also include imports from developing countries. This is the case of Dix-Carneiro and Kovak (2017), Dix-Carneiro (2014), Attanasio, Goldberg, and Pavcnik (2004), and Erten et al. (2019) who study how unilateral liberalization – that applies to imports from every country – decreases employment and earnings in Brazil, South Africa, and Colombia. Similarly, Moreira (2007), and Wood and Mayer (2011) focus on the effects of Chinese imports in developing countries. Our results indicate that imports for high-income countries, more intensive in high-skilled human capital, can also affect labor markets in less developed countries, and this relationship has not been previously highlighted.

The rest of the paper is organized as follows. Section 2 presents a dynamic trade model adding the substitution of foreign inputs and local employment. Section 4 describes the background and data, and details the empirical strategy that identifies the causal effect of import competition and foreign inputs on Colombian labor market outcomes. Section 5 presents the results, whereas in Section 6 we present results that explain the mechanisms behind our main results. Section 7 describes the calibration of the model and main counterfactual results. Finally, Section 8 concludes.

[8]The effect on the United States see D. H. Autor, Dorn, and Hanson (2013), D. H. Autor, Dorn, and Hanson (2015); Pierce and Schott (2016); D. H. Autor, Dorn, Hanson, and Song (2014); Feenstra and Hanson (1999); Bloom, Handley, Kurman, and Luck (2019); and Bernard, Jensen, and Schott (2006). For the effect on Europe, see: Bloom, Draca, and Van Reenen (2016); Branstetter, Kovak, Mauro, and Venancio (2019); and Hummels, Jørgensen, Munch, and Xiang (2014)

2. Model

We extend the dynamic spatial general equilibrium model from Caliendo et al. (2019) and Artuc, Chaudhuri, and McLaren (2010) to include different degrees of substitutability between labor and intermediate inputs. We assume a production function in which labor and intermediate can be complements or substitutes. We use the model for two purposes. First, the model guides our empirical strategy since we derive our main specification using a first-order approximation from the labor demand equation. Second, we use the model to compute several counterfactuals of the trade reform to analyze the aggregate and distributional impacts of the trade liberalization episode considering this new mechanism.

The model includes a mass of N locations in the economy. These locations correspond to regions within a country, or countries themselves. In our case, we calibrate the model to Colombian states, the US, and the RoW. There are also J sectors in the economy. At $t = 0$ there is a mass of households that can be employed in J sectors or not employed (Home production sector). As in CDP, preferences are Cobb-Douglass across sectors:

$$C_{nj,t} = \prod_{k=1}^{J} \left(\frac{c_{nj,k,t}}{\alpha_{nk}} \right)^{\alpha^{nk}},$$

where $c_{nj,k,t}$ is the consumption of sector k goods in market nj at time t and α_{nk} is the final consumption share in goods from sector k in location n. By the Cobb-Douglass properties, the ideal price index is given by $P_{n,t} = \prod_{k=1}^{J} P_{n,k,t}$. Following CDP, non-employed households obtain consumption in terms of home production $b_n > 0$. We follow their notation and index the home production sector as 0; thus, $C_{n0,t} = b_n$.

Households are forward-looking and solve a dynamic problem. Workers can move each period across regions and sectors. These decisions are subject to mobility costs across space and sectors denoted by $\tau_{nj,ik} > 0$ that corresponds to the cost of moving from market nj to market ik. These costs are measured in utility terms. Since we are interested in the trade channel, we assume that these costs are time invariant and additive and households take them as given. We assume that people do not migrate from Colombia to foreign countries and viceversa. Then, $\tau_{nj,ik} = \infty$ if $j \in \{Col\}$ and $i \in \{USA, RoW\}$.

Following the properties of discrete choice models, we assume that workers receive each period additive idiosyncratic shocks $\epsilon_{ik,t}$ and that they are drawn from a nested Gumbel distribution. In the first nest, they decide the location, and in the second nest, the sector as in Rodriguez-Clare et al. (2022). Formally, the value function is:

$$v_{nj,t} = U(C_{nj,t}) + \max_{\{i,k\}_{i=1,k=0}^{N,J}} \Big\{ \beta E[v_{t+1}^{ik}] - \tau_{nj,ik} + \epsilon_{ik,t} \Big\}, \tag{2.1}$$

where $C_{nj,t} = b_n$ corresponds to the consumption of households who are employed in the home-production sector and $C_{nj,t} = \frac{w_{nj,t}}{P_{nj,t}}$ if they are employed in the j sector in location n. As in RUV, we assume that the idiosyncratic shock $\epsilon_{ik,t}$ is drawn from a nested Gumbel distribution:

$$F(\epsilon) = \exp\left(-\sum_{i=1}^{N}\left(\sum_{k=0}^{J} -(\epsilon_{ik,t}/\nu)\right)^{\frac{\nu}{\kappa}}\right)$$

where $\kappa \geq \nu$; the parameter κ captures the shock dispersion across regions and ν across sectors. Following the properties of extreme value type shocks Train and McFadden (1978), let's define $V_{nj,t} = \mathbf{E}(v_{nj,t})$, the expected value measures the current value and the mobility opportunity to reallocate into new markets. Then,

$$V_{nj,t} = U(C_{nj,t}) + \kappa \ln\left(\sum_{i=1}^{N}\left(\sum_{k=0}^{J} \exp(\beta V_{ik,t+1} - \tau_{nj,ik})^{\frac{1}{\nu}}\right)^{\frac{\nu}{\kappa}}\right) + \gamma_{\kappa}. \tag{2.2}$$

where γ_{κ} is a constant term. By the properties of the extreme value type shocks the share of workers from market nj that decides to reallocate to any market in location i is:

$$\mu_{nj,ik,t} = \frac{\exp(\beta V_{ik,t+1} - \tau_{nj,ik})^{\frac{1}{\nu}}}{\sum_{l=1,h=0}^{N,J} \exp(\beta V_{lh,t+1} - \tau_{nj,lh})^{\frac{1}{\nu}}}. \tag{2.3}$$

This equation suggest that workers move more to the locations that has better value in the future net of the total migration costs. Look that $\frac{1}{\nu}$ corresponds to the migration elasticity. In the case in which $\nu \to 0$, locations and sectors become perfect substitutes. The sequential equilibrium conditions imply that labor markets evolve over time using the following expression:

$$L_{t+1}^{nj} = \sum_{i=1,k=0}^{N,J} \mu_t^{ik,nj} L_t^{ik}$$

This equilibrium condition determines the evolution of the economy in terms of its population, in particular, the distribution of employment and non-employment across the different labor markets. This structure is the same as CDP and AMC.

2.1. Production

Firms in each sector and location are able to produce a set of varieties of intermediate goods. The technology to produce these intermediate goods requires labor, structures, and materials, which consist of goods produced from all sectors. Total Factor Productivity (TFP) of an intermediate good in region n and sector j is composed of two terms: a sectoral-location component A_t^{nj}, which is common to all intermediate producers in a location and sector, and a specific variety component z^{nj} that is drawn from a Fréchet distribution as in Eaton and Kortum. We modify the production function from CDP. In particular our production function is defined as a Nested CES structure:

$$q_t^{nj} = z_t^{nj} A_t^{nj} (h_t^{nj})^{\psi^{nj}} (u_t^{nj})^{1-\psi^{nj}}, \tag{2.4}$$

where h_t^{nj} are structure inputs and u_t^{nj} is a composite intermediate input that is composed by labor and intermediate inputs or materials. The parameter ψ^n captures the share of structures in total sales. This composite intermediate inputs takes the following form:

$$u_t^{nj} = \left[\zeta^{nj} (l_t^{nj})^{\frac{\sigma^j - 1}{\sigma^j}} + (1-\zeta^{nj})(M_t^{nj})^{\frac{\sigma^j - 1}{\sigma^j}}\right]^{\frac{\sigma^j}{\sigma^j - 1}}, \tag{2.5}$$

where ζ^{nj} corresponds to the relative productivity of labor inputs, and $(1-\zeta^{nj})$ to the relative productivity of intermediate inputs. Our main parameters of interest are σ^j. These terms correspond to the degree of substitutaibility between labor and intermediate inputs. Most of the literature including CDP, GYR, and ACCDP have assumed a Cobb-Douglass production function implying that $\sigma^j = 1$ ignoring this mechanism. We show how this mechanism can amplify or mitigate the wage inequality effects of trade. We also assume that the intermediate inputs are a CES input. In particular:

$$M_t^{nj} = \left[\sum_{k=1}^{J} \tilde{\gamma}^{nj,nk} (M_t^{nj,nk})^{\frac{\delta^j - 1}{\delta^j}}\right]^{\frac{\delta^j}{\delta^j - 1}}. \tag{2.6}$$

The parameter δ_j corresponds to the elasticity of substitution across sectors. Given the CES structure, we assume that $\delta^j \geq \sigma^j$ meaning that it is easier to substitute intermediate inputs across sectors than intermediate inputs with labor. Since these parameters captures the degree of substituitability of intermediate inputs across the different sectors, we would also estimate them using the trade reform. We assume that the relative efficiencies across sectors add up to 1, meaning that $\sum_{k=1}^{J} \tilde{\gamma}^{nj,nk} = 1$.

Let's denote by r_t^{nj} the rental price of structures in region n and sector j. Then, the unit price of an input bundle is:

$$x_t^{nj} = B^n (r_t^{nj})^{\psi^{nj}} (c_t^{nj})^{1-\psi^{nj}},$$

where B^n is a constant term that is a function of ψ^{nj} and c_t^{nj} is the input cost of labor and intermediate inputs and it is given by:

$$c_t^{nj} = \left[(\zeta^{nj})^{\sigma^j} (w_t^{nj})^{1-\sigma^j} + (1-\zeta^{nj})^{\sigma^j} (s_t^{nj})^{1-\sigma^j}\right]^{\frac{1}{1-\sigma^j}},$$

where w_t^{nj} is the wage per efficiency unit of labor and s_t^{nj} is the unit cost of an input bundle of intermediate inputs. This intermediate input cost is given by the function:

$$s_t^{nj} = \left[\sum_{k=1}^{J} \tilde{\gamma}_{nj,nk}^{\delta j} (P_t^{nk})^{1-\delta^j} \right]^{\frac{1}{1-\delta^j}},$$

where P_t^{nk} is the sectoral price of sector k in region n and applied to final goods and intermediate inputs used in production. The unit cost of an intermediate good indexed by z_t^{nj} is given by $\frac{x_t^{nj}}{z_t^{nj}}$.

Following the notation by CDP, we denote the iceberg trade costs as $\kappa_t^{nj,ij} \geq 1$. In particular, one unit of any variety in sector j shipped from region i to n requires producing $\kappa_t^{nj,ij}$ in region i. For the nontradable goods such as services, we assume that $\kappa_t^{nj,ij} = \infty$. Moreover, we follow the EK framework. This means that competition implies that the price paid for a particular variety of good j in region n is given by the minimum unit cost across regions taking into account the iceberg trade costs. The vector of productivity draws for each variety by the different regions in good j is $z^j = (z^{1j}, z^{2j}, ..., z^{NJ}, z^{Fj})$.

$$p_t^{nj}(z^j) = \min \left\{ \frac{\kappa_t^{nj,ij} x_t^{ij}}{z^{ij} A_t^{ij}} \right\}$$

2.2. Local Sectoral Aggregate Goods

Intermediate goods demanded from sector j and from all locations are aggregated into a sectoral good denoted by Q as in the multisector EK model:

$$Q_t^{nj} = \left(\int \tilde{q}_t^{nj}(z_j)^{\frac{\eta^j - 1}{\eta^j}} d\phi^j(z^j) \right),$$

where $\phi^j(z^j)$ is the joint distribution over the vector z^j that we assume is Fréchet. As in CDP local sectoral aggregate goods are used as intermediate inputs by other sectors or for final consumption in location n. Given the properties of extreme value type shocks and from EK, the price of the sectoral aggregate good j in location n at time t is:

$$P_t^{nj} = \Gamma^{nj} \left(\sum_{i=1}^{N} (x_t^{ij} \kappa_t^{ij})^{-\theta^j} (A_t^{ij})^{\theta^j} \right)^{\frac{-1}{\theta^j}}, \tag{2.7}$$

where Γ^{nj} is a constant that corresponds to the Gamma function, θ^j is the dispersion parameter of the Fréchet distribution that also corresponds to the trade elasticity, and F. A standard assumption in the EK model is $\theta^j > \eta^j - 1$. By the properties of the Fréchet, we also obtain that the share of expenditure in location n from location i of good j is:

$$\pi_t^{nj,ij} = \frac{(x_t^{ij} \kappa_t^{ij})^{-\theta^j} (A_t^{ij})^{\theta^j}}{\sum_{m=1}^{N} (x_t^{mj} \kappa_t^{mj})^{-\theta^j} (A_t^{mj})^{\theta^j}}. \tag{2.8}$$

Then a regions exports more to another region if it is more productive, the cost of producing one unit of the good is cheaper, or the iceberg transport cost is lower.

2.3. Market Clearing Condition-Static Subproblem

As in CDP, we assume that the structures inputs are owned by agents that rent the structures and then send the rents to a global portfolio. The portfolio returns a constant share ι^n to each region. This assumption creates trade imbalances that we need to include in the market clearing conditions.[9] Following the notation from CDP, let X_t^{nj} be the total expenditure on sector j good in location n, then the market clearing condition implies that:

$$X_t^{nj} = \sum_{k=1}^{J}(1-\psi^{nk}) \cdot \gamma_t^{nk,nj} \sum_{i=1}^{N} \pi_t^{ik,nk} X_t^{ik} + \alpha^j \left(\sum_{k=1}^{J} w_t^{nk} L_t^{nk} + \iota^n \chi_t \right). \tag{2.9}$$

In this equation, the first term captures is the total demand for intermediate inputs, and the second term the demand for final consumption. The difference with CDP is that the parameter $\gamma_t^{nj,nk}$ is not constant. In particular, by the properties of the CES production function:

$$\gamma_t^{nj,nk} = \left(\frac{(1-\zeta^{nj})^{\sigma^j} (s_t^{nj})^{1-\sigma^j}}{(\zeta^{nj})^{\sigma^j} (w_t^{nj})^{1-\sigma_j} + (1-\zeta^{nj})^{\sigma^j} (s_t^{nj})^{1-\sigma^j}} \right) \left(\frac{\tilde{\gamma}_{nj,nk}^{\delta j} (P_t^{nk})^{1-\delta^j}}{\sum_{h=1}^{J} \tilde{\gamma}_{nj,nh}^{\delta j} (P_t^{nh})^{1-\delta^j}} \right), \tag{2.10}$$

where the first term corresponds to the share that firms redistribute to intermediate inputs relative to labor, and the second term to the share within intermediate inputs that goes to sector k. Similarly the labor market clearing condition is:

$$L_t^{nj} = \left(\frac{\alpha_t^{nj}(1-\psi^{nj})}{w_t^{nj}} \right) \sum_{i=1}^{N} \pi_t^{ij,nj} X_t^{ij}, \tag{2.11}$$

where $alpha_t^{nj}$ is the share of total sales that firms pay to workers relative to intermediate inputs:

$$\alpha_t^{nj} = \frac{(\zeta^{nj})^{\sigma^j} (w_t^{nj})^{1-\sigma_j}}{(\zeta^{nj})^{\sigma^j} (w_t^{nj})^{1-\sigma_j} + (1-\zeta^{nj})^{\sigma^j} (s_t^{nj})^{1-\sigma^j}}.$$

Given the properties of the CES the share is not constant and depends on the elasticity of substitution between intermediate inputs and labor. Lastly, the market clearing condition for market structures is:

$$H^{nj} = \left(\frac{\psi^{nj}}{r_t^{nj}} \right) \sum_{i=1}^{N} \pi_t^{ij,nj} X_t^{ij}. \tag{2.12}$$

These market clearing conditions solve the market equilibrium in the static framework. Fol-

[9] Look that we assume that $\sum_n \iota^n = 1$ for budget balance of the portfolio.

lowing CDP, we define three different equilibriums: i) the static equilibrium; ii) the sequential equilibrium that solves the dynamic problem; and iii) the counterfactual equilibrium that solves the model considering changes in the sequence of economic fundamentals. We show the different conditions for the sequential equilibrium and the counterfactuals in the Online Appendix. As in CDP, we can solve for a baseline economy and the counterfactuals without information on the baseline fundamentals. We now focus on deriving our baseline specification considering changes in tariffs from trade reforms.

2.4. First-Order Approximation

Our main parameters of interest are the different elasticity of substitution between labor and intermediate inputs. We need to estimate three set of parameters: $\{\sigma^j, \xi^j, \delta^j\}$. We use the structure of the model to understand the effect of the trade liberalization on labor market outcomes. From the labor market clearing conditions and omitting the time subindex, the total wage bill for workers is:

$$w^{njl} l^{nj} = \alpha^{njl}(1 - \varphi^{nj}) \sum_{i=1}^{N} \pi^{ij,nj} X^{ij}.$$

Assuming that there is a small change in tariffs we get that the change in the total wage bill of low-skilled workers for sector j and location n is:

$$d \ln w^{nj} l^{nj} = (\sigma^j - 1) \underbrace{\left[(1 - \phi^{nj}) \left(\sum_{k=1}^{J} \tilde{\gamma}^{nj,nk} \left(\sum_{i=1}^{N} \pi^{nk,ik} d \ln \kappa^{nk,ik} \right) \right) \right]}_{\text{Foreign Input Shock - Substitutaibility}} \tag{2.13a}$$

$$- \theta^j \underbrace{\left[(1 - \phi^{nj}) \left(\sum_{i=1}^{N} \frac{\pi^{ij,nj}(1 - \pi^{ij,nj}) X^{ij}}{Y^{nj}} \left(\sum_{k=1}^{J} \tilde{\gamma}^{nj,nk} \left(\sum_{i=1}^{N} \pi^{nk,ik} d \ln \kappa^{nk,ik} \right) \right) \right) \right]}_{\text{Foreign Input Shock - Marginal Cost}} \tag{2.13b}$$

$$+ \theta^j \underbrace{\left(\sum_{i=1}^{N} \psi^{ij,nj} \sum_{m=1}^{N} \pi^{ij,mj} d \ln \kappa^{ij,mj} \right)}_{\text{Import Competition Shock}}, \tag{2.13c}$$

where $\psi^{ij,nj} = \frac{\pi^{ij,nj} X^{ij}}{\sum_{m=1}^{N} \pi^{mj,nj} X^{mj}}$ corresponds to the share of total sales from location n-sector j to region i.

We can decompose the effect of foreign inputs on the total wage bill into three distinct terms. The first term represents the direct impact of foreign inputs on total earnings and enables us to determine the elasticity of substitution between low-skilled workers and intermediate inputs. If the production function is Cobb-Douglas, this term is not present, as σ^j equals 1. It is a weighted average of the change in tariffs from sector k in location i to location j, and depends on the change in tariffs weighted by the share that region n consumed before and the share that industry j consumed from sector k.

The second term captures changes in marginal cost. Cheaper inputs lead to a decrease in the marginal cost of production, prompting firms to expand to all markets. However, this effect is absent in non-tradeable sectors, as all regions only consume locally from the industry. Therefore, they cannot expand further in that market or other markets since the expenditure share is already 1. As a result, the decrease in the marginal cost does not significantly affect sales from a first-order approximation. In the case of the non-tradeable service sector, the foreign input shock only captures the substitutability between labor and intermediate inputs.

The third and final component captures the import competition effect. As firms face increased competition, the wage bill decreases, since firms experience a decline in market shares in all markets. The extent of exposure to the shock is determined by the initial share of sales that firms were already selling in those markets, and the initial consumption shares that are exposed to the shock.

Similarly, we can also do a first-order approximation to understand the effect of the tariff shock on inputs and estimate the elasticity of substitution across inputs. Specifically, recall that the expenditure share on inputs from the equilibrium conditions is:

$$\frac{P^{nk}Q^{nj,nk}}{1-\alpha^{nj}} = \tilde{\gamma}^{nj,nk}(1-\varphi^{nj})\sum_{i=1}^{N}\pi^{ij,nj}X^{ij},$$

taking a first-order approximation, we get that the change in input expenditure from sector k by sector j in location n is:

$$d\ln\left(\frac{P^{nk}Q^{nj,nk}}{1-\alpha^{nj}}\right) = (1-\delta^{j})\underbrace{\left(\sum_{i=1}^{N}\pi^{nk,ik}d\ln\kappa^{nk,ik} - \sum_{s=1}^{J}\tilde{\gamma}^{nj,ns}\sum_{i=1}^{N}\pi^{ns,is}d\ln\kappa^{ns,is}\right)}_{\text{Foreign Input Shock}} \tag{2.14a}$$

$$- \theta^{j}\underbrace{\left[(1-\alpha^{nj})\left(\sum_{i=1}^{N}\frac{\pi^{ij,nj}(1-\pi^{ij,nj})X^{ij}}{Y^{nj}}\left(\sum_{k=1}^{J}\tilde{\gamma}^{nj,nk}\left(\sum_{i=1}^{N}\pi^{nk,ik}d\ln\kappa^{nk,ik}\right)\right)\right)\right]}_{\text{Foreign Input Shock - Marginal Cost}} \tag{2.14b}$$

$$+ \theta^{j}\underbrace{\left(\sum_{i=1}^{N}\psi^{ij,nj}\sum_{m=1}^{N}\pi^{ij,mj}d\ln\kappa^{ij,mj}\right)}_{\text{Import Competition Shock}} \tag{2.14c}$$

Look that we can decompose the effect in the same three components. The main difference is with the first term, as the other two additional terms capture the change in total sales. This first term captures how easy is to substitute inputs across sectors for industry j. It depends on how much the trade cost of industry k changes relative to the other sectors s. Then, taking another difference between input k and input k', which is the reference sector, we can recover the elasticity from the following equation:

$$d\ln\left(\frac{P^{nk}Q^{nj,nk}}{1-\alpha^{nj}}\right) - d\ln\left(\frac{P^{nk'}Q^{nj,nk'}}{1-\alpha^{nj}}\right) = (1-\delta^j)\left[\left(\sum_{i=1}^{N}\pi^{nk,ik}d\ln\kappa^{nk,ik}\right) - \left(\sum_{i=1}^{N}\pi^{nk,ik}d\ln\kappa^{nk,ik}\right)\right] \tag{2.15}$$

3. Trade reforms in Colombia

Recent Colombian tariff reductions provide an excellent setting to study the labor market effects of imports in developing countries. The first reduction was implemented in 2010, with a unilateral tariff decrease, and the second in 2012, under the free trade agreement signed between Colombia and the United States.

Before the Free-Trade Agreement: Over the last decades of the twentieth century, Colombia undergone a liberalization process that reduced tariffs, irrespective of their origin, from around 50 percent in the 1970s to 12 percent in 2006 (Nieto, 2016). From 1970 to 1990, Colombian tariffs decreased continuously, from an average of 50 percent in 1970 to 29 in 1989, as part of government efforts to liberalize the country. During the 1990s, the country then embarked on a second liberalization wave that further reduced tariffs to around 12 percent on average.[10] In 1995, the country joined the *Comunidad Andina de Naciones* (CAN), which enforced a common tariff scheme for all participating Andean countries.[11] Under this scheme, the members of CAN charged a common tariff that was not altered until 2008, when the common tariff scheme ended.

In 2010, a newly elected Colombian government unexpectedly decided to decrease further tariffs on imported products passing from an average of 12 percent to 8.3 percent. The tariff cuts were implemented under the Colombian Decree 4114 of 2010, signed on November 5th, 2010. The decree, which mandated immediate cuts on tariffs for manufacturing imports, aimed to cut the prices of inputs and, thus, reduce costs and boost employment and production. The reductions applied to all incoming products irrespective of their country of origin. The agriculture sector remained mostly unaffected as agricultural products were not considered as essential inputs.

The Free Trade Agreement: Since the 1990s, the United States has been Colombia's biggest trade partner, accounting for around 25 to 30 percent of Colombia's imports.[12] Trade between both countries grew remarkably after the beginning of the 1990s when both countries took measures to

[10]A more detailed discussion about Colombian liberalization in the 1990s can be found in Eslava, Haltiwanger, Kugler, and Kugler (2004).

[11]The CAN is the union of the Andean countries (Colombia, Ecuador, Peru, and Bolivia) who came together to achieve development by the integration of trade in 1995.

[12]Colombian imports from the United States are mainly composed of manufacturing products. Appendix Figure A.1a, which plots U.S. imports according to their one-digit sector codes, shows that manufacturing represents 93 percent (6,273 products) of the U.S. products Colombia imports, accounting for 92 percent of the total import dollar value. By contrast, agriculture represents 8 percent of the dollar value (367 products), and mining and services account for less than one percent (126 products).

facilitate the flow of products. In 1991 the United States, under the Andean Trade Preference Act (ATPA), eliminated tariffs on a large number of Colombian products.[13] At the same time, Colombia's own liberalization decreased tariffs charged to the United States to around 15 percent. Later, in 2003, both countries started negotiations on the free trade agreement, which were officially concluded with a final text in 2006, after 15 rounds and more than 100 meetings (Romero, 2013).

The agreement required approval from both the U.S. and Colombian congresses before implementation. However, the process took much longer than expected because of the strong opposition faced in both countries. In Colombian, the agreement was approved by Congress in 2007 and declared constitutional in 2008. The process faced strong opposition by syndicalists, indigenous associations, left and center-left parties, and pharmaceuticals, among others. The opposition persists nowadays with multiple political parties claiming that it should be revoked because its implementation was not approved by the popular vote.

On the U.S. side, the process was even more complicated. After George Bush presented the final text to Congress in 2006, its voting was postponed after 2008 due to the opposition by Nancy Pelosi and the democratic party. Moreover, during the presidential campaign of 2008, Barack Obama claimed as irresponsible to implement an agreement with a government where human rights were violated, referring to Colombia. The opposition in the United States ended up being much stronger than expected because of the political elections, the change in government, and strong opposition by the democratic party. However, almost six years after the text was officially signed, in 2011, the U.S. Senate approved the agreement after the Colombian president manifested that if the agreement was not approved in 2011, then Colombia would stop insisting and will start negotiating in other markets. The agreement was then legally implemented in May 2012 under the Colombian Decree 730 of 2012, again receiving strong opposition in Colombia from political leaders asking for the agreement to be postponed until Colombia enforced tighter labor protection laws.[14]

The free trade agreement renewed the existing tariff exemptions granted to Colombian products under the ATPA. In return, Colombia reduced tariffs on products from the United States. Tariffs were dropped for most manufacturing, services, and mining products. Some other goods, most of which agricultural products, remained protected for some additional years (in most cases for five years, but for some products such as rice, the tariffs were set to continue for another 20 years), allowing local producers to adapt progressively to the incoming competition.[15]

Figure I presents the evolution of the tariffs charged by Colombia to the United States (Panel

[13] ATPA was established to promote Colombia's export industries, as well as to help fight drug production. It was continuously renewed after 2002 when it was called the Andean Trade Promotion and Drug Eradication Act (ATPDEA).

[14] More information about the negotiation process can be found in Iragorri (2008) and *TLC entre Colombia y EE.UU. entra en vigor casi 6 años después de su firma* (2012).

[15] The main protected products were rice, chicken, milk, cheese, butter, corn, meats, motorcycles (between 1500 and 3000 cc.), paper, ink, iron and steel products, glass, and plastics. The agreement additionally regulated competition, customs, environmental rights, intellectual property, and investment procedures.

Ia), and the evolution of tariffs charged by the United States to Colombia (Panel Ib). Panel Ia shows that tariffs on manufacturing and service goods decreased after 2010, whereas tariffs on agricultural and mining goods decreased with the free trade agreement. Even though an important share of the agriculture goods remained protected for some additional years, the sector was strongly liberalized in 2012. Panel Ib shows that tariffs for Colombian products entering the United States were minimal, largely renewing the already low tariff rates that were in place years before. Nonetheless, these minor changes were officially referred to as cuts and were implemented with the 2012 agreement.

Tariff reductions considerably increased Colombian imports from the United States. Between 2010 and 2014, the value of U.S. products subject to the reduced tariffs grew from approximately 9 billion to 15 billion dollars (USD). Starting 2015, there was a generalized drop of Colombian imports starting 2015, irrespective of their origin, triggered by a strong devaluation of the Colombian peso.[16] Imports coming from the United States fell less for products facing larger tariff cuts between 2010 and 2012. We present causal estimates of this in Section 5.1.

No-anticipatory Effects: Both reforms were overall unexpected and were very difficult to anticipate. The tariff reduction in 2010 was implemented by a newly installed government as part of its strategy to boost employment by decreasing input prices. The 2012 cuts were part of the free-trade agreement that was only implemented after a five-year-long wait for the approval of the U.S. Senate, given the opposition in both countries. Firms and consumers in Colombia could have hardly predicted whether the agreement was going to be approved or, even more difficult, the timing of the implementation. We plot the evolution of employment and earnings for industries affected or not by changes in tariffs and changes in inputs prices in Figure II. Both employment and earnings are re-scale dividing by the value in 2008 to present relative gains. Overall, we observe no important differences in trend before 2010, indicating no anticipatory effects before this date.

Isolating imports from exports: These reforms had no significant effect on Colombian exports. The reduction of 2010 applied only for imported products and, therefore, had no direct impact on exports. The implementation of the free-trade agreement in 2012 did not considerably reduce the tariffs placed on Colombian products by the United States to Colombian products. We test this and show the results in Appendix Table A.1. We observe small and statistically insignificant effects from the U.S. tariff cuts on Colombian exports to the United States. These results are consistent with the fact that most of the tariffs were already close to zero by the time the free-trade agreement was implemented.

[16] In Appendix Figure A.1b, we present the dollar value of imports from the United States by the year of tariff reduction. The solid line depicts products for which tariffs were cut in both years (3,621 products); the dashed line shows products for which tariffs dropped due to the 2012 free trade agreement (2,716 products). Tariffs for the remaining 150 products either did not change or decreased only in 2010. We observe a continuous increase in the value of imports from the moment of liberalization until 2014, when they decrease drastically. The trend is similar for total imports. The decline was triggered by a strong Colombian peso devaluation, which resulted from a shock in international oil prices (see Appendix Figures A.1a, A.1b, and A.2).

4. Data and Empirical Strategy

4.1. Data

Our empirical analysis is based on rich administrative data from multiple Colombian authorities. First, we use official Colombian tariff records to measure the trade reforms. We use the Colombian Decree 4589 of 2006 that stipulated the level of tariffs charged on every incoming product after January 1st of 2007. This decree does not reflect actual tariff changes but was published to adapt Colombian tariffs to the nomenclature established under the "NANDINA" 2007.[17] We combine this information with data provided under the Colombian Decree 4114 of 2010, which contemplated the unilateral tariff cuts of 2010, and with the Colombian Decree 730 of 2012, that regulated the free trade agreement between Colombia and the United States.[18] The three decrees provide information at the 10-digit product-code level, and, thus, they constitute a very detailed source of variation. We complement these with information about tariffs charged by the United States to Colombia from the U.S. International Trade Commission.

Second, we use detailed records on imports and exports from the Colombian Tax and Customs Department (DIAN for its Spanish initials) and the Colombian Central Bank. Imports and exports are measured between 2007 and 2018 at the product level (using 10-digit industry codes). We complement this information with two additional sources of data. First, we use the Economic Commission for Latin America and the Caribbean official classification of product by economic destination (CUODE) to classify the imported products as capital (which also includes construction), consumption, or raw materials.[19] Second, we complement the product-level data with individual records on imports at the product and firm-level in 2008. We collapse the data at the industry level (four-digit industry code) to create a matrix that measures the foreign inputs used by every industry before the tariff reductions took place. As a complementary source of information regarding inputs, we use the official two-digit input-output matrix built by the Colombian statistical offices. We use both of these measures, combined with the tariff data, to compute the foreign input shock. More details are given in subsection 4.2.

Third, we use social security records providing matched employer-employee earnings records from 2008 to 2018. This administrative dataset includes the universe of formal workers in the country, with over 10 million registries in any given month. One limitation of the data is that it contains only formal-sector workers, representing about 60 percent of Colombian workers. A

[17] NANDINA nomenclature, which resembles quite closely the harmonized system, was designed by the CAN to help with the identification and classification of commodities and to conform with international trade statistics. Decision 653 of the CAN ordered Andean countries to adapt their nomenclature. The Colombian government Decree 4589 of 2006 was adopted for this purpose.

[18] The data for the mentioned decrees can be found in http://www.suin-juriscol.gov.co

[19] The CUODE classifies merchandise by its economic destination at the three digit level. More information can be found in: https://www.dian.gov.co/dian/cifras/AvancesComEx/Avance_Comercio_Exterior_786_30_enero_2020.pdf

second limitation is that compliance increased gradually, and therefore data from 2008 should be interpreted with caution. We collapse these records at the four-digit industry and year level.

Due to the limitations, we complement the social security records with the Colombian household survey, *Gran Encuesta Integrada de Hogares* (GEIH). The survey is administered monthly and includes approximately 8.7 million observations between 2008 and 2018. The main advantage of the surveys is that they include informal workers and provide additional information, such as their education level. However, there are limitations in the representativeness of the surveys when we break the results into two-digit industries. In these cases, we base our analysis on the social security records.

We merge all the data sets and create two different estimating samples. The first is a product-balanced panel built by merging trade and tariff information at the 10-digit level. The panel includes information on 6,663 imported products observed during 12 years (2007-2018). The second is a four-digit industry-code panel that matches data from the employer-employee records, the household surveys, and the tariffs. This data set follows 416 four-digit ISIC sectors for 11 years. We built this panel by keeping sectors with at least one employee observed or information about trade (either imports or exports). The panel at the industry-year includes 4,576 observations, but the household survey only has information for 402 industries, which correspond to 4,422 observations. Appendix Table A.2 presents descriptive statistics for both samples.

Mining Sector: We drop the mining sector from the analysis because of potential cofounders due to variation in oil prices and exchange rates. This sector encompasses 21 industries, including oil and coal, constituting less than 0.5 percent of Colombia's imports. Including this sector in the estimations does not alter the paper's main conclusions; however, adding it may bias the estimates.

4.2. Competition and Input Shocks

The *competition* and *input* shocks quantify the increase in competition and the decrease in the prices of foreign inputs, respectively, induced by the tariff reductions. We define the competition shock as the direct change of tariffs at year t with respect to the value before the reductions of tariffs in industry j. Formally, the competition shock is defined as:

$$\tilde{\tau}_{jt} = \ln(1 + \tau_{j,2010}) - \ln(1 + \tau_{jt}), \tag{4.1}$$

where τ_{jt} represents the tariff charged by Colombia to imports from the United States of industry j at year t. This measure quantifies the degree of liberalization per industry. Before 2010, $\tilde{\tau}_{jt}$ is equal to zero since the tariffs did not change. After 2010, the tariffs start to decrease continuously. Notice that $\tilde{\tau}_{jt}$ between 2010 and 2012 is equal to the tariff change that applied to all the countries, but, after 2012 it takes the value charged exclusively to the United States. A bigger value for $\tilde{\tau}_{jt}$ implies a larger decrease in tariffs and, therefore, a larger increase in import competition.

We use information on imports per firm at the product level in 2008 to quantify the input shock in industry j. We aggregate the firm-level data to compute the shares of the different imported inputs by industry j, before the tariff reductions. We then multiply the respective share with the tariff reduction of each input k, and sum across inputs. Formally, the input shock is expressed as follows:

$$\tilde{q}_{jt} = \sum_{k} w_{jk}^{2008} \tilde{\tau}_{kt}, \tag{4.2}$$

where $w_{jk}^{2008} = \frac{X_{jk}^{2008}}{\sum_k X_{jk}^{2008}}$, and X_{jk}^{2008} corresponds industry j's imports of input k in 2008. Therefore, the input shock is the weighted reduction in tariffs of the imported inputs of sector j in year t. The weights are measured in 2008, before the tariff reforms, to eliminate any potential bias due to endogenous changes in inputs. A bigger value of $\tilde{q}_{jt}$ reflects a bigger reduction in the prices of foreign inputs. It is worth noting that this input shock measure is based exclusively on imported inputs. We provide an alternative measure to complement our analysis that derives the weights from the official national input-output matrix at the two-digit level. Since the level of detail of this input-output matrix is not sufficient to build a robust measure of inputs, we use it as a robustness check and focus on the more detailed matrix in the main specification. Our results remain unchanged in magnitude, although they are much more imprecise. This is consistent with the fact that there is considerably less variation at the two-digit industry code level.

The competition and input measures could be potentially collinear, affecting the standard errors of the estimations. However, the import competition shock affects mainly the manufacturing and agriculture sector and is zero among the industries in services. In contrast, the foreign input shock affects all industries. To confirm that collinearity is not a major concern, we present in Appendix Table **??** the average shocks by industry. The correlation between the two measures is below 0.4.

4.3. Identification

Our identification exploits the across-industry variation of the tariff reductions to estimate the effect of the competition and input shocks. We want to estimate such effects and also aggregate them into a single comparable measure. In what follows, we describe our baseline empirical model and a mechanism to aggregate both shocks into a unique measure.

4.3.1 Baseline Specification

We use the sample analog of Equation (**??**) to estimate the effects of the increase in competition and the reduction of input prices. Formally, our baseline specification takes the form of:

$$y_{jt} = \beta^c \tilde{\tau}_{jt} + \beta^i \tilde{q}_{jt} + \mu_j + \mu_t + u_{jt}, \tag{4.3}$$

Where y_{jt} refers to the logarithm of an outcome y, which are primarily employment and earnings. The parameters of interest β^c and β^i quantify the impact of the competition and input shocks, respectively, on outcome y. We include industry (μ_j) and year (μ_t) fixed effects to control for observed and unobserved heterogeneity across industries and time. Standard errors are clustered at the industry level.

The benchmark model is a reduced-form difference-in-differences with multiple periods and a continuous treatment. Estimates could be biased if the outcome levels vary considerably between treated and untreated units (Kahn-Lang and Lang, 2020). To address this point, we estimate the model in a matched sample that eliminates any preexisting differences in levels between treated and untreated sectors.[20] We present the results for the social security records, where we observe significant differences in levels. In the case of the household surveys, we do not observe any differences. Discrepancies between the longitudinal data and the household survey might stem from data quality in the first years that the longitudinal data was compiled (2008).

The consistency of the estimating parameters depends on the validity of the parallel trends assumption, i.e., industries with and without tariff cuts would have behaved similarly in the absence of the tariff reductions. The absence of any additional policies that exclusively affected the industries in which tariffs were dropped strongly supports our identification strategy. Additional empirical support for our strategy stems from the surprising and non-expected decrease in tariffs and the absence of knowledge about the timing of their implementation.

We test the parallel-trend assumption by estimating an event-study model reflecting the dynamic effects of both shocks. We define T_j^c as a dummy that takes the value of one if the tariffs for industry j decreased between 2010 and 2012, and zero otherwise. Likewise, T_j^i is a dummy that takes the value of one if the input prices of sector j decreased between 2010 and 2012, and zero otherwise. Using these two measures, we estimate:

$$y_{jt} = \sum_{t \neq 2010} \beta_t^c \left[T_j^c \times 1(\text{year=t})\right] + \sum_{t \neq 2010} \beta_t^i \left[T_j^i \times 1(\text{year=t})\right] + \mu_j + \mu_t + \varepsilon_{jt}, \tag{4.4}$$

where $1(year = t)$ is a dummy that takes the value of one if the observation is in year t. β_t^c and β_i^c are the time-varying effects of the competition and input shocks, respectively. The rest of the coefficients are the same as in Equation (4.3). Note that we use 2010 as the excluded category in both interaction terms and that the treatment adoption is not staggered.

This dynamic effect model is particularly helpful to validate our main results in three different

[20]We apply a Mahalanobis distance measure to match treated observations to their nearest control neighbor. The match is performed using employment, earnings, the share of women, and the share of workers less than 30 in the longitudinal data for 2008, 2009 and 2010. Ryan, Kontopantelis, Linden, and Burgess (2018) show that differences-in-differences in matched samples perform well even when the parallel trend assumption does not hold. More details about the matching procedure are shown in Appendix **??**.

ways. First, we test for potential pre-trends in the treatment assignment by testing the coefficients in the pre-period and pose formal evidence against anticipatory effects or violations to the parallel trend assumption. Second, it allows us to assess the impact of the tariff reductions several years after they took place. Third, as opposed to Equation (4.3), the treatment in Equation (4.4) is discrete, eliminating potential issues that arise because of the continuous variation of the treatment (Callaway, Goodman-Bacon, and Sant'Anna, 2021; de Chaisemartin and D'Haultfœuille, 2020).

A large part of the identifying variation in Equation (4.3) comes from cross-industry differences in tariff changes. The event study specification in Equation (4.4) does not capture such variation because the treatment is binary. We complement our analysis with a dynamic estimation that replaces the binary treatment with the total change in tariffs between 2010 and 2018. Results are very similar to those obtained using the binary treatments. Estimates based on continuous treatment, or setting with staggered adoption, could also lead to bias due to heterogeneous treatment effects (Callaway et al., 2021; Callaway and Sant'Anna, 2021; de Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2020). To address this point, we also apply the de Chaisemartin and D'Haultfoeuille (2021) bias-corrected estimator for intertemporal treatment effects. These results are also similar to the original ones, confirming the robustness of our findings. We provide more details on the alternative specifications of the model and estimations methods in Appendix B.

5. Results

5.1. Effect of Tariffs on Imports

The Colombian tariff reductions increased imports, especially those from the United States. Table I presents the results of estimating a differences-in-differences specification using multiple measures of imports as outcomes and at the product level.[21] Formally, the estimations take the form:

$$y_{pt} = \alpha\tilde{\tau}_{pt} + \mu_p + \mu_t + \epsilon_{pt}, \tag{5.1}$$

where y_{pt} corresponds to an outcome for product p in year t, and μ_p and μ_t are product and year fixed effects, respectively.[22] Standard errors are clustered at the product level.

Column (1) displays the effect of the tariff reductions on total imports. A one percentage point decrease in tariffs increases imports by around 1.5 percent, and, as shown in column (2), there are no differences before and after 2012. We then test whether the increase in imports is

[21] We estimate this at the product level to better exploit the variation induced by the free trade agreement. However, the results are very consistent when collapsing the data at the four-digit level.

[22] We use the logarithm of one plus imports in columns (1)- (4), (7), and (8). We additionally provide estimations using the inverse hyperbolic sine transformation for these columns in Appendix Table **??**.

explained exclusively by imports from the United States. In columns (3) and (4) the outcome is the log of U.S. imports, and in columns (5) and (6) it is the share of U.S. imports with respect to total imports. Tariff reductions significantly increase imports from the United States in absolute (measured by the logs) and relative (measured by the percentage) terms, particularly after 2012. As a contrast, columns (7) to (10) present the same estimations for imports from other countries, finding negligible effects and even negative point estimates when considering the imported share from countries different than the United States.[23]

These results imply that tariff reductions led to an increase in U.S. imports, which in turn increased import competition. This competition could have affected differently specific local industries depending on the type of imported goods. To better describe this increase in competition we test whether or not the tariff reductions increased imports of agricultural or manufacturing products. We present the results of estimating Equation (5.1) using as outcome the log of imports from the United States, and splitting between agriculture and manufacturing products, in Table II. We observe strong and robust increases in imports of both types of products. Recall, nonetheless, that the tariff cuts in 2010 did not include agricultural products. In line with this, we observe an increase of imports of agricultural goods only after 2012, when the free-trade agreement was implemented.

The increase in imports could also vary depending on the use of the goods. They can either be used for consumption or as intermediate inputs. We explore this aspect by splitting the estimations between capital, consumption, and raw material goods. We exploit the CUODE categories to estimate the effect in each subgroup of products, and present the results in Panel A of Table II. The increase in U.S. imports was driven by capital and consumption goods, whereas any sizable effect is observed among raw materials. This result is expected as the United States do not have strong comparative advantage in the production of raw materials but it does have in the production of capital and consumption goods.

Local firms could have profit from the new cheaper access to international products. We also assess such effects by analyzing the effects of the tariff reductions among products that were imported by firms before the tariff reductions (i.e. 2008) from different economic sectors, and present the results in Panels B to D of Table II. Panel B, for instance, computes the effects of tariff reductions among products that we identified as imported by firms in agriculture in 2008. It is possible to observe positive point estimates on consumption goods because firms can also import goods that are destined for individual consumption. It might be the case that a manufacturing

[23] We additionally present these results in event-study form in Appendix Figure A.3. We use two treatment groups: products that reduced tariffs in both reforms (2010 and 2012) and those that reduced tariffs only in 2012, and estimate a joint model. The control group includes all the products that did not change tariffs during this period. We do not observe any significant differences before 2010, which confirms that the common trends assumption holds. Consistent with the difference-in-differences estimates, imports from the United States started to increase after the tariff reductions.

firm imported a TV (which is a consumption good) in 2008 and this will enter the estimation as a consumption good for firms in manufacturing. Many of the products imported by firms are also bought by regular consumers.

The tariff reductions induced positive and substantial increases of imports of capital and consumption goods, especially among goods that were previously imported by manufacturing and services firms. We do not observe precise point estimates among goods imported by agricultural firms, although the point estimates on capital and consumption good are positive (especially capital goods between 2010 and 2012). We do observe robust increases among capital and consumption goods imported by firms in manufacturing and services in panel C and D. The point estimates corresponding to raw materials are systematically non-significant indicating that the tariff reductions did not imply an increase in imports of raw materials. These results suggest that the increase in imports was driven by capital and consumption goods consumed by firms in the manufacturing and services sector, which explain the nature of the foreign input shock.

In general, the tariff reductions fostered Colombian imports from the United States, and induced an increase in import competition and a decrease in the prices of foreign inputs. Import competition affected mainly agriculture and manufacturing sectors. Cheaper foreign inputs benefited firms in manufacturing and services by increasing the imports of capital and consumption goods.

5.2. The Effects on Employment and Earnings

We present in Table **??** the results of the estimation of Equation (4.3) using employment (Panel A) and earnings (Panel B) as outcomes. We separate the results using household surveys and the social security records. For the latter, we also show estimates based on the full and the matched sample.[24] In addition to the main estimates, we compute the weighted sum of the effects of the competition and input shocks (Equation (**??**)).

We observe persistently negative point estimates of the competition shock on employment, and positive, although less precise, effects of the foreign input shock. A one percentage point increase in the competition shock (i.e. a one percentage point reduction in tariffs) *reduces* (formal and informal) employment by 1.4 percent. In contrast, a one percentage point decrease in the prices of foreign inputs *increases* overall employment by around 1.2 percent when using the household survey and 1.1 percent when using the social security data. The effects of inputs are only significant at the 10 percent level. The weighted sum yields statistically insignificant estimates in all specifications; thus, we cannot reject the null hypothesis that the impact of one shock is larger than the other. When we use the national input-output matrix, which also includes domestic inputs to measure the input shock, we find very similar, but more imprecise, results (Appendix Table **??**).

As for earnings, we find no effect for the competition shock and a negative and significant effect

[24] More details regarding the matching procedure are presented in Append **??**.

of input shock, which is driven exclusively by informal workers. Specifically, a one percentage point decrease in the prices of foreign inputs decreases the earnings of informal workers by 0.4 percent.[25]

Figure **??** plots the event study estimates –detailed in Equation (4.4)– for the competition (Panel **??** and Panel **??**) and input (Panel **??** and Panel **??**) shocks, showing similar results as those in Table **??**. We observe, in Panel **??**, a decline in employment after the 2012 tariff reductions (i.e. those stipulated in the free trade agreement), and not significant differences prior to it. Panel **??** displays positive employment effects after 2010 (i.e. after the first decrease in foreign inputs prices) among industries in which the prices of foreign inputs were reduced, and no significant differences prior to it. We do not find any significant point estimates on earnings nor evidence of the existence of pre-trends.

We complement our analysis with an event study model that uses a continuous treatment in Appendix Figure B.1. We also apply the de Chaisemartin and D'Haultfoeuille (2021) bias-corrected estimator for intertemporal treatment effects in Appendix Figure B.2, and estimate the event-study specification described in Equation (4.4) using different data sources and samples in Appendix Figures B.3 and B.4. Overall, the results are similar across specifications, estimation methods, and samples.[26]

The above results suggest that: 1) import competition decreases employment; 2) reductions in input prices increase employment in a comparable magnitude, and 3) foreign inputs decrease earnings of workers employed in informal jobs. The first result is in line with most existing literature, which shows that import competition can have detrimental effects on employment, independently of the country and the trade partners. The second result is consistent with previous studies, including some based on Colombia, showing that there is a complementarity between imported inputs and labor demand (Fieler, Eslava, and Xu, 2018; Kamal, Lovely, and Mitra, 2019; Leblebicioğlu and Weinberger, 2021). These estimates, nonetheless, are imprecise. We show in the following section that this is due to heterogeneity in the effects among employment in manufacturing versus services. The third result is consistent with the fact that labor informality is prevalent in Colombia and workers employed informally are less likely to have rigid contracts or be bound by minimum wages. Therefore, their earnings are more adjustable against adverse shocks.

[25]We also present results splitting the effects before and after 2012 in Appendix Table **??**. In general, we observe that the competition shock decreases employment after 2012, whereas the input shock increases employment before 2012. This timing is in line with the results shown in Section 5.1.

[26]We observe some pre-trends in 2008 using the social security records, that are not found in the household survey estimates, even when we focus on formal workers. Data limitations in the first years of the social security records might explain the difference between data sources in this year. The estimation on the matched sample, nonetheless, corrects this imbalance and shows point estimates that are very similar to those of the other specifications.

6. Mechanisms

6.1. Heterogeneous Effects by Sector

We estimate heterogeneous effects by sectors to explore potential mechanisms that explain the impact on employment. These estimations shed some light on how the competition and input shocks affect different economic sectors, as described in Section 2. We estimate sector-specific effects by interacting the competition and input shocks with sector dummies in agriculture, manufacturing, and services and present the results in Table **??**. As in the previous set of results, we estimate the model using multiple data sets and samples.[27]

In column (1), we begin by presenting the effects of import competition without controlling for the foreign inputs shock. While point estimates are negative for both agriculture and manufacturing, they are only statistically significant for the latter. Column (2) shows the effect of the foreign inputs shock without controlling for the import competition shock. In this case, the estimated coefficients are positive and significant for the services sector and non-significant for agriculture and manufacturing. These positive effects on employment in services, along with the increase of imports of capital goods documented in Section 5.1, suggest that foreign inputs are complementary to labor in this sector.

Column (3) presents the joint estimates. There are two main findings. First, the positive employment effects of foreign inputs in services remain unchanged, indicating that the total positive effects displayed in Table **??**, are mainly driven by this sector. This result holds for all the other samples (columns (4) to (7)), except for informal workers, for which we do not find any significant effect. Second, the negative effect of import competition in manufacturing decreases to almost zero once we control for the input shock (-0.001). In contrast, the negative point estimate of foreign inputs on manufacturing remains unchanged, although it is not statistically precise. This pattern is similar across samples; point estimates of foreign inputs are negative, although not always significant, while the effect of import competition is either close to zero or positive.[28] Since we also observe an increase in capital and construction imports in the manufacturing sector, these results suggest that foreign inputs could be substitutes of labor demand in this sector.

The imprecision in the estimation of the effect of foreign inputs on total employment, presented in Table **??**, is partly explained by the counteracting effects on employment in services versus manufacturing. In fact, the effect of the foreign inputs shock on services is consistently positive and significant, while the effect on manufacturing is negative but, in most cases, statistically insignificant.

[27] For the sake of completeness, we also present the estimates for earnings in Appendix Table **??**.

[28] As can be seen in Appendix Table **??**, which presents separate and joint estimates for all samples, the import competition effect on manufacturing decreases dramatically when we include the foreign inputs shock. In contrast, the effect of foreign inputs on manufacturing remains unchanged.

As suggested by our conceptual framework in Section 2, we investigate these effects more deeply by exploiting the detailed variation in the competition and input shocks and interacting them with two-digit industry dummies. This analysis is based exclusively on the social security data for two reasons.[29] First, it is representative at the two-digit industry level, whereas the household survey is not. Second, it allows us to decompose employment into the number of firms and the average firm size (measured by the average number of employees) for each four-digit sector, and use these, in logarithms, as outcomes.[30]

Figure **??** presents the point estimates and confidence intervals for the competition and inputs shocks.[31] There are three results to highlight, all of which are consistent with our previous findings. First, import competition reduces employment in some manufacturing and agricultural sectors (column (1)), and this is mainly driven by a reduction in the number of firms (column (3)). These results are in line with the theoretical predictions in Melitz (2003).

Second, lower prices of foreign inputs increase employment in some service industries –such as travel agencies, construction, hotels and restaurants, and water transport (black estimates in column (2)). These job gains are explained by an increase in the number of firms in these sectors (column (4)), whereas the average firm size remains relatively unchanged (column (6)). Cheaper imported inputs stimulate firm creation in services and raise employment, without affecting the average size of firms. This is consistent with the observed increase in imports of capital goods by the services firms, and the potential complementarity between foreign inputs and labor in this sector.

Third, we observe that reductions in the price of foreign inputs decrease employment in some manufacturing sectors (blue estimates in column (2)). In this case, the decline of the average firm size is the primary driver of job losses (column (6)). In contrast, there are small or no significant changes in the number of firms (column (4)).[32] These results suggest that foreign inputs mainly substitute labor in the manufacturing sector through intensive margin adjustments (smaller firms), while extensive margin adjustments (firm exit) are less common. This relates to a broader literature on automation and substituability between capital inputs and labor (Acemoglu and Restrepo, 2018, 2020), where the substitution takes place across countries. For instance, Pierce and Schott (2016) argue that Chinese imports reduce manufacturing employment in the United States by increasing the capital intensity of firms. Likewise, Kugler, Kugler, Ripani, and Rodrigo (2020) find that technology adoption in the United States have negative effects on the Colombian labor market.

[29] We present the results using household surveys in Appendix Table **??** and the results for number of firms and average firm size in the full and matched samples of the social security records in Appendix Table **??**.

[30] Formally, the average firm size is the sum of individuals working in a sector j divided by the number of firms: $\frac{\sum_i L_{ij}}{N_j} = \bar{L}_j$. We use this identity to decompose employment in a measure of the number of firms and a measure of average firm size in sector j.

[31] For clarity purposes, we grouped some of the two-digit industries, ending up with 30 industries.

[32] One of the few exceptions is the the wood, paper, and printed industry, were we find positive and significant estimates in both the average firm size and total employment.

6.2. Heterogeneous Effects by Workers Education Level

Import competition and foreign inputs may have differential effects on workers, depending on their education level. This would imply that the degree of complementarity or substitutability between imported goods, foreign inputs, and labor vary by skill. This could happen if imported products from the United States had different skill components than those produced locally in Colombia. We explore this possibility using the household survey to estimate the heterogeneous effects of the shocks for college and non-college-educated workers.

Results for employment and earnings of college-educated (panel A) and non-college-educate workers (panel B) are presented in Table **??**. On the one hand, import competition affects employment for all workers, independently of their educational attainment. A one percentage point increase in the competition shock reduces employment of college-educated and non-college-educated workers by 1.0 and 1.1 percent, respectively. In both cases, the effect is driven by formal jobs, which are less flexible due to regulations. We also observe that import competition decreases earnings among the college-educated workers. This negative effect is particularly large for those working in informal jobs. This is consistent with the fact this group of workers is more likely to adjust via wages rather than employment.

On the other hand, we find that the input shock increases employment mainly among non-college-educated, formal workers. A one percentage point reduction in the prices of foreign inputs increases non-college-educated employment by 1.8 percent. We do not find any significant effects of foreign inputs on earnings. However, the imprecise 0.5 percent drop among earnings of college-educated workers is close in magnitude to the 0.4 percent drop displayed in Table **??** when considering the overall effect of foreign inputs on earning of informal workers. Despite this imprecision, we can still claim, based on the results on Table **??**, that foreign inputs decrease earning of informal workers.

All together, these results by levels of education are in line with the arguments presented in the previous section. Import competition decreases employment in agriculture and manufacturing, and decreases earnings of college-educated workers, by inducing firm exit. Foreign inputs, on the contrary, induce firm entry in services and increase non-college-educated employment. However, they affect the manufacturing sector by substituting labor with foreign inputs.

7. Model Calibration and Counterfactuals

We collect different data sources from the Banco de la Republica cuodeColombian Central Bank) to calibrate the model at the baseline. Our observation unit corresponds to the state-sector cell and includes the US and the RoW as two additional locations. Using information of the regional IO tables and WIOD, we construct bilateral trade flows, M_{ni,s,t_0} across the different locations in Colombian pesos.[33] The IO tables also include information on the input shares used by each sector, and we aggregate the tariffs at the two-digit sector level. We follow CP and define the following variables; gross production by location i in sector s, $Y_{is,t_0} = \sum_n M_{ni,s,t_0}$. We then can calculate the total expenditure by country n of sector s goods produced by country i as $X_{ni,s,t_0} = M_{ni,s,t_0} cuode 1 + t_{ni,s,t_0})$ and the total revenue of location n, $R_{n,t_0} = \sum_{i,s} M_{ni,s,t_0} t_{ni,s,t_0}$. With this information, we can calculate trade shares across locations as $\pi_{ni,s,t_0} = \frac{X_{ni,s,t_0}}{\sum_l X_{nl,s,t_0}}$. And using the information on the input share of sector s from sector k in location i, γ_{i,sk,t_0}, we construct the value added share $\gamma_{is,t_0} = \sum_k \gamma_{i,sk,t_0} = w_{is,t_0} L_{is,t_0} / Y_{is,t_0}$. Finally, we can define the trade deficits in each sector s, as $D_{is,t_0} = \sum_n M_{in,s,t_0} - \sum_n M_{ni,s,t_0}$, and total deficits $D_{i,t_0} = \sum_s D_{is,t_0}$. With this information, we can construct the absorption of location i, $I_{i,t_0} = \sum_s w_{is,t_0} L_{is,t_0} + R_{i,t_0} + D_{i,t_0}$, and the consumption shares, $\alpha_{is} = \frac{X_{is,t_0} - \sum_k \gamma_{i,ks,t_0} Y_{ik,t_0}}{I_{i,t_0}}$.

Recall that the baseline equilibrium condition is:

$$X_{is} = \sum_k \gamma_{i,ks} Y_{ik} + \alpha_{is} \left(\sum_r w_{ir} L_{ir} + R_i + D_i \right)$$

$$w_{is} L_{is} = \gamma_{is} Y_{is}$$

Dos formas de calcular el labor share

- Primera forma

$$\gamma_{is} = (1 - intermediateinputs/Y)$$

- Calcular $Y_{is} = \sum_n M_{ni,s}$ de la matriz 1

  Calcular $\gamma_{i,sk} = valor_{i,sk} / Y_{is}$ usando la matriz 3 y el Y anterior

  El labor share $= \gamma_{is} = 1 - \sum_k \gamma_{i,sk}$

8. Conclusion

The paper explores how import competition and foreign inputs from high-income countries affect employment in developing economies. We focus on the labor adjustment effects of increases in imports coming from the United States in Colombia. We exploit exogenous tariff reductions in Colombia that decreased the prices of foreign inputs and increased import competition from the United States. We combine these reductions into a differences-in-differences framework, enabling the estimation of reduced form causal effects. We provide strong evidence about the non-existence

[33] Imports of n from i in sector s.

of preexisting differences across affected and unaffected industries and show event study estimates, which validate our results against other biases posed by potential variation in treatment timing (Callaway and Sant'Anna, 2021; de Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2020).

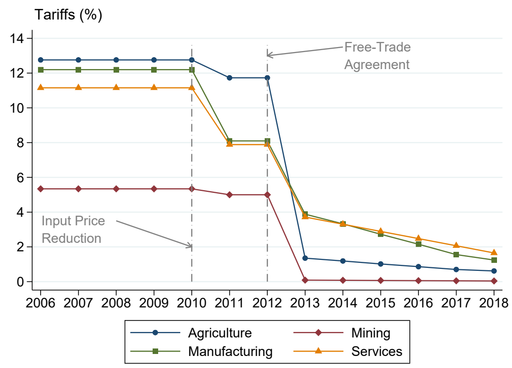
We use administrative records that link competition and inputs at the industry level and household surveys and social security records to track employment and earnings. The detailed features of the employment data allow us to estimate effects across industries and analyze the impact on formal and informal employment. We overcome the limitations of the household survey data and the social security records by estimating our results using both data sources and contrasting them. Each data set has particular limitations but also specific advantages. Regardless of which data set we use, our results are similar.

Our results show that import competition reduces employment, whereas foreign inputs increase it, although estimates are less precise for the latter mechanism. The negative effect of import competition is driven by firm exit in manufacturing and agriculture. The imprecision in the impact of foreign inputs results from the counteracting effects in manufacturing and services industries; foreign inputs increase employment in services by inducing firm entry, and decreases employment in manufacturing by substituting labor demand with foreign inputs. The increase in employment in services particularly increases non-college-educated employment. Furthermore, we observe that both shocks tend to reduce earnings among college-educated, informal workers.

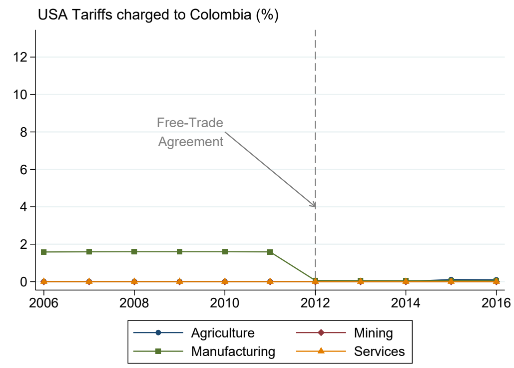
Figures and Tables

FIGURE I
Tariffs Charged by Country

(a) Colombia



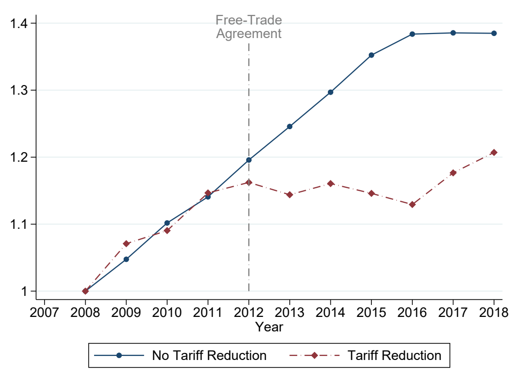
(b) United States



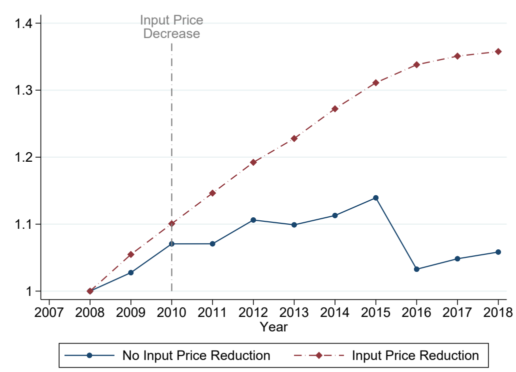
Notes: These graphs present the average tariffs charged by Colombia and the United States among agriculture, manufacturing, mining, and services goods. The values are computed by using simple averages across 10-digit industry codes. The left panel presents the historical tariffs that Colombia charged on products from the United States. The right panel plots the historical tariffs charged by the United States on imports from Colombia.

FIGURE II
Evolution of Employment

(a) By Sectors that Changed Tariffs



(b) By Sectors that Changed Foreign Input Prices



Notes: These graphs present the evolution of employment with respect to 2008. Panel IIa splits by industries that did and did not reduce tariffs. Panel IIb splits by industries that did and did not reduce the price of inputs. The graphs use household survey data from 2008 to 2018, and divide by the value of the variable in 2008.

FIGURE III

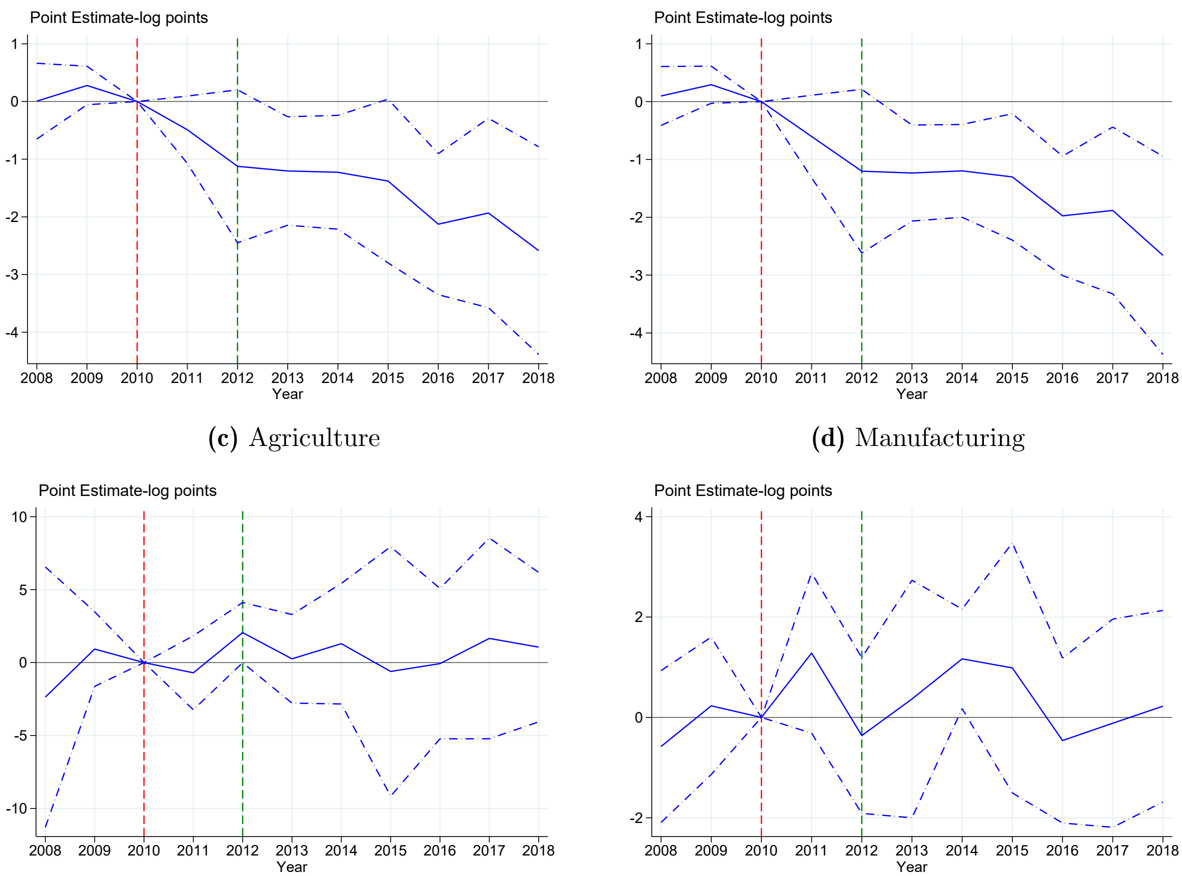
Liberalization on Imports from the United States

(a) Products that Liberalized in 2010 and 2012 **(b)** Products that Liberalized only 2012

Notes: $N = 84,460$. These figures use log imports from the United States as outcome. Estimations performed in a panel at the product (10-digit)-year level. Both estimations are performed jointly but presented separately. Excluded category corresponds to products that did not reduce tariffs. Plotted intervals correspond to the 95 percent confidence level, and standard errors clustered at the product level.

FIGURE IV

Input shock on Wagebill



(a) Pool of Industries

(b) Services

(c) Agriculture

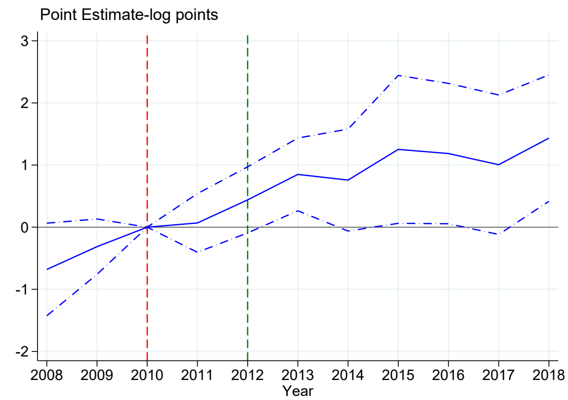
(d) Manufacturing

Notes: These figures plot the event study specification at the industry level for the input shock. Plotted intervals correspond to the 95 percent confidence level.

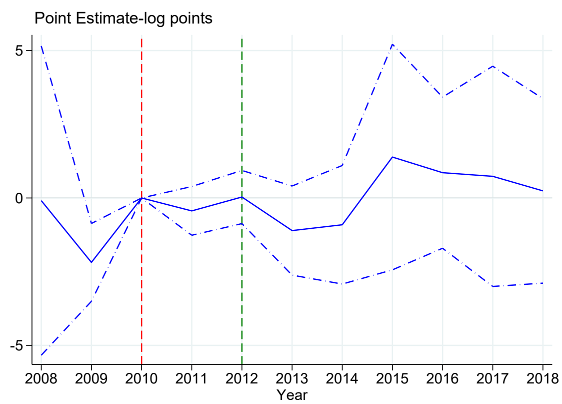
FIGURE V

Competition shock on Wagebill

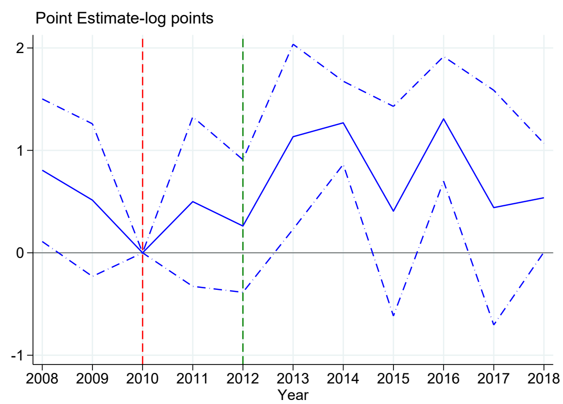
(a) Pool of Industries



(b) Agriculture



(c) Manufacturing

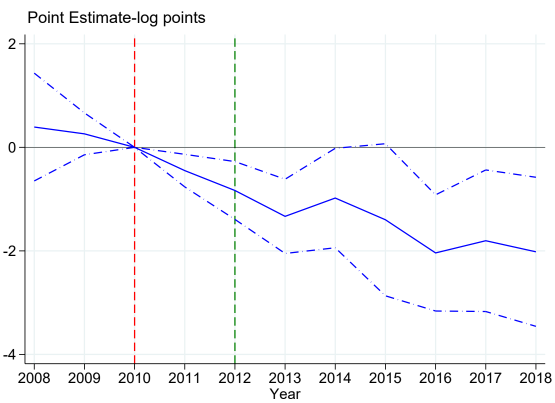


Notes: These figures plot the event study specification at the industry level for the competition shock. Plotted intervals correspond to the 95 percent confidence level.

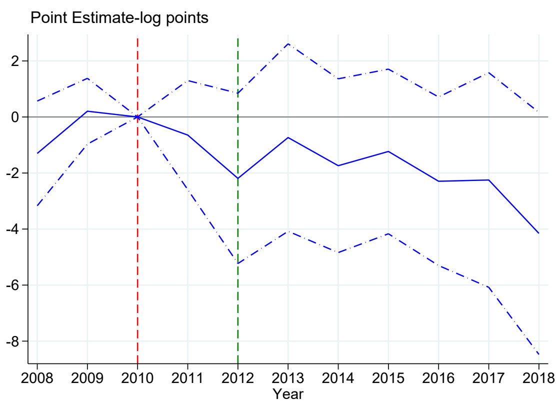
FIGURE VI

Competition and Input shocks on Wagebill by Skill Level

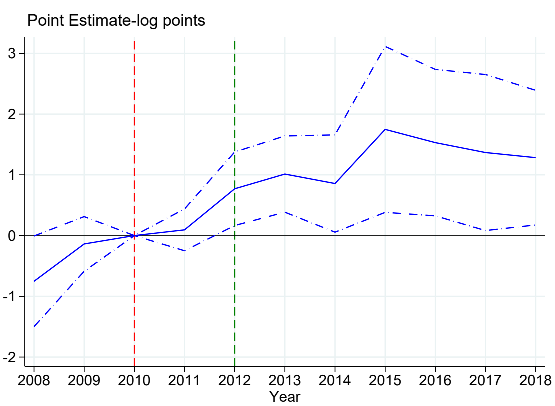
(a) Input Shock on Unskilled Wagebill



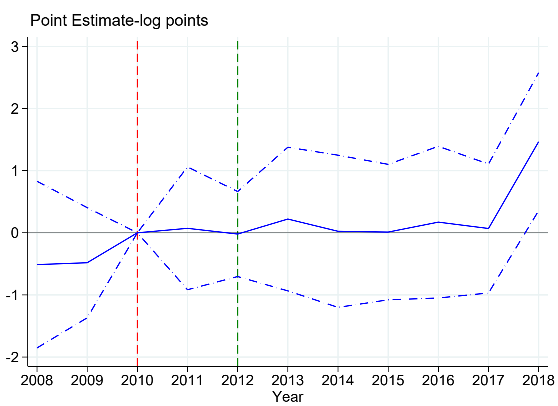
(b) Input Shock on Skilled Wagebill



(c) Competition Shock on Unskilled Wagebill



(d) Competition Shock on Skilled Wagebill

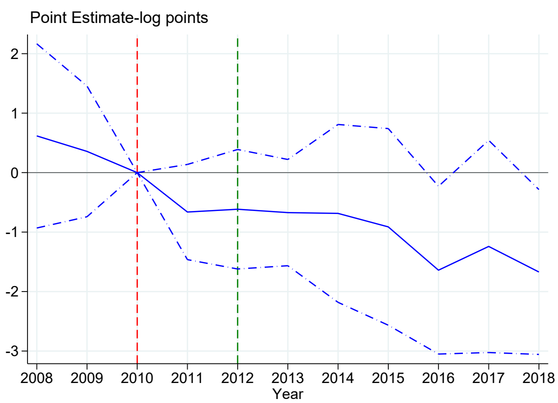


Notes: These figures plot the event study specification at the industry level for the competition shock. Plotted intervals correspond to the 95 percent confidence level.

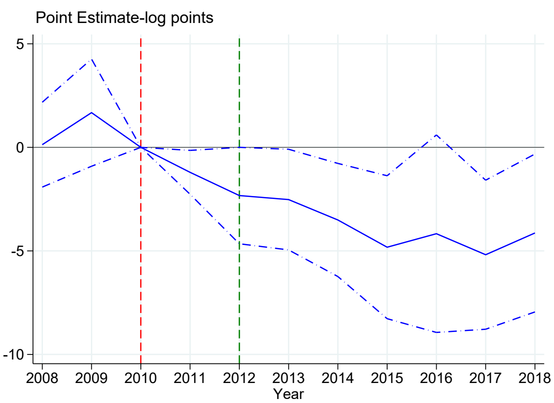
FIGURE VII

Robustness of the Effects to Alternative Methods and Data

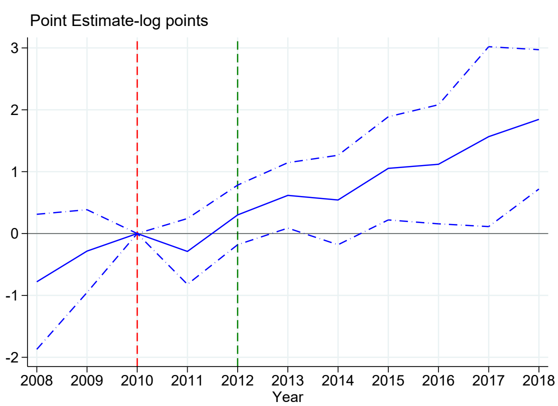
(a) Input Shock Using Least Squares



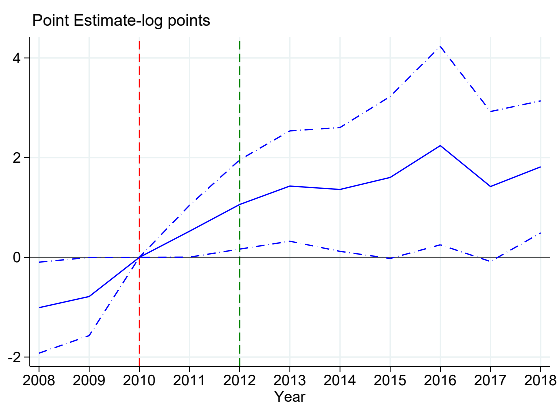
(b) Input Shock Using Social Security Records



(c) Competition Shock Using Least Squares



(d) Competition Shock Using Social Security Records



Notes: These figures plot the event study specification at the industry level for the competition shock. Plotted intervals correspond to the 95 percent confidence level.

TABLE I

Tariff Reduction on Imports

	Total		*U.S. Imports*				*Non U.S. Imports*			
	Log		Log		Percentage		Log		Percentage	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
A) All Imports										
Comp. Shock	1.415***		1.230***		0.994***		0.775***		-0.280***	
	(0.208)		(0.310)		(0.205)		(0.220)		(0.066)	
Comp. $\text{Shock}_{t\in\{2010,2012\}}$		1.346***		1.357***		0.620***		1.076***		-0.217**
		(0.280)		(0.404)		(0.238)		(0.308)		(0.092)
Comp. $\text{Shock}_{t\in\{2013,2018\}}$		1.425***		1.208***		1.068***		0.731***		-0.288***
		(0.226)		(0.342)		(0.228)		(0.237)		(0.070)
Observations	69987	69987	56441	56441	79956	79956	68286	68286	79956	79956
B) Imported Inputs										
Comp. Shock	1.428***		1.109***		0.848***		0.860***		-0.303***	
	(0.205)		(0.312)		(0.203)		(0.218)		(0.060)	
Comp. $\text{Shock}_{t\in\{2010,2012\}}$		1.456***		1.411***		0.482**		1.158***		-0.210**
		(0.263)		(0.404)		(0.229)		(0.292)		(0.082)
Comp. $\text{Shock}_{t\in\{2013,2018\}}$		1.424***		1.055***		0.929***		0.815***		-0.315***
		(0.223)		(0.346)		(0.229)		(0.236)		(0.065)
Observations	67125	67125	55390	55390	71496	71496	65903	65903	71496	71496
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table presents the results of estimating Equation (5.1) using imports as an outcome at the product level (10-digits). We are unable to compute the input shock at the product level due to the nonexistence of an input-output matrix at such level. Imported inputs correspond to the products imported by Colombian firms in 2008. Columns (1) and (2) use the log of total imports, columns (3) and (4) use the log of imports from the U.S, columns (5) and (6) the percentage of import from the U.S, columns (7) and (8) the log of non-U.S imports, and columns (9) and (10) the percentage of non-U.S. imports. Specifications using logarithmic outcomes correspond to least squares estimates. Specifications using percentages as outcomes are estimated using poisson regression. Odd columns present the linear effect. Even columns split the effect before and after 2012 by interacting the import competition measure with a dummy variable that takes a value of one for 2011 and 2012, and a dummy variable that takes the value of one for years after 2012. Standard errors clustered at the product level. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

TABLE II

Tariff Reductions on U.S. Imports by Type of Product and Economic Sector

	Capital		*Consumption*		*Raw Materials*	
	(1)	(2)	(3)	(4)	(5)	(6)
A) Overall Products by Purpose						
Comp. Shock	0.798		1.502**		0.817	
	(0.486)		(0.591)		(0.511)	
Comp. Shock$t \in \{2010, 2012\}$		1.158**		4.270**		0.563
		(0.565)		(1.660)		(0.611)
Comp. Shock$t \in \{2013, 2018\}$		0.649		1.465**		0.881
		(0.589)		(0.594)		(0.579)
Observations	17,191	17,191	12,710	12,710	26,244	26,244
B) Products Imported by Agricultural Firms in 2008						
Comp. Shock	0.559		-0.631		1.313	
	(0.698)		(1.281)		(1.015)	
Comp. Shock$t \in \{2010, 2012\}$		1.015		5.386**		1.206
		(0.774)		(2.698)		(0.899)
Comp. Shock$t \in \{2013, 2018\}$		0.382		-0.779		1.358
		(0.864)		(1.302)		(1.398)
Observations	5,191	5,191	2,033	2,033	3,642	3,642
C) Products Imported by Manufacturing Firms in 2008						
Comp. Shock	0.967**		0.755		0.702	
	(0.490)		(0.646)		(0.525)	
Comp. Shock$t \in \{2010, 2012\}$		0.958*		4.058**		0.519
		(0.545)		(1.690)		(0.629)
Comp. Shock$t \in \{2013, 2018\}$		0.970		0.731		0.747
		(0.600)		(0.648)		(0.596)
Observations	15,417	15,417	10,658	10,658	24,013	24,013
D) Products Imported by Services Firms in 2008						
Comp. Shock	0.892*		1.356**		0.593	
	(0.484)		(0.613)		(0.520)	
Comp. Shock$t \in \{2010, 2012\}$		1.391**		4.338***		0.533
		(0.553)		(1.667)		(0.616)
Comp. Shock$t \in \{2013, 2018\}$		0.688		1.324**		0.608
		(0.590)		(0.615)		(0.589)
Observations	16,695	16,695	12,293	12,293	24,484	24,484
R-squared	0.808	0.808	0.798	0.798	0.816	0.816
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: This table presents the results of estimating Equation (5.1) using imports from the United States as an outcome at the product level (10-digits), and splitting the sample in multiple subgroups. Columns (1) and (2) focus on capital (that also includes construction) goods, columns (3) and (4) on consumption goods, and columns (5) and (6) on raw materials. Panel A includes all products. Panel B focuses on products imported in 2008 by firms in agriculture. Panel C focuses on products imported in 2008 by firms in manufacturing, and panel D focuses on products imported in 2008 by firms in services. We identify these products using information about the imported products by firm in 2008. Odd columns present the linear effect, whereas even columns split the effect before and after 2012 by interacting the import competition measure with a dummy variable that takes a value of one for 2011 and 2012, and a dummy variable that takes the value of one for years after 2012. Standard errors clustered at the product level. *** p<0.01, ** p<0.05, * p<0.1

TABLE III

Input and Competition Shocks on Wage Bill (poisson)

	All		High-skilled		Low-skilled		Social Sec.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A) All Sectors								
Input Shock	-1.574***	-1.603***	-1.776**	-1.873**	-1.393***	-1.288***	-1.805	-1.601
	(0.375)	(0.392)	(0.731)	(0.784)	(0.342)	(0.403)	(1.354)	(1.262)
Comp. Shock	1.762***	1.909***	1.391***	1.321***	1.723***	1.898***	2.025***	1.919**
	(0.472)	(0.484)	(0.425)	(0.473)	(0.517)	(0.529)	(0.743)	(0.764)
B) By Industry								
Input shock × 1(Agric.)	1.601**	1.723*	4.505*	3.374	1.343*	1.692**	1.237	1.393
	(0.786)	(0.893)	(2.460)	(2.891)	(0.712)	(0.830)	(1.100)	(1.249)
Input shock × 1(Manuf.)	-1.577	-1.613*	-1.997	-1.741	-1.398	-1.602	0.818	1.086
	(1.011)	(0.913)	(1.462)	(1.343)	(0.892)	(0.974)	(0.827)	(0.758)
Input shock × 1(Serv.)	-1.945***	-1.882***	-1.929**	-2.011**	-1.792***	-1.629***	-2.175	-1.952
	(0.407)	(0.410)	(0.762)	(0.818)	(0.363)	(0.404)	(1.431)	(1.317)
Comp. shock × 1(Agric.)	2.329**	1.699*	-2.694	-2.787	2.226**	1.562	1.553*	1.302
	(1.008)	(0.970)	(2.249)	(2.129)	(1.001)	(0.953)	(0.883)	(0.847)
Comp. shock × 1(Manuf.)	1.092	1.233	1.398	1.061	0.959	1.385	-0.478	-0.651
	(0.807)	(0.770)	(1.246)	(1.166)	(0.707)	(0.851)	(0.690)	(0.808)
Observations	65,758	65,758	61,754	61,754	64,196	64,196	65,109	65,109
State-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-Year FE	Yes		Yes		Yes		Yes	
Year FE		Yes		Yes		Yes		Yes

Note: This table presents the results of estimating a poisson regression using the wagebill as outcome. All columns use outcomes measured in the household survey. Estimations are weighted by employment per industry and state in 2008. Standard errors clustered at the industry and year level. *** p<0.01, ** p<0.05, * p<0.1

TABLE IV
Input and Competition Shocks on Wage Bill (least squares)

	All		High-skilled		Low-skilled		Social Sec.	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
A) All Sectors								
Input Shock	-1.065***	-1.350***	-0.353	0.287	-0.867***	-1.267***	-1.489***	-0.869*
	(0.248)	(0.289)	(0.401)	(0.442)	(0.243)	(0.282)	(0.568)	(0.445)
Comp. Shock	2.788***	2.810***	2.212***	1.967***	2.416***	2.466***	1.529***	1.447***
	(0.361)	(0.392)	(0.468)	(0.506)	(0.356)	(0.390)	(0.393)	(0.448)
B) By Industry								
Input shock × 1(Agric.)	1.190	0.972	1.744	2.018	0.837	0.697	0.308	0.241
	(0.797)	(0.857)	(1.803)	(1.799)	(0.793)	(0.827)	(0.922)	(0.895)
Input shock × 1(Manuf.)	-0.489	-0.947**	0.473	1.337**	-0.353	-1.033*	0.669	1.422***
	(0.411)	(0.469)	(0.628)	(0.591)	(0.470)	(0.556)	(0.581)	(0.474)
Input shock × 1(Serv.)	-1.406***	-1.531***	-0.703*	0.042	-1.122***	-1.406***	-2.040***	-1.271**
	(0.238)	(0.271)	(0.375)	(0.420)	(0.233)	(0.261)	(0.606)	(0.499)
Comp. shock × 1(Agric.)	4.272***	4.113***	4.050*	3.082	3.719***	3.528***	2.305**	2.158*
	(1.028)	(1.116)	(2.176)	(2.270)	(1.015)	(1.099)	(1.146)	(1.277)
Comp. shock × 1(Manuf.)	1.268***	1.492***	0.766	0.620	1.133***	1.429***	-0.696**	-0.670*
	(0.327)	(0.390)	(0.509)	(0.493)	(0.375)	(0.481)	(0.345)	(0.384)
Observations	53,177	53,177	42,538	42,538	47,699	47,699	61,076	61,076
State-Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State-Year FE	Yes		Yes		Yes		Yes	
Year FE		Yes		Yes		Yes		Yes

Note: This table presents the results of estimating a least squares regression using the wagebill as outcome. All columns use outcomes measured in the household survey. Estimations are weighted by employment per industry and state in 2008. Standard errors clustered at the industry and year level. *** p<0.01, ** p<0.05, * p<0.1

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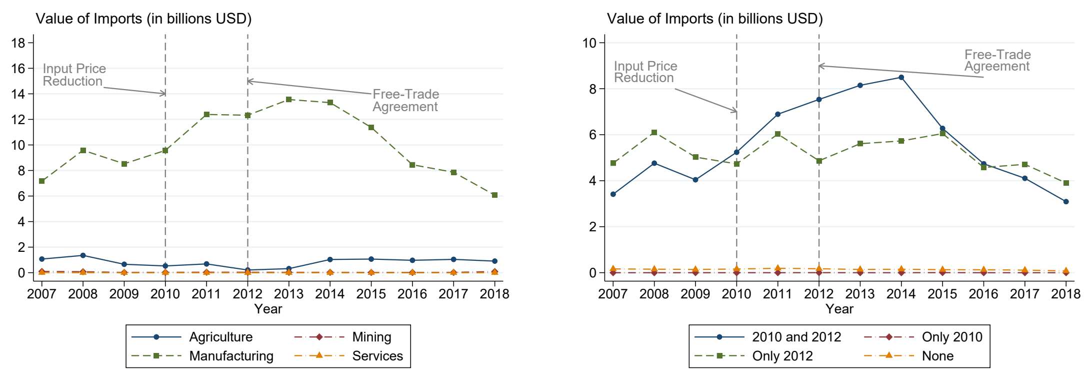
A. Appendix Figures and Tables

FIGURE A.1

Colombian Imports from the United States

(a) By Economic Sector **(b)** By year of Tariff Reduction

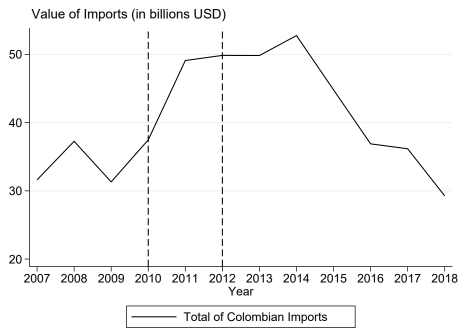


Notes: This graph plots the value of imports in billions USD. Panel A.1a plots the evolution of Colombian imports from the United States by industry. Panel A.1b plots the evolution of Colombian imports from the United States by the year in which the product's tariff was decreased. Vertical gray lines depict the years in which the two tariff reductions took place.

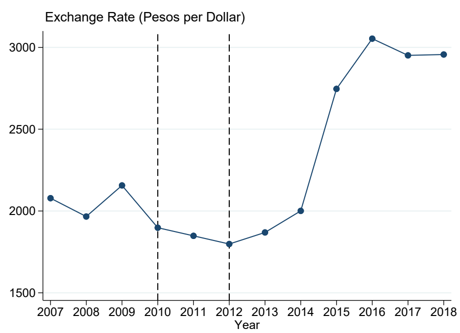
FIGURE A.2

Macroeconomic Environment

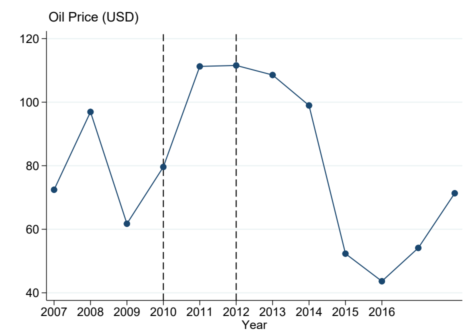
(a) Total Imports



(b) Exchange Rates



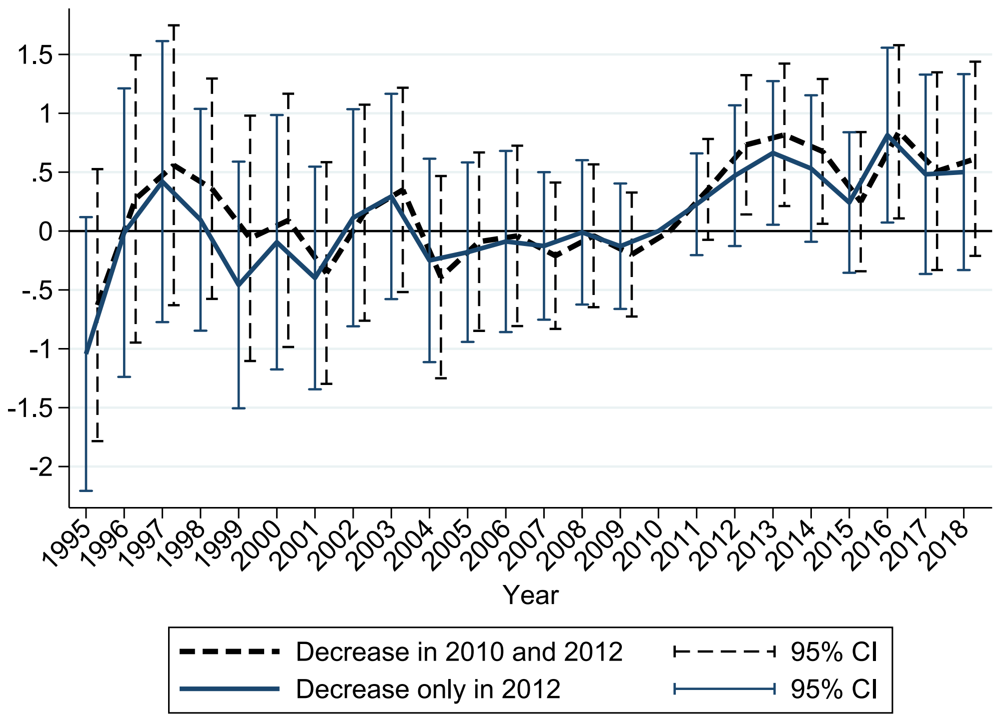
(c) Oil Prices



Notes: These graphs describe the macroeconomic environment around the implementation of the free-trade agreement. Panel A.2a presents the evolution of total imports in billions USD. Panel A.2b presents the evolution of the exchange rate of U.S. dollars to Colombian pesos. Panel A.2c presents the evolution of the price of oil (in dollars). The vertical dashed lines correspond to the years of tariffs reductions.

FIGURE A.3

Event Study Estimates on log Imports from the U.S.



Notes: N = 128,503. The figure plots the point estimates of Equation (4.4) including exclusively those associated to the tariff reductions (i.e. β_j^c), and excluding reductions on the prices of inputs (i.e. β_j^i). The dependent variable corresponds to the log imports from the United States. We use 2010 as year of reference, and split the treatment indicator (T_j^c) into two separate dummies: one for tariff reductions in 2010 and 2012, and the other for only 2010. These two dummy variables are interacted with year identifiers, and estimated jointly conditioning on year and industry fixed effects. The group of reference are tradable-products that did not change tariffs. The estimations are done at the product-year level. Standard errors are clustered at the product level.

TABLE A.1

U.S Tariff Reductions on Colombian Exports

	Total (1)	To the U.S. (2)	To All Other (3)
U.S. Tariff Reduction	-0.008	-0.006	-0.010
	(0.010)	(0.008)	(0.011)
Observations	55,903	55,903	55,903
Industry FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Note: This table uses Colombian exports as outcome. Column (1) refers to total exports, column (2) refers to exports to the United States, and column (3) to exports to other countries. Estimations are done at the six-digit industry and year level. Tariff reduction in year t is computed as the tariff charged by the United States to Colombian products in 2011 minus the tariff charged in year t. All specifications control for Colombian tariff reduction ($\Delta\tau$). *** p<0.01, ** p<0.05, * p<0.1

TABLE A.2

Descriptive Statistics Across Samples

	Count (1)	Mean (2)	S.D. (3)	Min. (4)	Max. (5)
A) Trade Data (10-Digit product)					
Δ Import Competition ($\tilde{\tau}$)	79,956	5.57	6.83	0.00	80.00
1(Ind. Decreased Tariffs)	79,956	0.98	0.15	0.00	1.00
1(Decreased in 2010 and 2012)	79,956	0.56	0.50	0.00	1.00
1(Decreased in 2012)	79,956	0.42	0.49	0.00	1.00
Log(value imports total)	79,956	11.60	5.07	0.00	22.02
Log(value imports USA)	79,956	8.03	5.74	0.00	22.02
Log(value imports AllOther)	79,956	11.09	5.23	0.00	21.23
Perc. value imports USA	79,956	19.10	27.50	0.00	100.00
Perc. value imports AllOther	79,956	68.43	37.03	0.00	100.00
B) Employment Data (4-Digit Industry)					
Δ Import Competition ($\tilde{\tau}$)	4,576	2.34	4.78	0.00	24.10
Δ Foreign Inputs ($\tilde{q}$)	4,576	4.50	4.48	0.00	21.48
1(Ind. Decreased Tariffs)	4,576	0.38	0.49	0.00	1.00
1(Decreased in 2010 and 2012)	4,576	0.34	0.47	0.00	1.00
1(Decreased in 2012)	4,576	0.04	0.20	0.00	1.00
1(Ind. Decreased Input Prices)	4,576	0.90	0.29	0.00	1.00
Number of Workers	4,576	36,025.36	162,065.90	5.00	3,936,561.00
Earnings Premia (HH-Survey)	4,325	0.45	0.52	-1.38	2.76
Earnings Premia Formal (long. data)	4,576	-0.01	0.29	-1.48	1.32
Earnings Premia Formal (HH-Survey)	4,278	0.08	0.45	-2.11	2.54
Earnings Premia Informal (HH-Survey)	4,130	0.50	0.60	-2.13	4.08
Number of Firms	4,576	1,146.32	4,766.26	1.00	97,152.00
Mean Firm Size	4,576	25.79	31.05	1.00	392.49
Employment HH-Survey	4,422	1,794.04	3,779.11	0.00	30,282.53
Formal Employment HH-Survey	4,422	766.60	1,473.93	0.00	13,487.39
Informal mployment HH-Survey	4,422	1,027.45	2,844.04	0.00	24,916.02

Note: This table presents descriptive statistics of the different samples used. Panel A) describes the panel at the product-year level. Panel B) describes the panel at the industry-year level. 1() stands for a dummy variable that takes the value of one if the condition inside parentheses is met.

B. Robustness of Event Study Estimations

In this appendix we address the robustness of the event study estimates displayed in the main text. Figure **??**, in the main paper, plots the estimates of Equation (4.4), where the treatment is binary and both shocks occur at the same time. However, a great deal of the variation in the paper comes by across-industry differences in the magnitudes of the treatment, constituted by a continuous treatment. We address this variation by estimating the following specification:

$$y_{jt} = \sum_{t \neq 2010} \beta_t^c \left[\tilde{\tau}_{j,2018} \times 1(\text{year=t})\right] + \sum_{t \neq 2010} \beta_t^i \left[\tilde{q}_{j,2018} \times 1(\text{year=t})\right] + \mu_j + \mu_t + \varepsilon_{jt}, \tag{B.1}$$

where $\tilde{\tau}_{j,2013}$ corresponds to a time-invariant measure equal to the change in tariffs from 2010 and 2018, and $\tilde{q}_{j,2018}$ corresponds to the time-invariant measure of the decrease in the prices of foreign inputs from 2010 to 2018. Both measures quantify the intensity of tariff reductions throughout the period 2010 to 2018, so we interact them with year dummies, and drop the category for 2010. The results are presented in Appendix Figure B.1. We observe very similar results as those presented in Figure **??**, in the main text.

Recent developments in the differences-in-differences literature suggest that the linear regression estimators could be biased if the treatment is continuous or assigned in different periods of time (Callaway et al., 2021; Callaway and Sant'Anna, 2021; de Chaisemartin and D'Haultfœuille, 2020; Goodman-Bacon, 2021; Sun and Abraham, 2020). Therefore, we use the de Chaisemartin and D'Haultfoeuille (2021) bias-corrected estimator for intertemporal treatment effects. Results are presented in Appendix Figure B.2.

We observe once again very similar patterns as those shown in Figure **??**. Furthermore, these estimates provide a formal test for anticipatory effects and for the existence of pre-trends in the years before the treatment adoption. We do not see any significant point estimates, posing strong evidence about the validity of our research design.

Finally, we present the event studies using our main specification in Equation 4.4, but using the outcomes measured in the different samples. We present the results for employment in Appendix Figure B.3 and for earnings in Appendix Figure B.4. We again observe similar patterns, and no-existence of pre-trends. An exception, however, is the point estimate for 2008 displayed in Figure B.3b for the full sample in the social security records, where we observe a small positive coefficient. The quality of the administrative records is low for this year because compliance was progressive, and some firms were still missing. Therefore, we employ the matching algorithm, detailed in Section **??**, to find a more comparable sample. When we estimate with the matched sample, we do not observe any statistical difference in the pre-treatment period.

FIGURE B.1

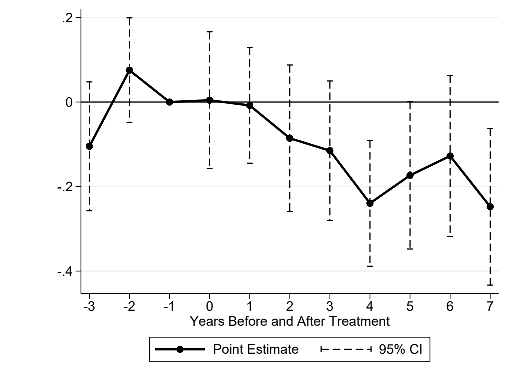
Event Study Estimates using Continuous Treatment

Notes: N = 4,222 for panels (B.1a) and (B.1b), and N = 4,324 in panel (B.1c) and (B.1d). These graphs plot the point estimates and the 95 percent confidence interval of the estimation in equation (B.1) using overall employment (panels A and B) and industry wage premia (panels C and D) as outcomes. We use 2010 as year of reference. Estimations done in the household survey data. Panels (B.1a) and (B.1c) present the coefficients attached to the competition shock $\tilde{\tau}^{c}_{j,2018}$, and panels (B.1b) and (B.1d) the coefficients attached to the input shock $\tilde{\tau}^{c}_{j,2018}$. The estimation includes industry and year fixed effects, and the standard errors are clustered at the industry level.

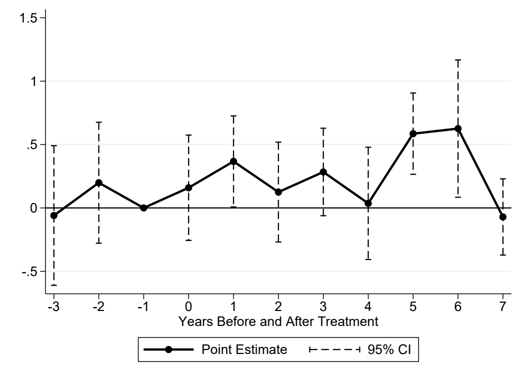
FIGURE B.2

Event Study Estimates using Correction in de Chaisemartin and D'Haultfoeuille (2021)

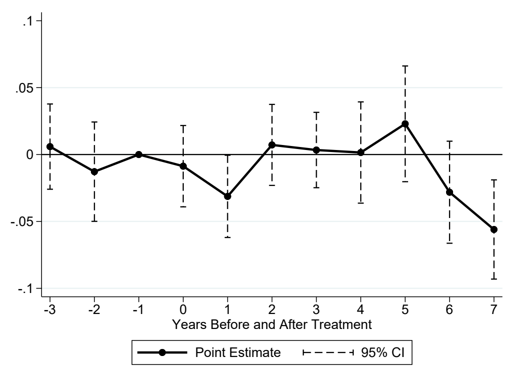
(a) *Competition Shock on Employment*



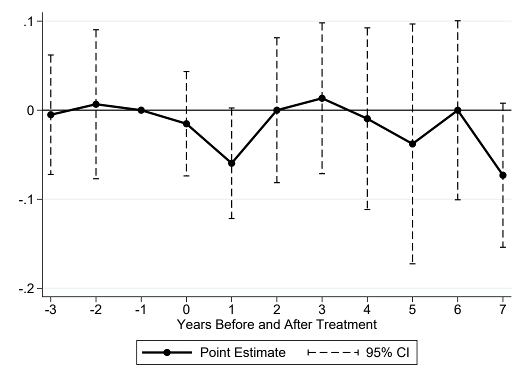
(b) *Input Shock on Employment*



(c) *Competition Shock on Earnings*



(d) *Input Shock on Earnings*

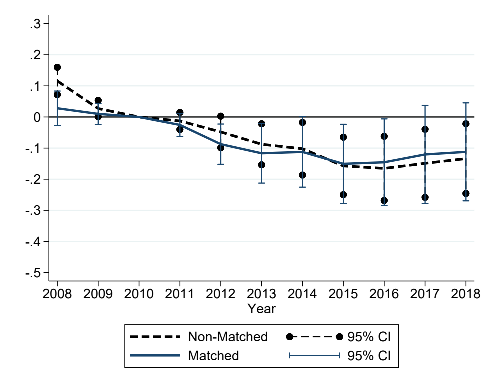


Notes: These graphs plot the point estimates and the 95 percent confidence interval of the estimator suggested in de Chaisemartin and D'Haultfoeuille (2021) for continuous treatments in staggered adoptions. The dependent variable corresponds to the overall employment (panels A and B) and industry wage premia (panels C and D) as outcomes. We use 2010 as year of reference. Estimations done in the household survey data. Panels (B.2a) and (B.2c) present the coefficients attached to the competition shock, and panels (B.2b) and (B.2d) the coefficients attached to the input shock. The estimation includes industry and year fixed effects, and the standard errors are clustered at the industry level.

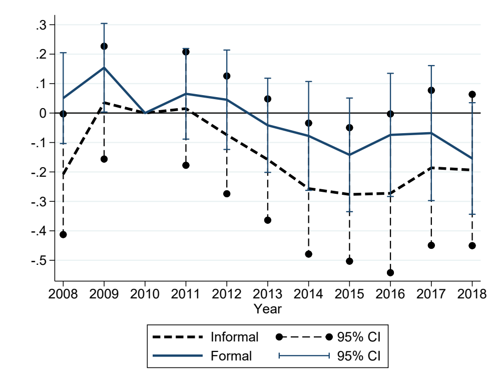
FIGURE B.3

Event Study Estimates of the Competition and Input Shocks on Employment

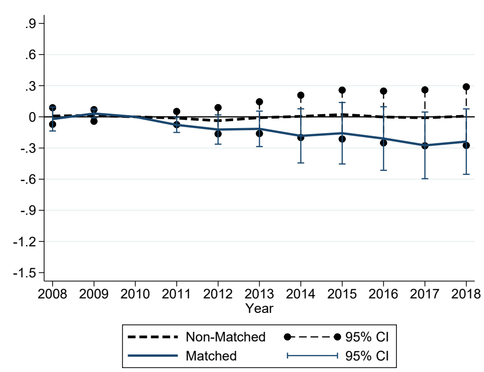
(a) *Competition Shock on Social Security Data*



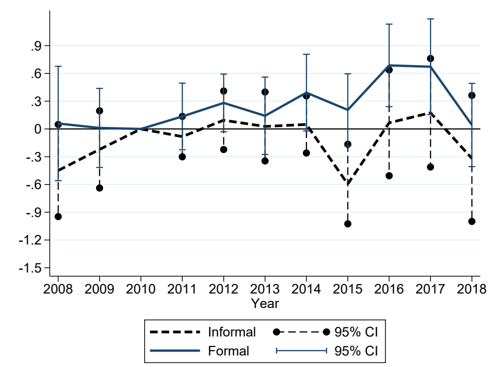
(b) *Competition Shock on HH-Survey*



(c) *Input Shock on Social Security Data*



(d) *Input Shock on HH-Survey*

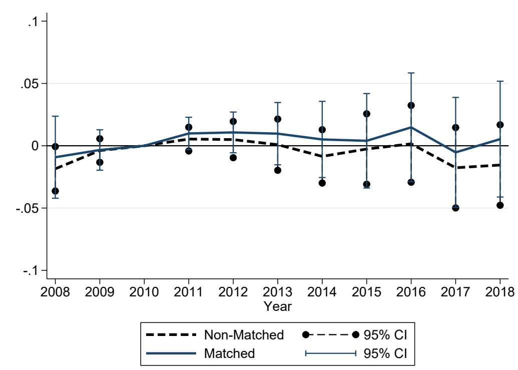


Notes: These graphs plot the point estimates and the 95 percent confidence interval of the estimation in Equation (4.4) using employment in the social security data in Panels B.3a and B.3c, and household survey data in Panels B.3b and B.3d. N = 4,576 in Panels B.3a and B.3c, and N = 4,222 in Panels B.3b and B.3d. Panels B.3a and B.3b present the coefficients attached to the competition shock T_j^c, and Panels B.3c and B.3d the coefficients attached to the input shock T_j^i. The estimation includes industry and year fixed effects, and the standard errors are clustered at the industry level.

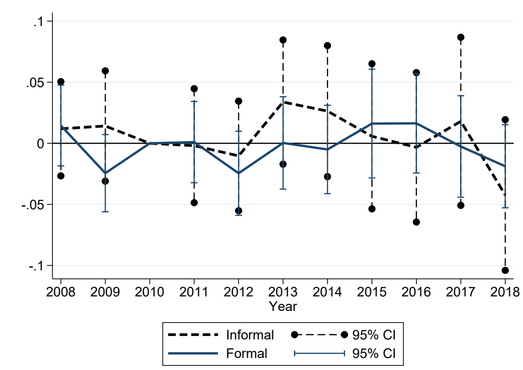
FIGURE B.4

Event Study Estimates of the Competition and Input Shocks on Earnings

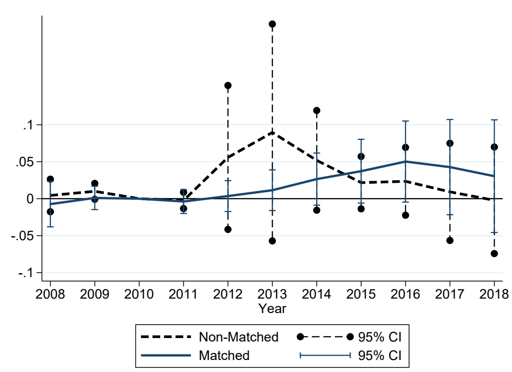
(a) *Competition Shock on Social Security Data*



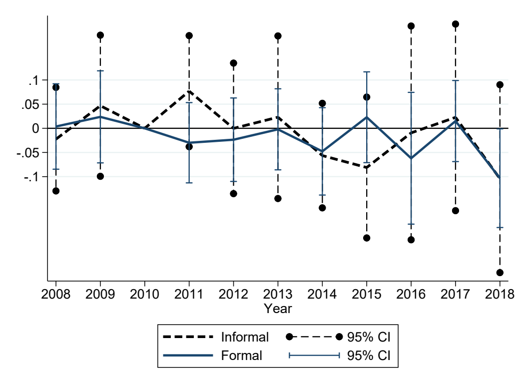
(b) *Competition Shock on HH-Survey*



(c) *Input Shock on Social Security Data*



(d) *Input Shock on HH-Survey*



Notes: These graphs plot the point estimates and the 95 percent confidence interval of the estimation in Equation (4.4) using earnings wage premia in the social security data in Panels B.4a and B.4c, and household survey data in Panels B.4b and B.4d. Industry wage premia computed controlling by age, age-squared, gender, and region and month indicators. Estimations are efficiency weighted by the inverse of the standard error of the estimated industry wage premia. Panels B.4a and B.4b present the coefficients attached to the competition shock T^c_j, and Panels B.4c and B.3d the coefficients attached to the input shock T^i_j. The estimation includes industry and year fixed effects, and the standard errors are clustered at the industry level.

C. Math Appendix

C.1. Algorithm

In this section, we describe the algorithm to solve the model at the baseline and the counterfactuals.

D. Trade Elasticities

TABLE D.1 Results: Trade Elasticities - Industry

VARIABLES	(1) Aggregate	(2) 1-digit	(3) 2-digit
ln (1+t) x Crop Production			4.158**
			(1.724)
ln (1+t) x Animal Production			-0.857
			(8.366)
ln (1+t) x Forestry			5.582
			(6.994)
ln (1+t) x Fishing			18.982***
			(0.256)
ln (1+t) x Foods and bevarages			4.468***
			(0.789)
ln (1+t) x Tobacco			3.711
			(5.646)
ln (1+t) x Textiles			3.616***
			(1.156)
ln (1+t) x Wearing Apparel			1.742*
			(1.017)
ln (1+t) x Wood			2.297
			(1.790)
ln (1+t) x Petroleum			10.571
			(7.918)
ln (1+t) x Chemicals			2.938***
			(0.895)
ln (1+t) x Metal products			-0.333
			(1.190)
ln (1+t) x Office products			2.280*
			(1.211)
ln (1+t) x Vehicles			1.966
			(1.210)
ln (1+t) x Ag		4.614***	
		(1.639)	
ln (1+t) x Manuf		2.992***	
		(0.482)	
ln (1+t)	3.060***		
	(0.476)		
Observations	30,578	30,578	30,578
R-squared	0.777	0.777	0.777

TABLE D.2 Results: Trade Elasticities - State-Industry

VARIABLES	(1) Aggregate	(2) 1-digit	(3) 2-digit
ln (1+t) x Crop Production			2.815***
			(0.913)
ln (1+t) x Animal Production			-10.887
			(9.775)
ln (1+t) x Forestry			5.169
			(4.998)
ln (1+t) x Fishing			18.996***
			(0.310)
ln (1+t) x Foods and bevarages			4.740***
			(1.014)
ln (1+t) x Tobacco			3.416***
			(0.229)
ln (1+t) x Textiles			2.682**
			(1.236)
ln (1+t) x Wearing Apparel			1.695
			(2.075)
ln (1+t) x Wood			3.109*
			(1.578)
ln (1+t) x Petroleum			10.879
			(6.547)
ln (1+t) x Chemicals			1.935***
			(0.563)
ln (1+t) x Metal products			0.345
			(0.727)
ln (1+t) x Office products			0.255
			(0.807)
ln (1+t) x Vehicles			2.018
			(1.673)
ln (1+t) x Ag		3.271***	
		(0.875)	
ln (1+t) x Manuf		2.509***	
		(0.447)	
ln (1+t)	2.531***		
	(0.445)		
Observations	108,743	108,743	108,743
R-squared	0.699	0.699	0.700