The Gains from International and Intranational Trade *

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Abstract

I study the implications of both international and intranational trade for welfare and the distribution of economic activity across sectors and regions within a country, as well as the relative importance of the underlying economic mechanisms, using a quantitative spatial general equilibrium model calibrated to the Brazilian economy. I find that the welfare gains from intranational trade (15.6%) are 4 times as large as those from international trade (3.9%). In the absence of labor migration within the country, the regional welfare gains from intranational trade (7.9%–33.9%) are 2.1 to 29.7 times as large as those from international trade (1%–6.5%). International trade reallocates economic activity from remote and less developed regions toward resource-rich areas, more developed coastal regions, and the free trade zone, without significantly affecting the spatial concentration of economic activity. In contrast, intranational trade induces a considerably larger reallocation, away from the more developed coastal regions, making economic activity more geographically dispersed. The sectoral reallocation associated with intranational trade is substantially smaller than that associated with international trade, and the implications of the two types of trade for the sectoral composition of the economy are markedly different. The extent to which labor can move across regions within the country has dramatic implications for the spatial distribution of the welfare gains from trade, but a small impact on the aggregate welfare effects. Sectoral linkages explain approximately half of the welfare gains and up to half of the spatial reallocation of economic activity associated with trade. The impact of trade on the sectoral composition of the economy depends crucially on how sectors relate to each other.

Keywords: Welfare Gains from Trade, International Trade, Intranational Trade, Quantitative Spatial General Equilibrium Model, Labor Migration, Sectoral Linkages.

JEL Classification Codes: F11, F14, F16, R11, R12, R15.

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1 Introduction

Trade across regions within countries tends to be considerably more prevalent than trade across countries. This is a salient feature of large economies in particular. They usually exhibit small international trade flows relative to their size, while heavily relying on intranational trade. Adam Smith notes in *The Wealth of Nations* that "It is remarkable that neither the ancient Egyptians, nor the Indians, nor the Chinese, encouraged foreign commerce, but seem all to have derived their great opulence from this inland navigation." Nowadays trade across U.S. states accounts for around two-thirds of the economy and is more than twice as large as U.S. international trade (Caliendo et al. 2018). How large are the welfare gains from intranational trade relative to those from international trade? Are the implications of intranational trade for the distribution of economic activity across sectors and regions within countries different from those of international trade?

A vast quantitative international trade literature, reviewed in Costinot and Rodríguez-Clare (2014), studies the welfare gains from international trade, including Eaton and Kortum (2002), Alvarez and Lucas (2007), Chor (2010), Fieler (2011), Arkolakis, Costinot, and Rodríguez-Clare (2012), Costinot, Donaldson, and Komunjer (2012), Caliendo and Parro (2015), and Levchenko and Zhang (2016). But the literature has given substantially less attention to the welfare gains from intranational trade and the effects of trade in general on the internal distribution of economic activity. In this paper, I study the implications of both international and intranational trade for welfare and the distribution of economic activity across sectors and regions within a country, as well as the relative importance of the underlying economic mechanisms, in the context of the Brazilian economy. To that end, I use the quantitative spatial general equilibrium model from Maggi and Haddad (2016). The model closely follows Caliendo et al. (2018), featuring economies with multiple regions and sectors, labor mobility across regions within countries, sectoral linkages, and international and intranational trade. The calibration of the model is based on all 27 Brazilian states, 40 countries, and 28 sectors. It matches trade flows by sector for all pairs of states and countries and, for each state and country, employment, labor compensation, sectoral gross output and value added, and intermediate expenditure for all pairs of sectors.

I find that the welfare gains from intranational trade are 4 times as large as those from international trade: international trade increases welfare by 3.9%, whereas intranational trade increases welfare by 15.6%. In the presence of free labor mobility across regions within the country, the spatial reallocation of economic activity associated with intranational trade is dramatically different from that associated with international trade, in terms of both pattern and magnitude. International trade reallocates economic activity from remote and less developed regions toward areas that are relatively abundant in natural resources, more developed coastal regions, and the free trade zone. This reallocation has a negligible effect on the degree of spatial concentration of economic activity. In contrast, intranational trade leads to a significantly larger reallocation, away from the more developed coastal regions, making economic activity more geographically dispersed. The migration flows that result from intranational trade are approximately an order of magnitude larger than those that result from international trade. In spite of the substantially larger spatial reallocation, the sectoral reallocation associated with intranational trade is considerably smaller than that associated with international trade, and the implications of the two types of trade for the sectoral composition of the economy are markedly different.

In the absence of labor migration, welfare does not necessarily equalize within the country, and the welfare gains from trade are indeed dramatically different across space. In this scenario, although all regions benefit from trade, the regional welfare gains from international trade range from 1% to 6.5%, whereas those from intranational trade range from 7.9% to 33.9%. The regional welfare gains from intranational trade are then 2.1 to 29.7 times as large as those from international trade. Labor migration equalizes welfare across space by allowing workers to move toward the regions that become relatively more attractive. This mechanism reduces the welfare of the regions that experience immigration, while the opposite takes place in the regions that are left behind, essentially through changes in the stock of geographically fixed factors per capita. In contrast, the degree of labor mobility across space has a small impact on the aggregate welfare gains from trade—on the population-weighted average welfare gains from trade across regions within the country. Therefore, the extent to which labor can move across regions within the country has a dramatic effect on the spatial distribution of the welfare gains from trade, but a small impact on the aggregate welfare effects.

Sectoral linkages are central determinants of the welfare gains from trade and play a fundamental role in shaping the sectoral implications of trade. Sectoral linkages explain approximately half of the welfare gains—through the access to cheaper material inputs—and up to half of the spatial reallocation of economic activity associated with both international and intranational trade. Although the strength of these linkages has a negligible effect on the number of workers that switch sectors as a result of trade, the impact of both types of trade on the sectoral composition of the economy depends crucially on how sectors relate to each other. For instance, employment in Mining and Quarrying contracts by 10% as a result of international trade in the presence of sectoral linkages, while it expands by 74% as a result of international trade in the absence of sectoral linkages.

This paper is related to the literature on New Economic Geography synthesized in Fujita, Krugman, and Venables (1999). Most notably, Behrens et al. (2007) study the impact of international and intranational trade costs on welfare and the internal distribution of economic activity in a model with two sectors and two countries which are comprised of two symmetric regions. The complexity of this class of models translates into a literature that usually considers stylized settings that are difficult to take to the data (Redding and Rossi-Hansberg 2017).

More recent research, reviewed in Redding and Rossi-Hansberg (2017), develops rich quantitative models of the spatial distribution of economic activity, including Costinot and Donaldson (2016), Caliendo, Dvorkin, and Parro (2019), Desmet, Nagy, and Rossi-Hansberg (2018), and Monte, Redding, and Rossi-Hansberg (2018). This paper builds on Caliendo et al. (2018) and Maggi and Haddad (2016). Caliendo et al. (2018) study the impact of intranational trade and sectoral linkages in propagating regional and sectoral productivity changes to the rest of the domestic economy, while Maggi and Haddad (2016) examine the implications of the propagation of productivity changes across countries through international trade for welfare and the internal distribution of economic activity. This paper is also closely related to Allen and Arkolakis (2014), Ramondo, Rodríguez-Clare, and Saborío-Rodríguez (2016), Redding (2016), Coşar and Fajgelbaum (2016), and Fajgelbaum and Redding (2018). Allen and Arkolakis (2014) investigate the relationship between geography, trade costs, and the spatial distribution of economic activity. Ramondo, Rodríguez-Clare, and Saborío-Rodríguez (2016) study the implications of intranational trade costs for the aggregate welfare gains from trade, whereas Redding (2016) studies the implications of labor migration for the regional welfare gains from trade. Coşar and Fajgelbaum (2016) consider the effect of international trade on the distribution of sectoral economic activity across regions within countries in the presence of intranational trade costs, and Fajgelbaum and Redding (2018) analyze the relationship between international and intranational trade costs, structural transformation, and development. None of these papers studies the implications of both international and intranational trade for welfare and the distribution of economic activity across sectors and regions within countries, particularly in a framework with multiple sectors and sectoral linkages, and using data on international and intranational trade flows by sector.

This paper is also related to the literature that studies the effects of international trade on the labor market in the context of the Brazilian economy. First, a line of research examines the impact of Brazil's trade liberalization in the early 1990s. Menezes-Filho and Muendler (2011) consider the reallocation of labor across firms and sectors, while Kovak (2013), Dix-Carneiro and Kovak (2017), and Dix-Carneiro and Kovak (2019) investigate the effects on local labor markets. Second, Costa, Garred, and Pessoa (2016) analyze the impact of the China trade shock on local labor markets. This literature, with the exception of Dix-Carneiro (2014), cannot identify the welfare gains from trade; Dix-Carneiro (2014) estimates a structural dynamic equilibrium model of the Brazilian labor market to study trade-induced transitional dynamics. Furthermore, none of these papers studies the implications of intranational trade for the distribution of economic activity across sectors and regions within Brazil.

The remainder of the paper is organized as follows. Section 2 argues that regions within large economies trade considerably more with each other than with other countries, and shows that their trade flows with other regions and countries vary dramatically across space in the context of the Brazilian economy. Section 3 outlines the model that I use to perform the quantitative analysis. Section 4 uses the theoretical model to decompose the welfare gains from trade and shed light on the underlying economic mechanisms at play. Section 5 uses the calibrated model to study the implications of international and intranational trade for welfare and the internal distribution of economic activity across regions and sectors. In addition, it quantifies the relative importance of the underlying economic mechanisms. Section 6 presents the concluding remarks.

2 The Prevalence of International and Intranational Trade

Large economies tend to engage in relatively little international trade. Their international trade flows are usually small relative to the size of their economies. Figure 1 illustrates the negative correlation between the size of the economy and international trade flows as a share of GDP. The smallest and largest economies, Malta and United States, trade 157.9% and 27.8% of their GDP with other countries.[1] Brazil, the eighth largest economy, exhibits the second smallest international trade flows as a share of GDP, 28.1%. International trade then plays a small role in large economies.

The reason behind the relatively little international trade associated with large economies: intranational trade. U.S. international and intranational trade flows in 2007 represented 29% and 67% of GDP (Caliendo et al. 2018), suggesting that U.S. intranational trade is 2.3 times as large as its international trade. Table 1 shows that trade flows within Brazil represent 96% of GDP and are 3.4 times as large as the country's international trade flows. The two cases suggest that regions within large economies trade little with other countries, but considerably with each other.

Table 1: The Prevalence of International and Intranational Trade

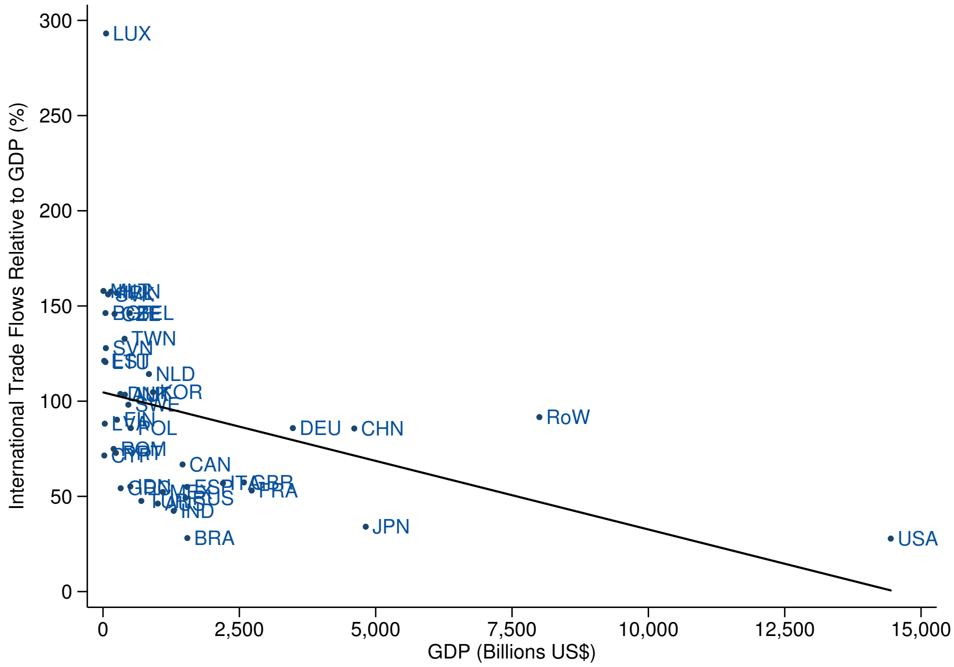
	Exports	Imports	Total
International Trade	14.6	13.5	28.1
Intranational Trade	48.0	48.0	96.0

Note: The table reports Brazilian trade flows as a percentage of GDP. The column Total is the sum of Exports and Imports. The data correspond to the year 2008.

This broad description of the trade structure associated with large economies masks substantial heterogeneity across their regions in terms of the degree of trade integration with other regions and countries.

[1] Figure 13 in Appendix B shows international trade flows as a percentage of GDP.

Figure 1: Market Size and the Prevalence of International Trade



Note: The figure shows the relationship between GDP and international trade flows as a percentage of GDP. International trade flows refers to the sum of exports and imports. Appendix B lists the countries and their corresponding codes. The data correspond to the year 2008.

Figure 2 illustrates the heterogeneity across the Brazilian states.[2] The top panels show regional trade flows with other countries as a percentage of regional GDP (GRP).[3] On the one hand, the states that export the largest shares of their GDP to other countries, Pará, Espírito Santo, and Mato Grosso, are relatively abundant in natural resources and specialize in the production of primary goods.[4] On the other hand, the state that imports the largest share of its GDP from other countries, Amazonas, houses the Manaus Free Trade Zone. The federal government instituted the free trade zone to foster the development of the North.[5] The states along the coast in the Southeast and South also exhibit relatively large trade flows with other countries. These more developed regions concentrate most of the manufacturing industry. In contrast, the remote states in the North and the less developed states in the Northeast trade little with the rest of the world. Therefore, trade flows with other countries vary significantly across regions within the country.

Trade flows within the country are also highly heterogeneous across regions, but present a markedly different spatial pattern. The bottom panels of Figure 2 show intranational trade flows as a percentage of regional GDP.[6] Amazonas trades large shares of its GDP with other states because of the free trade zone it

[2]Brazil is comprised of 26 states and a Federal District. For simplicity I refer to the Federal District as a state throughout the paper.

[3]Figure 14 in Appendix B presents the sum of international exports and imports as a percentage of GRP. Figure 15 in Appendix B shows the regional distribution of international trade flows.

[4]Maggi and Haddad (2016) provide a detailed characterization of the Brazilian economy.

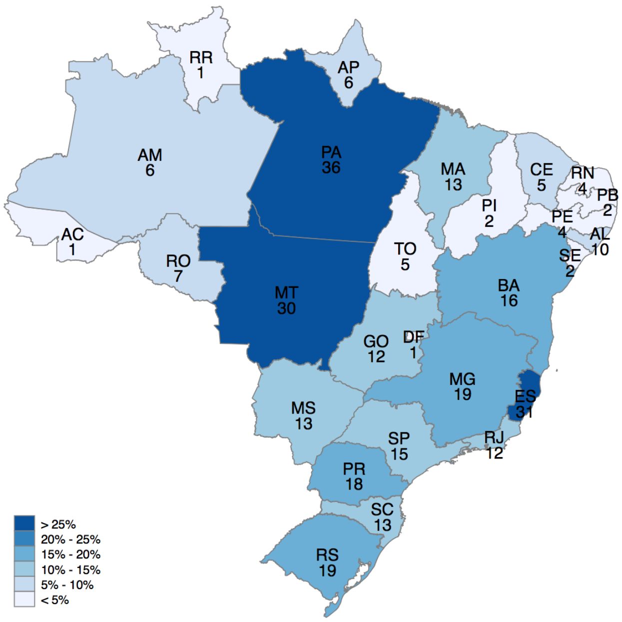
[5]Brazil is usually partitioned into five major regions: North (Rondônia, Acre, Amazonas, Roraima, Pará, and Amapá), Northeast (Maranhão, Piauí, Ceará, Rio Grande do Norte, Paraíba, Pernambuco, Alagoas, Sergipe, and Bahia), Center-West (Mato Grosso, Tocantins, Mato Grosso do Sul, Goiás, and Distrito Federal), Southeast (Minas Gerais, Espírito Santo, Rio de Janeiro, and São Paulo), and South (Paraná, Santa Catarina, and Rio Grande do Sul).

[6]Figure 14 in Appendix B presents the sum of intranational exports and imports as a percentage of GRP. Figure 15 in Appendix B shows the regional distribution of intranational trade flows.

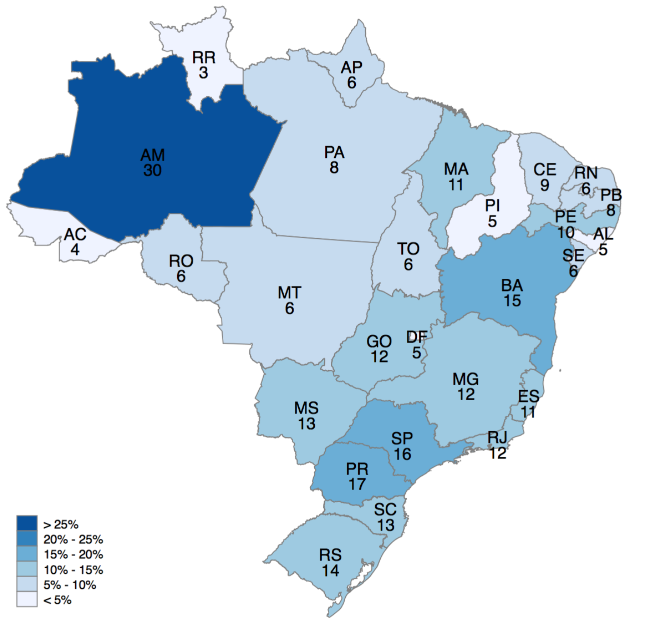
Figure 2: The Regional Prevalence of International and Intranational Trade

International Trade

A: Exports

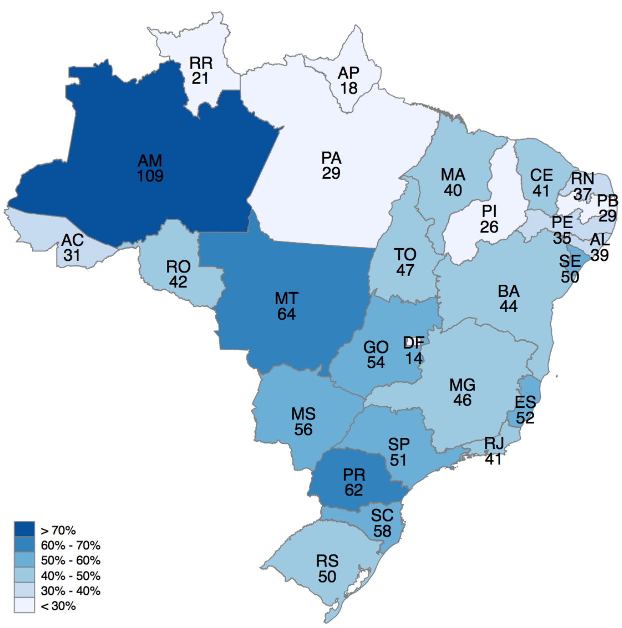


B: Imports

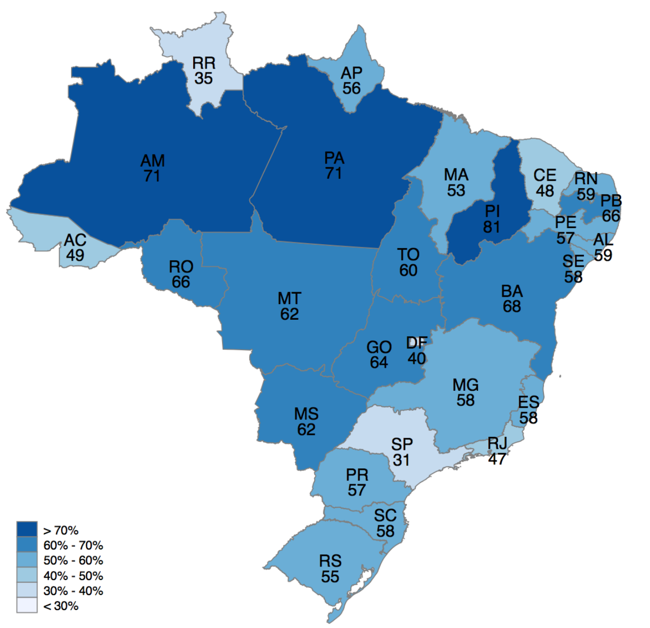


Intranational Trade

C: Exports



D: Imports



Note: The maps show regional trade flows as a percentage of GRP. Appendix B lists the states and their corresponding codes. The data correspond to the year 2008.

contains. So do the more developed states in the Center-West, Southeast, and South, although São Paulo, the largest regional economy, is relatively self-sufficient and imports little from the rest of the country. The states in the North and Northeast exhibit the opposite pattern: they export little, but import considerably from other states. These remote and less developed regions rely heavily on the rest of the country.

In conclusion, regions within large economies trade significantly more with each other than with other countries. Moreover, the extent of their trade integration with other regions and countries varies dramatically across space. The next section introduces the quantitative model that I use to study the implications of international and intranational trade in terms of welfare and the internal distribution of economic activity.

3 The Model

I use the quantitative spatial general equilibrium model from Maggi and Haddad (2016), which closely follows Caliendo et al. (2018). The world economy consists of W countries and J sectors. A country $B \in \{1,...,W\}$ is made up of N^B regions, and there is a total of N regions in the world. A region $n \in \{1,...,N\}$ has two factors of production: labor, L_n, and a composite of local factors, H_n. Labor can freely move across sectors and regions within a country, but not across countries. The total population in country B is L^B. In contrast, local factors are geographically fixed and can only move across sectors within the region. A sector $j \in \{1,...,J\}$ is tradable if its output can be traded across regions and countries; otherwise, it is nontradable.

3.1 Consumption

Workers in region n derive utility U_n from the consumption of final goods from the different sectors. Preferences are Cobb-Douglas with shares α_n^j, such that $\sum_{j=1}^{J} \alpha_n^j = 1$. Income per capita in region n, I_n, is given by $I_n = w_n + (r_n H_n - S_n)/L_n$, where w_n is the wage, r_n is the rental rate of fixed factors, and S_n is the trade surplus. Local governments own the fixed factors and distribute the rents $r_n H_n$ among all local residents. Trade imbalances represent transfers across regions and countries, which are shared among all local residents. They are exogenous throughout the paper.

Free labor mobility within countries implies that workers relocate until welfare is equalized across regions within a country. In equilibrium, workers are indifferent between the various locations within a country, so that $I_n/P_n = U^B$ for all regions n that belong to country B, where $P_n \equiv \prod_{j=1}^{J}(P_n^j/\alpha_n^j)^{\alpha_n^j}$ is the ideal price index in region n, P_n^j is the price of the final good from sector j in region n, and U^B is the utility level within country B.

3.2 Production

The economy produces two types of goods: intermediate and final goods. Intermediate goods are used to produce final goods, and their production adds value in addition to using final goods as material inputs. The productivity of firms that produce intermediate goods in region n and sector j depends on a fundamental productivity T_n^j and an idiosyncratic productivity z_n^j. The fundamental productivity T_n^j is exogenous and affects all firms that produce intermediate goods in this region and sector. The idiosyncratic productivity z_n^j is a random draw from a Fréchet distribution with shape parameter θ^j. Draws are independent across goods, sectors, regions, and countries.

A firm in region n and sector j produces the variety of the intermediate good associated with the idiosyncratic productivity z_n^j according to

$$q_n^j\left(z_n^j\right)=z_n^j\left[T_n^j h_n^j\left(z_n^j\right)^{\beta_n} l_n^j\left(z_n^j\right)^{1-\beta_n}\right]^{\gamma_n^j}\prod_{k=1}^{J} M_n^{jk}\left(z_n^j\right)^{\gamma_n^{jk}}.$$

The production of intermediate goods then requires local factors, $h_n^j\left(z_n^j\right)$, labor, $l_n^j\left(z_n^j\right)$, and material inputs from other sectors, $M_n^{jk}\left(z_n^j\right)$. The parameter β_n represents the share of rents to local factors in value added in region n. The parameter γ_n^j measures the participation of value added in gross output in region n and sector j, while the parameter γ_n^{jk} measures the share of gross output that sector j producers in region n spend on materials from sector k. The technology exhibits constant returns to scale, so that $\gamma_n^j+\sum_{k=1}^{J}\gamma_n^{jk}=1$. The cost of the input bundle needed to produce a variety of an intermediate good in region n and sector j is $x_n^j=F_n^j\left(r_n^{\beta_n}w_n^{1-\beta_n}\right)^{\gamma_n^j}\prod_{k=1}^{J}\left(P_n^k\right)^{\gamma_n^{jk}}$, where F_n^j is a constant. The market for intermediate goods is perfectly competitive; therefore, the price of an intermediate good variety in region n and sector j with idiosyncratic productivity z_n^j is given by its unit cost, $p_n^j\left(z_n^j\right)=x_n^j/\left[z_n^j\left(T_n^j\right)^{\gamma_n^j}\right]$.

Final goods are consumed and used as material inputs in the production of intermediate goods. They are produced by aggregating a continuum of intermediate good varieties from the same sector. Their market is perfectly competitive, with free entry and exit of firms driving profits to zero.

3.3 Trade

Final goods are nontradable, whereas intermediate goods from tradable sectors can be costly traded across regions and countries. Let κ_{ni}^j denote the amount of intermediate goods from sector j that needs to be shipped from region i so that one unit arrives to region n. Then $\kappa_{nn}^j=1$, $\kappa_{ni}^j\geq 1$ for tradable sectors, and $\kappa_{ni}^j=\infty$ for nontradable sectors.

Final good producers in region n and sector j purchase from the cheapest source the intermediate good varieties that they use to produce, considering trade costs in addition to the unit cost in the source region or country. The associated distribution of prices can be derived following Eaton and Kortum (2002). Given the assumptions on the distribution of the idiosyncratic productivity z_n^j, the resulting price index is

$$P_n^j=\Gamma\left(\xi_n^j\right)^{\frac{1}{1-\eta_n^j}}\left[\sum_{i=1}^{N}\left(\kappa_{ni}^j x_i^j\right)^{-\theta^j}\left(T_i^j\right)^{\theta^j\gamma_i^j}\right]^{-1/\theta^j},$$

where $\Gamma\left(\xi_n^j\right)$ is a constant and η_n^j is the elasticity of substitution across intermediate good varieties from sector j in region n. Let π_{ni}^j denote the share that region n spends on intermediate goods from sector j that are produced in region i. Following Eaton and Kortum (2002) and Alvarez and Lucas (2007), the expenditure share can be expressed as

$$\pi_{ni}^j=\frac{\left(\kappa_{ni}^j x_i^j\right)^{-\theta^j}\left(T_i^j\right)^{\gamma_i^j\theta^j}}{\sum_{m=1}^{N}\left(\kappa_{nm}^j x_m^j\right)^{-\theta^j}\left(T_m^j\right)^{\gamma_m^j\theta^j}}.$$

3.4 Market Clearing

Free labor mobility within countries, along with regional and national factor markets clearing and profit maximization by intermediate good producers, implies that the equilibrium distribution of labor across regions within a country is given by

$$L_n = \frac{\left(\frac{\omega_n}{P_n U^B + \frac{S_n}{L_n}}\right)^{1/\beta_n} H_n}{\sum_{i=1}^{N^B} \left(\frac{\omega_i}{P_i U^B + \frac{S_i}{L_i}}\right)^{1/\beta_i} H_i} L^B,$$

where $\omega_n \equiv [w_n / (1-\beta_n)]^{1-\beta_n} (r_n/\beta_n)^{\beta_n}$ is the factor price index in region n.

Equilibrium in the market for final goods requires that the quantity produced in a region and sector must equal the quantity demanded for consumption and used in all sectors as material input in the production of intermediate goods. The condition can be written as

$$X_n^j = \alpha_n^j \left(\omega_n H_n^{\beta_n} L_n^{1-\beta_n} - S_n\right) + \sum_{k=1}^{J} \gamma_n^{kj} \sum_{i=1}^{N} \pi_{in}^k X_i^k,$$

where X_n^j denotes the expenditure in region n on the final good from sector j.

Finally, total expenditure on intermediate goods from all regions and countries, in addition to the transfer made to other regions and countries, must balance total revenue from the sale of intermediate goods to all regions and countries,

$$\sum_{i=1}^{N} \sum_{j=1}^{J} \pi_{ni}^j X_n^j + S_n = \sum_{i=1}^{N} \sum_{j=1}^{J} \pi_{in}^j X_i^j.$$

Subsection A.1 in the Appendix defines the equilibrium in this economy.

4 Trade Costs and Welfare

Section 5 studies the implications of international and intranational trade by increasing the corresponding trade costs to prohibitive levels and therefore shutting down trade. Having outlined the quantitative model in Section 3, this section closely follows Caliendo et al. (2018) to decompose the change in welfare that results from a change in trade costs. The decomposition sheds light on the underlying economic mechanisms at play and is used in Section 5 to quantify the relative importance of the different forces.

Let $\hat{x} \equiv x'/x$ denote the relative change in an arbitrary variable, where x and x' represent the equilibrium levels associated with two different sets of fundamentals in the economy. The effect of a change in trade costs on region n's welfare is determined by the change in real income per capita, $\hat{U}_n = \hat{I}_n/\hat{P}_n$. On the one hand, the change in income per capita is given by the change in the wage, $\hat{I}_n = \hat{w}_n$. On the other hand, the change in the price index is given by the change in the price of the final good from each sector weighted by the sectoral consumption share, $\hat{P}_n = \prod_{j=1}^{J} (\hat{P}_n^j)^{\alpha_n^j}$. Moreover, the change in the price of the final good can be expressed as $\hat{P}_n^j = \hat{x}_n^j / (\hat{\pi}_{nn}^j)^{-1/\theta^j}$, where $\hat{\pi}_{nn}^j$ is the change in the share that region n spends on its own intermediate goods in sector j. The numerator shows that the change in the price of the final good is proportional to the change in the cost of the input bundle needed to produce intermediate goods. The denominator shows that the change in the price of the final good also depends on the change in measured TFP that results from the selection effect. Intuitively, an increase in the cost of transporting intermediate goods from region i to region n in sector j, $\hat{\kappa}_{ni}^j > 1$, usually leads to an increase in region n's production and self-sufficiency in this sector, $\hat{\pi}_{nn}^j > 1$. The varieties of the intermediate good that start being produced locally are associated with relatively low idiosyncratic productivity draws. This decline in measured TFP translates into a higher price of the final good.

The change in welfare can then be written as

$$\ln \hat{U}_n = \sum_{j=1}^{J} \alpha_n^j \left[\ln \left(\hat{\pi}_{nn}^j \right)^{-1/\theta^j} + \ln \left(\frac{\hat{w}_n}{\hat{x}_n^j} \right) \right] \tag{1}$$

and decomposed into two sectoral factors.[7] The first factor, $\ln \left(\hat{\pi}_{nn}^j \right)^{-1/\theta^j}$, captures the selection effect and the corresponding change in measured TFP, which affects welfare through the change in the price index. I refer to this factor as "measured TFP" throughout the paper. The second factor, $\ln \left(\hat{w}_n / \hat{x}_n^j \right)$, captures the change in the wage relative to the other component of the change in the price index—the change in the cost of the input bundle. I refer to this factor as "factor prices" throughout the paper. The change in welfare is given by these two sectoral factors, weighted by the participation of sectors in consumption expenditure.

Trade is the essential mechanism behind the change in measured productivity, whereas sectoral linkages and labor migration are the essential mechanisms behind the change in factor prices. In the absence of sectoral linkages ($\gamma_n^j = 1$ and $\gamma_n^{jk} = 0$ for all j, k, and n) and labor mobility across regions within countries ($\hat{L}_n = 1$ for all n), Equation (1) reduces to

$$\ln \hat{U}_n = \sum_{j=1}^{J} \alpha_n^j \ln \left(\hat{\pi}_{nn}^j \right)^{-1/\theta^j} . \tag{2}$$

In this case, a change in trade costs affects welfare only through the change in measured TFP; the change in factor prices plays no role. The lack of sectoral linkages implies that the change in the price of the final good from each sector has no effect on the cost of the input bundle. The lack of labor migration, together with the presence of constant returns to scale, implies that the wage and the rental rate change proportionally. Therefore, the wage and the cost of the input bundle change proportionally as well, and the change in welfare is determined only by the change in measured TFP. In other words, the change in real income per capita is given exclusively by the change in the price index associated with the selection effect and the corresponding change in measured productivity.

Sectoral linkages affect the change in welfare by propagating sectoral changes in prices to other sectors. The introduction of sectoral linkages transforms Equation (2) into

$$\ln \hat{U}_n = \sum_{j=1}^{J} \alpha_n^j \left[\ln \left(\hat{\pi}_{nn}^j \right)^{-1/\theta^j} + \sum_{k=1}^{J} \gamma_n^{jk} \ln \left(\frac{\hat{w}_n}{\hat{P}_n^k} \right) \right] . \tag{3}$$

In this case, a change in trade costs affects welfare through the change in measured TFP as well as the change in factor prices. But the lack of labor migration reduces the change in the wage relative to the change in the cost of the input bundle to the change in the wage relative to the change in the price of the final good from each sector, weighted by its participation in gross output. Therefore, sectoral linkages affect the welfare gains from trade through the change in the price index—the changes in both measured TFP and factor prices—by spreading sectoral changes in prices to the rest of the sectors.

Labor migration affects the change in welfare by altering the stock of local factors per capita. The introduction of labor migration instead of sectoral linkages transforms Equation (2) into

$$\ln \hat{U}_n = \sum_{j=1}^{J} \alpha_n^j \left[\ln \left(\hat{\pi}_{nn}^j \right)^{-1/\theta^j} - \beta_n \ln \hat{L}_n \right] . \tag{4}$$

[7] This section ignores the trade surplus because I use the counterfactual allocation without trade imbalances as the baseline economy.

In this case, the lack of sectoral linkages reduces the change in the wage relative to the change in the cost of the input bundle to the change in the wage relative to the change in the rental rate. Labor migration implies that the wage and the rental rate do not change proportionally. Intuitively, the regions that become relatively more attractive experience an influx of labor, which strains the stock of local factors, while the opposite takes place in the regions that are left behind. The strength of the mechanism is given by the participation of rents to local factors in value added. Therefore, labor migration affects the welfare gains from trade through the changes in both measured TFP and factor prices by changing the stock of local factors per capita.

5 The Gains from International and Intranational Trade

This section uses the model outlined in Section 3 to study the implications of international and intranational trade in terms of welfare and the distribution of economic activity across regions and sectors in the context of the Brazilian economy. In addition, it assesses the quantitative importance of the underlying economic mechanisms following the decomposition discussed in Section 4.

After expressing the equilibrium conditions in relative changes, as shown in Subsection A.2 in the Appendix, and calibrating the model, as outlined in Appendix B, I first compute the counterfactual allocation without trade imbalances. I use this counterfactual allocation as the baseline economy for the subsequent analysis. Subsection A.3 in the Appendix provides the solution algorithm that I use to perform all counterfactual exercises.

Subsection 5.1 studies the implications of international trade by making international trade costs prohibitive, moving Brazil to autarky. That is, I set $\hat{\kappa}^j_{ni} = \infty$ for all tradable sectors and pairs of locations that involve a Brazilian state and any of the other 40 countries. Instead, Subsection 5.2 studies the implications of intranational trade by making intranational trade costs prohibitive. That is, I set $\hat{\kappa}^j_{ni} = \infty$ for all tradable sectors and pairs of Brazilian states. This counterfactual exercise eliminates intranational trade while international trade still operates, allowing for the substitution of international for intranational trade. Alternatively, Table 2 studies the implications of intranational trade by making intranational trade costs prohibitive, but using the counterfactual allocation without international trade as the initial equilibrium, moving Brazilian states to autarky.

The analysis relies on different versions of the model introduced in Section 3 to assess the quantitative importance of the different economic mechanisms included in the model. First, to quantify the role of labor mobility across regions within countries, I use a version of the model in which labor is also a geographically fixed factor by imposing $\hat{L}_n = 1$ for all regions. Second, to quantify the role of sectoral linkages, I use a version of the model that ignores sectoral linkages by imposing $\gamma^j_n = 1$ and $\gamma^{jk}_n = 0$ for all regions, countries, and sectors. In this case, I first compute the counterfactual allocation that results from suppressing sectoral linkages, and then perform the counterfactual exercises related to the increase in trade costs. I compare the results from these alternative versions of the model with the findings from the model that incorporates all mechanisms to disentangle the quantitative importance of each mechanism.

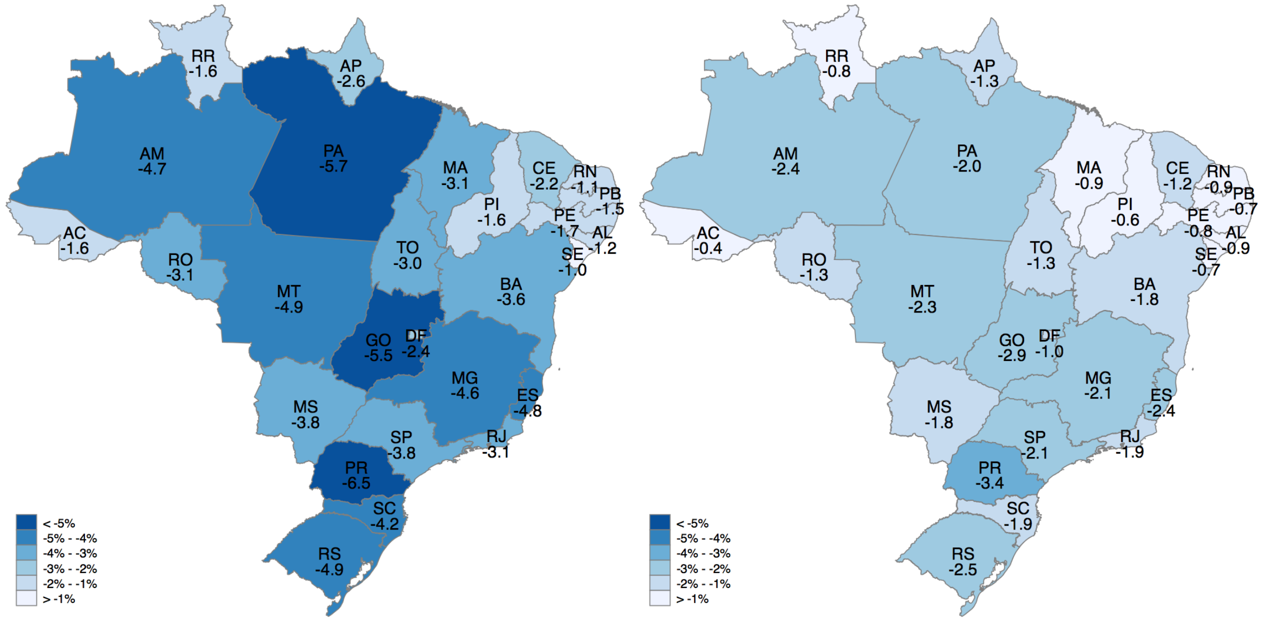
5.1 The Gains from International Trade

This subsection studies the implications of international trade by making international trade costs prohibitive, moving Brazil to autarky. Panel A of Figure 3 shows that, in the absence of labor migration, all states experience welfare losses, although to highly varying degrees.[8] The welfare losses range from 1% in Sergipe to 6.5% in Paraná, and the magnitudes are closely related to the exposure of states to international trade described in Section 2; the correlation between the welfare loss and international trade flows as a percentage of regional GDP is 0.87.[9] While the welfare loss is relatively small in states that trade little with other countries, such as Acre (-1.6%) and Roraima (-1.6%), the states that engage in substantial international trade are significantly affected, such as Espírito Santo (-4.8%) and Pará (-5.7%). Then, eliminating international trade in the absence of labor migration hurts the country overall, particularly the regions that are relatively abundant in natural resources, the more developed areas along the coast, and the free trade zone.

Figure 3: The Gains from International Trade Without Labor Migration

A: With Sectoral Linkages

B: Without Sectoral Linkages



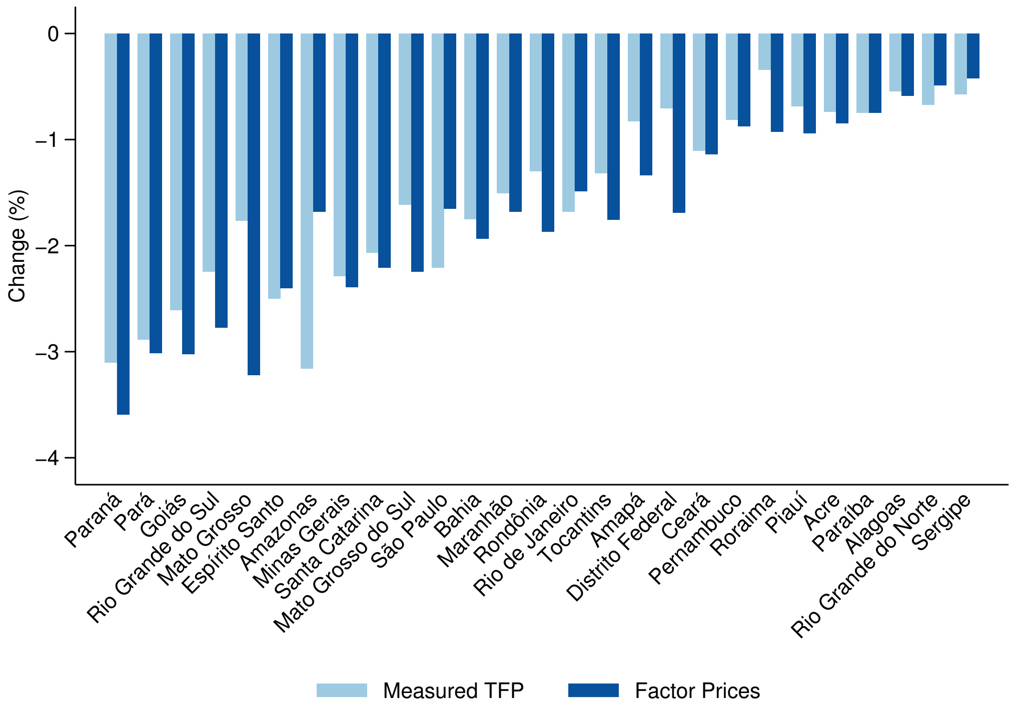
Note: The maps show the percentage change in regional welfare that results from eliminating international trade in the absence of labor migration. Appendix B lists the states and their corresponding codes.

The welfare effects are driven by an increase in self-sufficiency, the associated decline in measured productivity and increase in local prices, and their propagation throughout the economy—the selection effect and sectoral linkages. Figure 4 shows that both changes in measured TFP and factor prices are relevant determinants of the welfare losses, and that their magnitudes tend to be similar. All states experience a decline in measured TFP. Intuitively, states increase their self-sufficiency as international trade costs become prohibitive. The varieties of intermediate goods that start being produced locally are associated with relatively low idiosyncratic productivities, leading to higher domestic prices. For instance, the states that experience the smallest and largest declines in measured TFP are Roraima (-0.3%) and Amazonas (-3.2%), which also exhibit the smallest and largest imports from other countries as a share of regional GDP.

[8]Figure 16 and Figure 17 in Appendix C show the percentage change in welfare that results from eliminating international trade in the single region in this region and the other regions in the absence of labor migration.

[9]Panel A of Figure 18 in Appendix C shows the relationship between international trade flows as a percentage of GRP and the percentage change in regional welfare that results from eliminating international trade in the absence of labor migration.

Figure 4: A Decomposition of the Gains from International Trade Without Labor Migration



Note: The figure decomposes the percentage change in regional welfare that results from eliminating international trade in the absence of labor migration according to Equation (3).

The significant contribution of the changes in factor prices to the welfare losses suggests that sectoral linkages play a fundamental role in the gains from international trade. An increase in the price of the final good in a given sector as a result of the selection effect is propagated to the different sectors in the presence of sectoral linkages. The welfare losses from this mechanism range from 0.4% to 3.6%, and the magnitudes are strongly correlated with the decline in measured TFP. To emphasize this point, Panel B of Figure 3 presents the welfare effects of moving Brazil to autarky in the absence of labor migration and sectoral linkages. In this context, the change in welfare is exclusively given by the change in measured TFP (Equation (2)). The figure shows that the pattern is similar to the one from Panel A (the correlation is 0.94), but that the welfare losses tend to be significantly smaller in the absence of sectoral linkages.[10] The population-weighted average welfare loss is 2.03%, approximately half of the population-weighted average welfare loss in the presence of sectoral linkages (-3.97%).

In light of the welfare disparities across regions within the country, the introduction of labor migration leads to the spatial reallocation of workers presented in Panel A of Figure 5. The migration pattern follows immediately from the welfare effects shown in Panel A of Figure 3 in the absence of labor migration. The states that exhibit relatively large international trade flows undergo the largest employment contractions, whereas the states that trade little with other countries experience the largest employment growth. The regional reallocation of workers has no significant effect on the spatial concentration of economic activity; the normalized Herfindahl index that measures the regional concentration of employment barely increases

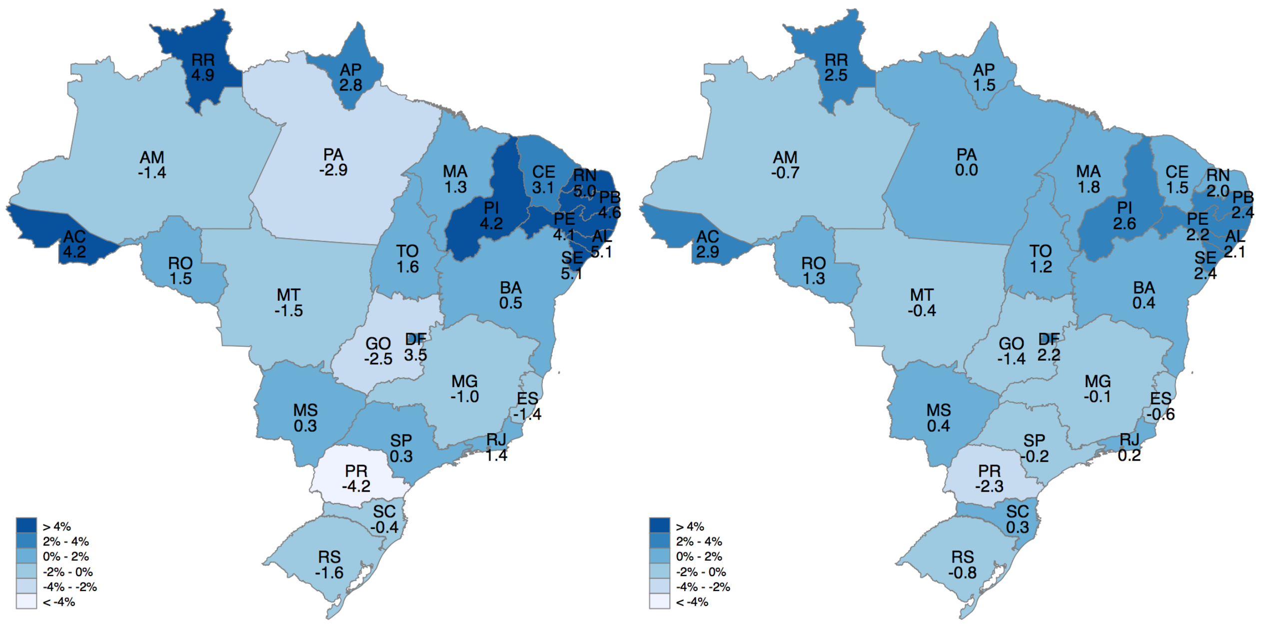
[10]Panel A of Figure 19 in Appendix C shows the relationship between the percentage change in regional welfare that results from eliminating international trade in the absence of labor migration with and without sectoral linkages.

from 0.1022 to 0.1023. Therefore, economic activity shifts from the regions that are relatively abundant in natural resources, the more developed areas along the coast, and the free trade zone, toward the remote and less developed regions, while maintaining its level of spatial concentration. Panel B of Figure 5 shows that the migration pattern in the absence of sectoral linkages is similar, but that the responses tend to be smaller in absolute value. In this context, the spatial reallocation of workers is approximately half of the one that takes place in the presence of sectoral linkages.

Figure 5: International Trade and the Regional Distribution of Employment

A: With Sectoral Linkages

B: Without Sectoral Linkages



Note: The maps show the percentage change in regional employment that results from eliminating international trade in the presence of labor migration. Appendix B lists the states and their corresponding codes.

Shutting down international trade in the presence of labor migration leads to a welfare loss of 3.94%.[11] This result implies that labor migration has a negligible effect on the population-weighted average welfare gains from international trade across regions within the country, as the corresponding welfare loss in the absence of labor migration is 3.97%. The conclusion also holds in the absence of sectoral linkages; in this context, the population-weighted average welfare loss from moving Brazil to autarky decreases only slightly, from 2.03% to 2.02%, with the introduction of labor migration. Then, while labor migration is the key mechanism that equalizes welfare across space, its quantitative relevance as a determinant of the weighted average welfare gains from international trade is negligible. This finding highlights the importance of the presence of local factors as a congestion force to counteract the agglomeration forces included in the model.[12]

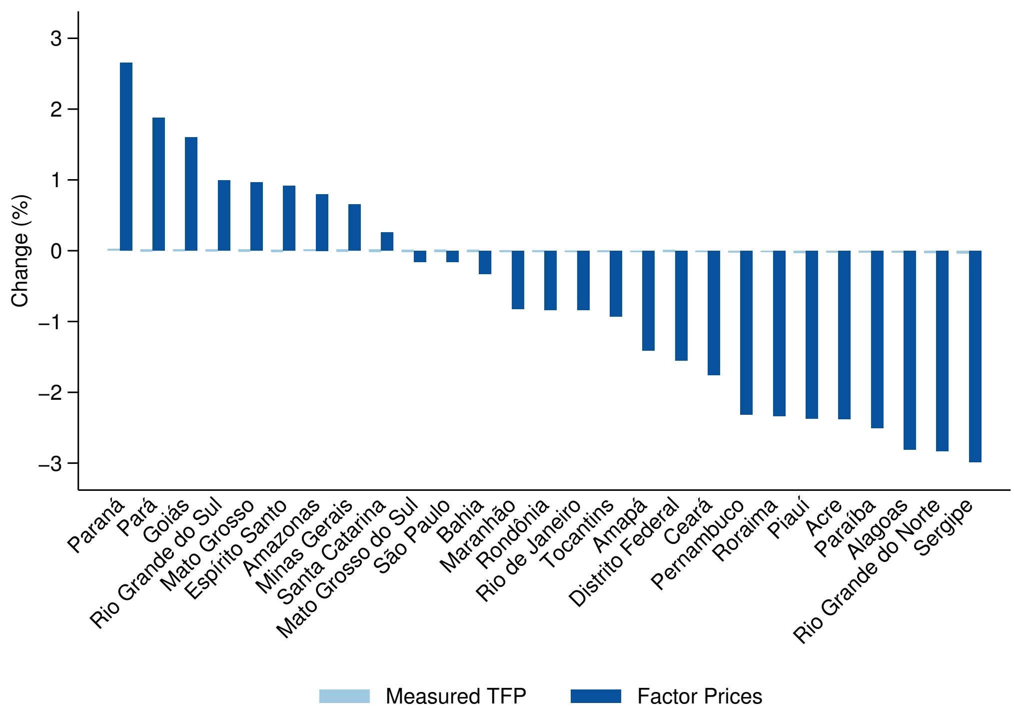
Labor migration affects regional welfare essentially through the change in the stock of local factors per capita; its effect on measured productivity is negligible. Figure 6 shows that the spatial reallocation of labor reduces the welfare of the states that experience immigration, while the opposite takes place in the states

[11] Panel A of Figure 20 in Appendix C shows the percentage change in national welfare that results from eliminating international trade in the single region in the presence of labor migration. Figure 22 in Appendix C shows the percentage change in national welfare that results from eliminating international trade with Brazil.

[12] The inclusion of other centripetal forces, such as externalities, increasing returns, or investment, would lead to larger welfare implications of labor migration, as in Desmet, Nagy, and Rossi-Hansberg (2018).

that are left behind.[13] Both changes in measured TFP and factor prices affect regional welfare in the same direction. For instance, the influx of workers in the states that become relatively more attractive leads to an increase in self-sufficiency as well as a strain on the local factors. The changes in regional welfare are nevertheless almost exclusively explained by the changes in factor prices; the changes in measured TFP range only from -0.04% to 0.02%, whereas the changes in factor prices range from -3% to 2.7%. Therefore, labor migration equalizes welfare across space mainly through adjustments in the stock of local factors per capita rather than changes in measured productivity.

Figure 6: A Decomposition of the Gains from International Trade With Labor Migration



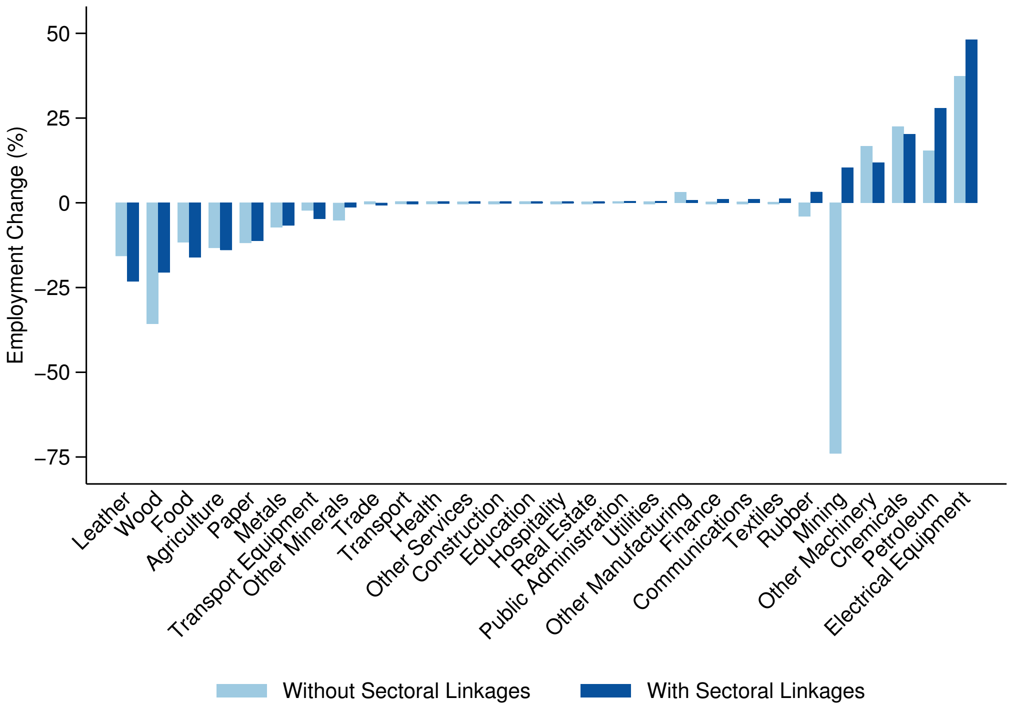
Note: The figure decomposes the percentage change in regional welfare that results from introducing labor migration after eliminating international trade in the absence of labor migration according to Equation (1).

The regional reallocation of economic activity is intimately related to the fate of sectoral economic activity, which is highly unevenly distributed across space. Figure 7 shows that sectors experience a broad range of employment changes, from a contraction of 23% in Leather, Leather Products, and Footwear to an expansion of 48% in Electrical and Optical Equipment. The sectors that undergo the largest responses are all tradable; nontradable sectors experience relatively small changes. The primary sector and light manufacturing contract the most, whereas heavy manufacturing expands the most, revealing Brazil's pattern of comparative advantage. Sectoral linkages play an important role in shaping the sectoral implications of international trade, as the sectoral responses differ substantially in the absence of sectoral linkages. For instance, while employment in Mining and Quarrying grows 10% in the presence of sectoral linkages, it contracts 74% in the absence of sectoral linkages. Intuitively, given that its products are almost exclusively used as material inputs and barely used for final consumption, the collapse of the international demand leads to a strong decline of the sector in

[13] Panel A of Figure 21 in Appendix C decomposes the percentage change in regional welfare that results from eliminating international trade in the presence of labor migration according to Equation (1).

the absence of sectoral linkages; the domestic final demand is relatively small. In spite of their importance in shaping the sectoral effects of international trade, the total number of workers that switch sectors is similar regardless of the strength of the sectoral linkages.

Figure 7: International Trade and the Sectoral Distribution of Employment



Note: The figure shows the percentage change in sectoral employment that results from eliminating international trade in the presence of labor migration. Table 3 in Appendix B lists the sectors and their corresponding abbreviations.

Table 2 summarizes the main findings. All regions gain from international trade, although the welfare gains are unevenly distributed across space in the absence of free labor migration within the country. In this context, the largest gains accrue to the regions that are relatively abundant in natural resources, the more developed regions along the coast, and the free trade zone, which are more integrated into the world market. In contrast, the remote and less developed regions experience relatively small gains. The gains are similarly determined by an increase in measured productivity and the access to cheaper material inputs. Labor migration allows for the reallocation of workers toward the regions that become relatively more attractive, reducing their welfare, while the opposite takes place in the regions that are left behind. This mechanism leads to the equalization of welfare across space essentially through changes in the stock of local factors per capita; its effect on measured productivity and the gains from international trade is negligible. The regional reallocation of workers has a negligible effect on the degree of spatial concentration of economic activity. Overall, welfare increases by 3.9% as a result of international trade. Sectoral linkages explain approximately half of the gains and the spatial reallocation of economic activity. The implications of international trade for the sectoral composition of the economy depend dramatically on the strength of sectoral linkages, although the extent of the sectoral reallocation is independent of these linkages.

Table 2: The Gains from International and Intranational Trade

	Without Labor Migration		With Labor Migration	
	Without Sectoral Linkages	With Sectoral Linkages	Without Sectoral Linkages	With Sectoral Linkages
	Trade Elasticities: Caliendo and Parro (2015)			
International Trade	0.40–3.40 (2.03)	0.99–6.48 (3.97)	2.02	3.94
Intranational With International Trade	3.25–23.74 (8.84)	7.92–33.88 (15.84)	8.68	15.57
Intranational Without International Trade	3.61–31.20 (11.05)	9.54–51.08 (21.22)	10.77	20.52
	Trade Elasticities: Simonovska and Waugh (2014)			
International Trade	0.33–2.79 (1.34)	0.07–9.49 (3.71)	1.33	3.66
Intranational With International Trade	2.99–12.25 (5.93)	9.27–27.68 (14.48)	5.89	14.36
Intranational Without International Trade	3.27–15.02 (6.75)	14.39–38.54 (19.89)	6.68	19.63

Note: The table reports the absolute value of the percentage change in welfare that results from eliminating international and intranational trade. The ranges represent the minimum and maximum regional changes in the absence of labor migration. The numbers in parentheses are population-weighted averages. The top panel uses the trade elasticities from Caliendo and Parro (2015); the bottom panel uses the trade elasticities from Simonovska and Waugh (2014).

5.2 The Gains from Intranational Trade

Having analyzed the implications of international trade by moving Brazil to autarky, this subsection studies the implications of intranational trade by making intranational trade costs prohibitive while international trade still operates.[14] This approach allows for the substitution of international for intranational trade. Alternatively, Table 2 examines the implications of making intranational trade costs prohibitive using the counterfactual allocation without international trade as the baseline economy, moving each state to autarky.

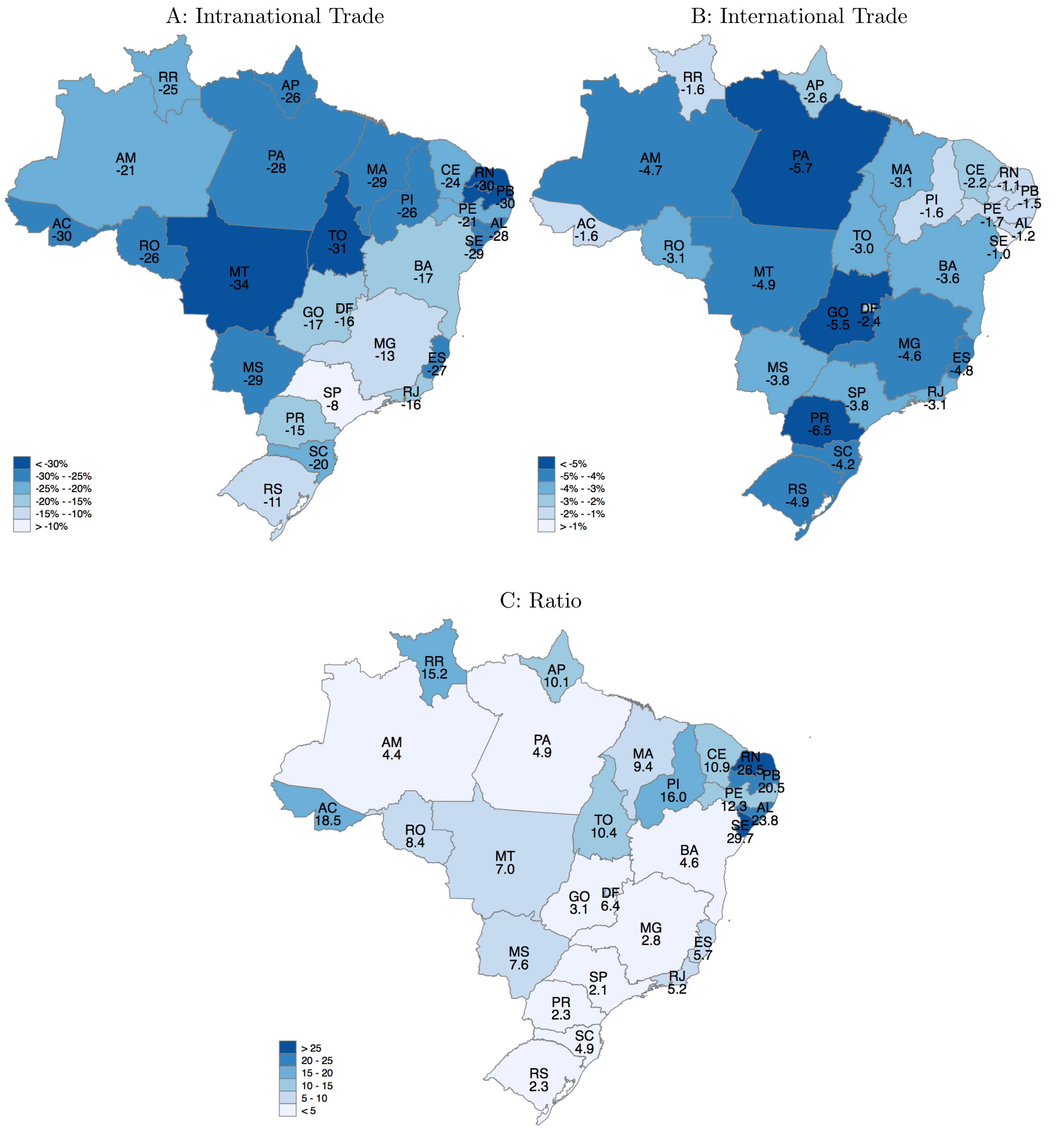
The regional gains from intranational trade are large and highly heterogeneous in the absence of labor migration. Figure 8 shows that all states undergo large welfare losses as intranational trade ceases to operate, ranging from 8% in São Paulo to 34% in Mato Grosso.[15] The remote, less developed, and resource-rich regions experience the largest welfare losses, whereas the more developed coastal areas are subject to relatively small losses.[16] These findings evidence the dramatic differences in the regional welfare implications of international and intranational trade in the absence of labor migration. First, the regional welfare losses that result from eliminating intranational trade are significantly larger than the ones that result from eliminating international trade; the former range from 2.1 to 29.7 times the latter in São Paulo and Sergipe. This finding is consistent

[14] The implications of intranational trade depend on the level of disaggregation of the spatial units. I disaggregate Brazil into its 27 states due to data availability.

[15] Figure 23 in Appendix C shows the percentage change in welfare that results from eliminating intranational trade in the single region in the other regions in the absence of labor migration.

[16] Panel B of Figure 18 in Appendix C shows the relationship between intranational trade flows as a percentage of GRP and the percentage change in regional welfare that results from eliminating intranational trade in the absence of labor migration.

Figure 8: The Gains from Intranational Trade Without Labor Migration



Note: The maps in Panel A and Panel B show the percentage change in regional welfare that results from eliminating trade in the absence of labor migration. The map in Panel C shows the ratio of the percentage change in regional welfare that results from eliminating intranational trade in the absence of labor migration to the percentage change in regional welfare that results from eliminating international trade in the absence of labor migration. Appendix B lists the states and their corresponding codes.

with trade within the country being much more prevalent than trade with other countries (Table 1). Second, the spatial distributions of the welfare losses that result from eliminating international and intranational trade exhibit markedly different patterns; the correlation between the two is -0.4.[17] Eliminating international trade harms particularly the resource-rich regions, the more developed coastal areas, and the free trade zone, while the remote and less developed regions undergo relatively small welfare losses. In contrast, eliminating intranational trade harms these last regions and the resource-rich areas the most, while the more developed coastal regions lose the least. This finding is consistent with the regional prevalence of international and intranational trade (Figure 2). Therefore, the gains from intranational trade are much larger and present a dramatically different spatial distribution than the gains from international trade in the presence of labor migration frictions.

The regional welfare losses are given by a decline in measured productivity and the propagation of the associated increase in prices through sectoral linkages. Figure 9 shows that the reductions in measured TFP due to the increase in self-sufficiency and the selection effect are significantly larger than the ones that result from eliminating international trade (Figure 4) because states are much more integrated with each other than with other countries. The—also significantly larger—changes in factor prices indicate that sectoral linkages exacerbate even more the increase in prices by spreading them throughout sectors, further reducing real income per capita. Panel B of Figure 25 in Appendix C shows that, although the spatial pattern is similar (the correlation is 0.98), the regional welfare losses are notably smaller in the absence of sectoral linkages.[18] The population-weighted average welfare loss, 8.84%, halves with respect to the population-weighted average welfare loss in the presence of sectoral linkages, 15.84%. Then, the selection effect and sectoral linkages are key mechanisms behind the gains from intranational trade, each explaining approximately half of the regional gains in the absence of labor migration.

The heterogeneous regional welfare effects trigger strong migration flows that increase the spatial concentration of economic activity with the introduction of labor migration. Figure 10 shows large migration flows from all over the country toward more developed coastal states, particularly São Paulo. Therefore, the lack of intranational trade leads to a higher spatial concentration of economic activity; the normalized Herfindahl index that measures the regional concentration of employment increases from 0.10 to 0.14. Figure 26 in Appendix C shows that sectoral linkages explain much of the migration. In the absence of sectoral linkages, although the regional pattern is similar, the number of migrants falls by approximately 30%. Overall, the spatial reallocation of workers is dramatically different from the one that results from eliminating international trade, in terms of both pattern and strength of the migration flows. The lack of international trade reallocates economic activity from resource-rich regions, more developed coastal areas, and the free trade zone, toward remote and less developed regions, without significantly affecting the level of spatial concentration. In contrast, the lack of intranational trade triggers a substantially larger reallocation from all over the country toward more developed coastal regions, increasing the spatial concentration of economic activity. The migration flows associated with intranational trade are approximately an order of magnitude larger than the ones associated with international trade.

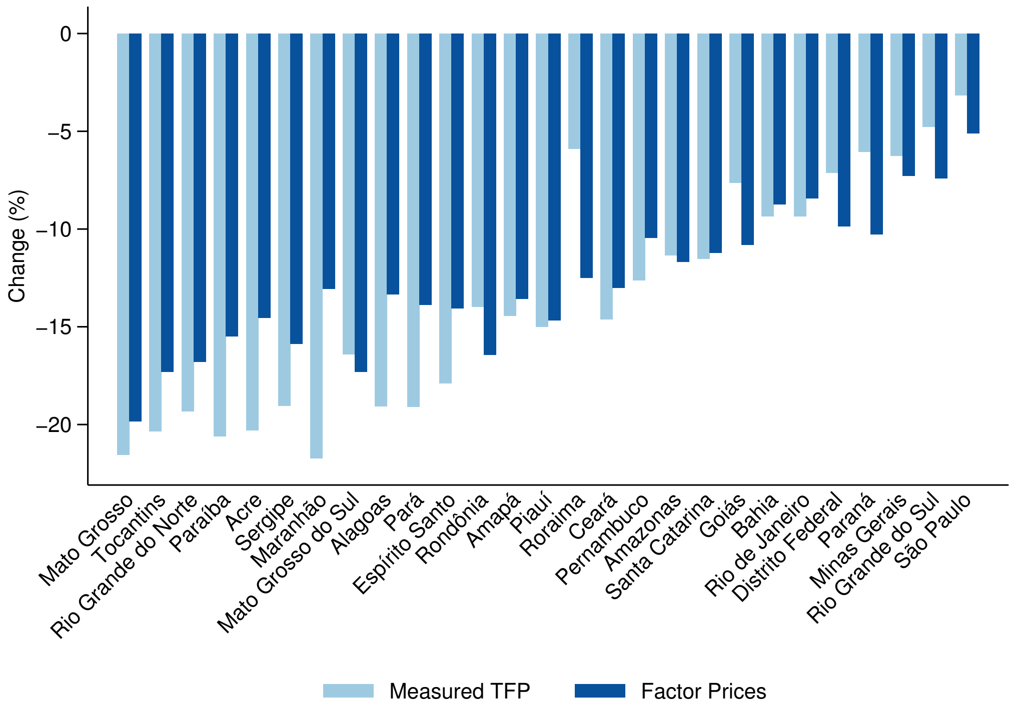
Labor migration equalizes the welfare effects across space without significantly affecting the average gains from intranational trade. The increase in intranational trade costs in the presence of labor migration leads to a common welfare loss of 15.57%.[19] This result has two important implications. First, labor migration has

[17] Figure 24 in Appendix C shows the relationship between the percentage change in regional welfare that results from eliminating international and intranational trade in the absence of labor migration.

[18] Panel B of Figure 19 in Appendix C shows the relationship between the percentage change in regional welfare that results from eliminating intranational trade in the absence of labor migration with and without sectoral linkages.

[19] Panel B of Figure 20 in Appendix C shows the percentage change in national welfare that results from eliminating intra-

Figure 9: A Decomposition of the Gains from Intranational Trade Without Labor Migration



Note: The figure decomposes the percentage change in regional welfare that results from eliminating intranational trade in the absence of labor migration according to Equation (3).

a negligible impact on the population-weighted average welfare loss across regions within the country, as its introduction reduces the population-weighted average welfare loss from 15.84% to just 15.57%. Furthermore, sectoral linkages explain approximately half of the gains from intranational trade; the common welfare loss is 8.68% in the absence of sectoral linkages. Second, and most important, the welfare loss that results from eliminating intranational trade is 3.95 times the one that results from eliminating international trade. Then, the gains from intranational trade are significantly larger than the gains from international trade in the presence of labor migration.

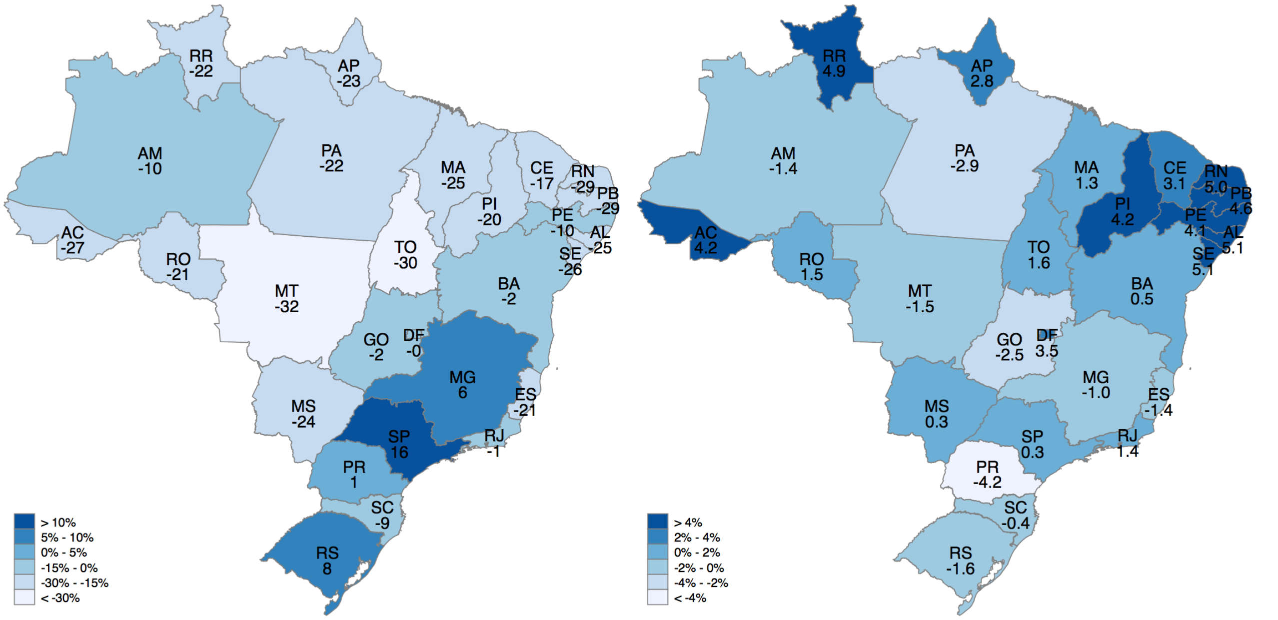
Labor migration eliminates the large welfare differences across space through strong migration flows that significantly alter the regional stock of fixed factors per capita.[20] Figure 11 shows that the four states that experience immigration undergo a welfare loss because of a decrease in measured productivity—through the selection effect—and a reduction in the stock of local factors per capita; the opposite takes place in the states that are left behind. The changes in regional welfare are yet almost exclusively explained by the change in the stock of local factors per capita, which ranges from -8.6% to 24.3%. These changes are substantially larger than the ones that result from introducing labor migration after eliminating international trade, which range from -3% to 2.7% (Figure 6). This difference reflects the much larger adjustment needed in the regional stock of local factors per capita through labor migration to close the considerable welfare gaps across space that emerge from eliminating intranational trade in the absence of labor migration.

national trade in the single region in the presence of labor migration.

[20] Panel B of Figure 21 in Appendix C decomposes the percentage change in regional welfare that results from eliminating intranational trade in the presence of labor migration according to Equation (1).

Figure 10: Intranational Trade and the Regional Distribution of Employment

A: Intranational Trade B: International Trade



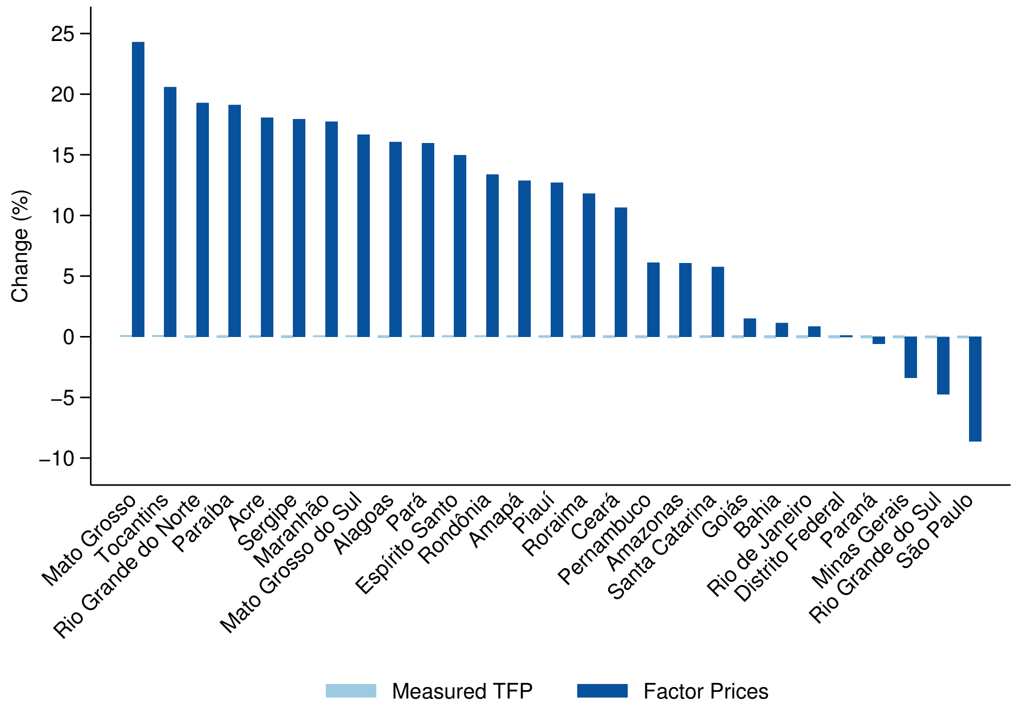
Note: The maps show the percentage change in regional employment that results from eliminating trade in the presence of labor migration. Appendix B lists the states and their corresponding codes.

In spite of the substantially larger spatial reallocation of economic activity associated with intranational trade, the sectoral reallocation is significantly smaller—and compositionally different—than the one associated with international trade. Figure 12 shows that the sectoral employment responses that result from eliminating intranational trade tend to be smaller than the ones that result from eliminating international trade; the number of workers that switch sectors in the first case is only 60% of the number of workers that switch sectors in the second case.[21] In addition, the correlation between the sectoral employment responses associated with international and intranational trade is 0.002, which suggests dramatically different implications of the two types of trade for the sectoral composition of the economy.

Table 2 summarizes the main findings. All regions gain from intranational trade, although to highly varying degrees in the presence of labor migration frictions. In this context, the resource-rich, remote, and less developed regions gain the most, while more developed coastal regions, which exhibit larger and more self-sufficient economies, gain the least. In contrast, these last regions, together with the resource-rich and the free trade zone, are the ones that gain the most from international trade, while the remote and less developed regions gain the least. The regional welfare gains from intranational trade are nevertheless significantly larger than those from international trade; they range from 2.1 to 29.7 times those from international trade in the absence of labor migration. They are similarly determined by an increase in measured productivity and the access to cheaper material inputs. Labor migration closes the welfare gaps across space through adjustments in the regional stock of fixed factors per capita, without significantly affecting the aggregate gains from intranational trade. The larger regional welfare effects associated with intranational trade trigger

[21]Figure 27 in Appendix C shows the percentage change in sectoral employment that results from eliminating intranational trade in the presence of labor migration with and without sectoral linkages. The number of workers that switch sectors is similar regardless of the strength of the sectoral linkages.

Figure 11: A Decomposition of the Gains from Intranational Trade With Labor Migration



Note: The figure decomposes the percentage change in regional welfare that results from introducing labor migration after eliminating intranational trade in the absence of labor migration according to Equation (1).

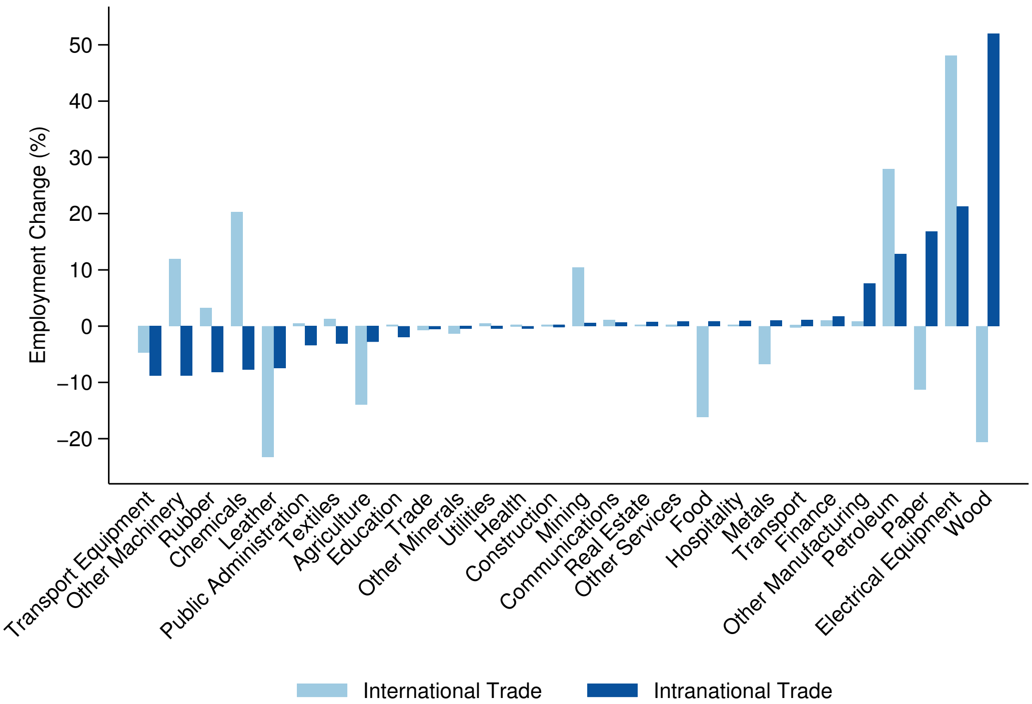
migration flows from more developed coastal regions to all over the country that are substantially larger than those associated with international trade, reducing the spatial concentration of economic activity. In spite of the much larger regional reallocation, the sectoral reallocation is considerably smaller than that associated with international trade, and the implications of the two types of trade for the sectoral composition of the economy are markedly different. Overall, intranational trade leads to a welfare gain of 15.57%, 3.95 times the welfare gain from international trade. Sectoral linkages explain approximately half of the gains and much of the spatial reallocation of economic activity. They are fundamental determinants of the implications of intranational trade for the sectoral composition of the economy, although the extent of the sectoral reallocation is independent of their strength.

6 Conclusions

Trade across regions within countries tends to be more prevalent than trade across countries, particularly in large economies. In this paper, I compare the implications of international and intranational trade for welfare and the distribution of economic activity across sectors and regions within a country, and study the relative importance of the underlying economic mechanisms. To that end, I use a quantitative spatial general equilibrium model calibrated to the Brazilian economy.

I find that the welfare gains from intranational trade (15.6%) are 4 times as large as those from international trade (3.9%). But the gains from trade are highly unevenly distributed across space in the presence

Figure 12: Intranational Trade and the Sectoral Distribution of Employment



Note: The figure shows the percentage change in sectoral employment that results from eliminating trade in the presence of labor migration. Table 3 in Appendix B lists the sectors and their corresponding abbreviations.

of migration frictions within the country: the regional welfare gains from intranational trade (7.9%–33.9%) are 2.1 to 29.7 times as large as those from international trade (1%–6.5%) in the absence of labor migration. These welfare differences across space incentivize labor to move toward the regions that become relatively more attractive. International trade then reallocates economic activity from remote and less developed regions toward regions that are relatively abundant in natural resources, the more developed regions along the coast, and the free trade zone, which are more integrated into the world market, without significantly affecting the degree of spatial concentration of economic activity. In contrast, intranational trade induces a considerably larger reallocation, away from more developed coastal regions, which exhibit larger and more self-sufficient economies, making economic activity more geographically dispersed. These migrations equalize welfare across space by reducing the welfare of the regions that experience immigration, while the opposite takes place in the regions that are left behind, essentially through adjustments in the stock of local factors per capita. In contrast, labor migration has a small impact on the aggregate welfare gains from trade. Therefore, the extent to which labor can move across regions within the country has a dramatic effect on the spatial distribution of the welfare gains from trade, but a small impact on the aggregate welfare effects.

In spite of its substantially larger regional reallocation, the sectoral reallocation associated with intranational trade is considerably smaller than that associated with international trade, and the implications of the two types of trade for the sectoral composition of the economy are markedly different. Sectoral linkages explain approximately half of the welfare gains–through the access to cheaper material inputs–and up to half of the spatial reallocation of economic activity associated with trade. Although these linkages have a negligible effect on the extent of the sectoral reallocation associated with trade, the impact of trade on the sectoral composition of the economy depends crucially on how sectors relate to each other. Then, sectoral linkages are central determinants of the welfare gains from trade and play a fundamental role in shaping the sectoral implications of trade.

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A The Model

This section defines the competitive equilibrium, expresses the equilibrium conditions in relative changes, and outlines the solution algorithm.

A.1 Equilibrium

Given national labor endowments, $\{L^B\}_{B=1}^{W}$, regional fixed factor endowments and trade surpluses, $\{H_n,S_n\}_{n=1}^{N}$, sectoral fundamental productivities for all regions, $\{T_n^j\}_{n=1,j=1}^{N,J}$, and pairwise regional trade costs for all sectors, $\{\kappa_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$, a competitive equilibrium in this economy is given by national utilities, $\{U^B\}_{B=1}^{W}$, regional factor prices, $\{r_n,w_n\}_{n=1}^{N}$, sectoral labor and local factor allocations, final good prices, per capita consumption, and expenditure for all regions, $\{L_n^j,H_n^j,P_n^j,C_n^j,X_n^j\}_{n=1,j=1}^{N,J}$, pairwise regional expenditure shares for all sectors, $\{\pi_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$, and pairwise sectoral material use for all regions, $\{M_n^{jk}\}_{n=1,j=1,k=1}^{N,J,J}$, such that consumers, intermediate good producers, and final good producers optimize, utility is equalized across regions within countries, markets clear, and regional expenditure, together with the trade surplus, equals revenue. The equilibrium can then be characterized by

$$P_n^j = \Gamma\left(\xi_n^j\right)^{\frac{1}{1-\eta_n^j}}\left[\sum_{i=1}^{N}\left(\kappa_{ni}^j x_i^j\right)^{-\theta^j}\left(T_i^j\right)^{\theta^j\gamma_i^j}\right]^{-1/\theta^j} \quad \forall j\in\{1,...,J\},\ \forall n\in\{1,...,N\},$$

$$x_n^j = \tilde{F}_n^j \omega_n^{\gamma_n^j}\prod_{k=1}^{J}\left(P_n^k\right)^{\gamma_n^{jk}} \quad \forall j\in\{1,...,J\},\ \forall n\in\{1,...,N\},$$

$$\pi_{ni}^j = \frac{\left(\kappa_{ni}^j x_i^j\right)^{-\theta^j}\left(T_i^j\right)^{\gamma_i^j\theta^j}}{\sum_{m=1}^{N}\left(\kappa_{nm}^j x_m^j\right)^{-\theta^j}\left(T_m^j\right)^{\gamma_m^j\theta^j}} \quad \forall j\in\{1,...,J\},\ \forall n,i\in\{1,...,N\},$$

$$L_n = \frac{\left(\frac{\omega_n}{P_nU^B+\frac{S_n}{L_n}}\right)^{1/\beta_n}H_n}{\sum_{i=1}^{N^B}\left(\frac{\omega_i}{P_iU^B+\frac{S_i}{L_i}}\right)^{1/\beta_i}H_i}L^B \quad \forall n\in\left\{1,...,N^B\right\},\ \forall B\in\{1,...,W\},$$

$$X_n^j = \alpha_n^j\left(\omega_n H_n^{\beta_n}L_n^{1-\beta_n}-S_n\right)+\sum_{k=1}^{J}\gamma_n^{kj}\sum_{i=1}^{N}\pi_{in}^k X_i^k \quad \forall j\in\{1,...,J\},\ \forall n\in\{1,...,N\},$$

and

$$\omega_n H_n^{\beta_n}L_n^{1-\beta_n} = \sum_{j=1}^{J}\gamma_n^j\sum_{i=1}^{N}\pi_{in}^j X_i^j \quad \forall n\in\{1,...,N\},$$

where $\tilde{F}_n^j \equiv \left(\gamma_n^j\right)^{-\gamma_n^j}\prod_{k=1}^{J}\left(\gamma_n^{jk}\right)^{-\gamma_n^{jk}}$ and $U^B = \sum_{n=1}^{N^B}\frac{L_n}{L^B}\left[\frac{\omega_n}{P_n}\left(\frac{H_n}{L_n}\right)^{\beta_n}-\frac{S_n}{P_nL_n}\right]$.

A.2 Equilibrium Conditions in Relative Changes

To facilitate the calibration of the model, the equilibrium conditions in Subsection A.1 can be expressed in relative changes, following Dekle, Eaton, and Kortum (2008), as

$$\hat{P}_n^j = \left\{ \sum_{i=1}^{N} \pi_{ni}^j \left(\hat{\kappa}_{ni}^j \hat{x}_i^j \right)^{-\theta^j} \left(\hat{T}_i^j \right)^{\gamma_i^j \theta^j} \right\}^{-1/\theta^j} \quad \forall j \in \{1,...,J\}, \forall n \in \{1,...,N\}, \tag{5}$$

$$\hat{x}_n^j = \hat{\omega}_n^{\gamma_n^j} \prod_{k=1}^{J} \left(\hat{P}_n^k \right)^{\gamma_n^{jk}} \quad \forall j \in \{1,...,J\}, \forall n \in \{1,...,N\}, \tag{6}$$

$$\pi_{ni}^{j\prime} = \pi_{ni}^j \left(\frac{\hat{P}_n^j}{\hat{\kappa}_{ni}^j \hat{x}_i^j} \right)^{\theta^j} \left(\hat{T}_i^j \right)^{\gamma_i^j \theta^j} \quad \forall j \in \{1,...,J\}, \forall n,i \in \{1,...,N\}, \tag{7}$$

$$\hat{L}_n = \frac{\left(\frac{\hat{\omega}_n}{\varphi_n \hat{P}_n \hat{U}^B + (1-\varphi_n) \frac{\hat{S}_n}{\hat{L}_n}} \right)^{1/\beta_n}}{\sum_{i=1}^{N^B} L_i \left(\frac{\hat{\omega}_i}{\varphi_i \hat{P}_i \hat{U}^B + (1-\varphi_i) \frac{\hat{S}_i}{\hat{L}_i}} \right)^{1/\beta_i}} L^B \quad \forall n \in \left\{1,...,N^B\right\}, \forall B \in \{1,...,W\}, \tag{8}$$

$$X_n^{j\prime} = \alpha_n^j \left[\hat{\omega}_n \hat{L}_n^{1-\beta_n} \left(I_n L_n + S_n \right) - S_n^{\prime} \right] + \sum_{k=1}^{J} \gamma_n^{kj} \sum_{i=1}^{N} \pi_{in}^{k\prime} X_n^{k\prime} \quad \forall j \in \{1,...,J\}, \forall n \in \{1,...,N\}, \tag{9}$$

and

$$\hat{\omega}_n \hat{L}_n^{1-\beta_n} \left(I_n L_n + S_n \right) = \sum_{j=1}^{J} \gamma_n^j \sum_{i=1}^{N} \pi_{in}^{j\prime} X_i^{j\prime} \quad \forall n \in \{1,...,N\}, \tag{10}$$

where $\varphi_n \equiv \frac{1}{1+\frac{S_n}{I_n L_n}}$, $\hat{P}_n \equiv \prod_{j=1}^J \left(\hat{P}_n^j \right)^{\alpha_n^j}$, and $\hat{U}^B = \sum_{n=1}^{N^B} \frac{L_n}{L^B} \left(\frac{1}{\varphi_n} \frac{\hat{\omega}_n \hat{L}_n^{1-\beta_n}}{\hat{P}_n} - \frac{1-\varphi_n}{\varphi_n} \frac{\hat{S}_n}{\hat{P}_n} \right)$.

This system of $2N + 3NJ + N^2 J$ equations can be used to compute the relative change in the equilibrium allocations $\{\hat{\omega}_n, \hat{L}_n, \hat{P}_n^j, \hat{X}_n^j, \hat{\pi}_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$ that follow from a relative change in the exogenous variables $\{\hat{S}_n, \hat{T}_n^j, \hat{\kappa}_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$. To that end, the model requires the parameters $\{\beta_n, \theta^j, \alpha_n^j, \gamma_n^j, \gamma_n^{jk}\}_{n=1,j=1,k=1}^{N,J,J}$ and the variables $\{I_n, L_n, S_n, \pi_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$.

A.3 Solution Algorithm

The algorithm to solve the model expressed in relative changes is as follows. Given the parameters $\{\beta_n, \theta^j, \alpha_n^j, \gamma_n^j, \gamma_n^{jk}\}_{n=1,j=1,k=1}^{N,J,J}$, the variables $\{I_n, L_n, S_n, \pi_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$, the relative change in the exogenous variables $\{\hat{S}_n, \hat{T}_n^j, \hat{\kappa}_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$, and an initial guess $\{\hat{\omega}_n^\circ\}_{n=1}^N$ denoted by $\hat{\omega}^\circ$,

1. Solve for $\{\hat{P}_n^j(\hat{\omega}^\circ), \hat{x}_n^j(\hat{\omega}^\circ)\}_{n=1,j=1}^{N,J}$ from Equation (5) and Equation (6).
2. Compute $\{\pi_{ni}^{j\prime}(\hat{\omega}^\circ)\}_{n=1,i=1,j=1}^{N,N,J}$ from Equation (7) consistent with $\{\hat{P}_n^j(\hat{\omega}^\circ), \hat{x}_n^j(\hat{\omega}^\circ)\}_{n=1,j=1}^{N,J}$.
3. Solve for $\{\hat{L}_n(\hat{\omega}^\circ)\}_{n=1}^N$ from Equation (8) consistent with $\{\hat{P}_n^j(\hat{\omega}^\circ)\}_{n=1,j=1}^{N,J}$.
4. Solve for $\{X_n^{j\prime}(\hat{\omega}^\circ)\}_{n=1,j=1}^{N,J}$ from Equation (9) consistent with $\{\pi_{ni}^{j\prime}(\hat{\omega}^\circ)\}_{n=1,i=1,j=1}^{N,N,J}$ and $\{\hat{L}_n(\hat{\omega}^\circ)\}_{n=1}^N$.
5. Obtain a new guess $\hat{\omega}^\star$ from Equation (10) such that

$$\hat{\omega}_n^\star = \frac{\sum_{j=1}^J \gamma_n^j \sum_{i=1}^N \pi_{in}^{j\prime}(\hat{\omega}^\circ) X_i^{j\prime}(\hat{\omega}^\circ)}{\hat{L}_n(\hat{\omega}^\circ)^{1-\beta_n} \left(I_n L_n + S_n \right)}.$$

6. Repeat the previous steps until $\|\hat{\omega}^{\star} - \hat{\omega}^{\circ}\| < \varepsilon$.

B Data and Calibration

This section presents the data sources and outlines the calibration procedure. The calibration of the model expressed in relative changes requires data on the parameters $\{\beta_n,\theta^j,\alpha_n^j,\gamma_n^j,\gamma_n^{jk}\}_{n=1,j=1,k=1}^{N,J,J}$ and the variables $\{I_n,L_n,S_n,\pi_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$. I use the data from Maggi and Haddad (2016), which cover 41 countries, 27 regions, and 28 sectors. The countries and their corresponding codes are Australia (AUS), Austria (AUT), Belgium (BEL), Bulgaria (BGR), Brazil (BRA), Canada (CAN), China (CHN), Cyprus (CYP), Czech Republic (CZE), Germany (DEU), Denmark (DNK), Spain (ESP), Estonia (EST), Finland (FIN), France (FRA), United Kingdom (GBR), Greece (GRC), Hungary (HUN), Indonesia (IDN), India (IND), Ireland (IRL), Italy (ITA), Japan (JPN), South Korea (KOR), Lithuania (LTU), Luxembourg (LUX), Latvia (LVA), Mexico (MEX), Malta (MLT), Netherlands (NLD), Poland (POL), Portugal (PRT), Romania (ROM), Russia (RUS), Slovak Republic (SVK), Slovenia (SVN), Sweden (SWE), Turkey (TUR), Taiwan (TWN), United States (USA), and Rest of the World (ROW).

Brazil is the only country which I disaggregate into regions—the 27 Brazilian states. The Brazilian states and their corresponding codes are Acre (AC), Amapá (AP), Amazonas (AM), Pará (PA), Rondônia (RO), Roraima (RR), Tocantins (TO), Alagoas (AL), Bahia (BA), Ceará (CE), Maranhão (MA), Paraíba (PB), Pernambuco (PE), Piauí (PI), Sergipe (SE), Rio Grande do Norte (RN), Distrito Federal (DF), Goiás (GO), Mato Grosso (MT), Mato Grosso do Sul (MS), Espírito Santo (ES), Minas Gerais (MG), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR), Santa Catarina (SC), and Rio Grande do Sul (RS).

Table 3 lists the sectors and their corresponding codes and abbreviations. Sectors c1 through c16 are tradable, whereas sectors c17 through c28 are nontradable.

The share that region n spends on intermediate goods from region i in sector j, $\{\pi_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$, is computed using trade flows from region i to region n in sector j, $\{X_{ni}^j\}_{n=1,i=1,j=1}^{N,N,J}$, such that $\pi_{ni}^j = X_{ni}^j/\sum_{m=1}^N X_{nm}^j$. The same data are used to compute the trade surplus in region n, $\{S_n\}_{n=1}^N$. Trade flows for all countries, Brazilian states, and sectors are from Dietzenbacher, Guilhoto, and Imori (2013). They combine the World Input-Output Table (WIOT) from the *World Input-Output Database* (WIOD) *Project* (Dietzenbacher et al. 2013), which includes Brazil as one of its countries, with the Inter-Regional Input-Output Table (IRIOT) for Brazil from Guilhoto et al. (2010). Guilhoto et al. (2010) use Regional Accounts from the *Instituto Brasileiro de Geografia e Estadística* (IBGE) to estimate state-level total demand and supply for all sectors, and combine cross-industry location quotients and RAS methods to generate the interstate sectoral trade matrices. Gonçalves (2018) shows that the correlation between the estimated interstate trade flows from Guilhoto et al. (2010) and tax-based interstate trade data from the *Conselho Nacional de Política Fazendária* (CONFAZ) is 0.9855 for the manufacturing sectors. Dietzenbacher, Guilhoto, and Imori (2013) follow Guilhoto et al. (2010) to estimate interstate sectoral trade flows, using the tax-based interstate trade data from the CONFAZ as anchors for the manufacturing sectors. Sectoral trade flows between the Brazilian states and the other countries are from the *Ministério do Desenvolvimento, Indústria e Comércio Exterior*'s *Análise de Informações de Comércio Exterior-Web* (ALICEWeb). The data correspond to the year 2008 in all cases.

The dataset presents small trade flows in sectors that I define as nontradable. I eliminate these trade flows by imposing prohibitive trade costs when I eliminate trade imbalances. Ninety-two cases out of 125,692 (0.07%) present small negative trade flows due to changes in inventories. The Rest of the World is the destination country in 66 of them (72%). They span 18 different sectors and 72 of them (78%) involve tradable sectors. I replace the small negative trade flows with zeros.

Employment in region n, $\{L_n\}_{n=1}^N$, is directly observed from the data. Employment for all countries

Table 3: List of Sectors

Code	Name	Abbreviation	Trade Elasticity
c1	Agriculture, Hunting, Forestry, and Fishing	Agriculture	8.11
c2	Mining and Quarrying	Mining	15.72
c3	Food, Beverages, and Tobacco	Food	2.55
c4	Textiles and Textile Products	Textiles	5.56
c5	Leather, Leather Products, and Footwear	Leather	5.56
c6	Wood and Products of Wood and Cork	Wood	10.83
c7	Pulp, Paper, Paper Products, Printing, and Publishing	Paper	9.07
c8	Coke, Refined Petroleum, and Nuclear Fuel	Petroleum	51.08
c9	Chemicals and Chemical Products	Chemicals	4.75
c10	Rubber and Plastics	Rubber	1.66
c11	Other Non-Metallic Minerals	Other Minerals	2.76
c12	Basic Metals and Fabricated Metal	Metals	6.78
c13	Other Machinery	Other Machinery	1.52
c14	Electrical and Optical Equipment	Electrical Equipment	9.63
c15	Transport Equipment	Transport Equipment	1.01
c16	Other Manufacturing and Recycling	Other Manufacturing	5.00
c17	Electricity, Gas, and Water Supply	Utilities	4.55
c18	Construction	Construction	4.55
c19	Wholesale and Retail Trade	Trade	4.55
c20	Hotels and Restaurants	Hospitality	4.55
c21	Transport	Transport	4.55
c22	Post and Telecommunications, and Other Business Activities	Communications	4.55
c23	Financial Intermediation	Finance	4.55
c24	Real Estate Activities	Real Estate	4.55
c25	Public Administration and Defence, and Compulsory Social Security	Public Administration	4.55
c26	Education	Education	4.55
c27	Health and Social Work	Health	4.55
c28	Other Community, Social, and Personal Services, and Private Households with Employed Persons	Other Services	4.55

is from the World Bank's *World Development Indicators* (WDI). The estimate for Brazil is disaggregated using state-level employment from IBGE's *Pesquisa Nacional por Amostra de Domicílios* (PNAD). Income per capita in region n, $\{I_n\}_{n=1}^{N}$, is calculated as $I_n = (VA_n - S_n)/L_n$, where $\{VA_n\}_{n=1}^{N}$ represents value added in region n, which is directly observed from the data. Gross output and value added for all countries, Brazilian states, and sectors are from Dietzenbacher, Guilhoto, and Imori (2013).

In terms of the parameters of the model, the share of labor compensation in value added in region n, $\{1-\beta_n\}_{n=1}^{N}$, and the share of value added in gross output in region n and sector j, $\{\gamma_n^j\}_{n=1,j=1}^{N,J}$, are computed using labor compensation in region n, $\{w_n L_n\}_{n=1}^{N}$, value added in region n and sector j, $\{VA_n^j\}_{n=1,j=1}^{N,J}$, and gross output in region n and sector j, $\{Y_n^j\}_{n=1,j=1}^{N,J}$. In particular, $1-\beta_n = (w_n L_n)/VA_n$ and $\gamma_n^j = VA_n^j/Y_n^j$. The share of payments to labor in value added for all countries is from the *Global Trade Analysis Project* (GTAP) database for the year 2007. The estimate for Brazil is disaggregated using state-level shares of payments to labor in value added from Guilhoto et al. (2010) for the year 2008. Luxembourg presents small negative gross output and value added in Coke, Refined Petroleum, and Nuclear Fuel; I replace them with zeros. Because Luxembourg presents zero gross output in Leather, Leather Products, and Footwear and Coke, Refined Petroleum, and Nuclear Fuel, I use the median share of value added in gross output across the rest of the countries in each of these two sectors as the share of value added in gross output in Luxembourg in the corresponding sector.

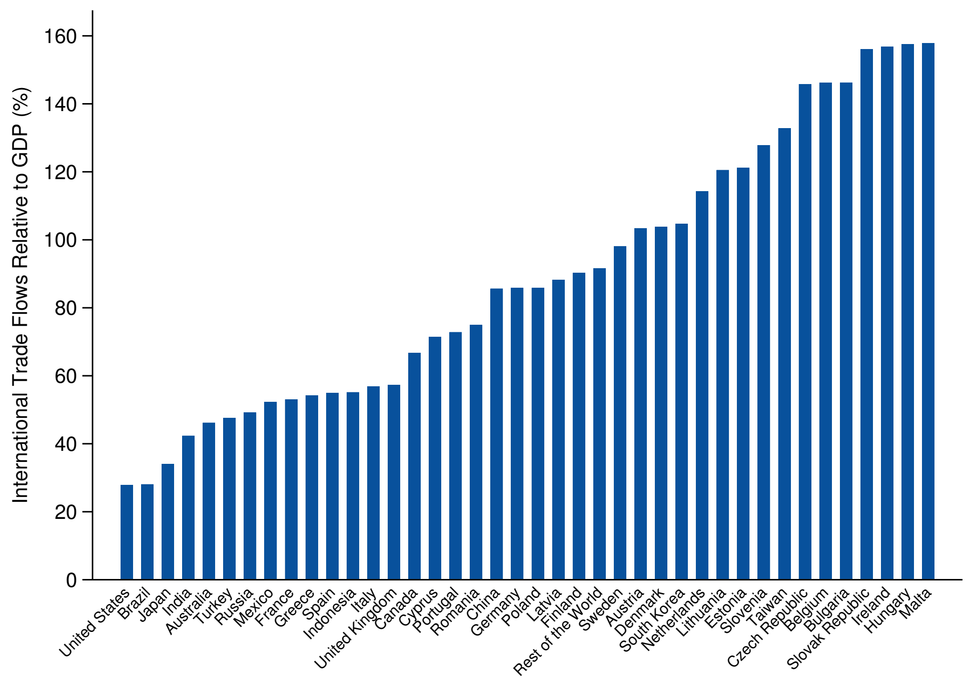
The share of gross output that sector j producers spend on materials from sector k in region n, $\{\gamma_n^{jk}\}_{n=1,j=1,k=1}^{N,J,J}$, is computed from the Input-Output Tables using the expenditure of sector j on materials from sector k in region n, $\{M_n^{jk}\}_{n=1,j=1,k=1}^{N,J,J}$, such that $\gamma_n^{jk} = M_n^{jk}/Y_n^j$. Input-Output Tables for all countries and Brazilian states are from Dietzenbacher, Guilhoto, and Imori (2013) for the year 2008. Because Luxembourg presents zero gross output in Leather, Leather Products, and Footwear and Coke, Refined Petroleum, and Nuclear Fuel, I use the median participation of materials from the different sectors in gross output across the rest of the countries in each of these two sectors as the participation of materials from the different sectors in gross output in Luxembourg in the corresponding sector. I rescale them so that $\sum_{k=1}^{J} \gamma_n^{jk} = 1 - \gamma_n^j$.

The participation of sector j in final consumption expenditure in region n, $\{\alpha_n^j\}_{n=1,j=1}^{N,J}$, is computed from the Input-Output Tables using the final demand estimates. Ten cases out of 1,876 (0.5%) present small negative consumption shares due to changes in inventories. Most of the cases occur in Mining and Quarrying and Basic Metals and Fabricated Metal, whose participation in total final demand is usually close to zero. I replace the small negative consumption shares with zeros.

The trade elasticity in sector j, $\{\theta^j\}_{j=1}^{J}$, is from Caliendo and Parro (2015).[22] Table 3 presents the sectoral estimates. Caliendo and Parro (2015) aggregate Textiles and Textile Products and Leather, Leather Products, and Footwear; I use their estimate for both sectors. They disaggregate Basic Metals and Fabricated Metal into two different sectors; I use their data to estimate the trade elasticity for the aggregated sector following their methodology. They disaggregate Electrical and Optical Equipment into two different sectors; I use their data to estimate the trade elasticity for the aggregated sector. I use the aggregate trade elasticity from Caliendo and Parro (2015) as the trade elasticity for nontradable sectors, although it operates only when I eliminate the small trade flows in the sectors that I define as nontradable.

[22] Table 2 reproduces the main results of the paper using the estimate from Simonovska and Waugh (2014).

Figure 13: The Prevalence of International Trade

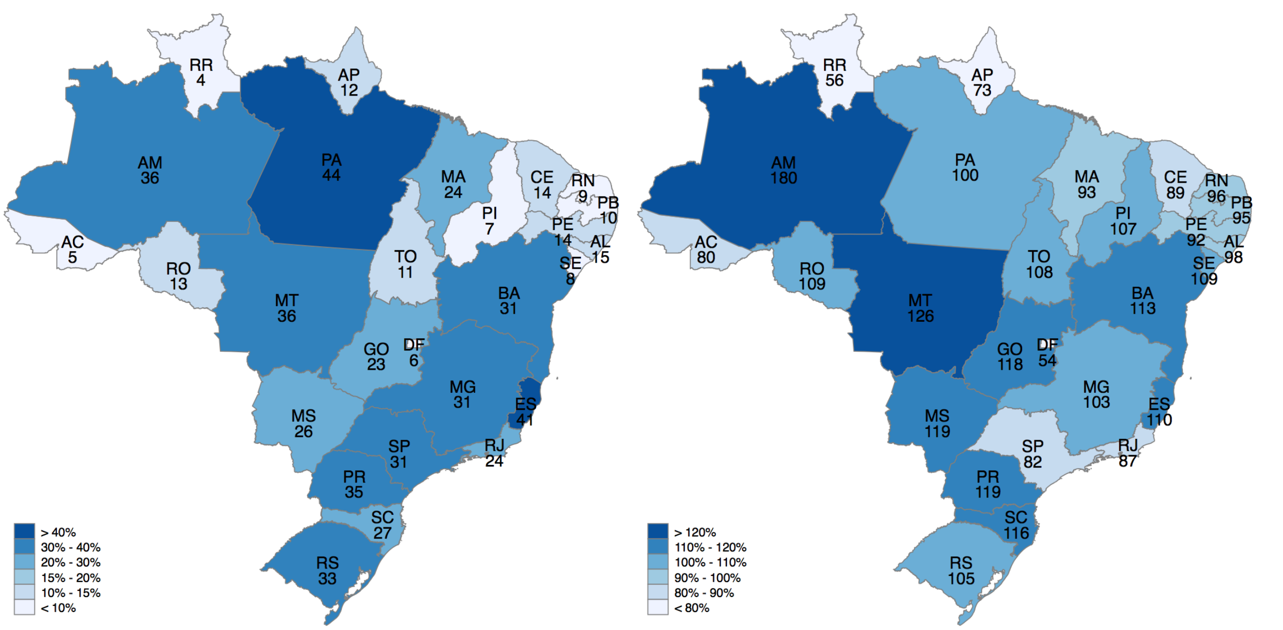


Note: The figure shows international trade flows as a percentage of GDP. Luxembourg's international trade flows amount to 293% of GDP. International trade flows refers to the sum of exports and imports. The data correspond to the year 2008.

Figure 14: The Regional Prevalence of International and Intranational Trade

A: International Trade

B: Intranational Trade

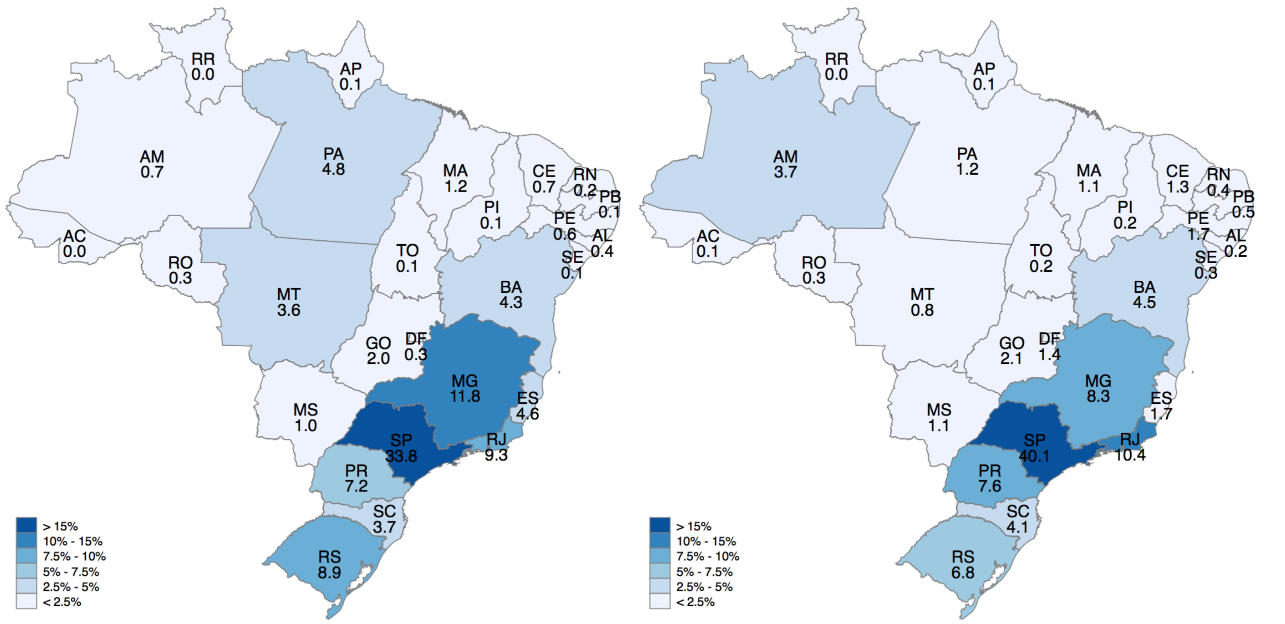


Note: The maps show regional trade flows (the sum of exports and imports) as a percentage of GRP. Appendix B lists the states and their corresponding codes. The data correspond to the year 2008.

Figure 15: The Regional Distribution of Trade Flows

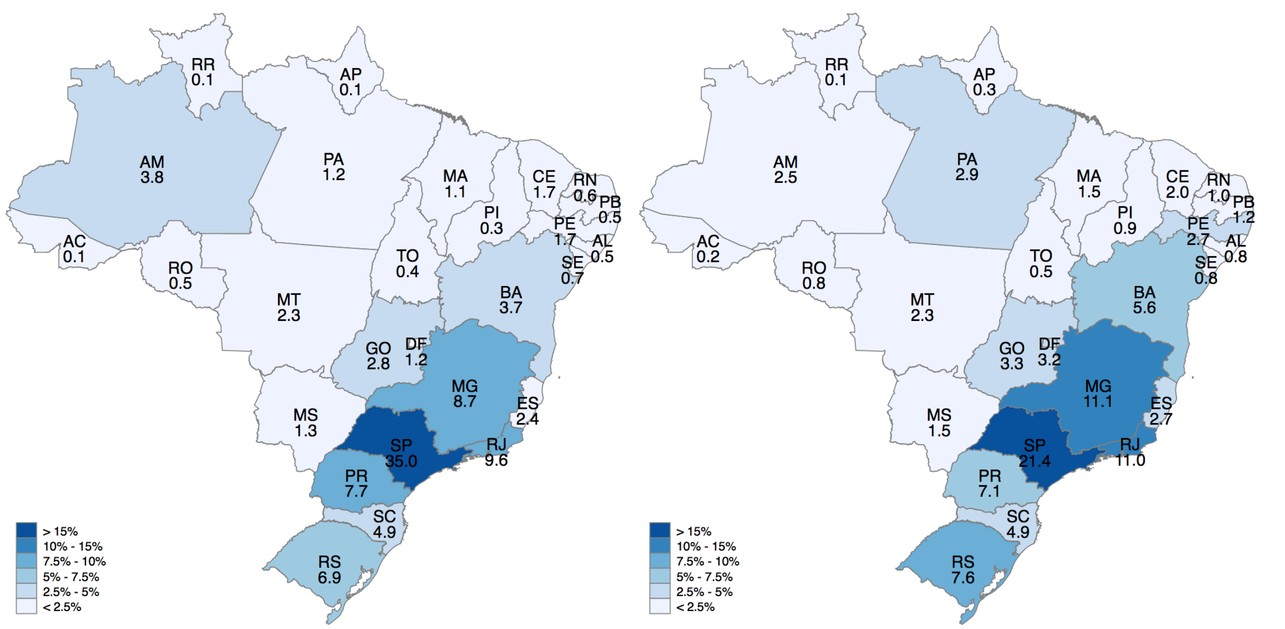
International Trade

A: Exports B: Imports



Intranational Trade

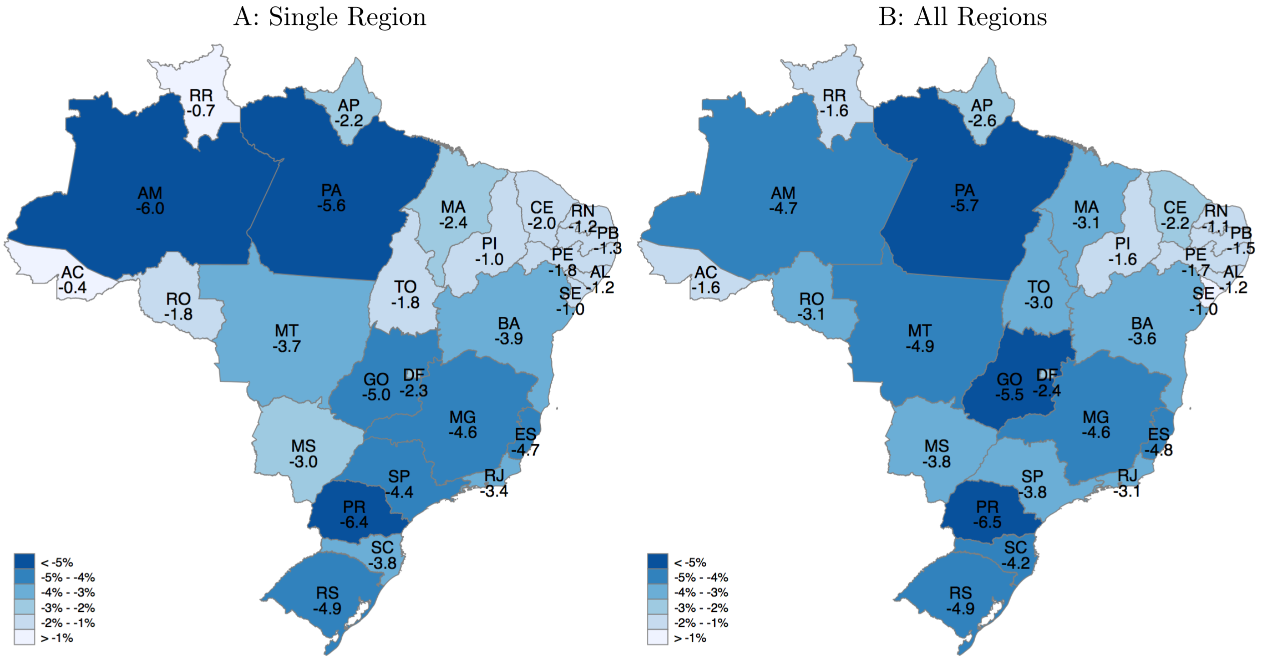
C: Exports D: Imports



Note: The maps show regional trade flows as a percentage of national trade flows. Appendix B lists the states and their corresponding codes. The data correspond to the year 2008.

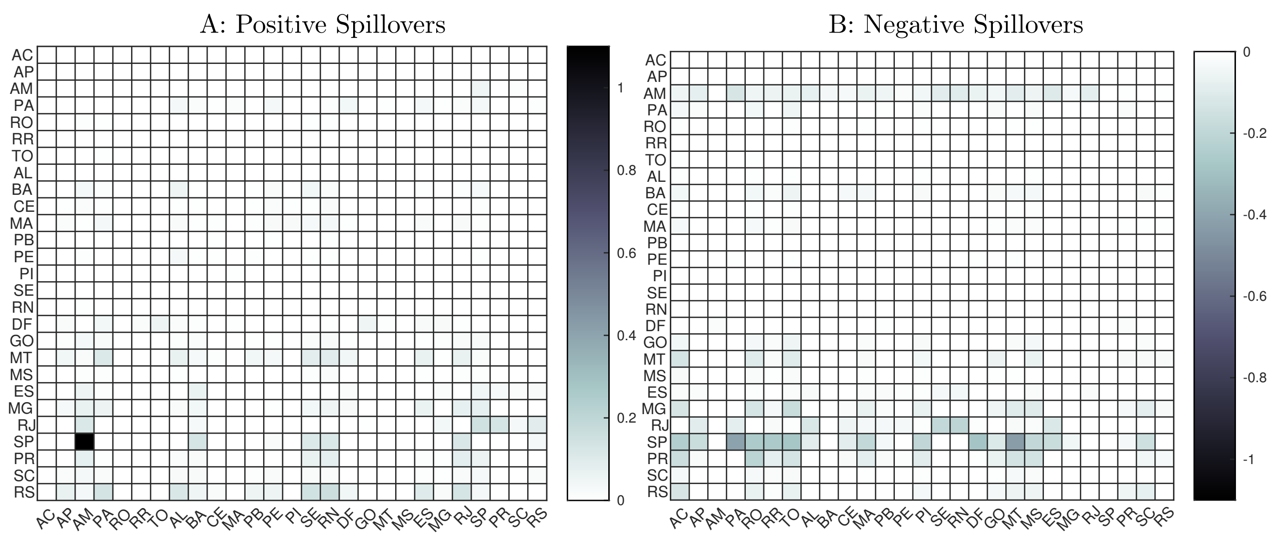
C Additional Results

Figure 16: The Own Gains from International Trade Without Labor Migration



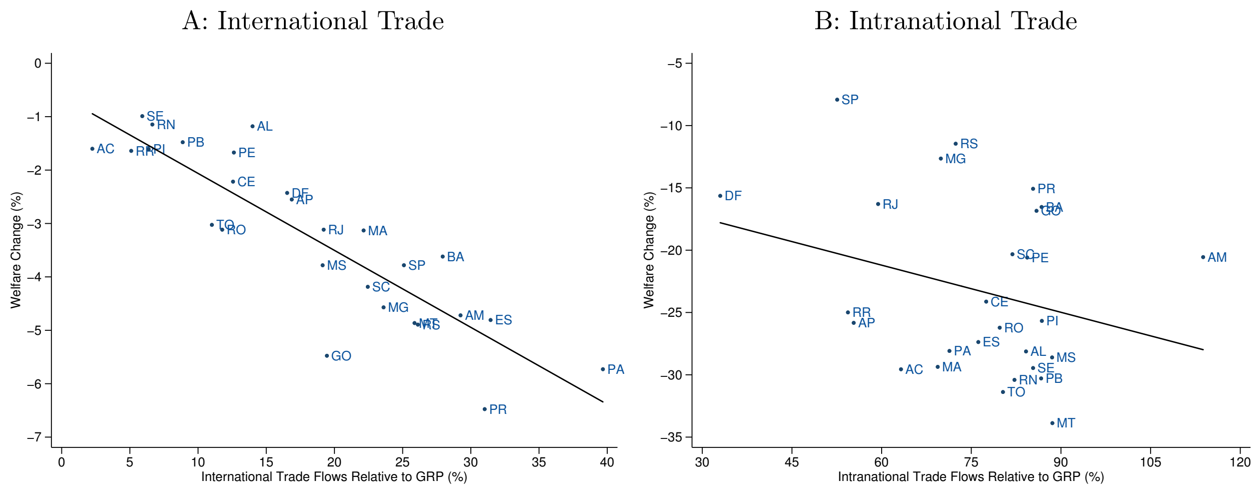
Note: The maps show the percentage change in regional welfare that results from eliminating international trade in the single region (Panel A) and in all regions (Panel B) in the absence of labor migration. Appendix B lists the states and their corresponding codes.

Figure 17: The Spillover Gains from International Trade Without Labor Migration



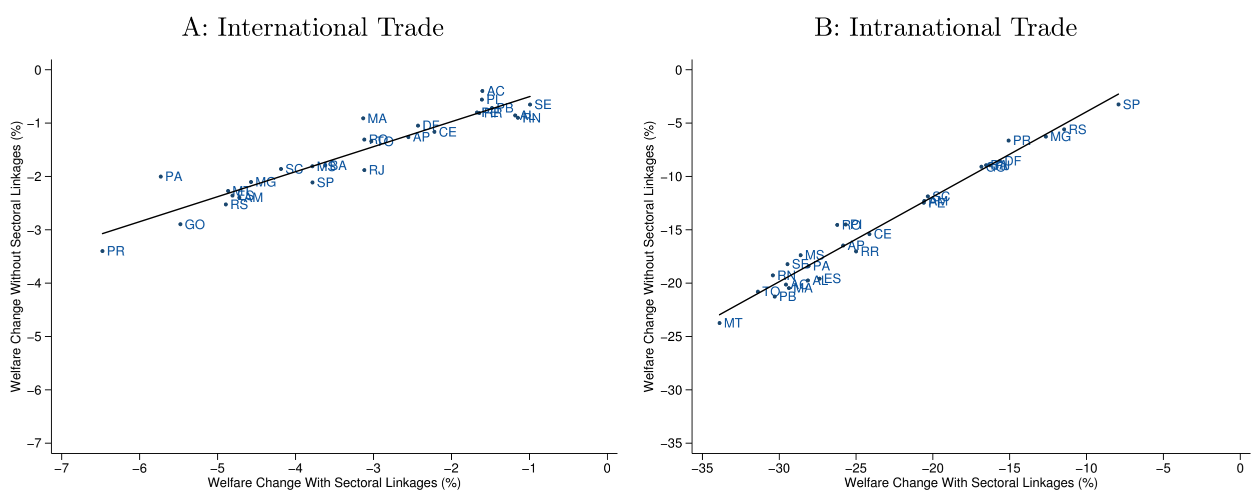
Note: The figures show the percentage change in welfare in the column region that results from eliminating international trade in the row region in the absence of labor migration. The figures exclude the main diagonal. Appendix B lists the states and their corresponding codes.

Figure 18: The Prevalence of Trade and the Gains from Trade Without Labor Migration



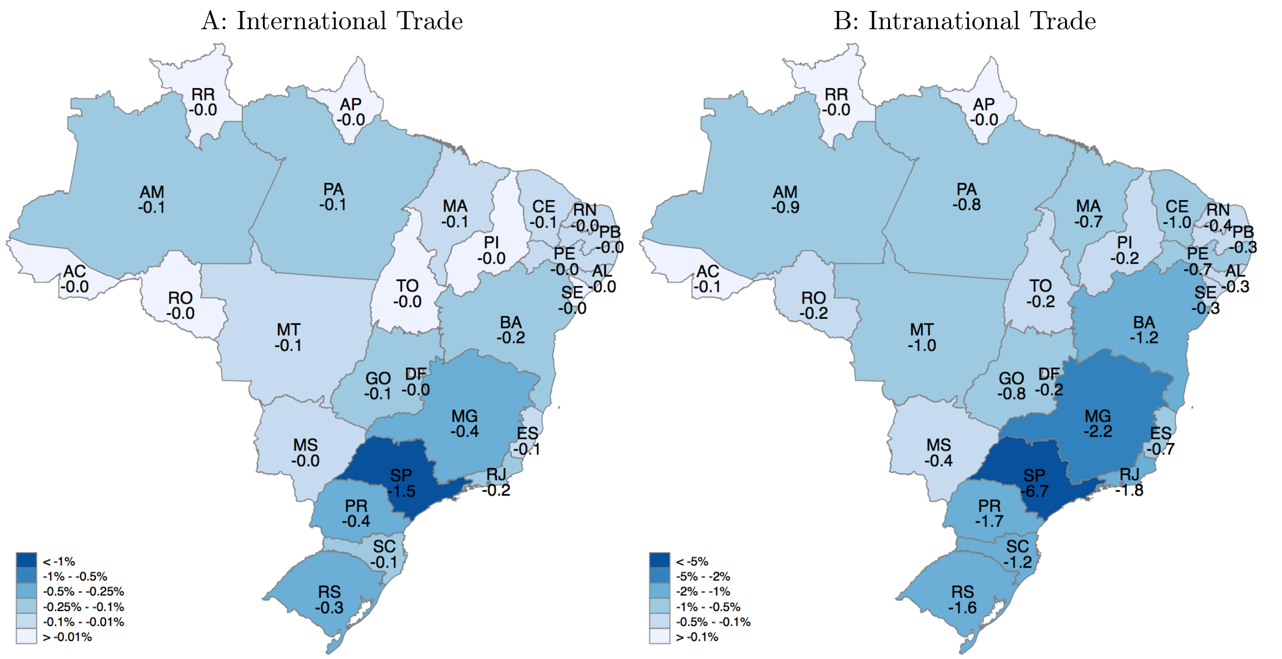
Note: The figures show the relationship between regional trade flows as a percentage of GRP and the percentage change in regional welfare that results from eliminating trade in the absence of labor migration. Trade flows relative to GRP refers to the counterfactual values that result from eliminating trade imbalances and trade flows in nontradable sectors. Trade flows refers to the sum of exports and imports. Appendix B lists the states and their corresponding codes.

Figure 19: Sectoral Linkages and the Gains from Trade Without Labor Migration



Note: The figures show the relationship between the percentage change in regional welfare that results from eliminating trade in the absence of labor migration with and without sectoral linkages. Appendix B lists the states and their corresponding codes.

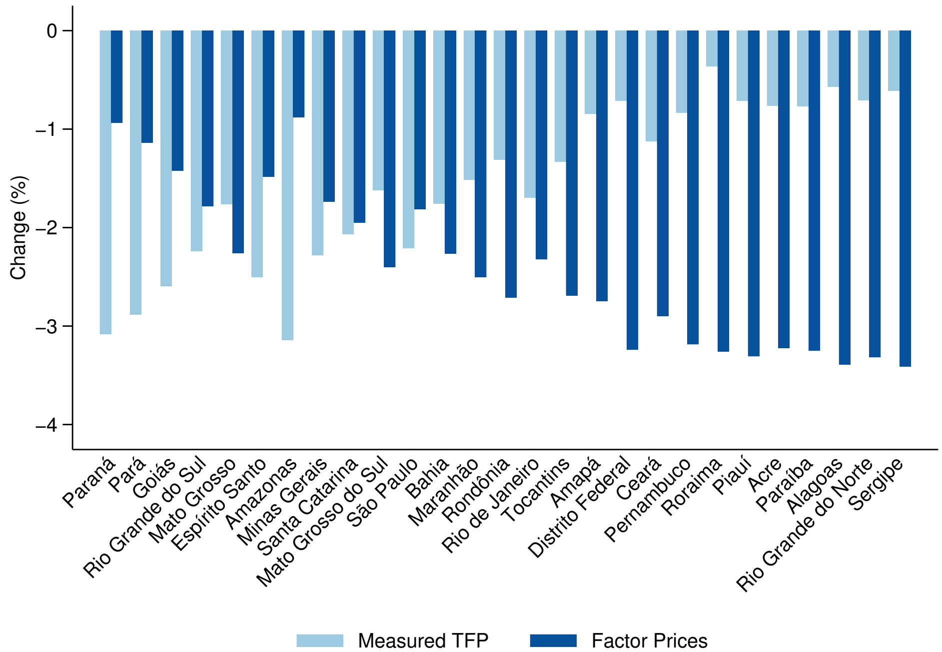
Figure 20: The Partial Gains from Trade



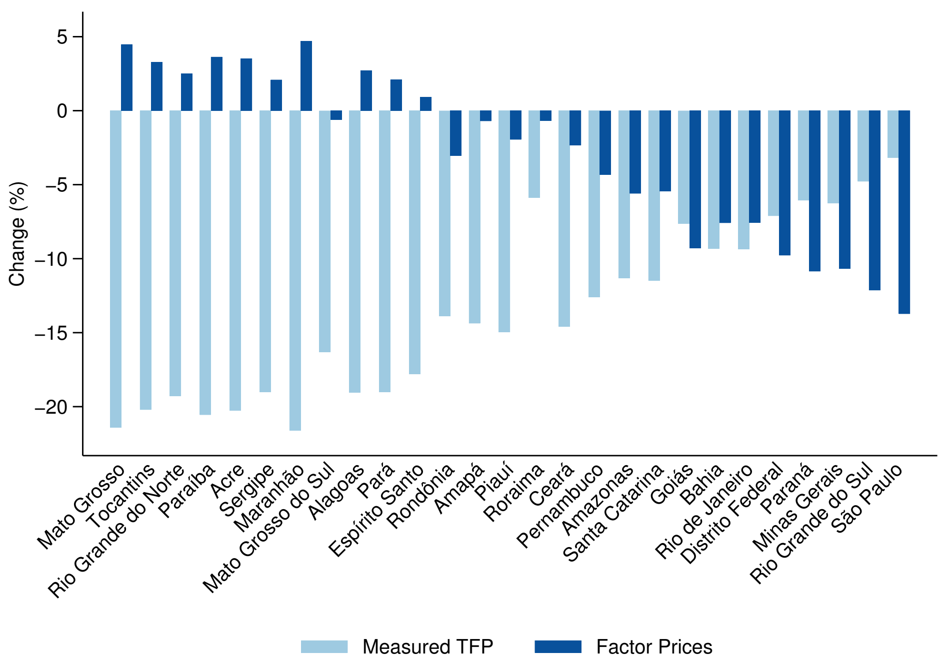
Note: The maps show the percentage change in national welfare that results from eliminating trade in the single region in the presence of labor migration. Appendix B lists the states and their corresponding codes.

Figure 21: A Decomposition of the Gains from International and Intranational Trade

A: International Trade

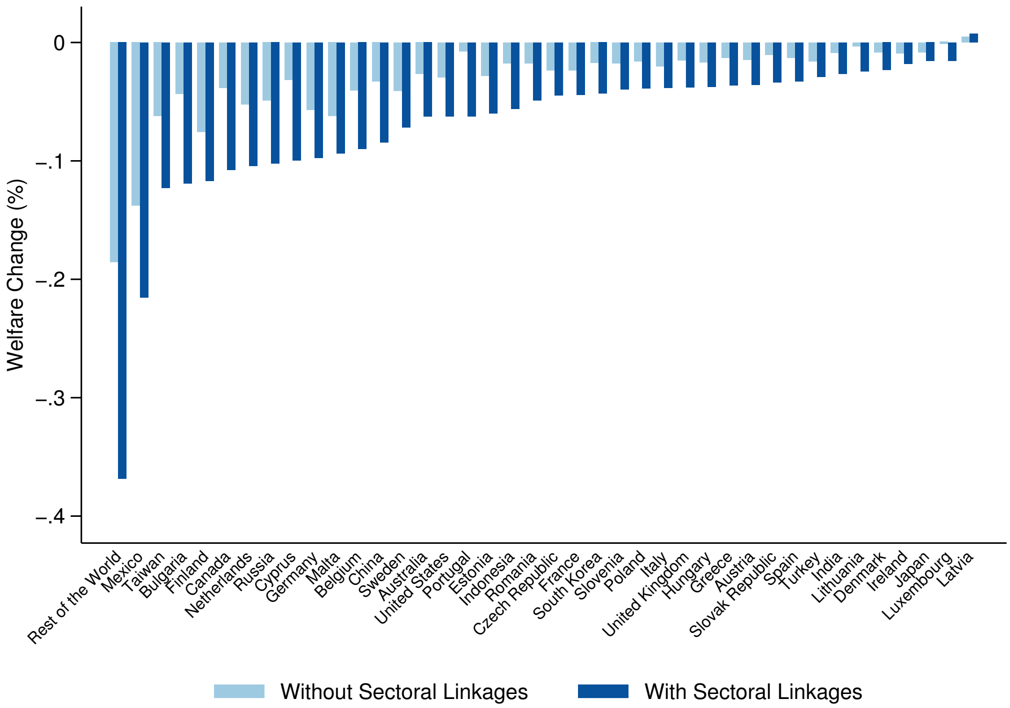


B: Intranational Trade



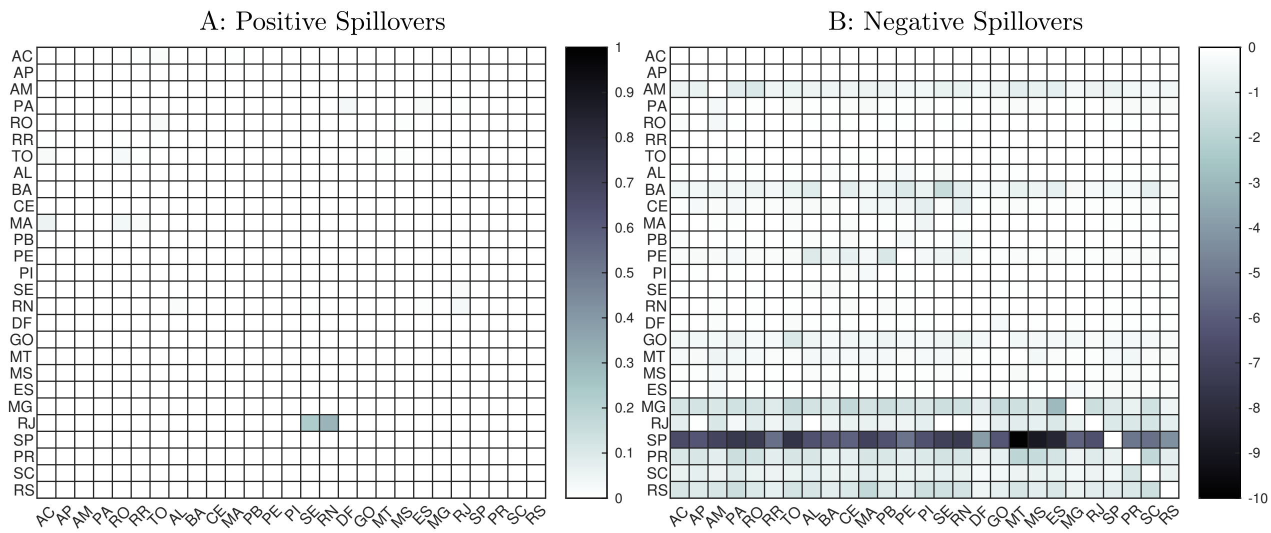
Note: The figures decompose the percentage change in regional welfare that results from eliminating trade in the presence of labor migration according to Equation (1).

Figure 22: The Global Gains from International Trade with Brazil



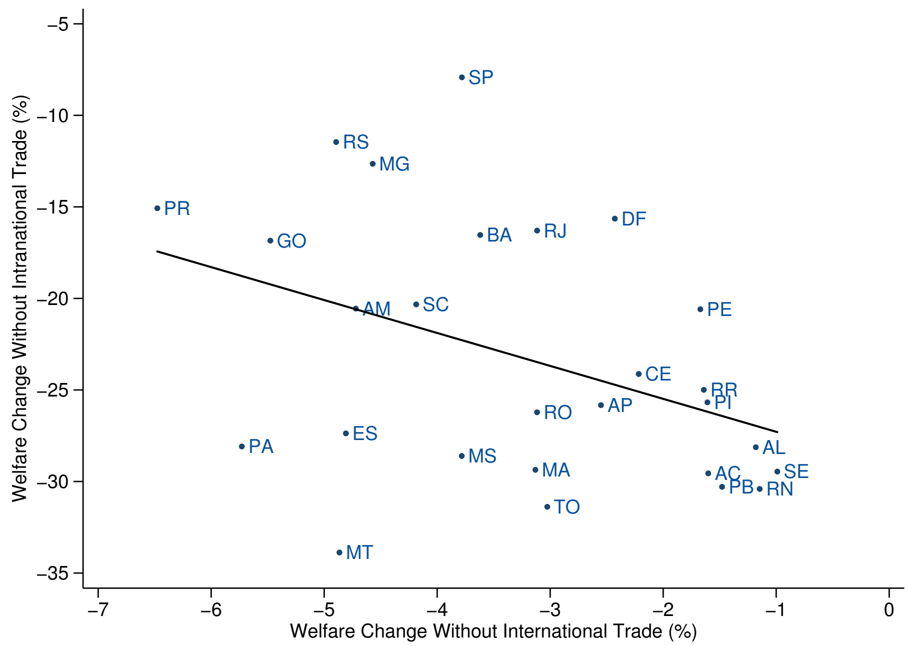
Note: The figure shows the percentage change in national welfare that results from eliminating international trade with Brazil.

Figure 23: The Spillover Gains from Intranational Trade Without Labor Migration



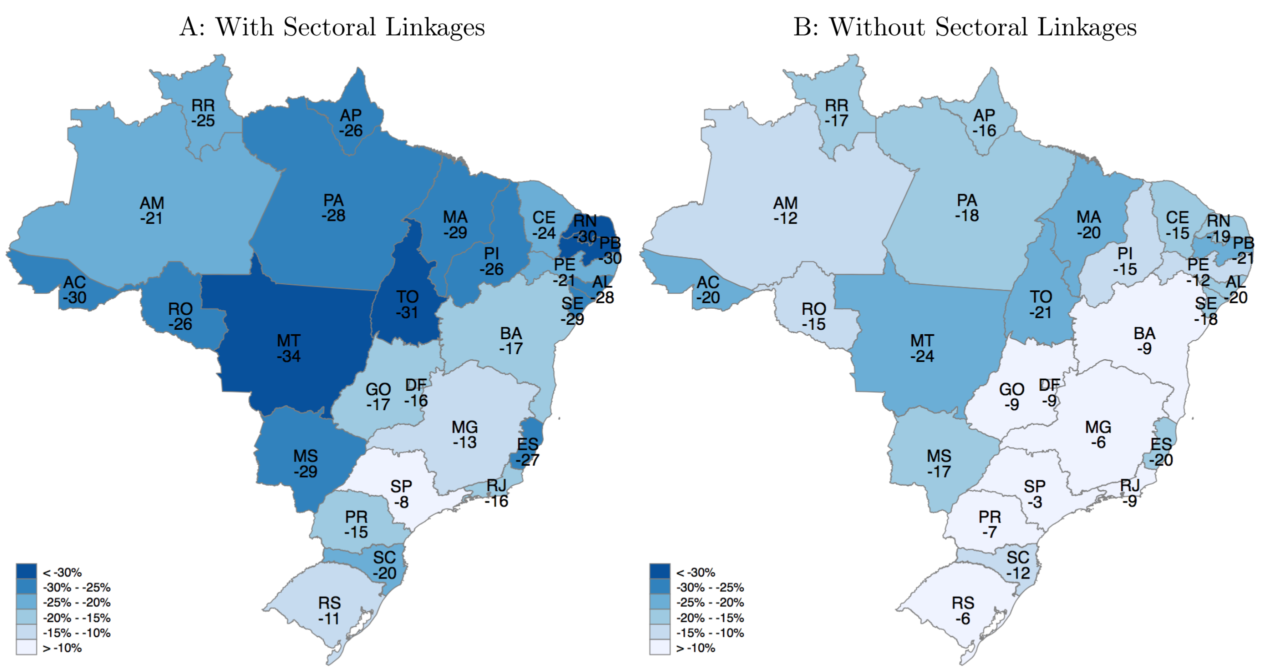
Note: The figures show the percentage change in welfare in the column region that results from eliminating intranational trade in the row region in the absence of labor migration. The figures exclude the main diagonal. Appendix B lists the states and their corresponding codes.

Figure 24: The Gains from International and Intranational Trade Without Labor Migration



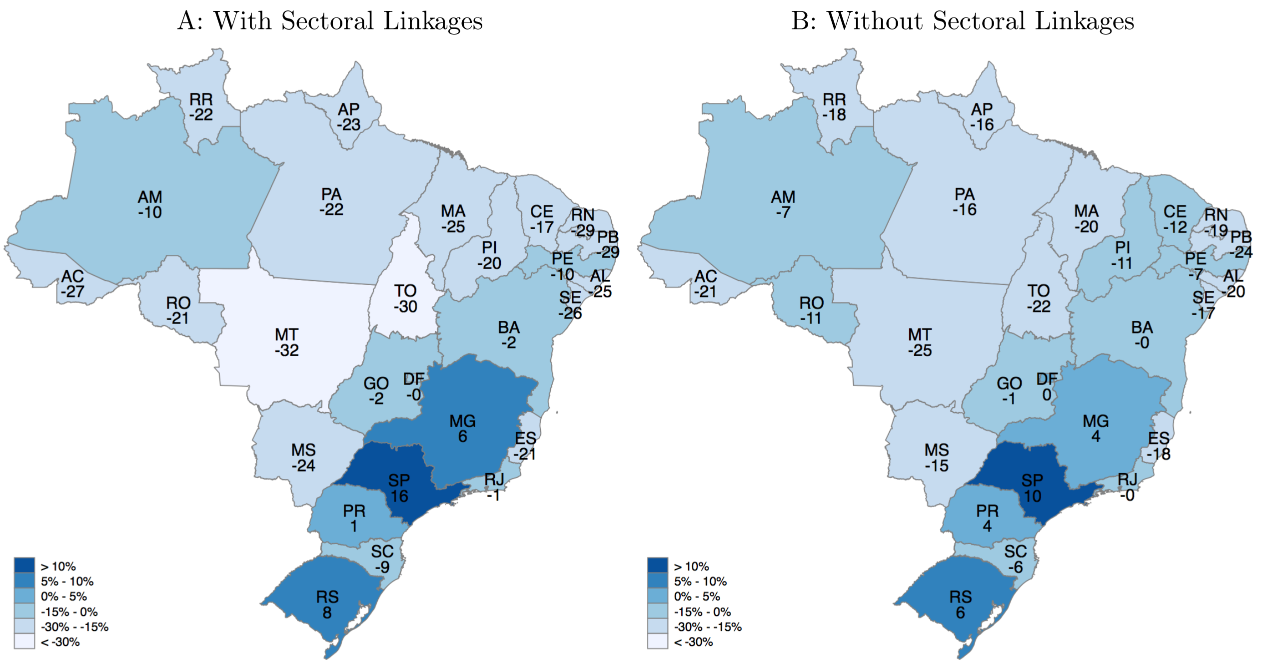
Note: The figure shows the relationship between the percentage change in regional welfare that results from eliminating international and intranational trade in the absence of labor migration. Appendix B lists the states and their corresponding codes.

Figure 25: Sectoral Linkages and the Gains from Intranational Trade Without Labor Migration



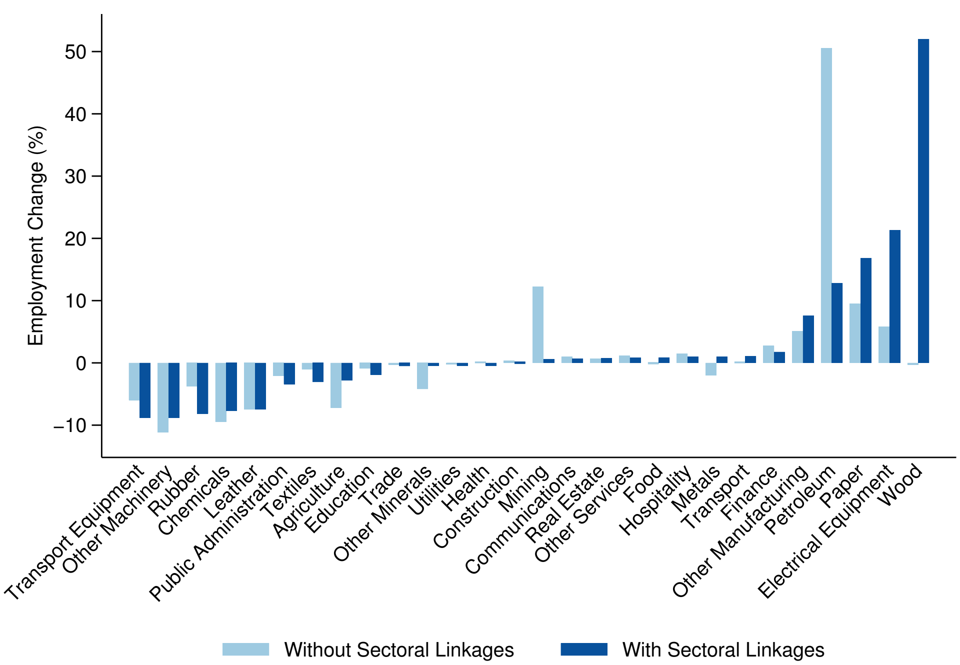
Note: The maps show the percentage change in regional welfare that results from eliminating intranational trade in the absence of labor migration. Appendix B lists the states and their corresponding codes.

Figure 26: Sectoral Linkages, Intranational Trade, and the Regional Distribution of Employment



Note: The maps show the percentage change in regional employment that results from eliminating intranational trade in the presence of labor migration. Appendix B lists the states and their corresponding codes.

Figure 27: Sectoral Linkages, Intranational Trade, and the Sectoral Distribution of Employment



Note: The figure shows the percentage change in sectoral employment that results from eliminating intranational trade in the presence of labor migration. Table 3 in Appendix B lists the sectors and their corresponding abbreviations.