# Gains from Domestic versus International Trade: Evidence from the U.S.*

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**Abstract**

Using varieties of a rich model that considers sectoral heterogeneity and input-output linkages, this paper shows that the overall welfare gains of a region within a country can be decomposed into domestic versus international welfare gains from trade. Empirical results based on sector- and state-level data from the U.S. suggest that about 94 percent of the overall welfare gains of a state is due to domestic trade with other states. The ocean states gain from international trade about two times the Great Lake states and about three times the landlocked states.

**JEL Classification:** F12, F14, R13

**Key Words:** Welfare Gains; Domestic Trade; Sectoral Heterogeneity; State-Level Analysis

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# 1 Introduction

Domestic trade of a typical state within the U.S. is about five times its international trade, where about three quarters of this domestic trade is achieved with other states. It is implied that a typical state is about 20 percent open to international trade, while it is about 60 percent open to domestic trade with other states.[1] Since welfare gains from trade are directly connected to such openness measures as shown by Arkolakis, Costinot, and Rodríguez-Clare (2012) for a vast variety of models, the greater part of the welfare gains is implied to be through domestic trade. Nevertheless, since domestic trade data are not available for the majority of the countries, the existing literature has mostly focused on international welfare gains from trade that represent only a small portion of overall welfare gains.

This paper compares welfare gains from domestic trade and international trade by introducing a rich model that considers sectoral heterogeneity as well as input-output linkages (as in studies such as by Levchenko and Zhang (2014), Caliendo and Parro (2015) and Ossa (2015)), where the unit of investigation is set as regions representing U.S. states. As standard in the literature, the corresponding welfare gains from trade (measured as the costs of autarky) are shown to be a function of expenditure shares and model parameters, where changes in expenditure shares are used to capture the changes in welfare in case of a hypothetical change in trade costs. All parameters and expenditure shares are either estimated or calculated by using the corresponding sector- or state-level U.S. data.

The corresponding literature starting with Arkolakis, Costinot, and Rodríguez-Clare (2012) has focused on the hypothetical case of an autarky in the context of international

[1] Domestic trade of a state is defined as its trade within the U.S., either within itself or with other U.S. states. See Appendix Table A.2 and Section 2 of this paper regarding the details of the data used to obtain this information.

trade. This paper follows this literature by having the same definition of international autarky while calculating the international welfare gains from trade. The main contribution of this paper is achieved by considering an additional/alternative hypothetical case of autarky, namely domestic autarky, which is useful to calculate the domestic welfare gains from trade. In particular, domestic autarky is defined as the case in which a region still imports products internationally, but the domestic trade with other regions of the same country is shut down in this hypothetical case. Although such a scenario of domestic autarky may not be realistic, it is useful to measure and compare the effects of domestic versus international welfare gains from trade from an accounting perspective. Such an approach allows us to show that the overall percentage welfare gains of a state/region is the summation of domestic and international percentage welfare gains.

Based on the significant difference between international and domestic openness measures of states in the U.S., the corresponding welfare analysis shows that about 94 percent of the overall welfare gains of a state is due to domestic trade with other states, with a range between 85 percent and 99 percent across states. When the same investigation is replicated by using data at the U.S. level, it is shown that the international welfare gains from trade measures are virtually identical to the measures obtained by the aggregation of state-level results, suggesting that one can use the implications of a state-level analysis to have U.S. level results based on welfare gains from trade.

Regarding state-level implications, the landlocked states gain more out of domestic trade, whereas the ocean states gain more out of international trade, both compared to each other. Specifically, the ocean states gain from international trade about two times the Great Lake states and about three times the landlocked states. Since this result is partly due to the international openness of these states and partly due to considering a multi-sector framework, it is implied that the ocean states gain more from international trade not only because they overall trade more internationally but also certain sectors in these states are dependent more on international trade (e.g., "Chemical products" or "Transportation equipment"). This result is also consistent with studies such as by Limao and Venables (2001), Irwin and Terviö (2002), or Van Leemput (2016) who have shown that international trade costs are higher for landlocked regions.

In the existing literature, the consideration of domestic integration is shown to be important to explain observed import shares, effects of economic integration agreements, relative income and price levels as well as the relationship between country size and income levels across countries (e.g., see Bergstrand, Larch, and Yotov (2015) and Ramondo, Rodriguez-Clare, and Saborio-Rodriguez (2016)). Domestic integration through lowering domestic trade costs is also shown to result in substantial welfare gains, especially for poor regions (e.g., see Donaldson (2018), Tombe and Winter (2014), or Van Leemput (2016)). This paper contributes to this literature by showing that domestic welfare gains from trade explain about 94 percent of the overall welfare gains from trade within the U.S.. This is in contrast to studies such as by Albrecht and Tombe (2016) who have achieved a similar investigation for a more open country, Canada, and shown that gains from international trade are typically larger than the gains from domestic trade.[2]

[2]The corresponding difference can be attributed to the Canadian provinces having higher trade volumes with international (rather than intranational) trade partners as shown in Tables 1 and 3 in Albrecht and Tombe (2016), while the U.S. states have higher trade columes with intranational (rather than international) trade partners as shown in Appendix Table A.2 of this paper. As suggested by an anonymous referee, this difference can also be attributed to the number of provinces in Canada versus the number of states in the U.S..

The rest of this paper is organized as follows. The next section depicts the state-level welfare gains obtained by alternative specifications of the model introduced in the Appendix. Section 3 connects the state-level results to those at the U.S. level through appropriate aggregations as well as additional aggregate-level analyses. Section 4 concludes. The economic environment, the derivations of expressions regarding the welfare gains from trade, and the details of data used in the empirical investigation are provided in the Appendix.

## 2 State-Level Investigation

The empirical investigation is based on a multi-sector model with input-output linkages as detailed in the Appendix. Since Arkolakis, Costinot, and Rodríguez-Clare (2012) have shown that welfare gains from trade can be measured by simple expressions based on expenditure shares and certain parameters for a wide range of models, we consider an Armington (1969) type model in order to have an empirical motivation. In particular, we introduce a multi-region multi-sector model, where individuals supply labor to firms in return for their wage income. Production is achieved by using both labor and intermediate inputs purchased from other sectors and regions, which allows us to consider input-output linkages as well as sectoral heterogeneity. While the demand side of the model is similar to studies such as by Costinot and Rodríguez-Clare (2014), the production side of the model follows studies such as by Ossa (2015) that consider monopolistically competitive firms that make positive profits. Having positive profits is convenient for estimating trade elasticity measures by using profit/production data as in studies such as by Yilmazkuday (2012). The corresponding sector- and state-level data from the U.S. are also described in the Appendix.

Considering its ingredients, we call our complete model the multi-sector model with input-output linkages or *MSIO* in short. To see the contribution of each model ingredient, we consider several special cases of the model in the following subsections, where we focus on measuring welfare gains from trade compared to certain hypothetical cases. The first special case is the one-sector-labor-only (OSLO) model, where welfare gains from trade depend on expenditure shares of consumption goods and a unique aggregate-level trade elasticity measure. The second special case is the one-sector model with input-output linkages (OSIO), where welfare gains not only depend on the aggregate-level trade elasticity and expenditure shares of consumption goods and but also those of intermediate inputs, together with the intermediate input share in production. The third special case is the multi-sector-labor-only (MSLO) model, where welfare gains depend on sector-level expenditure shares, sector-level trade elasticity measures, and sector shares in the economy. Finally, the complete model of MSIO implies that welfare gains from trade depend on sector-level expenditure shares, sector-level expenditure shares of intermediates, sector-level intermediate input shares in production, sector-level trade elasticity measures, and sector shares in the economy. Further technical details are given in the Appendix.

Based on the complete model and its special cases, the welfare gains from trade of a region are investigated with respect to three hypothetical cases. The first case is full autarky ($fa$) which corresponds to shutting down both intranational trade (with other domestic regions) and international trade, although the region can still trade within itself. The second case is international autarky ($ia$) which corresponds to shutting down international trade only, whereas the region can still trade with itself and other domestic regions. The third case is domestic autarky ($da$) which corresponds to shutting down intranational trade (with other domestic regions) only, although the region can still trade with itself and internationally.

We start with providing the results based on the most basic OSLO model so that we can explain the contribution of each additional model ingredient with respect to this simple case until we finally reach our complete MSIO model.

## 2.1 One-Sector-Labor-Only (OSLO) Model

When there is a unique sector and intermediate input trade is shut down, we have the special case of one-sector-labor-only (OSLO) model. In such a case, welfare gains from trade in region $r$ are given by the following expression:

$$WGT_r = \left( \frac{\pi_{r,r}}{\pi'_{r,r}} \right)^{\frac{1}{1-\eta}} \tag{1}$$

where $\pi_{r,r}$ is the current home expenditure share in region $r$, $\pi'_{r,r}$ is the home expenditure share in an hypothetical case (with the notation of $x'$ representing any variable $x$ in the hypothetical case), and $1-\eta$ represents the trade elasticity (with $\eta$ representing the elasticity of substitution across goods, each produced in a different location). This equation reduces to the typical expression in the literature (introduced by Arkolakis, Costinot, and Rodríguez-Clare (2012)) when the hypothetical case refers to the full autarky ($fa$) of region $r$ (i.e., when $\pi'_{r,r} = 1$). By using the current state-level home expenditure shares $\pi_{r,r}$'s from the year of 2012 and a value of $\eta = 3.612$ as detailed in the Appendix, $WGT_r$ can be calculated for any U.S. state when $\pi'_{r,r} = 1$.

The corresponding results for the hypothetical case of full autarky are summarized in Table 1, where states have been categorized as ocean states (that have access to an ocean and thus water transportation with the rest of the world), Great Lakes states (that have access to the Great Lakes and thus water transportation with Canada), and landlocked states. Such a categorization is essential to connect our results to studies such as by Limao and Venables (2001), Irwin and Terviö (2002), or Van Leemput (2016) who have shown that international trade costs are higher for landlocked regions. As is evident, $\log WGT_r$ (representing *overall* gains from trade) ranges between 0.242 and 1.154 with an average of 0.635 across states.[3] Since the value of $\eta = 3.612$ is common across states, the heterogeneity across states is completely due to their current home expenditure shares; e.g., the ocean states have an average gain of about 0.690, while the Great Lakes states have an average gain of about 0.580.

Similarly, *international* welfare gains from trade are calculated by shutting down international trade only for which the hypothetical home expenditure share of $\pi'_{r,r}$ in Equation 1 can be calculated by removing the expenditure on international imports from the overall expenditure of the region. The corresponding results for the hypothetical case of international autarky are also summarized in Table 1, where $\log WGT_r$ (representing *international* gains from trade) ranges between 0.019 and 1.171 with an average of 0.075 across states. One interesting observation is that international welfare gains of the ocean states is almost double those of the landlocked states, mostly due to their high international trade volumes.

Finally, *domestic* welfare gains from trade are calculated by shutting down domestic trade only for which the hypothetical home expenditure share of $\pi'_{r,r}$ in Equation 1 can be

[3]The results for each state can be found in Appendix Table A.3.

calculated by removing the expenditure on domestic imports from the overall expenditure of the region. The corresponding results for the hypothetical case of domestic autarky are also summarized in Table 1, where $\log WGT_r$ (representing *domestic* gains from trade) ranges between 0.193 and 1.087 with an average of 0.560 across states. The landlocked states has an average gain of about 0.594, while the Great Lakes states have an average gain of about 0.503, suggesting that the landlocked states gain more from domestic trade compared to the Great Lakes states.

Based on these results, we also calculate the contribution of *domestic* versus *international* welfare gains to *overall* welfare gains (for which the derivations are achieved in the Appendix). The corresponding summary results are also given in Table 1, where, on average across states, about 87.8% of overall welfare gains from trade are due to domestic trade in the OSLO model, with a range of 74.1% and 96.2% across states. Therefore, for a typical U.S. state, a big portion of overall welfare gains from trade is due to domestic trade, while the contribution of international trade is low. As is also evident in Table 1, the ocean states gain more from international trade, while the landlocked states gain more from domestic trade, both compared to each other. Since the value of $\eta = 3.612$ is common across states in Equation 1, the heterogeneity across states is completely due to their current foreign versus international expenditure shares as given in Table 2, where the ocean states are open to international trade about 10% more than the landlocked states.

## 2.2 One-Sector Model with Input-Output Linkages (OSIO)

When there is a unique sector with input-output linkages, we have the special case of one-sector model with input-output linkages or OSIO in short. In such a case, welfare gains from trade in region $r$ are given by the following expression:

$$WGT_r = \left(\frac{\pi_{r,r}}{\pi'_{r,r}}\right)^{\frac{1}{1-\eta}} \left(\frac{\kappa_{r,r}}{\kappa'_{r,r}}\right)^{\frac{g}{(1-\eta)(1-g)}} \tag{2}$$

where the additional variable of $\kappa_{r,r}$ is the current home expenditure share of intermediate inputs in region $r$, $\kappa'_{r,r}$ is the home expenditure share of intermediate inputs in an hypothetical case, and $g$ is the intermediate input share in production. Compared to the OSLO model, this expression has the additional term of $\left(\frac{\kappa_{r,r}}{\kappa'_{r,r}}\right)^{\frac{g}{(1-\eta)(1-g)}}$, where the interaction between $(\pi_{r,r})^{\frac{1}{1-\eta}}$ and $(\kappa_{r,r})^{\frac{g}{(1-\eta)(1-g)}}$ is the key to understand the contribution of having input-output linkages in the model.

By using the current state-level home expenditure shares $\pi_{r,r}$'s and $\kappa_{r,r}$'s, together with the values of $\eta = 3.612$ and $g = 0.682$ as detailed in the Appendix, *overall* welfare gains $WGT_r$ can be calculated for any U.S. state when $\pi'_{r,r} = \kappa'_{r,r} = 1$. The corresponding results for the hypothetical case of full autarky are summarized in Table 1, where $\log WGT_r$ (representing *overall* gains from trade) ranges between 0.923 and 3.574 with an average of 2.054 across states. These values are almost triple of those implied by the OSLO model, showing the importance of input-output linkages in the calculation of welfare gains from trade.

Similarly, international gains from trade range between 0.067 and 0.518 with an average of 0.238 across states, while domestic gains from trade ranges between 0.783 and 3.428 with an average of 1.816 across states. It is implied that about 88.2% of overall welfare gains from trade is due to domestic trade in the OSIO model, with a range of 76.2% and 96.0% across states. The latter set of results is very similar to those implied by the OSLO model, suggesting that the consideration of input-output linkages in a one-sector framework has a negligible impact on the comparison between domestic and international gains from trade.

## 2.3 Multi-Sector-Labor-Only (MSLO) Model

When we shut down intermediate input trade in a multi-sector framework, we have the special case of multi-sector-labor-only (MSLO) model. In such a case, welfare gains from trade in region $r$ are given by the following expression:

$$WGT_r = \prod_j \left( \frac{\pi^j_{r,r}}{\pi^{j\prime}_{r,r}} \right)^{\frac{\beta^j_r}{1-\eta^j}} \tag{3}$$

where the additional parameter of $\beta^j_r$ represents expenditure share on sector $j$ in region $r$, and the trade elasticity measure of $1 - \eta^j$ is now at the sector level. As before, *overall* welfare gains can be calculated by considering the case of full autarky (i.e., $\pi^{j\prime}_{r,r} = 1$). The corresponding results are given in Table 1, where $\log WGT_r$ ranges between 0.524 and 6.147 with an average of 1.244 across states. On average, these values are almost double of those implied by the OSLO model, but they are lower compared to the OSIO model, suggesting that considering input-output linkages leads into higher welfare gains from trade compared to considering a multi-sector framework consistent with studies such as by Costinot and Rodríguez-Clare (2014).

Similarly, *international* welfare gains range between 0.024 and 0.788 with an average of 0.112 across states. Across states, international welfare gains of the ocean states are almost double those of the Great Lakes states and almost triple those of the landlocked states. Although the latter result is consistent with the OSLO model qualitatively, the magnitude is higher in this multi-sector framework, suggesting that sectoral heterogeneity is an important component of welfare-gains calculations for these states.

Finally, domestic welfare gains range between 0.441 and 5.360 with an average of 1.132 across states. It is implied that about 90.6% of overall welfare gains from trade is due to domestic trade in the OSIO model, with a range of 72.0% and 98.9% across states. The latter set of results is again similar to those implied by the OSLO model, suggesting that the consideration of a multi-sector framework has a negligible impact on the comparison between domestic and international gains from trade.

## 2.4 Multi-Sector Model with Input-Output Linkages (MSIO)

The complete version of the model, which is the multi-sector model with input-output linkages (MSIO), is already given in details in the Appendix. The corresponding *overall* welfare gains given in Table 1 range between 3.693 and 24.489 with an average of 7.086 across states. These values are almost ten times of those implied by the OSLO model (consistent with Costinot and Rodríguez-Clare (2014)), suggesting that considering input-output linkages in a multi-sector framework (as in this paper) is essential to calculate "unbiased" gains from trade as suggested by Ossa (2015).

Similarly, *international* gains from trade range between 0.091 and 2.399 with an average of 0.408 across states. As in the case of MSLO model above, international welfare gains of the ocean states are almost double those of the Great Lakes states and almost triple those of the landlocked states, confirming the importance of having a multi-sector framework in welfare-gains calculations. Since this result is partly due to the international openness of these states and partly due to considering a multi-sector framework, it is implied that the ocean states gain more from international trade not only because they overall trade more internationally but also certain sectors in these states are dependent more on international trade (e.g., "Chemical products" or "Transportation equipment").

Finally, domestic welfare gains range between 3.227 and 24.281 with an average of 6.678 across states. It is implied that about 94.1% of overall welfare gains from trade are is to domestic trade, with a range of 84.6% and 99.1% across states. The latter values are about 5% higher compared to the OSLO model, suggesting that the consideration of input-output linkages in a multi-sector framework is the essential to achieve "unbiased" calculations.

## 2.5 Comparison across Alternative Models

It is evident that compared to the OSLO model, having input-output linkages or sectoral heterogeneity results in higher welfare gains from trade for any definition of autarky considered. This result is consistent with several studies in the literature such as by Levchenko and Zhang (2014), Costinot and Rodríguez-Clare (2014), Caliendo and Parro (2015) and Ossa (2015) who have shown that having more structural models through sectoral heterogeneity or input-output linkages brings higher welfare gains from trade.

Compared to the OSLO model, we would like to investigate the reasons behind having higher welfare gains in other models of OSIO, MSLO and MSIO.[4] In particular, we would like to know whether the deviations from the OSLO model are due to different expenditure shares or different model parameters (and thus model specifications) across different states. Accordingly, following studies such as by Ossa (2015), we investigate the OSLO-equivalent

[4]The technical details of these special cases are given in the Appendix.

elasticity $\eta_r^{OSLO}$ measures defined as follows in full, international and domestic autarky cases:

$$WGT_r^{AM} = \left( \frac{\pi_{r,r}}{\pi'_{r,r}} \right)^{\frac{1}{1-\eta_r^{OSLO}}} \tag{4}$$

where the superscript $AM$ stands for alternative models of OSIO, MSLO and MSIO. The objective of this exercise is to figure out whether the deviations from the OSLO model are due to having different home expenditure shares or they are due to having different model specifications that would be captured by the deviations of $\eta_r^{OSLO}$ measures (that are both state and autarky-definition specific) from our aggregate $\eta$ measure of $\eta = 3.612$. In particular, if $\eta_r^{OSLO} < 3.612$, there are higher welfare gains from trade due to model specification, and if $\eta_r^{OSLO} > 3.612$, there are higher welfare gains from trade due to the home expenditure share of the state.

The results of this exercise suggest that in all definitions of autarky, $\eta_r^{OSLO}$ are below $\eta = 3.612$ for all states in both OSIO and MSIO models, suggesting that when input-output linkages are considered, the model specifications are responsible for higher welfare gains from trade.[5] However, for the MSLO model, especially for the case of international autarky, there are several states for which $\eta_r^{OSLO} > 3.612$, implying that their higher welfare gains from trade (with respect to the OSLO model) are due to their trade openness, although there are several other states for which $\eta_r^{OSLO} < 3.612$, suggesting that their higher welfare gains are due to model specifications.

Independent of the scale of welfare gains, the results regarding the main focus of this paper, which is the comparison of domestic versus international welfare gains from trade,

[5] The state-level results are given in Appendix Table A.4.

are very similar across different model specifications as summarized in Table 1, where the contribution of domestic trade to overall welfare gains range between 72% and 99.1% with an average of about 90% across all models and states. It is implied that independent of the model considered, the domestic welfare gains are much higher than international welfare gains from trade. When we search for the reason behind this result, the basic intuition can be best observed through the OSLO model which implies the following ratio between the *domestic* gains (calculated by the hypothetical case of domestic autarky, $da$) and *overall* gains (calculated by the hypothetical case of full autarky, $fa$) from trade:

$$\frac{\log WGT_r(da)}{\log WGT_r(fa)} = \frac{\log \pi_{r,r} - \log \pi'_{r,r}(da)}{\log \pi_{r,r}} \tag{5}$$

where, as is evident, the trade elasticity measure of $\eta - 1$ is effectively eliminated. Hence, the results based on the OSLO model are independent of the trade elasticity measure. This is also confirmed in Figure 1, where we plot this ratio against the share of domestic trade, and, as expected, we observe the perfect negative correlation between the horizontal and vertical axes. Nevertheless, since sectoral heterogeneity and/or input-output linkages enter into model specifications other than OSLO, the share of domestic trade is not perfectly correlated to this ratio in other specifications, although the negative correlation is still highly evident across states.

In order to investigate whether geography contributes to the share of domestic welfare gains within overall welfare gains, we further show the contribution of domestic trade to the overall welfare gains (i.e., the ratio of $\log WGT_r(da)$ to $\log WGT_r(fa)$) on the U.S. map for the complete (MSIO) model in Figure 2. As is evident, the ocean states (e.g., California, Texas, New York) and the Great Lake states (e.g., Michigan, Ohio, Illinois) gain relatively more from international trade, while landlocked states gain relatively more from domestic trade.[6] This result is consistent with the literature based on how landlockedness may affect international trade of a region/country. For example, studies such as by Limao and Venables (2001) or Irwin and Terviö (2002) have shown that landlocked regions trade less than coastal regions, because they simply face higher trade costs.

# 3 Implications for the U.S.

This section compares the state-level results to those that can be obtained for the U.S. at the national level. We focus on the OSLO model to have simple aggregate-level implications, although the analysis in this section can easily be extended for other model specifications. The technical details of this investigation are given in the Appendix.

The aggregation of the state-level empirical results shows that overall welfare gains from trade of the U.S. are about 0.599 that can be decomposed into domestic welfare gains of 0.509 and international welfare gains of 0.090.

The international welfare gains from trade for the U.S. can also be calculated using the U.S. level home expenditure share of 0.793 and the OSLO trade elasticity measure of $\eta = 3.612$. The results obtained by U.S. data at the national level correspond to international welfare gains of about 0.089 (as given in Table 1) that are highly comparable to the value (of 0.090) obtained from the weighted aggregation of state-level numbers as shown above. This result at the national level is also consistent with earlier studies such as by Ossa (2015) who

[6] The U.S. maps for alternative model specifications are virtually the same, and they are available upon request.

have estimated welfare gains of about 0.099 for the U.S. by using the implications of a very similar OSLO model. Therefore, the state-level investigation in this paper is supported by the empirical evidence at the national level as well.

# 4 Conclusion

Based on a rich model that takes into account sectoral heterogeneity and input-output linkages, this paper has shown by using sector- and state-level data from the U.S. that domestic welfare gains from trade are much higher than international welfare gains from trade. In particular, the share of domestic welfare gains within the overall welfare gains is about 94 percent on average across states, with a range of between 85 percent and 99 percent depending on the current domestic versus international openness of states. This result is robust to the consideration of alternative model specifications as well. When the same investigation is replicated at the U.S. level, the corresponding international welfare gains match with those obtained by the aggregation of state-level results, suggesting that national-level welfare gains can be calculated by using the implications of a region-level analysis as in this paper.

The results have also shown that the ocean states gain from international trade about two times the Great Lake states and about three times the landlocked states. Since this result is partly due to the international openness of these states and partly due to considering a multi-sector framework, it is implied that the ocean states gain more from international trade not only because they overall trade more internationally but also certain sectors in these states are dependent more on international trade (e.g., "Chemical products" or "Transportation equipment"). This result is also reflected as the landlocked states gaining more from domestic trade compared to the coastal states, consistent with earlier studies in the literature suggesting that landlocked regions trade less than coastal regions due to facing higher trade costs.

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# 5 Appendix

## 5.1 Economic Environment

A typical individual in region $r$ maximizes utility given by:

$$C_r \equiv \left(\frac{\left(C_r^{NT}\right)^{1-\phi_r}}{1-\phi_r}\right)\prod_j\left(\frac{\left(\sum_i\left(\beta_{r,i}^j\right)^{\frac{1}{\eta^j}}\left(C_{r,i}^j\right)^{\frac{\eta^j-1}{\eta^j}}\right)^{\frac{\eta^j}{\eta^j-1}}}{\phi_r\beta_r^j}\right)^{\phi_r\beta_r^j} \tag{6}$$

where $C_r^{NT}$ is the consumption of nontraded goods, $\phi_r$ is the share of traded goods, $C_{r,i}^j$ is consumption of good $i$ of sector $j$, $\eta^j > 1$ is the elasticity of substitution across goods of sector $j$, and $\beta_r^j$, $\beta_{r,i}^j$ are taste parameters satisfying $\sum_j \beta_r^j = \sum_i \beta_{r,i}^j = 1$. The individual receives both labor income $W_r$ (out of inelastically supplying unit labor endowment) and profit income $\Gamma_r$ (out of the profits made by the firm that the individual supplies labor to in region $r$):

$$P_rC_r = P_r^{NT}C_r^{NT} + \sum_j P_r^jC_r^j = P_r^{NT}C_r^{NT} + \sum_j\sum_i P_{r,i}^jC_{r,i}^j = W_r + \Gamma_r \tag{7}$$

where $P_r$, $P_r^{NT}$, $P_r^j$ and $P_{r,i}^j$ are prices per units of $C_r$, $C_r^{NT}$, $C_r^j$ and $C_{r,i}^j$, respectively. The optimal allocation of any given expenditure yields the following demand function for $C_{r,i}^j$:

$$C_{r,i}^j = \phi_r \beta_r^j \beta_{r,i}^j \left(P_{r,i}^j\right)^{-\eta^j} \left(P_r^j\right)^{\eta^j - 1} P_r C_r \tag{8}$$

where $P_r^j \equiv \left(\sum_i \beta_{r,i}^j \left(P_{r,i}^j\right)^{1-\eta^j}\right)^{\frac{1}{1-\eta^j}}$ and $P_r = \left(P_r^{NT}\right)^{1-\phi_r} \prod_j \left(P_r^j\right)^{\phi_r \beta_r^j}$.

Firm $j$ of region $r$ is specialized in the production of good $r$ in sector $j$. For example, "Food and beverage and tobacco products" of Florida is a particular good within the sector of "Food and beverage and tobacco products", and it is produced by a unique firm in Florida. The production is achieved by using local labor and intermediate inputs according to the following production function:

$$Y_r^j = A_r^j \left(\frac{L_r^j}{l^j}\right)^{l^j} \left(\frac{G_r^j}{g^j}\right)^{g^j} \tag{9}$$

where $A_r^j$ represents sector- and region-specific technology, $L_r^j$ represents labor used, $G_r^j$ represents the composite intermediate input, and finally, $l^j$ and $g^j$ $(= 1 - l^j)$ represent sector-specific factor shares. The cost minimization problem of the firm results in the following marginal cost expression:

$$Z_r^j = \frac{\left(W_r\right)^{l^j} \left(Q_r^j\right)^{g^j}}{A_r^j} \tag{10}$$

where $Q_r^j$ is the price of $G_r^j$ that is further given by:

$$G_r^j \equiv \prod_k \left( \frac{\left( \sum_i \left(\gamma_{r,i}^{j,k}\right)^{\frac{1}{\eta^k}} \left(G_{r,i}^{j,k}\right)^{\frac{\eta^k-1}{\eta^k}} \right)^{\frac{\eta^k}{\eta^k-1}}}{\gamma^{j,k}} \right)^{\gamma^{j,k}} \tag{11}$$

where $G_{r,i}^{j,k}$ is the intermediate input of good $i$ of sector $k$ (which is produced in region $i$), $\gamma^{j,k}$ and $\gamma_{r,i}^{j,k}$ are technology parameters satisfying $\sum_k \gamma^{j,k} = \sum_i \gamma_{r,i}^{j,k} = 1$. The optimal allocation of any given expenditure yields the following demand function for $G_{r,i}^{j,k}$:

$$G_{r,i}^{j,k} = \gamma^{j,k}\gamma_{r,i}^{j,k} \left(P_{r,i}^{j,k}\right)^{-\eta^k} \left(Q_r^{j,k}\right)^{\eta^k-1} Q_r^j G_r^j \tag{12}$$

where $P_{r,i}^{j,k}$ and $Q_r^{j,k}$ are prices of $G_{r,i}^{j,k}$ and $G_r^{j,k}$, respectively, satisfying $Q_r^{j,k} \equiv \left( \sum_i \gamma_{r,i}^{j,k} \left(P_{r,i}^{j,k}\right)^{1-\eta^k} \right)^{\frac{1}{1-\eta^k}}$ and $Q_r^j = \prod\limits_k \left(Q_r^{j,k}\right)^{\gamma^{j,k}}$.

Since each firm sells its products as both final goods and intermediate inputs to all regions, the market clearing condition is implied as follows:

$$Y_r^j = \sum_i \tau_{i,r}^j C_{i,r}^j + \sum_i \sum_k \tau_{i,r}^j G_{r,i}^{k,j} \tag{13}$$

where $\tau_{i,r}^j > 1$ represents gross iceberg trade costs. Using Equations 8 and 12, the firm's profit maximization problem results in the following optimal-price expression:

$$P_{r,r}^{j*} = \frac{\eta^j Z_r^j}{\eta^j - 1} \tag{14}$$

which is measured at the source. Accordingly, the destination price at region $i$ is implied as $P_{i,r}^{j} = \tau_{i,r}^{j} P_{r,r}^{j*}$, while total expenditure of region $i$ for sector $j$ produced in region $r$ is implied as $P_{i,r}^{j} C_{i,r}^{j} = P_{r,r}^{j*} \tau_{i,r}^{j} C_{i,r}^{j} = P_{r,r}^{j*} Y_{i,r}^{j}$, with $Y_{i,r}^{j}$ representing the source quantity of sector $j$ products in region $r$ exported to region $i$. Hence, according to iceberg trade costs, it does not matter where the value (price times quantity) of trade is measured.

Since $l^{j} + g^{j} = 1$, Equation 14 implies the following expression for gross profits:

$$Y_{r}^{j} P_{r,r}^{j} = \left( \frac{\eta^{j}}{\eta^{j} - 1} \right) Y_{r}^{j} Z_{r}^{j} \tag{15}$$

This expression can be aggregated across regions to have:

$$\frac{\sum_{r} Y_{r}^{j} P_{r,r}^{j}}{\sum_{r} Y_{r}^{j} Z_{r}^{j}} = \frac{\eta^{j}}{\eta^{j} - 1} \tag{16}$$

which is a useful expression to estimate $\eta^{j}$'s when the corresponding production data are available as shown by Yilmazkuday (2012).

Per capita profits (that are equal across individuals supplying labor to this firm) are implied as follows:

$$\Gamma_{r} = \frac{Y_{r}^{j} Z_{r}^{j}}{L_{r}^{j} \left( \eta^{j} - 1 \right)} = \frac{W_{r}}{l^{j} \left( \eta^{j} - 1 \right)} \tag{17}$$

These profits are equalized across individuals in region $r$ (through the equalization of utilities) working in different sectors (e.g., $j$ and $k$) due to the mobility of labor within each region:

$$\Gamma_{r} = \frac{W_{r}}{l^{j} \left( \eta^{j} - 1 \right)} = \frac{W_{r}}{l^{k} \left( \eta^{k} - 1 \right)} = \chi W_{r} \tag{18}$$

It is implied that total per capita expenditure (Equation 7) in region $r$ is given by the following expression:

$$P_r C_r = (1 + \chi) W_r \tag{19}$$

Finally, nontraded goods are produced with zero profit according to $Y_r^{NT} = A_r^{NT} L_r^{NT}$, which implies that $P_r^{NT} = W_r / A_r^{NT}$.

## 5.2 Welfare Gains from Trade

We are interested in the change of utility that is given by:

$$WGT_r = \frac{C_r}{C_r'} = \frac{W_r P_r'}{W_r' P_r} \tag{20}$$

where $C_r$ represents the current utility, while $C_r'$ represents utility under a hypothetical case for investigation purposes; we will use the notation of $x'$ to represent any variable $x$ in the hypothetical case from this point on.

We start with finding an expression for $P_r$ by using $P_r = \left(P_r^{NT}\right)^{1-\phi_r} \prod_j \left(P_r^j\right)^{\phi_r \beta_r^j}$ and Equation 8 when $i = r$ as follows:

$$P_r = \left(P_r^{NT}\right)^{1-\phi_r} \prod_j \left( P_{r,r}^j \left( \frac{\phi_r \beta_r^j \beta_{r,r}^j}{\pi_{r,r}^j} \right)^{\frac{1}{1-\eta^j}} \right)^{\phi_r \beta_r^j} \tag{21}$$

This can be rewritten by using Equations 14 and 10, together with $P_{r,r}^{j} = \tau_{r,r}^{j} P_{r,r}^{j*}$ (where $\tau_{r,r}^{j}$ represents internal trade costs), as follows:

$$P_r = \left(P_r^{NT}\right)^{1-\phi_r} \prod_j \left( \left( \frac{\phi_r \beta_r^j \beta_{r,r}^j}{\pi_{r,r}^j} \right)^{\frac{1}{1-\eta^j}} \frac{\tau_{r,r}^j \eta^j \left(W_r\right)^{l^j} \left(Q_r^j\right)^{g^j}}{A_r^j \left(\eta^j - 1\right)} \right)^{\phi_r \beta_r^j} \tag{22}$$

where $\pi_{r,r}^{j} = \frac{P_{r,r}^{j} C_{r,r}^{j}}{P_r C_r}$ is the current home expenditure share of sector $j$ in region $r$. It is implied that:

$$\frac{P_r'}{P_r} = \left(\frac{W_r'}{W_r}\right)^{1-\phi_r} \prod_j \left( \left( \frac{\pi_{r,r}^j}{\pi_{r,r}^{j\prime}} \right)^{\frac{1}{1-\eta^j}} \left(\frac{W_r'}{W_r}\right)^{l^j} \left(\frac{Q_r^{j\prime}}{Q_r^j}\right)^{g^j} \right)^{\phi_r \beta_r^j} \tag{23}$$

In this expression, preferences of $\beta_r^j$'s and $\beta_{r,r}^j$'s, internal trade costs of $\tau_{r,r}^j$'s, technology parameters of $A_r^j$'s, and elasticities of $\eta^j$'s have effectively been cancelled out, since they are assumed to be the same between the current and hypothetical cases. Substituting this expression into Equation 20 results in the following expression after simple manipulations:

$$WGT_r = \prod_j \left( \left( \frac{\pi_{r,r}^j}{\pi_{r,r}^{j\prime}} \right)^{\frac{1}{1-\eta^j}} \left( \frac{Q_r^{j\prime}}{Q_r^j} \frac{W_r}{W_r'} \right)^{g^j} \right)^{\beta_r^j} \tag{24}$$

where

$$\left( \frac{Q_r^{j\prime}}{Q_r^j} \frac{W_r}{W_r'} \right) = \prod_k \left( \left( \frac{\kappa_{r,r}^{j,k}}{\kappa_{r,r}^{j,k\prime}} \right)^{\frac{1}{1-\eta^k}} \left( \frac{Q_r^{k\prime}}{Q_r^k} \frac{W_r}{W_r'} \right)^{g^k} \right)^{\gamma^{j,k}} \tag{25}$$

corresponds to a system of equations that are log-linear in $\frac{Q_r^{j\prime}}{Q_r^j} \frac{W_r}{W_r'}$'s. This system can be solved for each region $r$ individually after taking logs and representing everything in matrix format as $\mathbf{Q} = \left(\mathbf{I} - \mathbf{g}\right)^{\mathbf{-1}} \mathbf{K}\mathbf{v}$. In this expression, $\mathbf{Q}$ is a region-$r$ specific vector (of size $J \times 1$) consisting of $\log \left( \frac{Q_r^{j\prime}}{Q_r^j} \frac{W_r}{W_r'} \right)$'s, $\mathbf{I}$ is the identity matrix (of size $J \times J$), $\mathbf{g}$ is a matrix (of size $J \times J$) consisting of $g^k \gamma^{j,k}$'s, $\mathbf{K}$ is a matrix (of size $J \times J$) consisting of $\log \left( \frac{\kappa_{r,r}^{j,k}}{\kappa_{r,r}^{j,k\prime}} \right)^{\frac{\gamma^{j,k}}{1-\eta^k}}$'s, $\mathbf{v}$ is a vector of ones (of size $J \times 1$), with $J$ representing the number of sectors and $\kappa_{r,r}^{j,k} = \frac{P_{r,r}^{k} G_{r,r}^{j,k}}{Q_r^j G_r^j}$ representing the share of home intermediate inputs of sector $k$ used in the production of sector $j$ products.

For the calculation of Equation 24, one only needs information on the expenditure share of $\frac{\pi_{r,r}^{j}}{\pi_{r,r}^{j\prime}}$ and $\frac{\kappa_{r,r}^{j,k}}{\kappa_{r,r}^{j,k\prime}}$ as well the parameters of $\eta^j$'s, $g^j$'s, $\beta_r^j$'s, and $\gamma^{j,k}$'s. Hence, we do not need any information on either wages (of $W_r$ and $W_r'$) or intermediate input prices (of $Q_r^j$ and $Q_r^{j\prime}$), since they are calculated according to Equation 25, where we only need information on $\kappa_{r,r}^{j,k}$'s, $\kappa_{r,r}^{j,k\prime}$'s, $g^k$'s and $\gamma^{j,k}$'s. Similarly, we do not impose any restrictions (across regions) on preferences of $\beta_r^j$'s and $\beta_{r,r}^j$'s or technology parameters of $A_r^j$'s, either; i.e., preferences can be uniform or variable, and technology can be mobile or immobile across regions of a country.

In sum, we keep parameters the same between the current and hypothetical cases, the current expenditure shares of $\pi_{r,r}^{j}$ and $\kappa_{r,r}^{j,k}$ are given by the current data, and wages and intermediate-input prices are identified through these measures in Equation 25. Therefore, the definition of expenditure shares in the hypothetical case ($\pi_{r,r}^{j\prime}$ and $\kappa_{r,r}^{j,k\prime}$) plays an important role in the determination of welfare gains from trade, which we focus on next.

### 5.2.1 Domestic versus International Welfare Gains from Trade

While calculating the welfare gains from trade, we would like to distinguish between *domestic* and *international* imports, where the former is defined as imports coming from regions within the same country, while the latter is defined as imports coming from other countries. In order to keep things simple, we consider all *international* imports of a region as the products coming from region $F$ representing the combination of countries other than the *domestic* country. In terms of definitions, we use the phrase of *home products* to represent goods produced within the same region, *domestic products* to represent goods produced within the same country (i.e., products coming from all domestic regions), and *international products* to represent goods imported from other countries (i.e., the rest of the world internationally).

Within this context, while calculating the welfare gains from trade, we focus on two alternative definitions of autarky. The first one is what we call as the *full* autarky ($fa$), with the corresponding notation of $\pi^{j\prime}_{r,r}(fa)$, $\kappa^{j,k\prime}_{r,r}(fa)$ and $WGT_r(fa)$, which follows the literature by setting $\pi^{j\prime}_{r,r}(fa) = \kappa^{j,k\prime}_{r,r}(fa) = 1$ in Equations 24 and 25. This corresponds to the case in which region $r$ does not import products from any other region, either domestically or internationally.

The second definition deviates from the literature by focusing on *international* autarky ($ia$) that is defined as the case in which region $r$ imports products from all *domestic* regions within the same country, but it does not have any *international* imports. Since international imports are represented by products coming from region $F$, when we shut down international imports in region $r$ for the hypothetical case, the hypothetical home expenditure share of final goods is given by:

$$\pi^{j\prime}_{r,r}(ia) = \frac{P^j_{r,r}C^j_{r,r}}{P_rC_r - P^j_{r,F}C^j_{r,F}} = \frac{P^j_{r,r}C^j_{r,r}}{\sum_{i\neq F}\sum_j P^j_{r,i}C^j_{r,i}} \tag{26}$$

which, according to the second equality, also represents the current final home expenditure share of sector $j$ within all domestic products (coming from all domestic regions). Similarly, the hypothetical home expenditure share of intermediate inputs is given by:

$$\kappa^{j,k\prime}_{r,r}(ia) = \frac{P^k_{r,r}G^{j,k}_{r,r}}{Q^j_rG^j_r - P^{j,k}_{r,F}G^{j,k}_{r,F}} = \frac{P^k_{r,r}G^{j,k}_{r,r}}{\sum_{i\neq F}\sum_k P^{j,k}_{r,i}G^{j,k}_{r,i}} \tag{27}$$

According to the second equality, this expression also represents the current home expenditure share of intermediate input $k$ within all domestic intermediate inputs used in the production of sector $j$ products in region $r$ (coming from all domestic regions). It is implied that the ratio between the current and hypothetical home expenditure shares on final goods that can be used in Equation 24 is given by:

$$\frac{\pi_{r,r}^{j}}{\pi_{r,r}^{j\prime}\left(ia\right)} = \frac{\sum_{i\neq F}\sum_{j} P_{r,i}^{j} C_{r,i}^{j}}{P_{r} C_{r}} \tag{28}$$

This expression also represents the current domestic expenditure share of sector $j$ in region $r$ within its overall expenditure. Similarly, the ratio between the current and hypothetical home expenditure shares on intermediate inputs that can be used in Equation 25 is given by:

$$\frac{\kappa_{r,r}^{j,k}}{\kappa_{r,r}^{j,k\prime}\left(ia\right)} = \frac{\sum_{i\neq F}\sum_{k} P_{r,i}^{j,k} G_{r,i}^{j,k}}{Q_{r}^{j} G_{r}^{j}} \tag{29}$$

which also represents the current domestic expenditure share of sector $k$ used in the production of sector $j$ products in region $r$ within overall domestic expenditure. We denote the corresponding welfare gains measuring the costs of international autarky by $WGT_{r}\left(ia\right)$.

In order to show the contribution of domestic trade to overall welfare gains from trade $WGT_{r}\left(fa\right)$, we define the domestic welfare gains from trade as follows:

$$WGT_{r}\left(da\right) = \frac{WGT_{r}\left(fa\right)}{WGT_{r}\left(ia\right)} \tag{30}$$

which can be calculated according to Equation 24 by using the following ratio between the current $\pi_{r,r}^{j}$ and hypothetical $\pi_{r,r}^{j\prime}\left(da\right)$ home expenditure shares on final goods in the case of domestic autarky $(da)$ that is defined as the case in which region $r$ consumes its own products as well as international imports, but it does not import any products from other *domestic* regions within the same country:

$$\frac{\pi_{r,r}^{j}}{\pi_{r,r}^{j\prime}(da)} = \pi_{r,r}^{j\prime}(ia) = \frac{P_{r,r}^{j}C_{r,r}^{j}}{\sum_{i\neq F}\sum_{j}P_{r,i}^{j}C_{r,i}^{j}} \tag{31}$$

which is the current final home expenditure share of sector $j$ within all domestic products (coming from all domestic regions) as in Equation 26, and the following ratio between the current and hypothetical home expenditure shares on intermediate inputs:

$$\frac{\kappa_{r,r}^{j,k}}{\kappa_{r,r}^{j,k\prime}(da)} = \kappa_{r,r}^{j,k\prime}(ia) = \frac{P_{r,r}^{k}G_{r,r}^{j,k}}{\sum_{i\neq F}\sum_{k}P_{r,i}^{j,k}G_{r,i}^{j,k}} \tag{32}$$

which is the current home expenditure share of intermediate input $k$ within all domestic intermediate inputs used in the production of sector $j$ products in region $r$ (coming from all domestic regions) as in Equation 27. Although the hypothetical case of domestic autarky may not be realistic, it is useful to measure and compare the effects of domestic versus international welfare gains from trade from an accounting perspective, as we achieve next.[7]

According to Equation 30, we can also decompose overall welfare gains from trade $WGT_r(fa)$ into domestic welfare gains from trade $WGT_r(da)$ and international welfare gains from trade

[7] One caveat with the approach used here is the underlying assumption that the ratio of home, foreign or international consumption shares are assumed to stay constant under different "autarkies." In particular, if a state goes to international autarky, the hypothetical home expenditure share relative to foreign consumption is unchanged. Similarly, if a state goes into domestic autarky, the ratio of the hypothetical home expenditure share relative to the international expenditure share is constant. Accordingly, the current accounting exercise is meant to be "all else equal," where disproportional changes in home expenditure shares due to heterogeneities across states (e.g., depending on their geographic location) are not investigated.

$WGT_r\,(ia)$ as follows:

$$\underbrace{\log WGT_r\,(fa)}_{\text{Overall WGT}} = \underbrace{\log WGT_r\,(da)}_{\text{Domestic WGT}} + \underbrace{\log WGT_r\,(ia)}_{\text{International WGT}} \tag{33}$$

which can be rewritten as follows for each region $r$:

$$1 = \frac{\log WGT_r\,(da)}{\log WGT_r\,(fa)} + \frac{\log WGT_r\,(ia)}{\log WGT_r\,(fa)} \tag{34}$$

where the first term represents the contribution of domestic welfare gains, while the second term represents the contribution of international welfare gains.

## 5.3 Special Cases

Certain special cases of this model (used in the main text) can be obtained as follows:

- The special case of one-sector-labor-only (OSLO) model corresponds to having $\beta_r^j = \gamma^{j,k} = 1$, $g^k = g^j = g = 0$, $\pi_{r,r}^j = \pi_{r,r}$, $\kappa_{r,r}^{j,k} = \kappa_{r,r}$, and $\eta^j = \eta^k = \eta$ for all $j$,$k$.
- The special case of one-sector model with input-output linkages (OSIO) corresponds to having $\beta_r^j = \gamma^{j,k} = 1$, $g^k = g^j = g$, $\pi_{r,r}^j = \pi_{r,r}$, $\kappa_{r,r}^{j,k} = \kappa_{r,r}$, and $\eta^j = \eta^k = \eta$ for all $j$,$k$.
- The special case of multi-sector-labor-only (MSLO) model corresponds to having $g^j = 0$ for all $j$.

### 5.4 Implications for the U.S.

Having the welfare measures at the state level, we would like to know their implications for the U.S. at the aggregate level. Accordingly, considering the utility function in Equation 6 in a particular state, we define the utility function in the U.S. as follows:

$$C_{US} = \prod_{r} (C_r)^{\varphi_r}$$

where $\varphi_r = H_r P_r C_r / \left(\sum_r H_r P_r C_r\right)$ represents the expenditure share of state $r$ within the U.S., with $H_r$ representing the number of individuals in state $r$. The welfare gains from trade in the U.S. are implied as follows:

$$WGT_{US} = \frac{C_{US}}{C'_{US}} = \prod_{r} \left(\frac{C_r}{C'_r}\right)^{\varphi_r} = \prod_{r} (WGT_r)^{\varphi_r}$$

where the last equality is implied by Equation 20. Regarding the decomposition of domestic versus international welfare gains from trade, this expression can be written in log form by using Equation 33 as follows:

$$\underbrace{\log WGT_{US}(fa)}_{\text{Overall WGT}} = \underbrace{\sum_{r} \varphi_r \log\left(WGT_r(da)\right)}_{\text{Domestic WGT}} + \underbrace{\sum_{r} \varphi_r \log\left(WGT_r(ia)\right)}_{\text{International WGT}} \tag{35}$$

where the left hand side represents the overall welfare gains from trade, the first right hand side variable represents domestic welfare gains from trade, and the second right hand side variable represents international welfare gains from trade. Compared to the existing literature that focuses only on the international welfare gains of $\left(\sum_r \varphi_r \log\left(WGT_r(ia)\right)\right)$, our analysis can reveals important information on domestic welfare gains of $\left(\sum_r \varphi_r \log\left(WGT_r\left(da\right)\right)\right)$ that are new in this paper.

### 5.5 Data

Since the calculation of expenditure shares (that are necessary for the determination of domestic and international welfare gains from trade) require data on both domestic and international imports, we focus on the state-level data from the U.S. for the year of 2012.

State-level domestic data are from Commodity Flow Survey (CFS) covering bilateral trade across states, including internal trade within each state.[8] The CFS captures data on shipments originating from select types of business establishments located in the 50 states and the District of Columbia. To collect the data, these establishments were mailed a questionnaire once every quarter of 2012, asking about details about their shipment such as the value of their shipment, the good category/definition, U.S. destination, whether it is an international export, etc. CFS puts the replies to these questionnaires together to estimate the total value of shipments between states. Since collection of data through questionnaires are subject to errors, CFS uses sophisticated survey techniques to obtain the sum of weighted shipment data that are comparable with other data sets (e.g., international trade data as in this paper). We ignore the problematic international shipments in CFS data and directly focus on the domestic shipments of establishments within the U.S. to have an investigation that is consistent with our model. Since CFS can identify shipments from wholesale/retail

[8]The data can be downloaded at https://www.census.gov/econ/cfs/.

establishments, following Hillberry and Hummels (2003), we are also able to ignore these problematic observations.[9]

State-level international imports data are from U.S. Census Bureau. It is important to emphasize that the filing requirements for imports do specify to report the state of *ultimate* destination (i.e., the destination of consumption or use) and the country of origin. Accordingly, except for the issues in filing that we cannot detect, the international data set is consistent with our model as well.[10] We focus on the combination of these domestic and international imports data sets, which results in the coverage of 19 three-digit NAICS sectors, covering mining (except oil and gas) and manufacturing sectors. The list of these sectors is given in Appendix Table A.1.

When the complete version of the model is used in order to calculate welfare gains from trade (according to Equation 24), where we need expenditure share information on both final goods and intermediate inputs, following Hillberry and Hummels (2008), we decompose overall trade data into final goods and intermediate inputs by using input-output tables for the U.S. for the year of 2012 from Bureau of Economic Analysis.[11] These tables include information on the use of commodities produced by each NAICS industry and consumed by each NAICS industry as well as personal consumption expenditure; hence, for each destination state, we can identify the share of intermediate inputs consumed by each NAICS industry (and by final consumers given in Appendix Table A.1) within the overall value of imports

[9]The distance traveled by each freight shipment reported by the respondents to the 2012 CFS is estimated by a software tool called GeoMiler that uses routing algorithms and an integrated, intermodal transportation network that has been developed and updated expressly for this purpose. More technical details can be found at https://www.census.gov/econ/cfs/.

[10]More technical details about this data set can be found at https://www.census.gov/foreign-trade/guide/index.html.

[11]The corresponding "Use of Commodities by Industries" data are obtained from https://www.bea.gov/industry/io_annual.htm.

coming from a particular source. Once expenditures on final goods and intermediate inputs are identified for each NAICS industry, they are further used to construct region-specific expenditure shares of $\beta_r^j$'s and $\kappa_{r,r}^{j,k}$'s. The input-output tables also provide information on the factor shares of $\gamma^{j,k}$'s and $g^j$'s across all NAICS sectors, where one minus the latter (i.e., sector-specific labor shares of $l^j = 1 - g^j$'s) are represented in Appendix Table A.1.

Finally, using Equation 16, as in Yilmazkuday (2012), we identify the elasticity of substitution $\eta^j$ for each NAICS sector by using the very same input-output tables, where the total revenue for sector $j$ across all U.S. regions $\sum_r Y_r^j P_{r,r}^j$ is calculated as the summation of "intermediate-input expenditure" and "total value added," and the total cost for sector $j$ across all U.S. regions $\sum_r Y_r^j Z_r^j$ is calculated as the summation of "intermediate-input expenditure" and "compensation of employees." The corresponding $\eta^j$ measures are given in Appendix Table A.1, with an average of 5.327 across sectors and a range between 1.385 and 10.229; these values are highly consistent with the estimates of $\eta^j$ in the literature (e.g., see the estimates and the literature covered in Yilmazkuday (2012)).

When the number of goods is restricted to one (as shown in Equation 2, below), welfare gains from trade calculations require the aggregate-level measures of $\pi_{r,r}$, $\kappa_{r,r}$, $\eta$ and $g$. When intermediate-input trade is shut down by setting $g^j = 0$ for all $j$ (as shown in Equation 3, below), we need sector-level measures of $\pi_{r,r}^j$, $\beta_r^j$ and $\eta^j$, this time $\pi_{r,r}^j$ and $\beta_r^j$ representing the statistics from the overall trade (rather than just final goods as in the complete case). When the first two restrictions are combined (as shown in Equation 1, below), we need the aggregate-level measures of $\pi_{r,r}$ and $\eta$, where the calculation of $\pi_{r,r}$ in this case considers trade in both final and intermediate-inputs. We calculate all of these statistics from the very same input-output tables introduced above by achieving the necessary aggregations (implied by the details of the model) across our NAICS sectors.

Based on these definitions, Appendix Table A.2 provides state-level measures of home expenditure share (defined as the expenditure of a state on its own products), foreign expenditure share (defined as the expenditure of a state on products coming from other states) and international expenditure share (defined as the expenditure of a state on products coming from other countries). As is evident, international expenditure share is only about 17.5% on average across states with a range between 4.8% and 35.9%, while the foreign expenditure share is about 60.7% on average across states with a range between 33.9% and 83.2%. It is implied that a big portion of a state's expenditure is on the products of other states rather than the state's own products or other international products.

## Table 1 - Welfare Gains from Trade

| | Full Autarky | | | | International Autarky | | | | Domestic Autarky | | | | Domestic over Full Autarky | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OSLO | OSIO | MSLO | MSIO | OSLO | OSIO | MSLO | MSIO | OSLO | OSIO | MSLO | MSIO | OSLO | OSIO | MSLO | MSIO |
| Average of Ocean States | 0.690 | 2.223 | 1.414 | 7.559 | 0.103 | 0.323 | 0.184 | 0.666 | 0.587 | 1.900 | 1.230 | 6.893 | 0.842 | 0.849 | 0.869 | 0.915 |
| Average of Great Lakes States | 0.580 | 1.843 | 0.710 | 4.897 | 0.076 | 0.241 | 0.072 | 0.300 | 0.503 | 1.602 | 0.638 | 4.597 | 0.870 | 0.871 | 0.897 | 0.939 |
| Average of Landlocked States | 0.649 | 2.114 | 1.355 | 7.771 | 0.055 | 0.175 | 0.064 | 0.232 | 0.594 | 1.938 | 1.291 | 7.539 | 0.917 | 0.918 | 0.948 | 0.966 |
| Average of All States | 0.635 | 2.054 | 1.244 | 7.086 | 0.075 | 0.238 | 0.112 | 0.408 | 0.560 | 1.816 | 1.132 | 6.678 | 0.878 | 0.882 | 0.906 | 0.941 |
| Minimum of All States | 0.242 | 0.923 | 0.524 | 3.693 | 0.019 | 0.067 | 0.024 | 0.091 | 0.193 | 0.783 | 0.441 | 3.227 | 0.741 | 0.762 | 0.720 | 0.846 |
| Maximum of All States | 1.154 | 3.574 | 6.147 | 24.489 | 0.171 | 0.518 | 0.788 | 2.399 | 1.087 | 3.428 | 5.360 | 24.281 | 0.962 | 0.960 | 0.989 | 0.991 |
| United States | - | - | - | - | 0.089 | 0.281 | 0.177 | 0.384 | | | | | - | - | - | - |

**Notes:** Full autarky is defined as the case in which the state consumes only its own products. International autarky is defined as th e case in which the state consumes both its own products and products coming from other states, excluding international imports. The measures of domestic autarky are calculated as the difference between the cases of full and international autarky. OSLO stands for one-sector-labor-only model, OSIO stands for one-sector model with input-output linkages, MSLO stands for multiple-sector-labor-only model, MSIO stands for multiple-sector model with input-output linkages. United States values have been calculated by using the corresponding aggregates across states.

## Table 2 - State-Specific Measures

| | Home Share ($w_{r,r}$) | Foreign Share | International Share |
|---|---|---|---|
| **Average of Ocean States** | 0.198 | 0.568 | 0.234 |
| **Average of Great Lakes States** | 0.223 | 0.598 | 0.180 |
| **Average of Landlocked States** | 0.207 | 0.662 | 0.131 |
| **Average of All States** | 0.218 | 0.607 | 0.175 |
| **Minimum of All States** | 0.049 | 0.339 | 0.048 |
| **Maximum of All States** | 0.531 | 0.832 | 0.359 |
| **United States** | 0.793 | - | 0.207 |

**Notes:** Home share, foreign share, and international shares represent the average expenditure shares of state groups on their own products, products imported from other states, and products imported from other countries, respectively. United States values have been calculated by using the corresponding aggregates across states.

Figure 1 - Comparison across Alternative Models
Share of Domestic Welfare Gains in Overall Welfare Gains

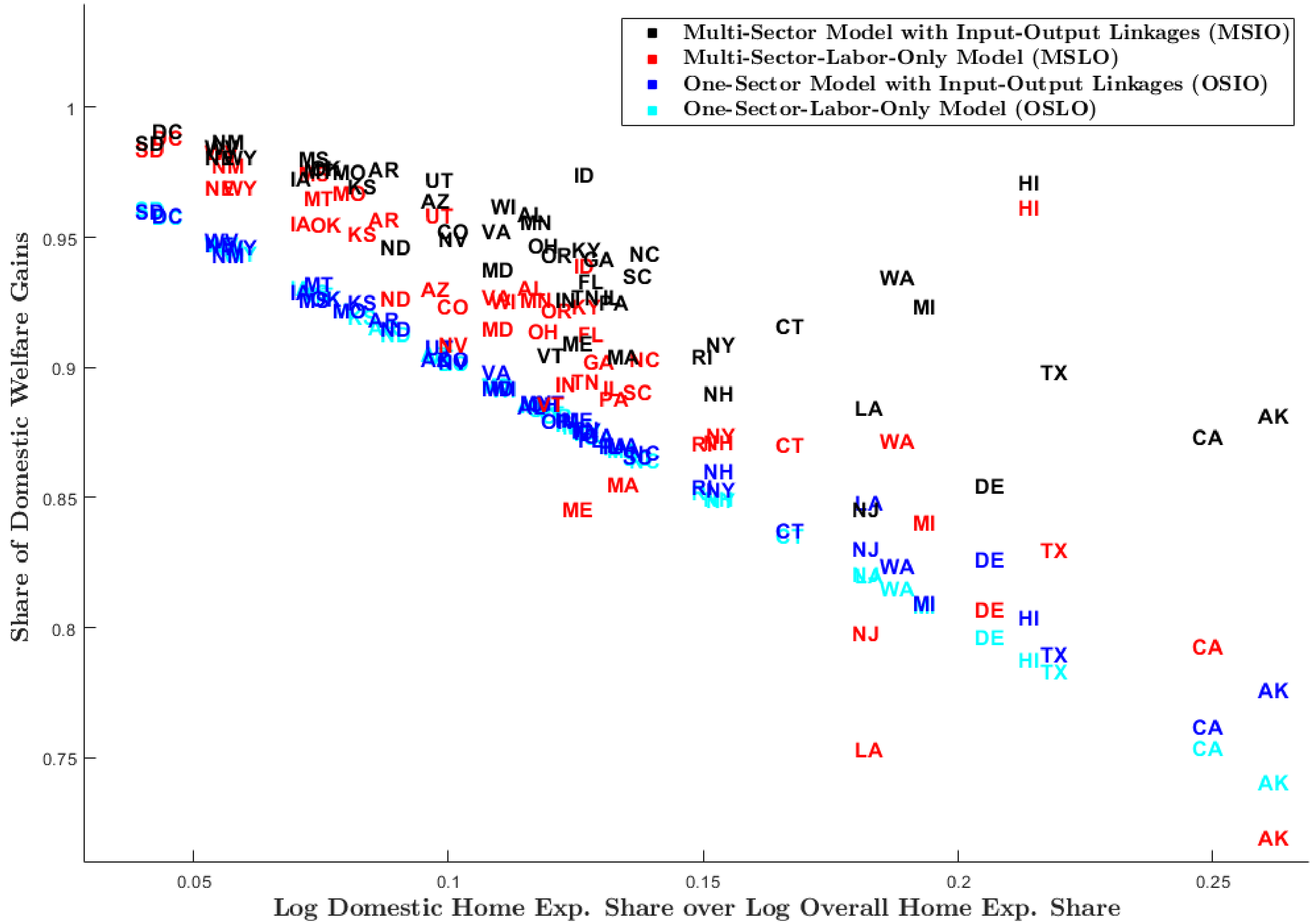
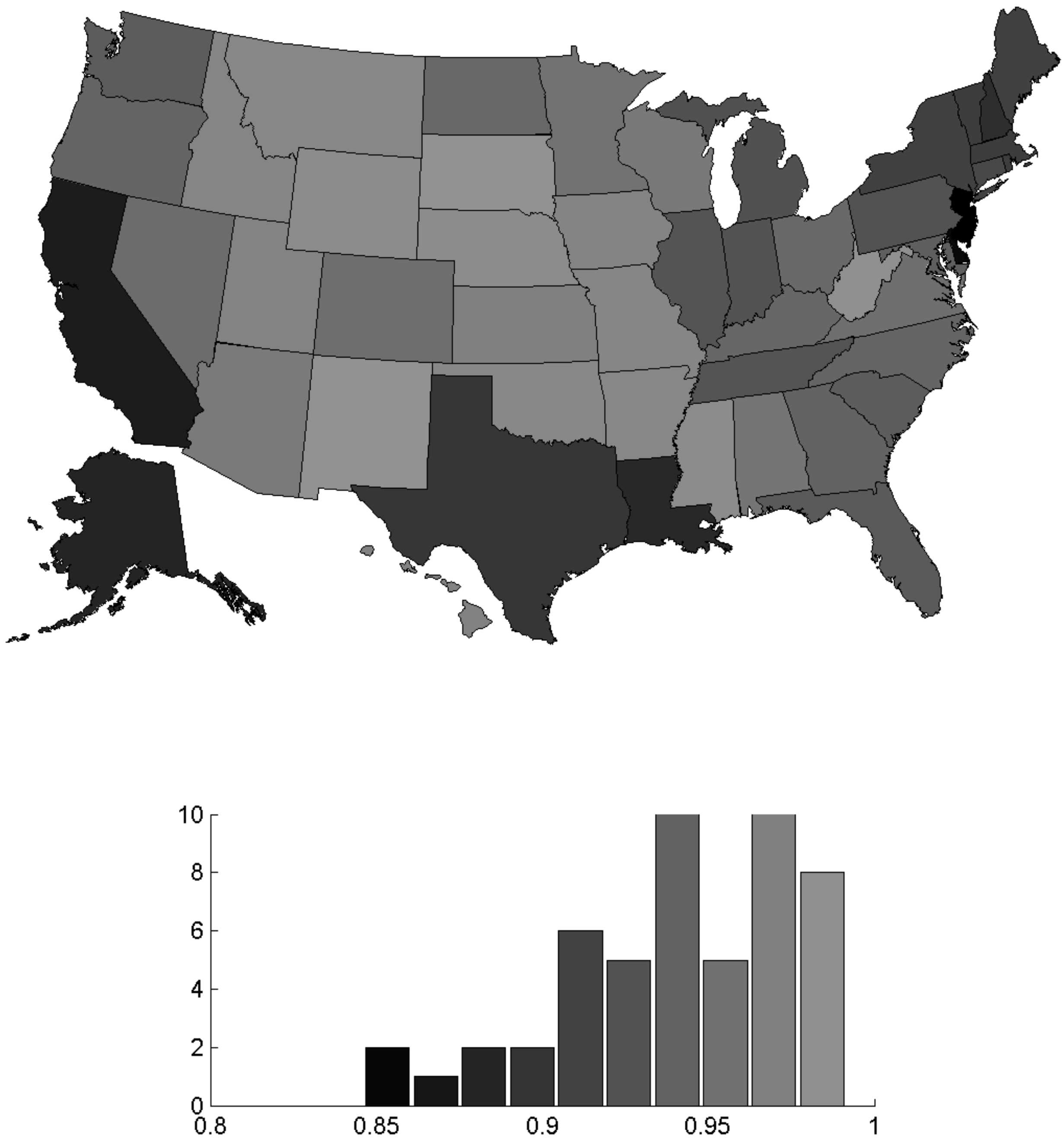


**Figure 2 - Domestic versus Overall Welfare Gains from Trade**
**Multi-Sector Model with Input-Output Linkages (MSIO)**





Notes: The values show the domestic over overall percentage welfare gains from trade in Appendix Table A.3.

## Appendix Table A.1 - Sector-Specific Measures

| NAICS Sector Code | Description | $\eta$ | Labor Share | Final-Consumption Shares |
|---|---|---|---|---|
| 212 | Mining, except oil and gas | 1.796 | 0.388 | 0.006 |
| 311-312 | Food and beverage and tobacco products | 3.565 | 0.260 | 0.753 |
| 313-314 | Textile mills and textile product mills | 7.907 | 0.334 | 0.452 |
| 315-316 | Apparel and leather and allied products | 10.229 | 0.429 | 0.940 |
| 321 | Wood products | 7.275 | 0.385 | 0.093 |
| 322 | Paper products | 5.914 | 0.262 | 0.224 |
| 323 | Printing and related support activities | 5.270 | 0.504 | 0.582 |
| 324 | Petroleum and coal products | 1.385 | 0.300 | 0.788 |
| 325 | Chemical products | 2.514 | 0.235 | 0.404 |
| 326 | Plastics and rubber products | 5.580 | 0.274 | 0.226 |
| 327 | Nonmetallic mineral products | 4.726 | 0.411 | 0.218 |
| 331 | Primary metals | 6.672 | 0.190 | 0.003 |
| 332 | Fabricated metal products | 6.001 | 0.375 | 0.072 |
| 333 | Machinery | 6.010 | 0.323 | 0.092 |
| 334 | Computer and electronic products | 2.632 | 0.635 | 0.415 |
| 335 | Electrical equipment, appliances, and components | 5.422 | 0.376 | 0.472 |
| 336 | Transportation equipment | 5.887 | 0.239 | 0.486 |
| 337 | Furniture and related products | 8.713 | 0.387 | 0.893 |
| 339 | Miscellaneous manufacturing | 3.711 | 0.525 | 0.862 |
| Average | - | 5.327 | 0.360 | 0.420 |
| Minimum | - | 1.385 | 0.190 | 0.003 |
| Maximum | - | 10.229 | 0.635 | 0.940 |
| Aggregate | One-sector equivalent measure | 3.612 | 0.318 | 0.479 |

**Notes:** Sector-specific measures of elasticity of substitution $\eta$, factor share of labor, and final-consumption share have been calculated using input-output data of "Use of Commodities by Industries" obtained from the U.S. Bureau of Economic Analysis for the year of 2012. Final-consumption share represents the share of products of a particular NAICS sector used as final consumption goods; hence, one minus final-consumption share corresponds to the share of products of a particular NAICS sector used as intermediate inputs.

Appendix Table A.2 - State-Specific Measures

| State | State-Code | Home Share ($w_{r,r}$) | Foreign Share | International Share | $w'_{r,r}(ia)$ | $w'_{r,r}(da)$ |
|---|---|---|---|---|---|---|
| Alabama | AL | 0.304 | 0.570 | 0.126 | 0.348 | 0.874 |
| Alaska | AK | 0.493 | 0.339 | 0.167 | 0.592 | 0.833 |
| Arizona | AZ | 0.165 | 0.678 | 0.157 | 0.195 | 0.843 |
| Arkansas | AR | 0.295 | 0.607 | 0.098 | 0.327 | 0.902 |
| California | CA | 0.231 | 0.466 | 0.302 | 0.332 | 0.698 |
| Colorado | CO | 0.239 | 0.631 | 0.131 | 0.275 | 0.869 |
| Connecticut | CT | 0.201 | 0.567 | 0.232 | 0.262 | 0.768 |
| Delaware | DE | 0.242 | 0.507 | 0.250 | 0.323 | 0.750 |
| District of Columbia | DC | 0.052 | 0.832 | 0.117 | 0.058 | 0.883 |
| Florida | FL | 0.132 | 0.644 | 0.224 | 0.170 | 0.776 |
| Georgia | GA | 0.136 | 0.641 | 0.223 | 0.175 | 0.777 |
| Hawaii | HI | 0.527 | 0.346 | 0.127 | 0.603 | 0.873 |
| Idaho | ID | 0.146 | 0.641 | 0.213 | 0.186 | 0.787 |
| Illinois | IL | 0.176 | 0.621 | 0.202 | 0.221 | 0.798 |
| Indiana | IN | 0.255 | 0.593 | 0.153 | 0.300 | 0.847 |
| Iowa | IA | 0.259 | 0.652 | 0.089 | 0.285 | 0.911 |
| Kansas | KS | 0.216 | 0.668 | 0.115 | 0.245 | 0.885 |
| Kentucky | KY | 0.211 | 0.614 | 0.176 | 0.255 | 0.824 |
| Louisiana | LA | 0.531 | 0.361 | 0.107 | 0.595 | 0.893 |
| Maine | ME | 0.209 | 0.617 | 0.174 | 0.253 | 0.826 |
| Maryland | MD | 0.082 | 0.684 | 0.234 | 0.107 | 0.766 |
| Massachusetts | MA | 0.127 | 0.636 | 0.237 | 0.167 | 0.763 |
| Michigan | MI | 0.179 | 0.541 | 0.280 | 0.249 | 0.720 |
| Minnesota | MN | 0.217 | 0.623 | 0.160 | 0.258 | 0.840 |
| Mississippi | MS | 0.218 | 0.680 | 0.102 | 0.242 | 0.898 |
| Missouri | MO | 0.242 | 0.654 | 0.104 | 0.270 | 0.896 |
| Montana | MT | 0.393 | 0.543 | 0.065 | 0.420 | 0.935 |
| Nebraska | NE | 0.215 | 0.707 | 0.077 | 0.233 | 0.923 |
| Nevada | NV | 0.088 | 0.700 | 0.212 | 0.112 | 0.788 |
| New Hampshire | NH | 0.074 | 0.603 | 0.323 | 0.110 | 0.677 |
| New Jersey | NJ | 0.119 | 0.564 | 0.317 | 0.174 | 0.683 |
| New Mexico | NM | 0.222 | 0.701 | 0.077 | 0.240 | 0.923 |
| New York | NY | 0.084 | 0.605 | 0.311 | 0.122 | 0.689 |
| North Carolina | NC | 0.196 | 0.606 | 0.198 | 0.244 | 0.802 |
| North Dakota | ND | 0.225 | 0.654 | 0.121 | 0.256 | 0.879 |
| Ohio | OH | 0.258 | 0.598 | 0.145 | 0.301 | 0.855 |
| Oklahoma | OK | 0.282 | 0.630 | 0.088 | 0.309 | 0.912 |
| Oregon | OR | 0.153 | 0.648 | 0.199 | 0.191 | 0.801 |
| Pennsylvania | PA | 0.212 | 0.606 | 0.182 | 0.259 | 0.818 |
| Rhode Island | RI | 0.049 | 0.592 | 0.359 | 0.077 | 0.641 |
| South Carolina | SC | 0.136 | 0.629 | 0.235 | 0.178 | 0.765 |
| South Dakota | SD | 0.166 | 0.767 | 0.067 | 0.178 | 0.933 |
| Tennessee | TN | 0.110 | 0.650 | 0.240 | 0.145 | 0.760 |
| Texas | TX | 0.386 | 0.428 | 0.186 | 0.474 | 0.814 |
| Utah | UT | 0.214 | 0.649 | 0.137 | 0.248 | 0.863 |
| Vermont | VT | 0.067 | 0.661 | 0.271 | 0.092 | 0.729 |
| Virginia | VA | 0.234 | 0.623 | 0.143 | 0.273 | 0.857 |
| Washington | WA | 0.337 | 0.481 | 0.182 | 0.412 | 0.818 |
| West Virginia | WV | 0.142 | 0.761 | 0.097 | 0.157 | 0.903 |
| Wisconsin | WI | 0.263 | 0.603 | 0.135 | 0.303 | 0.865 |
| Wyoming | WY | 0.412 | 0.540 | 0.048 | 0.433 | 0.952 |
| Average | - | 0.218 | 0.607 | 0.175 | 0.260 | 0.825 |
| Minimum | - | 0.049 | 0.339 | 0.048 | 0.058 | 0.641 |
| Maximum | - | 0.531 | 0.832 | 0.359 | 0.603 | 0.952 |
| United States | US | 0.793 | - | 0.207 | - | - |

**Notes:** Home share, foreign share, and international shares represent the expenditure share of the state on its own products, products imported from other states, and products imported from other countries, respectively.

Appendix Table A.3 - Welfare Gains from Trade

| State | Full Autarky | | | | International Autarky | | | | Domestic over Full Autarky | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | OSLO | OSIO | MSLO | MSIO | OSLO | OSIO | MSLO | MSIO | OSLO | OSIO | MSLO | MSIO |
| Alabama | 0.456 | 1.465 | 0.576 | 4.784 | 0.052 | 0.168 | 0.040 | 0.194 | 0.886 | 0.885 | 0.931 | 0.959 |
| Alaska | 0.271 | 1.056 | 1.024 | 7.000 | 0.070 | 0.236 | 0.287 | 0.829 | 0.741 | 0.776 | 0.720 | 0.882 |
| Arizona | 0.690 | 2.150 | 0.949 | 5.566 | 0.065 | 0.207 | 0.066 | 0.199 | 0.905 | 0.904 | 0.931 | 0.964 |
| Arkansas | 0.467 | 1.584 | 0.686 | 5.109 | 0.039 | 0.128 | 0.029 | 0.119 | 0.916 | 0.919 | 0.958 | 0.977 |
| California | 0.561 | 1.843 | 0.741 | 3.693 | 0.138 | 0.438 | 0.153 | 0.466 | 0.754 | 0.762 | 0.793 | 0.874 |
| Colorado | 0.548 | 1.775 | 0.736 | 4.199 | 0.054 | 0.171 | 0.056 | 0.198 | 0.902 | 0.904 | 0.924 | 0.953 |
| Connecticut | 0.614 | 1.951 | 0.953 | 6.881 | 0.101 | 0.316 | 0.123 | 0.577 | 0.836 | 0.838 | 0.871 | 0.916 |
| Delaware | 0.543 | 2.087 | 1.637 | 8.042 | 0.110 | 0.362 | 0.316 | 1.164 | 0.797 | 0.827 | 0.807 | 0.855 |
| District of Columbia | 1.135 | 3.574 | 4.437 | 24.489 | 0.047 | 0.146 | 0.049 | 0.208 | 0.958 | 0.959 | 0.989 | 0.991 |
| Florida | 0.775 | 2.423 | 1.747 | 8.634 | 0.097 | 0.309 | 0.151 | 0.574 | 0.875 | 0.873 | 0.913 | 0.934 |
| Georgia | 0.764 | 2.417 | 0.980 | 6.843 | 0.097 | 0.304 | 0.095 | 0.396 | 0.874 | 0.874 | 0.903 | 0.942 |
| Hawaii | 0.245 | 0.985 | 1.388 | 6.218 | 0.052 | 0.192 | 0.053 | 0.177 | 0.788 | 0.805 | 0.962 | 0.971 |
| Idaho | 0.736 | 2.384 | 2.308 | 14.532 | 0.092 | 0.296 | 0.139 | 0.372 | 0.875 | 0.876 | 0.940 | 0.974 |
| Illinois | 0.665 | 2.154 | 0.902 | 4.962 | 0.087 | 0.280 | 0.097 | 0.360 | 0.870 | 0.870 | 0.893 | 0.927 |
| Indiana | 0.524 | 1.678 | 0.673 | 4.701 | 0.063 | 0.201 | 0.071 | 0.345 | 0.879 | 0.880 | 0.894 | 0.927 |
| Iowa | 0.517 | 1.673 | 0.676 | 5.688 | 0.036 | 0.118 | 0.030 | 0.152 | 0.931 | 0.930 | 0.956 | 0.973 |
| Kansas | 0.586 | 2.034 | 0.938 | 5.372 | 0.047 | 0.152 | 0.045 | 0.162 | 0.920 | 0.925 | 0.952 | 0.970 |
| Kentucky | 0.597 | 1.876 | 1.025 | 5.899 | 0.074 | 0.232 | 0.078 | 0.321 | 0.876 | 0.876 | 0.924 | 0.946 |
| Louisiana | 0.242 | 0.923 | 0.725 | 4.746 | 0.044 | 0.140 | 0.179 | 0.546 | 0.820 | 0.848 | 0.753 | 0.885 |
| Maine | 0.599 | 1.877 | 0.942 | 6.794 | 0.073 | 0.224 | 0.145 | 0.615 | 0.878 | 0.881 | 0.846 | 0.910 |
| Maryland | 0.958 | 3.042 | 1.044 | 6.246 | 0.102 | 0.326 | 0.089 | 0.387 | 0.894 | 0.893 | 0.915 | 0.938 |
| Massachusetts | 0.790 | 2.499 | 1.192 | 6.831 | 0.103 | 0.323 | 0.172 | 0.650 | 0.869 | 0.871 | 0.855 | 0.905 |
| Michigan | 0.658 | 2.058 | 0.524 | 4.671 | 0.126 | 0.392 | 0.084 | 0.354 | 0.809 | 0.810 | 0.841 | 0.924 |
| Minnesota | 0.585 | 1.871 | 0.899 | 5.269 | 0.067 | 0.211 | 0.066 | 0.229 | 0.886 | 0.887 | 0.926 | 0.956 |
| Mississippi | 0.584 | 1.854 | 1.622 | 8.106 | 0.041 | 0.137 | 0.040 | 0.155 | 0.929 | 0.926 | 0.975 | 0.981 |
| Missouri | 0.544 | 1.733 | 1.168 | 7.699 | 0.042 | 0.135 | 0.038 | 0.188 | 0.923 | 0.922 | 0.967 | 0.976 |
| Montana | 0.358 | 1.367 | 0.864 | 5.966 | 0.026 | 0.092 | 0.030 | 0.142 | 0.928 | 0.933 | 0.965 | 0.976 |
| Nebraska | 0.588 | 1.880 | 0.832 | 6.557 | 0.031 | 0.098 | 0.025 | 0.124 | 0.948 | 0.948 | 0.969 | 0.981 |
| Nevada | 0.931 | 2.916 | 1.272 | 5.742 | 0.091 | 0.283 | 0.115 | 0.287 | 0.902 | 0.903 | 0.909 | 0.950 |
| New Hampshire | 0.995 | 2.982 | 6.147 | 21.908 | 0.149 | 0.416 | 0.788 | 2.399 | 0.850 | 0.860 | 0.872 | 0.890 |
| New Jersey | 0.815 | 2.718 | 1.374 | 6.619 | 0.146 | 0.460 | 0.277 | 1.019 | 0.821 | 0.831 | 0.798 | 0.846 |
| New Mexico | 0.577 | 1.959 | 1.389 | 7.146 | 0.031 | 0.110 | 0.030 | 0.091 | 0.946 | 0.944 | 0.978 | 0.987 |
| New York | 0.947 | 2.898 | 1.157 | 6.355 | 0.142 | 0.425 | 0.146 | 0.575 | 0.850 | 0.853 | 0.874 | 0.909 |
| North Carolina | 0.624 | 1.997 | 0.864 | 6.381 | 0.085 | 0.265 | 0.083 | 0.357 | 0.865 | 0.867 | 0.904 | 0.944 |
| North Dakota | 0.572 | 1.862 | 0.850 | 6.131 | 0.049 | 0.157 | 0.062 | 0.325 | 0.914 | 0.915 | 0.927 | 0.947 |
| Ohio | 0.519 | 1.658 | 0.586 | 4.472 | 0.060 | 0.189 | 0.050 | 0.236 | 0.885 | 0.886 | 0.914 | 0.947 |
| Oklahoma | 0.485 | 1.587 | 0.704 | 5.187 | 0.035 | 0.116 | 0.032 | 0.117 | 0.927 | 0.927 | 0.955 | 0.977 |
| Oregon | 0.718 | 2.247 | 0.996 | 5.876 | 0.085 | 0.270 | 0.077 | 0.330 | 0.882 | 0.880 | 0.922 | 0.944 |
| Pennsylvania | 0.594 | 1.881 | 0.811 | 5.120 | 0.077 | 0.244 | 0.090 | 0.382 | 0.870 | 0.870 | 0.888 | 0.925 |
| Rhode Island | 1.154 | 3.562 | 2.323 | 11.706 | 0.171 | 0.518 | 0.299 | 1.113 | 0.852 | 0.855 | 0.871 | 0.905 |
| South Carolina | 0.764 | 2.395 | 0.941 | 7.177 | 0.103 | 0.321 | 0.103 | 0.462 | 0.866 | 0.866 | 0.891 | 0.936 |
| South Dakota | 0.687 | 2.160 | 1.516 | 8.630 | 0.026 | 0.086 | 0.024 | 0.114 | 0.962 | 0.960 | 0.984 | 0.987 |
| Tennessee | 0.844 | 2.679 | 1.078 | 5.664 | 0.105 | 0.330 | 0.113 | 0.410 | 0.876 | 0.877 | 0.895 | 0.928 |
| Texas | 0.365 | 1.237 | 0.750 | 3.850 | 0.079 | 0.259 | 0.127 | 0.390 | 0.784 | 0.790 | 0.830 | 0.899 |
| Utah | 0.591 | 1.983 | 0.906 | 5.065 | 0.056 | 0.182 | 0.037 | 0.138 | 0.905 | 0.908 | 0.959 | 0.973 |
| Vermont | 1.033 | 3.281 | 2.121 | 8.320 | 0.121 | 0.371 | 0.240 | 0.787 | 0.883 | 0.887 | 0.887 | 0.905 |
| Virginia | 0.556 | 1.876 | 0.822 | 6.002 | 0.059 | 0.191 | 0.059 | 0.282 | 0.893 | 0.898 | 0.928 | 0.953 |
| Washington | 0.416 | 1.386 | 0.590 | 4.416 | 0.077 | 0.244 | 0.075 | 0.286 | 0.815 | 0.824 | 0.872 | 0.935 |
| West Virginia | 0.748 | 2.436 | 2.574 | 13.262 | 0.039 | 0.123 | 0.043 | 0.197 | 0.948 | 0.949 | 0.983 | 0.985 |
| Wisconsin | 0.512 | 1.602 | 0.576 | 5.084 | 0.055 | 0.172 | 0.043 | 0.190 | 0.892 | 0.892 | 0.926 | 0.963 |
| Wyoming | 0.340 | 1.258 | 0.908 | 5.759 | 0.019 | 0.067 | 0.028 | 0.109 | 0.944 | 0.947 | 0.970 | 0.981 |
| Average | 0.635 | 2.054 | 1.244 | 7.086 | 0.075 | 0.238 | 0.112 | 0.408 | 0.878 | 0.882 | 0.906 | 0.941 |
| Minimum | 0.242 | 0.923 | 0.524 | 3.693 | 0.019 | 0.067 | 0.024 | 0.091 | 0.741 | 0.762 | 0.720 | 0.846 |
| Maximum | 1.154 | 3.574 | 6.147 | 24.489 | 0.171 | 0.518 | 0.788 | 2.399 | 0.962 | 0.960 | 0.989 | 0.991 |
| United States | - | - | - | - | 0.089 | 0.281 | 0.177 | 0.384 | - | - | - | - |

**Notes:** Full autarky is defined as the case in which the state consumes only its own products. International autarky is defined as the case in which the state consumes both its own products and products coming from other states, excluding international imports. The measures of domestic autarky are calculated as the difference between the cases of full and international autarky. OSLO stands for one-sector-labor-only model, OSIO stands for one-sector model with input-output linkages, MSLO stands for multi-sector-labor-only model, MSIO stands for multi-sector model with input-output linkages. United States values have been calculated by using the corresponding aggregates across states.

Appendix Table A.4 - OSLO-Equivalent Elasticity $\eta$ Measures

| State | Full Autarky | | | International Autarky | | | Domestic Autarky | | |
|---|---|---|---|---|---|---|---|---|---|
| | OSIO | MSLO | MSIO | OSIO | MSLO | MSIO | OSIO | MSLO | MSIO |
| Alabama | 1.813 | 3.069 | 1.249 | 1.804 | 4.398 | 1.697 | 1.814 | 2.970 | 1.230 |
| Alaska | 1.669 | 1.690 | 1.101 | 1.774 | 1.637 | 1.221 | 1.638 | 1.711 | 1.085 |
| Arizona | 1.839 | 2.900 | 1.324 | 1.824 | 3.588 | 1.859 | 1.840 | 2.849 | 1.304 |
| Arkansas | 1.770 | 2.777 | 1.239 | 1.801 | 4.539 | 1.868 | 1.767 | 2.699 | 1.224 |
| California | 1.794 | 2.975 | 1.396 | 1.822 | 3.346 | 1.773 | 1.786 | 2.878 | 1.342 |
| Colorado | 1.807 | 2.946 | 1.341 | 1.820 | 3.505 | 1.705 | 1.806 | 2.900 | 1.323 |
| Connecticut | 1.822 | 2.683 | 1.233 | 1.832 | 3.137 | 1.457 | 1.820 | 2.616 | 1.213 |
| Delaware | 1.679 | 1.865 | 1.176 | 1.796 | 1.913 | 1.248 | 1.654 | 1.854 | 1.164 |
| District of Columbia | 1.829 | 1.668 | 1.121 | 1.847 | 3.526 | 1.595 | 1.829 | 1.647 | 1.117 |
| Florida | 1.835 | 2.158 | 1.234 | 1.821 | 2.676 | 1.441 | 1.837 | 2.109 | 1.220 |
| Georgia | 1.825 | 3.035 | 1.291 | 1.830 | 3.648 | 1.636 | 1.825 | 2.969 | 1.270 |
| Hawaii | 1.651 | 1.462 | 1.103 | 1.705 | 3.570 | 1.765 | 1.637 | 1.378 | 1.084 |
| Idaho | 1.806 | 1.833 | 1.132 | 1.810 | 2.726 | 1.644 | 1.806 | 1.776 | 1.119 |
| Illinois | 1.806 | 2.926 | 1.350 | 1.810 | 3.335 | 1.628 | 1.806 | 2.877 | 1.328 |
| Indiana | 1.815 | 3.034 | 1.291 | 1.825 | 3.326 | 1.480 | 1.814 | 3.000 | 1.276 |
| Iowa | 1.806 | 2.996 | 1.237 | 1.788 | 4.127 | 1.611 | 1.808 | 2.944 | 1.227 |
| Kansas | 1.753 | 2.631 | 1.285 | 1.807 | 3.710 | 1.759 | 1.748 | 2.577 | 1.270 |
| Kentucky | 1.830 | 2.520 | 1.264 | 1.834 | 3.487 | 1.603 | 1.830 | 2.441 | 1.245 |
| Louisiana | 1.686 | 1.872 | 1.133 | 1.812 | 1.635 | 1.208 | 1.663 | 1.950 | 1.124 |
| Maine | 1.834 | 2.662 | 1.230 | 1.854 | 2.320 | 1.312 | 1.831 | 2.724 | 1.222 |
| Maryland | 1.822 | 3.396 | 1.401 | 1.816 | 4.003 | 1.687 | 1.823 | 3.339 | 1.382 |
| Massachusetts | 1.825 | 2.730 | 1.302 | 1.836 | 2.568 | 1.416 | 1.824 | 2.758 | 1.290 |
| Michigan | 1.835 | 4.277 | 1.368 | 1.838 | 4.930 | 1.926 | 1.834 | 4.154 | 1.322 |
| Minnesota | 1.816 | 2.699 | 1.290 | 1.824 | 3.624 | 1.759 | 1.815 | 2.625 | 1.269 |
| Mississippi | 1.823 | 1.940 | 1.188 | 1.788 | 3.688 | 1.693 | 1.825 | 1.896 | 1.178 |
| Missouri | 1.819 | 2.216 | 1.184 | 1.815 | 3.881 | 1.584 | 1.820 | 2.160 | 1.174 |
| Montana | 1.684 | 2.082 | 1.157 | 1.730 | 3.246 | 1.472 | 1.681 | 2.041 | 1.149 |
| Nebraska | 1.817 | 2.846 | 1.234 | 1.817 | 4.157 | 1.650 | 1.816 | 2.805 | 1.226 |
| Nevada | 1.834 | 2.912 | 1.424 | 1.840 | 3.064 | 1.830 | 1.833 | 2.896 | 1.402 |
| New Hampshire | 1.871 | 1.423 | 1.119 | 1.936 | 1.494 | 1.162 | 1.861 | 1.412 | 1.113 |
| New Jersey | 1.784 | 2.550 | 1.322 | 1.830 | 2.377 | 1.375 | 1.774 | 2.594 | 1.312 |
| New Mexico | 1.769 | 2.085 | 1.211 | 1.732 | 3.652 | 1.882 | 1.771 | 2.049 | 1.202 |
| New York | 1.853 | 3.138 | 1.389 | 1.876 | 3.553 | 1.646 | 1.849 | 3.078 | 1.363 |
| North Carolina | 1.817 | 2.887 | 1.256 | 1.834 | 3.655 | 1.618 | 1.814 | 2.805 | 1.234 |
| North Dakota | 1.802 | 2.758 | 1.244 | 1.820 | 3.078 | 1.397 | 1.800 | 2.732 | 1.235 |
| Ohio | 1.818 | 3.316 | 1.303 | 1.830 | 4.118 | 1.662 | 1.816 | 3.240 | 1.283 |
| Oklahoma | 1.798 | 2.798 | 1.244 | 1.795 | 3.925 | 1.786 | 1.798 | 2.745 | 1.231 |
| Oregon | 1.834 | 2.883 | 1.319 | 1.822 | 3.872 | 1.672 | 1.836 | 2.800 | 1.298 |
| Pennsylvania | 1.825 | 2.915 | 1.303 | 1.825 | 3.226 | 1.526 | 1.825 | 2.876 | 1.285 |
| Rhode Island | 1.846 | 2.298 | 1.258 | 1.860 | 2.487 | 1.400 | 1.844 | 2.270 | 1.243 |
| South Carolina | 1.833 | 3.120 | 1.278 | 1.835 | 3.609 | 1.580 | 1.833 | 3.061 | 1.257 |
| South Dakota | 1.830 | 2.182 | 1.208 | 1.803 | 3.865 | 1.604 | 1.831 | 2.155 | 1.202 |
| Tennessee | 1.823 | 3.045 | 1.389 | 1.830 | 3.416 | 1.667 | 1.822 | 3.002 | 1.367 |
| Texas | 1.770 | 2.272 | 1.248 | 1.794 | 2.620 | 1.529 | 1.764 | 2.200 | 1.216 |
| Utah | 1.778 | 2.703 | 1.304 | 1.809 | 4.958 | 2.063 | 1.774 | 2.607 | 1.283 |
| Vermont | 1.823 | 2.273 | 1.324 | 1.854 | 2.318 | 1.402 | 1.819 | 2.267 | 1.316 |
| Virginia | 1.775 | 2.768 | 1.242 | 1.813 | 3.604 | 1.549 | 1.770 | 2.703 | 1.227 |
| Washington | 1.784 | 2.840 | 1.246 | 1.823 | 3.662 | 1.701 | 1.775 | 2.720 | 1.214 |
| West Virginia | 1.802 | 1.759 | 1.147 | 1.830 | 3.397 | 1.519 | 1.800 | 1.731 | 1.142 |
| Wisconsin | 1.835 | 3.321 | 1.263 | 1.840 | 4.381 | 1.761 | 1.834 | 3.236 | 1.244 |
| Wyoming | 1.705 | 1.977 | 1.154 | 1.740 | 2.797 | 1.453 | 1.703 | 1.951 | 1.148 |
| Average | 1.798 | 2.590 | 1.256 | 1.817 | 3.360 | 1.598 | 1.795 | 2.545 | 1.239 |
| Minimum | 1.651 | 1.423 | 1.101 | 1.705 | 1.494 | 1.162 | 1.637 | 1.378 | 1.084 |
| Maximum | 1.871 | 4.277 | 1.424 | 1.936 | 4.958 | 2.063 | 1.861 | 4.154 | 1.402 |
| United States | - | - | - | 1.826 | 2.311 | 1.604 | - | - | - |

**Notes:** Full autarky is defined as the case in which the state consumes only its own products. International autarky is defined as the case in which the state consumes both its own products and products coming from other states, excluding international imports. Domestic autarky is defined as the case in which the state consumes both its own products and international products, excluding products coming from other states. OSLO stands for one-sector-labor-only model with $\eta = 3.612$, OSIO stands for one-sector model with input-output linkages, MSLO stands for multi-sector-labor-only model, MSIO stands for multi-sector model with input-output linkages. United States values have been calculated by using the corresponding aggregates across states.