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November 22, 2024

Abstract

Analyzing and simulating trade policy scenarios in a complex and intertwined global economy requires a database with a complete bilateral trade matrix at the level of highly disaggregated industries over several decades. Such a database has not been created until now. This paper introduces the *International Trade and Production Database for Simulation* (ITPD-S). In combination with the *International Trade and Production Database for Estimation* (ITPD-E), we use it to quantify the impact of globalization on bilateral trade, real income, and inequality in the world at the detailed industry level in 1990-2019. To perform the analysis, we rely on a new quantitative trade model that enables us to estimate the magnitude of globalization and then perform a counterfactual analysis of the impact of globalization on real output within the same framework. Our estimates reveal that, on average, bilateral globalization forces have led to a remarkable increase in international trade of about 570%, between 1990 and 2019, with very wide but intuitive variation across industries. Our counterfactual analysis reveals that globalization has benefited most countries but relatively more so smaller and more open economies, which are typically developing countries. As a result, this 'catch-up' implies less cross-country income inequality.

JEL codes: F10, F14, F63, O11, O19

Keywords: Trade dataset, Domestic trade, Globalization, Inequality, Disaggregated simulation analysis, Gravity

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*The data that support the findings of this study are openly available from the USITC Gravity Portal at https://gravity.usitc.gov.

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1 Introduction

Trade policy is best analyzed in a model that takes into account trade diversion and price and income effects. It is well-documented that not accounting for trade diversion may lead to significant biases in estimated effects of trade policy on trade and other economic outcomes. Recent developments combining data with theory culminated in what is now called new quantitative trade models (NQTMs), which allow for estimation and simulation analysis within the same multi-country and multi-sector framework, which is representative of a wide class of trade models (Arkolakis et al., 2012).

However, data are lagging behind, at least from two perspectives. First, many trade policies, such as tariffs, are negotiated and implemented at the disaggregated level. Even policies that are applied at the aggregate level, such as sanctions and some aspects of trade agreements, may have very heterogeneous effects at the disaggregated level. Therefore, data needs to be sufficiently disaggregated.

Second, model estimation and simulation is best done with the same data to ensure consistency. Yet currently, in most cases when simulation analysis requires estimates of the effects of different policies, or even an estimate of the trade elasticity, such estimates are taken from external studies, which often rely on completely different data from the one used in the simulation. Naturally, this may lead to significant biases in policy predictions and analysis.

Against this backdrop, we make the following contributions to the literature. First, we introduce the ***International Trade and Production Database for Simulation*** **(ITPD-S)**, which is a fully balanced database covering 170 industries in 265 countries for the years 1990-2019. The significance of this contribution is that currently there are no databases that allow for counterfactual analysis at such a disaggregated level. Second, we combine the ITPD-S with the *International Trade and Production Database for Estimation* (ITPD-E), which is of the same dimensions and can be used for estimation as it relies on official trade statistics without estimated trade flows. The significance of this contribution is that we offer a combination of two datasets that are perfectly compatible by design, one of which can be used for estimation and the other for simulation.

We deploy the two ITPD databases to study the impact of globalization. We define as globalization any factors that affect bilateral *border-crossing* trade flows differently relative to domestic trade flows, above and beyond the impact of conventional gravity variables such as distance. Thus, our empirical proxy for unfolding globalization are estimated time-varying "border effects" that capture the average wedge between international and domestic trade flows. Since their estimation is conditional on observable gravity variables, they serve as an 'all-inclusive' residual measure of the effects of globalization on trade. Against that backdrop, the fact that ITPD-E data include domestic trade flows is crucial as it enables us to identify and obtain a large number of globalization estimates at the industry level within an established econometric framework, subject to a full set of three-way fixed effects.

No such globalization index is currently available in the literature. By combining the estimates of globalization with ITPD-S data, we can translate the partial equilibrium globalization effects into effects on real output. In turn, this enables us to quantify the impact of globalization on global income inequality as it unfolded between 1990 and 2019.

The key to this study is the construction of ITPD-S, which starts with ITPD-E. The fact that ITPD-E uses only raw administrative data renders it perfectly suitable for estimation, but that also implies that it has many missing domestic trade values, which renders it unsuitable for simulation. The subsequent construction of ITPD-S fills in those missing values. At the same time, the dimensions of ITPD-S are the same as those of ITPD-E: 170 industries across broad sectors of agriculture, mining, manufacturing, and services, respectively, for many years and countries. This makes ITPD-E and ITPD-S perfect complements for estimating key parameters and then performing counterfactual simulations.

Construction of ITPD-S is done in several steps involving a variety of methods. Some methods are simple, such as interpolation. Other methods involve the estimation of a state-of-the-art gravity model. We perform a thorough evaluation of the methods and give priority to the best-performing methods when filling in missing trade values. Using these methods we can create a complete set of domestic trade observations for 198 countries, plus an additional 67 countries for which some, but not all, domestic trade observations are available.

To perform the empirical analysis, we rely on a well-established new quantitative trade model, which, as demonstrated by Arkolakis et al. (2012), is representative of a wide family of trade models. New quantitative trade models use structural gravity to explain trade. In addition to its intuitive appeal and solid theoretical foundations, an attractive feature of the gravity system is that it nests the theoretical foundation for the estimating gravity equation, which delivers our partial equilibrium estimates of the effects of globalization.

In addition to the ITPD-E database, which we use for our estimation analysis, and the ITPD-S database, which we use for the counterfactual analysis, we utilize several other datasets, including the Regional Trade Agreement dataset of Egger and Larch (2008) for data on RTAs, the Dynamic Gravity Database of the United States International Trade Commission (Gurevich and Herman, 2018) for data on WTO and EU membership, the Global Sanctions Database (Felbermayr et al., 2020; Syropoulos et al., 2023) for data on complete and partial trade sanctions, and the classification of countries by income level of the World Bank (year 2000).

Several noteworthy findings stand out from our estimation results. First, overall, we obtain very large, positive, and statistically significant estimates of the effects of globalization on trade. Specifically, only 5 of our estimates are negative, while 93% of the positive estimates are also statistically significant. In terms of magnitude, our estimates imply that, on average, bilateral globalization forces (other than trade agreements, WTO membership, and EU membership) have led to a remarkable increase of 570% in international trade relative to domestic sales over the period 1990-2019.

Second, the globalization estimates that we obtain manifest in a very heterogeneous way across broad ITPD sectors. Our estimates suggest that the services sector has experienced the largest impact of globalization, followed by manufacturing, and then agriculture. We also see significant heterogeneity of globalization effects across industries within each broad sector. Thus, for example, the services categories that have experienced the largest effects are 'Health' services and 'Travel' services, while the smallest effects are for 'Transport' services and 'Trade-related' services. Finally, out of five negative globalization estimates the only statistically significant negative effect is for 'Cutting shaping and finishing of stone' while the largest negative estimate that we obtain is for the industry 'Publishing of newspapers journals etc.' We present our interpretation of these results in Section 4.1.

We also offer a preliminary investigation for possible heterogeneous effects of globalization depending on the country income group. To this end, we rely on the 2000 income classification of the World Bank to identify the *'High Income'* countries in our sample, and we obtain estimates of the effects of globalization for that subsample of rich economies only. Overall, we do not observe systematic differences in the effects of globalization for the rich countries. One possible explanation for this result is mechanical; i.e., due to the disproportional size and trade shares of these large countries, our average results may be driven by these large high-income countries.[1] Moreover, we see some intuitive variation across the four broad sectors in our sample. Specifically, we find that the globalization effects in Agriculture are smaller for the rich countries, but they are larger for the rich countries in Services, while for manufacturing, the two estimates are almost identical with a slightly larger estimate for the rich countries.

Using simulation of a simple endowment economy model, we translate our partial equilibrium estimates into effects on real industry-level output. Due to the large number of estimates (e.g., one for each country-industry combination), we aggregate our findings and summarize them along two dimensions - by industry and country, respectively. Three main findings stand out from this analysis. First, perhaps not surprisingly given the large magnitudes of our partial equilibrium estimates, we obtain large and positive average real output

[1] Therefore, we plan to investigate further the effects of globalization across four groups, including exports from rich to rich countries, exports from rich to poor countries, exports from poor to rich countries, and exports from poor to poor countries.

effects, both across the countries and across the industries in our sample. Second, we observe substantial heterogeneity in our estimates in both dimensions, with the heterogeneity across countries even more pronounced. Third, a closer look at the heterogeneous effects across countries reveals that developing, smaller countries seem to have gained relatively more from opening up to international trade. This means that global inequality has fallen overall across all countries. This conclusion is also supported by a calculation of the Gini index over current cross-country output and the counterfactual output without globalization, suggesting that world inequality has decreased due to the globalization forces that we identify. The fact that some small, open economies have gained the most in percentage terms implies that inequality has risen within that group of economies as some have benefited more than others.

The rest of the paper is organized as follows. Section 2 describes the methods that we use to construct the International Trade and Production Database for Simulation (ITPD-S), showcases its main features, and discusses potential caveats with its use. Section 3 offers a brief review of the new quantitative trade model, which we rely upon to obtain our partial equilibrium estimates and for the counterfactual analysis as well. Section 4 presents our partial equilibrium estimates of the effects of globalization, translates them into real output effects, and discusses our main findings. Section 5 summarizes our main contributions and offers directions for future work. More detailed descriptions of the procedures that were used to construct the ITPD-S, including additional estimates and results, are available in Online Appendix II.

2 The ITPD-S

The International Trade and Production Database for Simulation, or ITPD-S, that underpins this paper is based on the International Trade and Production Database for Estimation, or ITPD-E (Borchert et al., 2021, 2022). ITPD-E uses only raw administrative data, which makes it suitable for estimation, but also means that it has many missing values.[2] Yet simulation of new quantitative trade models requires data that is complete—i.e., non-missing in all relevant dimensions. The ITPD-S meets these requirements and thus allows researchers to perform simulations with a variety of partial equilibrium (PE) and general equilibrium (GE) models, including the the structural gravity model. In combination, ITPD-E and ITPD-S provide researchers and policy analysts with mutually consistent databases for estimation **and** simulation; in particular, estimation of simulation parameters can be done with ITPD-E with comparable official data that exhibits the same dimensionality as the envisaged simulation exercise.

By taking the latest version of ITPD-E as a starting point, ITPD-S inherits its high granularity and breadth of coverage. It includes international and domestic trade data for 265 countries, 170 industries across all broad sectors (agriculture, mining and energy, manufacturing, and services), and over 30 years.[3] In addition, ITPD-S fills in most domestic trade values that are missing in ITPD-E using the methodology explained in the next section.

2.1 ITPD-S Methodology

The first step in the construction of ITPD-S[4] is the creation of a blank database with 265 exporters and importers, 170 industries, and the year dimensions matching ITPD-E-R02: 1986-2019 for agriculture, 1988-2019 for mining and energy, 1988-2019 for manufacturing, and 2000-2019 for services. The resulting blank database is square in the exporter and importer dimension for each industry and year. Following ITPD-E, countries in ITPD-S are defined by the USITC's Dynamic Gravity Dataset (Gurevich and Herman, 2018). Industries in ITPD-S R01 follow the definitions in ITPD-S R02.

The blank database is then populated by international trade entries from ITPD-E-R02.

[2]The current version of ITPD-E (Release R02) covers 265 countries, 170 sectors, and over 30 years for most industries. It is publicly available on the U.S. International Trade Commission's Gravity Portal.

[3]By broad sector, years covered are 1986-2019 for agriculture, 1988-2019 for both mining and energy and manufacturing, and 2000-2019 for services.

[4]A detailed technical documentation of ITPD-S that goes beyond the broad outline offered in Section 2.1 is available from the authors upon request.

Similar to ITPD-E, ITPD-S contains a flag variable ($flag\_zero$) that is equal to 'r' for observations with zeroes coming from original data sources, 'p' for observations with positive trade flows, and 'u' for observations filled with zeroes. As in ITPD-E, all trade observations that are not reported by either importer or exporter are assumed to be zero and denoted by the appropriate flag. Considering that reported international trade flow statistics as taken from ITPD-E are quite comprehensive, we believe that this is a plausible assumption.[5] It is well known, after all, that the international trade flow matrix in its entirety is indeed sparse.

While ITPD-E includes many missing domestic trade observations, considerable effort is made in ITPD-S to fill those missing observations. Missing domestic trade flows are more prevalent compared to missing international trade flows because of the dearth of sectorally disaggregated gross output statistics, from which domestic sales are derived. The flag variable called $flag\_itpds$ shows how each domestic trade observation was obtained. All domestic trade observations reported in ITPD-E, positive or zero, are denoted by flag 1. These observations are obtained from data on output and total exports.

The methods used to fill in missing domestic trade values can be divided into two categories: simple and econometric. We discuss them in the next two sections.

2.1.1 Simple methods

We assume that domestic sales are zero if there are no exports to any destination, even in the mirror data, in a particular industry and year while output data are missing. Setting domestic trade to zero in this situation applies to all industries except services.[6] Domestic trade observations filled using this assumption are denoted by flag 2.

Building upon the raw data from ITPD-E and the imputed zero domestic trade from the previous step, linear interpolation over time is used for filling in intermittent missing values. Interpolated domestic trade is denoted by flag 3.

[5] Recall that ITPD-E already employs cautious steps such as a mirroring protocol that enhance data availability beyond what is in trade statistics, without altering the nature of data as official reported statistics.

[6] For services, output could well be non-zero even if we do not observe any international sales.

Next, we use forward and backward fill methods, i.e. we carry forward in time the last observed value and backward in time the first observed value for a maximum of seven years to avoid over-reliance on individual data points. Domestic trade values obtained using forward and backward fill are denoted with flags 4 and 5, respectively.

We aim to recover domestic trade flows that are still missing at this stage by deploying estimation and projection methods as described in the next section.

2.1.2 Econometric methods

This set of methods for predicting missing domestic trade flows relies on state-of-the-art structural gravity models (Anderson and van Wincoop, 2003; Yotov et al., 2016, see). This section offers an outline of the main steps for filling in domestic trade flows, whereas a full account of the various estimation procedures and equations is provided in Online Appendix II.

In essence, domestic trade flows are related to international trade flows by the "border effect", i.e. the friction that reduces a bilateral trade flow relative to domestic trade when such flow crosses a border. Border effects are usually estimated by an indicator variable $BRDER_{ij}$, a dummy variable that is equal to one for international trade (whenever $i \neq j$) and zero else (i.e. $i = j$). Border effects can be estimated in a variety of different ways, depending on what data are available. Accordingly, we explore a range of options for specifying international border dummy variables (e.g. country- and time-specific or country-time-specific, see Anderson et al., 2018) with a view to maximizing our ability to predict missing domestic trade flows out of sample. In general, because border effects for domestic trade are identified relative to international trade, modeling trade costs as accurately as possible even for international flows is important for obtaining consistent domestic trade flow estimates.

The baseline structural gravity specification follows theory-grounded best practices, including its fixed effects structure. At the same time, there is considerable flexibility in modeling the trade cost function, part of which consists of the border effects that we wish to estimate and exploit for prediction. Thus, we devise two approaches for recovering estimates of domestic trade costs, or equivalently, border frictions: i) we proxy for trade costs using observables, and ii) we rely on the panel structure in ITPD-E to proxy for trade costs using time-invariant bilateral fixed effects in combination with utilizing different aggregations and common fixed effects for these aggregates.

In the first approach, structural gravity estimation is deployed at the level of each individual industry in ITPD, whereby—in addition to the fixed effects structure—trade costs are proxied by a set of 10 bilateral time-varying observables that comprehensively cover geography, policy and institutions.[7] Within that baseline framework, we estimate five alternative specifications for modeling domestic trade costs:

1. One common, time-invariant border effect for all countries;
2. Time-varying border effects common for all countries;
3. Time-invariant but country-specific border effects;
4. A border effect that is allowed to vary with observable country characteristics;[8]
5. A time-varying border effect that is allowed to vary with observable country characteristics.

To see the intuition for these modeling choices, consider the following example: if there were no 'gross output' statistics for ITPD industry 148 (Furniture) for Bolivia, domestic trade for that industry will be missing across all years. Yet, if it were possible to estimate a border effect and its variation with internal distance, market size etc. based upon data for countries that do report gross output for Furniture (specification 4 above), then we can use that coefficient, combined with values for observable characteristics such as distance, GDP, etc. for Bolivia, to predict Bolivian domestic trade in industry 148, suitably adjusted

[7]The complete list of observables entails bilateral distance, contiguity, common language, common legal origin, common religion, common colonial past, joint EU membership, joint WTO membership, and whether countries are signatories to a customs union or any kind of preferential trade agreement at time t, respectively. The data come from USITC's Dynamic Gravity Dataset and from CEPII.

[8]We employ four proxies for capturing domestic trade costs: internal distance, degree of religious homogeneity within a country, log GDP for market size, and log GDP per capita for stage of development.

for differences in Bolivia's macroeconomic state relative to the countries from which the coefficient was estimated, and thereby fill in the missing values.

These strategies at the industry level can fill a certain share of missing values but not all. Therefore, we adopt a second approach that exploits the panel structure of the data and estimates domestic trade costs at alternative levels of sectoral aggregation, starting at the individual industry level and re-estimating domestic trade cost (and previously not identified exporter-time, importer-time fixed effects) at progressively higher levels of aggregation, until in the last step all industries are combined. Projections of domestic sales from these models help fill in nearly all of the missing domestic trade flows that remain at this stage.

2.1.3 Summary and flag documentation

Our methods for filling in missing domestic trade observations and corresponding flags are summarized in Table 1 below. Note that flags 13-15 correspond to the same simple methods as flags 3-5. Their purpose is explained in the next section.

2.2 Evaluation of estimation methods and our procedure

Since various simple and econometric methods described above can be used to fill in missing domestic trade observations, it is imperative to evaluate these methods to determine how well they perform and which methods perform better than others, so that they could be used first. To evaluate our methods we randomly drop 10% of domestic trade observations in each industry. These dropped observations are then estimated together with all other missing trade observations using various methods described earlier.

Once the dropped trade flows are estimated, we compare the estimated values to the values in the original data using several statistics, such as the mean absolute deviation and the mean deviation of estimated from actual trade, the mean absolute log point deviation and the mean log point deviation of estimated from actual trade, and the correlation between the estimated and actual trade values.

Table 1: Documentation of methods flags

1. **Simple** estimation methods:	
Flag=1	Trade values from the data, not estimated.
Flag=2	Domestic trade flows are set to zero when there are no exports to any destination in the given industry and year.
Flag=3	Using data from step 2 as the starting point, domestic and international trade flows are estimated by interpolation.
Flag=4	Using data from step 3 as the starting point, domestic and international trade flows are estimated by forward fill up to the maximum of 7 years.[1]
Flag=5	Using data from step 4 as the starting point, domestic and international trade flows are estimated by backward fill up to the maximum of 7 years.[2]
Flag=13	Extends the final data by filling in the remaining missing observations by interpolation.
Flag=14	Extends the final data by filling in remaining missing observations by forward fill.
Flag=15	Extends the final data by filling in the remaining missing observations by backward fill.
2. **Cross-sectional** estimation methods:	
Flag=21	Time-unvarying common border effect for all countries (model 1)
Flag=22	Time-varying common border effect for all countries (model 2)
Flag=23	Time-unvarying country-specific border effect (model 3)
Flag=24	Border effect proxied by country characteristics (model 4)
Flag=25	Border effect proxied by country characteristics interacted with year fixed effects (model 5)
3. **Panel** estimation methods:	
Flag=31	170 industries (level 1)
Flag=32	26 industry groups (level 2)
Flag=33	15 industry groups (level 3)
Flag=34	11 industry groups (level 4)
Flag=35	4 broad sectors (level 5)
Flag=36	1 economy, i.e. all industries combined (level 6)

[1] The results are the same whether this step is done using data from step 2 or step 3 as the starting point.

[2] See Note 1.

The results, described in detail in Online Appendix II, show that the simple methods, which have flags 2-5, produce the most accurate estimates of the dropped trade values in terms of all measures of quality. Therefore, these methods are used first to fill in missing trade observations.

Of the econometric methods, evaluation results suggest that the panel method at level 1 performs best, just ahead of the cross-sectional method model 3. The order in which various methods are used to fill in missing domestic trade values is shown below. Once missing observations are filled in using model estimates, we check for outliers, which are defined as estimated observations that are greater than the maximum domestic trade value observed in the data (flag 1). This maximum value is observed in the United States. Outlier estimates are set to missing. Then, simple methods are applied again to fill in missing observations, in the sequence shown below:

1. Simple methods with flags 2-5
2. Panel method level 1, flag 31
3. Cross-sectional method model 3, flag 23
4. Panel method levels 2, 3, 4, 5, 6, flags 32-36
5. Cross-sectional methods 4, 1, 2, 5, flags 24, 21, 22, 25
6. Set outliers to missing
7. Simple methods with flags 13-15

2.3 Summary of estimated domestic trade observations

This section summarizes the provenance of domestic trade observations in ITPD-S. Note that some missing observations cannot be estimated because not enough information is available. However, there are 203 countries for which all missing observations are estimated.

Table 2 shows the results of filling in missing domestic trade observations in all countries, industries, and years of ITPD-E. There are 1,216,679 domestic trade observations in ITPD-S overall, as shown in column 1 of Table 2, of which 159,351 have data from ITPD-E and

1,057,328 are missing in ITPD-E. Of these missing observations, 1,037,821 are then estimated and 19,514 cannot be estimated. Simple methods with flags 2-5 provide 688,751 estimates, gravity models provide 331,160 estimates, and post-estimation simple methods with flags 13-15 provide another 17,903 estimates.

The 19,514 observations that cannot be estimated are in 62 countries. Online Appendix II (Table 9) shows the list of these countries. On the other hand, 203 countries have a complete set of domestic trade observations.

Table 2: Summary of all domestic trade observations

category or flag	count
all observations	1,216,679
missing	1,057,328
estimated	1,037,821
not estimated	19,514
1	159,351
2	314,316
3	221,241
4	138,130
5	15,064
31	22,920
23	29
32	100,907
33	20,622
34	9,460
35	34,906
36	128,337
24	7,294
21	6,685
22	0
25	0
13	1,009
14	16,733
15	161

2.4 List of Variables

The variables included in ITPD-S are shown in Table 3. Most of the variables are carried over from ITPD-E. The only addition is *flag_itpds* which shows the provenance of domestic trade values.

Table 3: Variables in ITPD-S-R01

Variable name	Variable description
exporter_iso3	ISO 3-letter alpha code of the exporter
exporter_name	Name of the exporter
importer_iso3	ISO 3-letter alpha code of the importer
importer_name	Name of the importer
exporter_iso3_dynamic	Extended ISO3 code of the exporter based on DGD
importer_dynamic_code	Extended ISO3 code of the importer based on DGD
year	Year
industry_id	ITPD industry code
industry_descr	ITPD industry description
broad_sector	Broad sector description
trade	Trade flows in million of current US dollars
flag_mirror	Flag indicator, 1 if trade mirror value is used
flag_zero	Flag indicator:
	'p' if positive trade
	'r' if the raw data contained zero
	'u' missing (unknown, assigned zero)
flag_itpds	Flag showing how domestic trade value was obtained

3 Quantifying the Impact of Globalization

Capitalizing on the ITPD-E and the ITPD-S datasets, we can quantify both the partial and general equilibrium effects of globalization. To this end, we rely on a well-established new quantitative trade framework (a.k.a. a structural gravity model), which, as forcefully demonstrated by Arkolakis et al. (2012), is representative of a wide family of trade models. In Subsection 3.1, we briefly present the theoretical model and, in Subsection 3.2, we introduce the corresponding econometric specification.

3.1 Theoretical Foundations

Arkolakis et al. (2012) demonstrate that the generic theory-founded structural gravity model can be derived from a wide class of microeconomic foundations, including the first theoretical foundation of gravity in trade by Anderson (1979), and the famous gravity models of Eaton and Kortum (2002) and Anderson and van Wincoop (2003), among many others. In addition to its intuitive appeal and solid theoretical foundations, an attractive feature of the gravity framework is that it nests the theoretical foundation for the estimating gravity model, which will deliver our estimates of the effects of globalization.

Capitalizing on the power and representativeness of the gravity model and given the characteristics of our data (e.g., we do not have input-output linkages at such disaggregated level), we present its theoretical foundations in a simple one-sector endowment-economy setting with CES preferences as, for example, summarized in Costinot and Rodríguez-Clare (2014) and Yotov et al. (2016).[9]

There are N countries with a fixed stock Q_i of endowment with a unique variety (Armington, 1969). Varieties are traded internationally. The value of total output is given by

[9] We refer the reader to Anderson and van Wincoop (2004) and Costinot et al. (2012) for derivations of structural gravity models on the demand side and the supply side, respectively. The time subscript and dimension of the model, which is crucial for our identification purposes of estimating the impact of globalization, can be motivated by the dynamic gravity models of Olivero and Yotov (2012), Eaton et al. (2016), and Anderson et al. (2020).

$Y_i = p_i Q_i$, with p_i denoting the product price in the exporting country i.[10] Preferences are assumed to follow a constant elasticity of substitution (CES) function, where σ denotes the elasticity of substitution and γ_i the CES preference parameter, i.e.,

$$\left\{ \sum_i \gamma_i^{\frac{1-\sigma}{\sigma}} c_{ij}^{\frac{\sigma-1}{\sigma}} \right\}^{\frac{\sigma}{\sigma-1}}. \tag{1}$$

c_{ij} denotes the consumption of varieties from country i in country j. Trade costs are of the iceberg-type and denoted by $t_{ij} \geq 1$. Hence, consumer prices for variety i in country j can be written as $p_{ij} = p_i t_{ij}$. Total expenditures in country j, E_j, are given by $E_j = \sum_i p_{ij} c_{ij}$. Taking into account that total expenditures restrict the amount that consumers can spend, utility maximization leads to the demand for goods from country i in country j:

$$X_{ij} = \left(\frac{\gamma_i p_i t_{ij}}{P_j} \right)^{1-\sigma} E_j, \tag{2}$$

with P_j denoting the price index, which is given by:

$$P_j^{1-\sigma} = \sum_i \left(\gamma_i p_i t_{ij} \right)^{1-\sigma}. \tag{3}$$

Noting that X_{ij} given in Equation (2) also gives the trade flows from country i to country j, and utilizing $P_j^{1-\sigma}$, bilateral trade flows between any two countries i and j can be stated as follows:

$$X_{ij} = \frac{\left(\gamma_i p_i t_{ij} \right)^{1-\sigma}}{\sum_l \left(\gamma_l p_l t_{lj} \right)^{1-\sigma}} E_j. \tag{4}$$

Dividing both sides of this equation by total spending from country j, E_j, we obtain the share of total spending of imports from country i in country j, π_{ij}:

$$\pi_{ij} = \frac{X_{ij}}{E_j} = \frac{\left(\gamma_i p_i t_{ij} \right)^{1-\sigma}}{\sum_l \left(\gamma_l p_l t_{lj} \right)^{1-\sigma}}. \tag{5}$$

[10] Exporter price p_i implicitly includes the cost of production, which in turn incorporates factor costs, such as wage and cost of capital.

The share of spending is a function of prices and trade costs. From our partial estimates, we obtain estimates for the effects of international borders, but not trade costs in levels. Assuming that the CES preference parameters γ's stay constant in the counterfactual analysis, Dekle et al. (2007, 2008) demonstrated that formulating the structural gravity framework in changes avoids the need for trade costs in levels. Let us denote changes by a hat, baseline values by a superscript b, and the counterfactual values by a superscript c. Then the change of the share of total spending after a counterfactual shock, i.e., when comparing the change from the baseline values before the shock to the counterfactual values after the shock, can be written as:

$$\widehat{\pi}_{ij} = \frac{\pi_{ij}^c}{\pi_{ij}^b} = \frac{\left(\widehat{p}_i \widehat{t}_{ij}\right)^{1-\sigma}}{\sum_l \pi_{lj}^b \left(\widehat{p}_l \widehat{t}_{lj}\right)^{1-\sigma}}. \tag{6}$$

To close the model, we use the market clearing condition ensuring that the total output of each country is equal to its total sales, i.e., $Y_i = \sum_j X_{ij}$. Replacing trade flows as given in equation (4) and trade shares as given in equation (5), Y_i can be written as:

$$Y_i = \sum_j \frac{\left(\gamma_i p_i t_{ij}\right)^{1-\sigma}}{\sum_l \left(\gamma_l p_l t_{lj}\right)^{1-\sigma}} E_j = \sum_j \pi_{ij} E_j. \tag{7}$$

This expression for Y_i holds in the baseline and the counterfactual, i.e., $Y_i^b = \sum_j \pi_{ij}^b E_j^b$ and $Y_i^c = \sum_j \pi_{ij}^c E_j^c$, respectively.

As we perform our quantification of the real expenditure effects industry-by-industry, we observe trade imbalances in the data, i.e., total expenditures of a country in an industry will not equal total output of that industry. We take the observed trade imbalances, denoted by TI_i, as exogenous and constant between baseline and counterfactual, i.e, $TI_i = E_i - Y_i$.

To solve for the change of Y_i, $\widehat{Y}_i$, we can use equations (6), $Y_i^c = \sum_j \pi_{ij}^c E_j^c$, $E_i = Y_i + TI_i$, $\widehat{Y}_i = \widehat{p}_i$, and $\widehat{E}_i = (Y_i^b \widehat{Y}_i + TI_i)/E_i^b$, to end up with:

$$Y_i^b \widehat{Y}_i = \sum_j \frac{\pi_{ij}^b \left(\widehat{Y}_i \widehat{t}_{ij}\right)^{1-\sigma}}{\sum_l \pi_{lj}^b \left(\widehat{Y}_l \widehat{t}_{lj}\right)^{1-\sigma}} \left(Y_j^b \widehat{Y}_j + TI_j\right). \tag{8}$$

Hence, only data on trade shares in the baseline (π_{ij}^b) and knowledge about σ, are needed to solve for $\widehat{Y}_i$. Output is calculated from the observed trade flows, i.e., $Y_i^b = \sum_j X_{ij}^b$. Trade imbalances, $TI_j = E_j^b - Y_j^b$, are calculated using output in the baseline and expenditure in the baseline, calculated as $E_j^b = \sum_i X_{ij}^b$. We set σ equal to 5 in line with the median value of -3.78 of the price elasticities $(1-\sigma)$ for structural gravity estimates reported in Table 3.5 in Head and Mayer (2014). Ideally, σ would be estimated using the econometric specification presented in 3.2, e.g., as in Fontagné et al. (2022). This would require additional data on tariffs at the ITPD industry level. Such a database is currently under construction and, when completed, can be used to estimate industry-specific elasticities.

The change in trade costs $\widehat{t}_{ij}$ is defined by our counterfactual experiment. Specifically, we use the point estimates for international borders of the year 2019 for each industry. Since the international border coefficient for the first year in our dataset for each industry is dropped, it is convenient to take the border coefficients of the last year in the dataset as measures of the globalization effect for each industry for the respective periods.[11] We obtain border estimates for the year 2019 for 148 out of the 170 industries.[12] As we want to quantify the effects of globalization and use the latest year in our dataset, 2019, for the quantification, we perform an ex-post analysis. The observed values therefore are the baseline values in 2019, whereas the calculated counterfactual values are the values when globalization would not have taken place. The point estimates are therefore translated into changes of trade costs, $\widehat{t}_{ij}$, in the following way: $\widehat{t}_{ij} = [1/\exp(\alpha_T)]^{1/(1-\sigma)}$ for all $i \neq j$, $T = 2019$ and $\widehat{t}_{ij} = 1$ for $i = j$, in which α_T denotes the international border coefficient estimate in the final period (2019) as per equation (15) below. Note that the theory section abstracts from the sectoral dimension, which is present in the estimable equation and indicated with a k superscript on the time-varying border coefficients.

[11] The inclusion of pair fixed effects in our econometric specification (equation 15) implies the dropping of coefficients for one border-year combination for collinearity reasons, which we chose to be the first year, namely 1990 for goods and 2000 for services.

[12] For 22 industries, namely industries 5, 8, 14, 15, 17, 18, 23, 27, 28, 30, 31, 34, 35, 73, 75, 81, 137, 154, 155, 161, 167, and 168, we do not obtain border estimates because of lack of (enough) data of domestic sales necessary to identify an international border effect.

With solved values for changes of Y_i, $\widehat{Y}_i$, the changes for expenditures ($\widehat{E}_j$), producer prices ($\widehat{p}_j$), consumer prices ($\widehat{P}_j$), trade shares ($\widehat{\pi}_{ij}$), and nominal trade flows ($\widehat{X}_{ij}$) can be calculated as follows:

$$\widehat{E}_j = \frac{Y_j^b \widehat{Y}_j + TI_j}{E_j^b}, \tag{9}$$

$$\widehat{p}_j = \widehat{Y}_j, \tag{10}$$

$$\widehat{P}_j = \left(\sum_l \pi_{lj}^b \left(\widehat{p}_l \widehat{t}_{lj} \right)^{1-\sigma} \right)^{\frac{1}{1-\sigma}}, \tag{11}$$

$$\widehat{\pi}_{ij} = \frac{\left(\widehat{p}_i \widehat{t}_{ij} \right)^{1-\sigma}}{\sum_l \pi_{lj}^b \left(\widehat{p}_l \widehat{t}_{lj} \right)^{1-\sigma}}, \tag{12}$$

$$\widehat{X}_{ij} = \widehat{\pi}_{ij} \widehat{E}_j. \tag{13}$$

Note that these changes give the values for the counterfactual when no globalization would haven taken place. For our variable of interest, real output changes, $\hat{\mathcal{Y}}_j$, we calculated the effect of globalization as follows:

$$\hat{\mathcal{Y}}_j = \frac{\widehat{P}_j}{\widehat{Y}_j} = \left(\frac{1}{\widehat{\pi}_{jj}} \right)^{\frac{1}{1-\sigma}}, \tag{14}$$

where we report the change from the solved, counterfactual values to the observed ones to get a quantification of globalization.[13] The last expression was derived by Arkolakis et al. (2012), holding when $\widehat{t}_{jj} = 1$ for all j, as is the case in our counterfactual scenario.[14]

3.2 Econometric Specification

Based on Equation (2), and capitalizing on many developments from the empirical gravity literature, we specify the following econometric model, which will deliver the estimates of

[13] As defined in equation (14, changes in real output are positive when moving from the no-globalization scenario to the globalization scenario.

[14] As the equation system (8) is homogeneous of degree zero in prices, we chose producer prices in Canada as our numéraire.

the effects of globalization for each industry k from the ITPD-E database:

$$\begin{aligned} X_{ij,t}^{k} &= \exp\Big[\sum_{t}\alpha_{t}^{k}BRDR_{ij,t}+\alpha_{1}^{k}RTA_{ij,t}+\alpha_{2}^{k}WTO_{ij,t}+\alpha_{3}^{k}EU_{ij,t}\Big]\times \\ & \exp\Big[\alpha_{4}^{k}SANCT\_COMPL_{ij,t}+\alpha_{5}^{k}SANCT\_PARTL_{ij,t}\Big]\times \\ & \exp\Big[\pi_{i,t}^{k}+\chi_{j,t}^{k}+\mu_{ij}^{k}\Big]\times\epsilon_{ij,t}^{k}. \end{aligned} \tag{15}$$

Here, $X_{ij,t}^{k}$ denote bilateral trade flows in levels in industry k from exporter i to importer j at time t. As discussed in the theory subsection, due to the separability property of the structural gravity model, equation (15) can be estimated at any desired level of aggregation (e.g., at the product, sector, industry, and/or aggregate levels).[15] This is particularly important for us, as we will obtain estimates of the globalization effects for each of the ITPD-E industries in our sample. Consistent with gravity theory, $X_{ij,t}^{k}$ includes domestic trade flows, cf. Yotov (2022). Domestic trade flows are important because they allow for trade diversion or import substitution with the domestic market, depending on the policy or trade shock being analyzed. Most important for our purposes, the fact that ITPD-E includes domestic trade flows will enable us to identify the effects of globalization that we are after. Finally, following the recommendations of Egger et al. (2022), $X_{ij,t}^{k}$ includes data for all years in the sample.[16]

We will estimate Equation 15 for each industry with the Poisson Pseudo Maximum Likelihood (PPML) estimator, which, owing to Santos Silva and Tenreyro (2006, 2011), has two main advantages for gravity estimations. First, PPML addresses the problem that, due to heteroskedasticity, the OLS gravity estimates are inconsistent. Second, due to its

[15] See Anderson and van Wincoop (2004) for a derivation of an industry-level gravity model from a demand-side perspective, Costinot et al. (2012) for a derivation of an industry-level gravity model from a supply-side perspective, and Yotov et al. (2016) for a demonstration that the demand-side and supply-side industry-level gravity models are identical from an estimation point of view and for a discussion on the challenges and best practices for estimating industry-level/disaggregated gravity models.

[16] Cheng and Wall (2005) criticize gravity specifications with consecutive-year data "on the grounds that dependent and independent variables cannot fully adjust in a single year's time" (Footnote 8, p. 52, Cheng and Wall, 2005). However, more recently, Egger et al. (2022) offer econometric and economic arguments for the use of pooled/consecutive-year data and we follow their recommendation to obtain our main results. In the robustness analysis, we experiment by using interval data and we obtain similar results.

multiplicative form, the PPML estimator takes into account the information contained in the zero trade flows, which are omitted in OLS gravity regressions. The standard errors in all of our specifications are clustered by industry-country-pair. Following the recommendations of Egger and Tarlea (2015), we also experiment with three-way clustered standard errors, i.e., by exporter, importer, and time.

Turning to the covariates in (15), the most important term in our estimating model is $\sum_t \alpha_t^k BRDR_{ij,t}$. This term includes the set of time-varying border indicators, i.e., dummy variables that take a value of 1 for international trade and a value of zero for domestic trade for each year in our sample. Anderson and Yotov (2020) provide a theoretical motivation for the inclusion of these covariates and Bergstrand et al. (2015) demonstrate that the estimates of trade agreements in gravity regressions may be biased upward because they potentially capture common globalization trends. Relying on a comprehensive set of dummy variables to capture the effects of globalization has two advantages for our purposes. First, these covariates are exogenous by construction. Second, they would account for all possible globalization forces shaping trade, in addition to the policy covariates that will be included explicitly in our model. The large and significant estimates that we will obtain reinforce our choice for the econometric treatment of globalization with time-varying border dummies.[17]

In addition to the time-varying globalization effects, we also control for time-varying policy variables. Specifically, we use indicator variables for the presence of regional trade agreements (RTAs) between i and j at time t, $RTA_{ij,t}$. The data on RTAs come from Egger and Larch (2008). We also control for whether the two trading partners are members of the World Trade Organization (WTO), $WTO_{ij,t}$, or of the European Union (EU), $EU_{ij,t}$. Data on memberships in the EU and the WTO come from the Dynamic Gravity Database of the United States International Trade Commission (USITC), (Gurevich and Herman, 2018). Finally,

[17]Ideally, one would like to capture the impact of globalization by including only observable variables. To this end, we do include a set of policy variables that are conventionally used in gravity models. However, we still obtain very large additional effects of globalization, which suggests the presence of many omitted factors for which data may not be available. From that perspective, our industry-time-varying estimates may be interpreted as "all-inclusive" measures of the effects of globalization on trade.

we control for the presence of complete and partial trade sanctions, $SANCT\_COMPL_{ij,t}$ and $SANCT\_PARTL_{ij,t}$, respectively. Data on sanctions come from the latest edition of the Global Sanctions Database (Felbermayr et al., 2020; Syropoulos et al., 2023).

Equation (15) includes three sets of fixed effects. $\pi^k_{i,t}$ and $\chi^k_{j,t}$ are exporter-industry-time and importer-industry-time fixed effects. The theoretical motivation for including these fixed effects in gravity regressions is that they fully control for the unobservable multilateral resistance terms of Anderson and van Wincoop (2003) or, alternatively, for consumer and producer prices. In addition to controlling for the structural MRs, the exporter-industry-time and the importer-industry-time fixed effects will also absorb size variables (e.g., per capita income) and control for any other country-industry-specific characteristics on the exporter and on the importer side that may affect bilateral trade flows.

μ^k_{ij} denotes the set of directional country-pair-industry fixed effects. The motivation for μ^k_{ij} is twofold. First, the country-pair-industry fixed effects will control for and absorb all possible time-invariant bilateral determinants of trade flows. This is potentially important in light of the findings from Egger and Nigai (2015) and Agnosteva et al. (2019) who show that the standard gravity variables (e.g., distance, colonial relationships, etc.) are poor proxies for bilateral trade costs. Second, on a related note, as famously demonstrated by Baier and Bergstrand (2007), the use of country-pair fixed effects mitigates potential endogeneity concerns in relation to bilateral trade policies by absorbing much of the unobserved/unmodeled correlation between the endogenous policy variables and the error term.

4 Results and Discussion

This section presents our disaggregated partial equilibrium estimates of the effects of globalization on trade (in Subsection 4.1) and translates them into the impacts on real output using simulation (in Subsection 4.2).

4.1 Partial Equilibrium Effects of Globalization on Trade

Equation 15 delivers a sequence of globalization estimates for each of the ITPD-E industries. Due to different time-coverages for goods and services in the original data, we obtain globalization effects over different periods for goods vs. services. Specifically, for Agriculture, Mining and Energy, and Manufacturing, we use the period 1990-2019, while for Services, it is 2000-2019. We also note that, by construction, the estimates for the last year in our sample, i.e., 2019, capture the cumulated globalization effects over the whole period of investigation. Therefore, for expositional simplicity, we report and discuss the estimates for 2019.

Due to the large number of industries in our sample, we visualize our results in Figure 1. The top panel of the figure reports all estimates, and the bottom panel removes the top and bottom 5% of outliers. Whereas conventional border effects would ordinarily yield negative coefficient estimates as they reflect the border friction, the coefficients depicted in Figure 1 are positive since these border effects in 2019 are *relative* to the initial (unidentified) year. This setup implies that, if the border became less important over time, this effect of a relatively lower border friction then manifests as a positive coefficient. All estimates also appear in Table 4.[18]

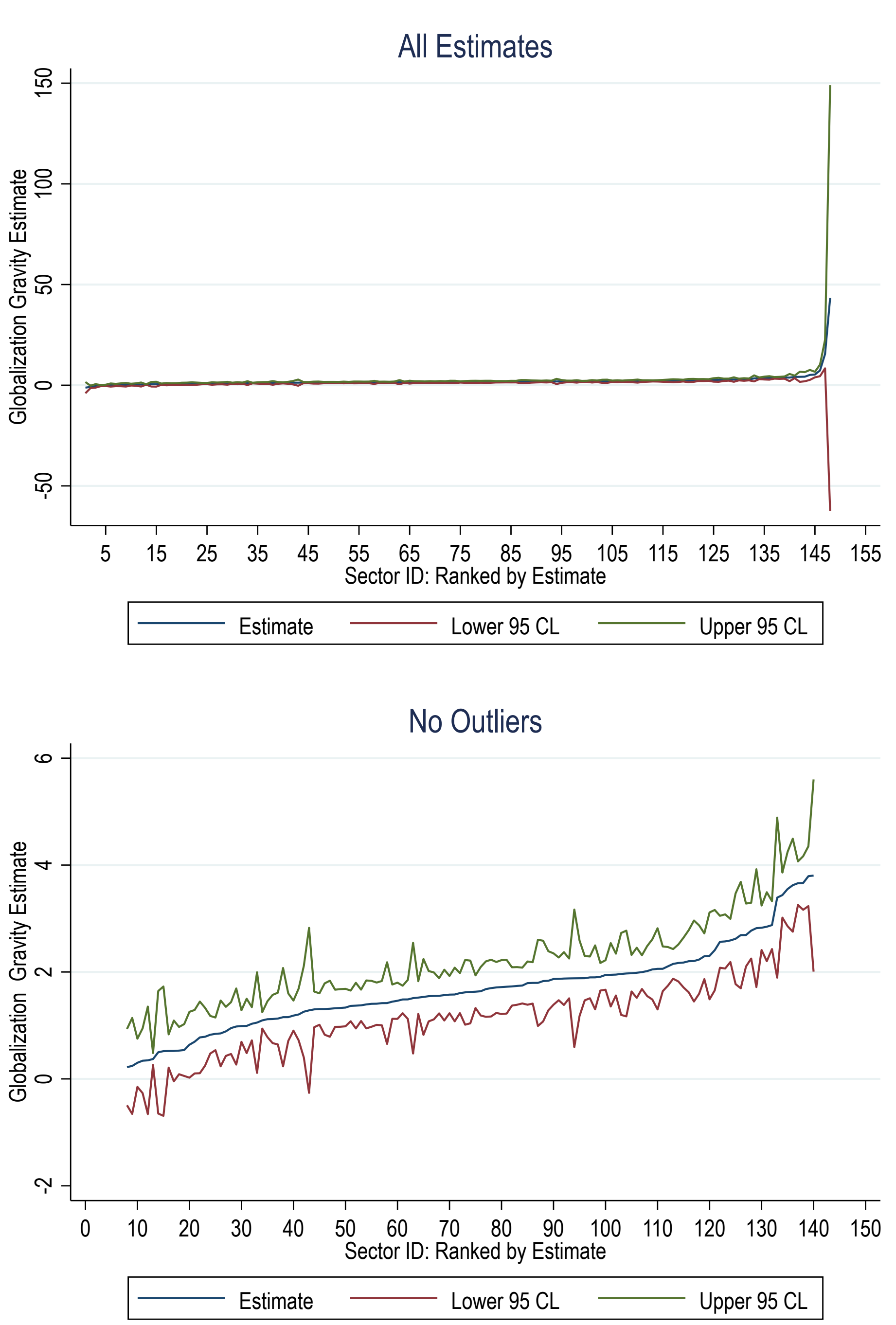
We draw two main conclusions based on the estimates in Figure 1 and Table 4. First, we note that, even after explicitly controlling for the impact of the WTO, RTAs, and EU membership, the effects of globalization on international trade have been very large and significant. The average across all industries globalization effect that we obtain is 1.9,[19] which implies a remarkable increase in global trade of about 570%[20] over the period of investigation. By contrast, only five industries have negative estimated globalization effects and only one of them, 'Cutting shaping and finishing of stone', is statistically significant, while more than 93% of the positive estimates are statistically significant.

[18]Estimates could not be obtained in 22 industries: 12 because they do not have any domestic trade data in ITPD-E or 10 because they have too few domestic trade observations in ITPD-E. For example, there may be only one observation for a pair of countries, which would be perfectly controlled for by the fixed effect.

[19]The average estimate based on the statistically significant estimates is 2.0.

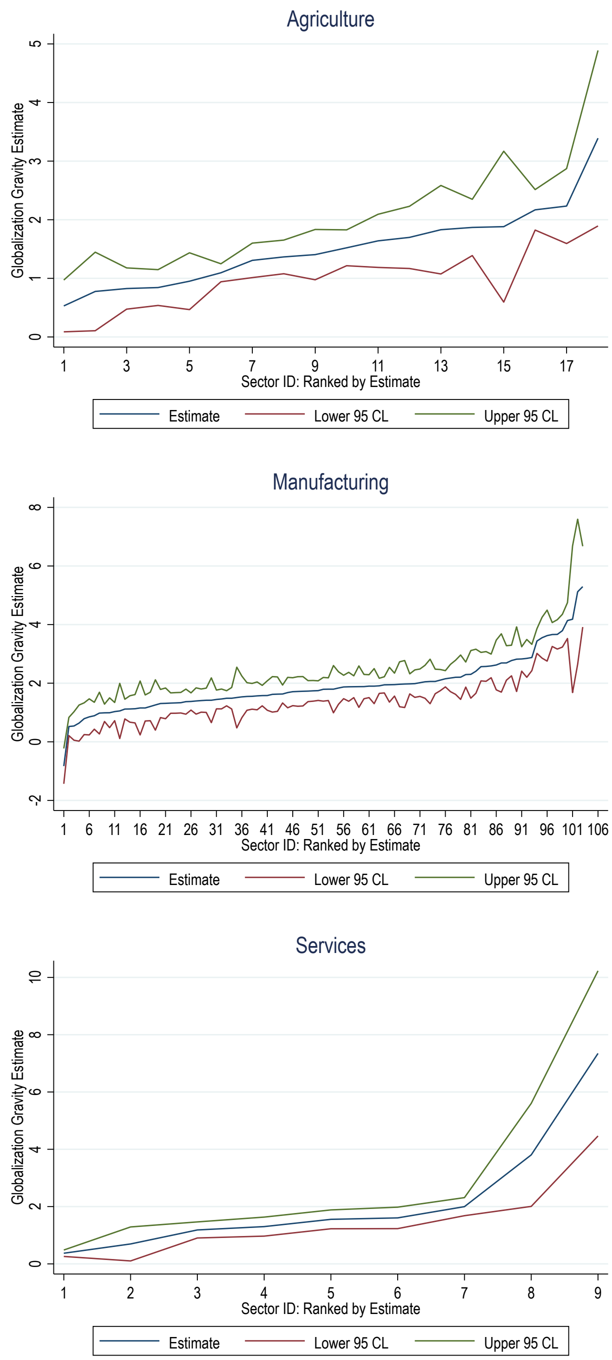
[20]Calculated as [exp(1.9)-1]*100=568.59.

Figure 1: Industry-level Globalization Estimates



Notes: This figure plots the PPML gravity estimates and corresponding confidence intervals for the effects of globalization on industry-level trade. The dependent variable is nominal trade in levels from ITPD-E. All estimates are obtained with exporter-time fixed effects, importer-time fixed effects, pair fixed effects, and time-varying policy variables (e.g., WTO membership, EU membership, RTAs, and Sanctions). The globalization estimates are those for 2019, thus capturing the cumulated effects from the first year of the sample for each industry. For Agriculture, Mining and Energy, and Manufacturing the omittted/reference year is 1991. For Services, it is 2000. Standard errors are clustered by country pair. The full set of estimates appears in Table 4. The top panel reports all estimates. The bottom panel removes the top and bottom 5% of outliers.

Figure 2: Globalization Estimates, Broad Sectors



Notes: This figure plots the statistically significant PPML gravity estimates and corresponding confidence intervals for the effects of globalization on industry-level trade. The dependent variable is nominal trade in levels from ITPD-E. All estimates are obtained with exporter-time fixed effects, importer-time fixed effects, pair fixed effects, and time-varying policy variables (e.g., WTO membership, EU membership, RTAs, and Sanctions). The globalization estimates are those for 2019, thus capturing the cumulated effects from the first year of the sample for each industry. For Agriculture, Mining and Energy, and Manufacturing the omittted/reference year is 1991. For Services, it is 2000. Standard errors are clustered by country pair. The full set of estimates appears in Table 4. The top, middle, and lower panels report the estimates for Agriculture, Manufacturing, and Services, respectively.

The second main conclusion that we draw from the estimates in Figure 1 and Table 4 is that the effects of globalization have been very heterogeneous. To highlight this finding, Figure 2 visualizes the estimates across each of the broad sectors in the ITPD-E. The main findings are that, despite the shorter period of investigation, the services sector has experienced the largest impact of globalization, followed by manufacturing, and then agriculture. We also see significant heterogeneity of the globalization effects within each broad sector. Thus, for example, the services categories that have experienced the largest effects are 'health' services and 'travel' services, while the smallest effects are for 'transport' services and 'trade-related' services.

The five industries with negative estimated globalization effects may seem surprising at first, but we believe that these results should not be discarded as they may yield some insights. Specifically, even though not statistically significant, the largest negative estimate that we obtained is for the industry 'Publishing of newspapers journals etc.' Our estimates suggest that, due to the globalization forces that are captured by our time-varying border dummy variables, international trade of newspapers and journals has decreased relative to domestic sales. We find this result intuitive, and a natural explanation for it is a combination of relatively high transportation costs for such media on the one hand and the rapid advancements in online and social media on the other hand. The other three industries for which we obtain negative estimates are 'Aircraft and spacecraft', 'Construction', and 'Electric motors generators and transformers'.

We also offer a preliminary investigation for possible heterogeneous effects of globalization depending on country level of development. To this end, we use the 2000 classification of the World Bank to identify the *'High Income'* countries in our sample, and we obtain estimates of the effects of globalization for the subsample of rich countries only. Our estimates for 2019 are included in Table 5 and we visualize them, together with the average industry estimates, in Figure 3. The main conclusion that we draw based on these results is that there are no systematic differences in the effects of globalization for the rich countries.

However, it may also be possible that, due to their disproportional size, our average results are driven by large and rich countries. Therefore, we investigate the effects of globalization across four groups, including exports from rich to rich countries, from rich to poor countries, from poor to rich countries, and from poor to poor countries. Moreover, we do see some intuitive variation when we compare the average globalization estimates with those for the rich countries across the four broad sectors in our sample. Specifically, we find the the globalization effects are smaller for the rich countries in Agriculture, but larger for the rich countries in Services, while for manufacturing, the two estimates are almost identical with a slightly larger estimate for the rich countries. Finally, we noted that it is very likely that even if the effects of globalization are uniform across the countries in our sample within each sector, they can generate very heterogeneous welfare effects across the countries.

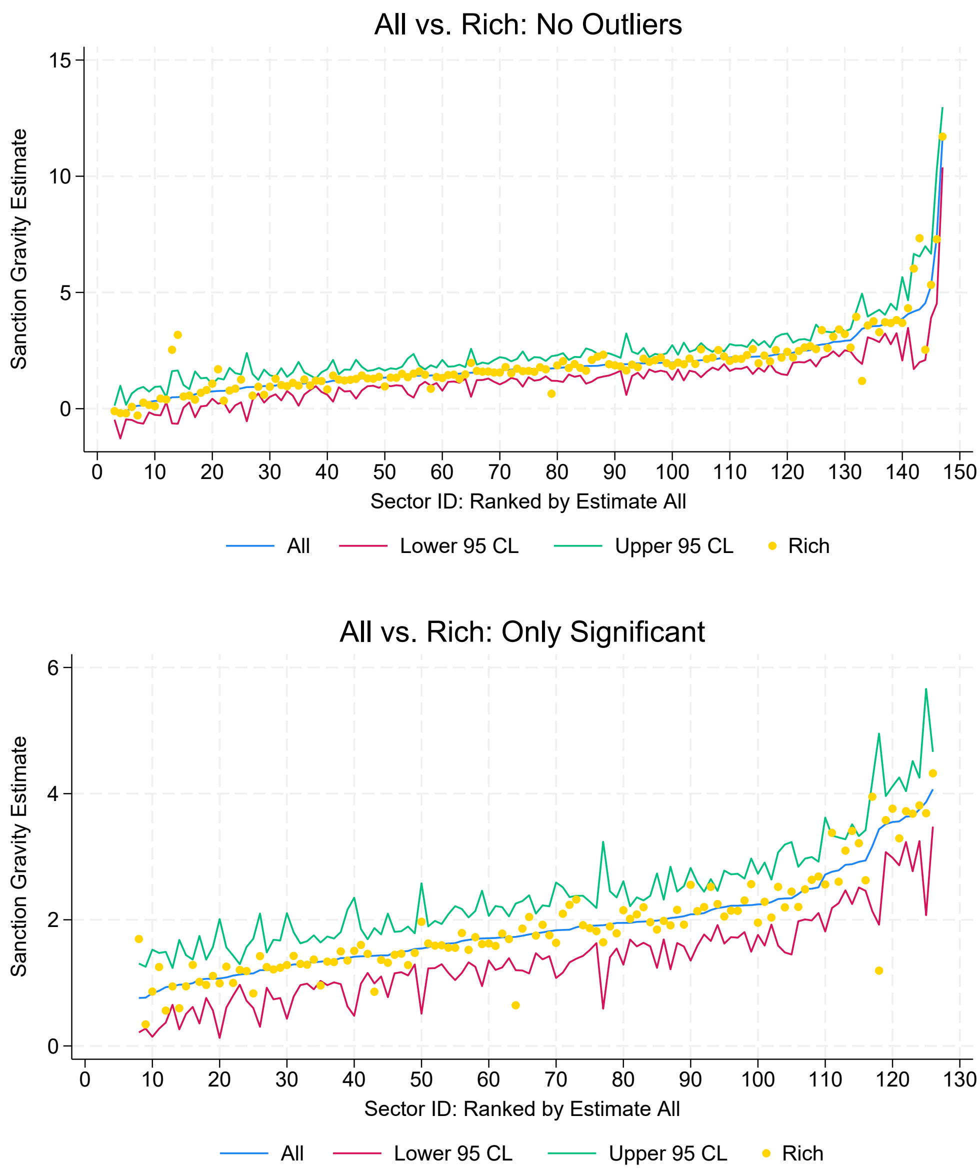
4.2 On The Real Output Effects of Globalization

This section presents and discusses the real output effects that correspond to our partial estimates, and which we obtained from the model that we described in Section 3.1. While we use ITPD-E for our estimations, as it relies only on reported data, ITPD-E is highly unbalanced and thus not suitable for the quantification of the real output effects. With ITPD-S, researchers now have a dataset that is consistent with ITPD-E in terms of countries, industries, and years, and which is balanced, such that it is suitable for quantitative, counterfactual analysis.

To obtain the impact of globalization on real output, we use the model presented in Section 3.1 to simulate a counterfactual scenario in which globalization had not occurred. Our base year is the average of the last three years in ITPD-S, 2017-2019. This averaging increases the number of non-zero observations by 17%. The change in real output due to globalization is calculated as the real output in the base year with globalization relative to the real output in the base year without globalization.

To simplify computation, we aggregate some countries into the rest of the world (ROW)

Figure 3: Globalization Gravity Estimates, Rich vs. All



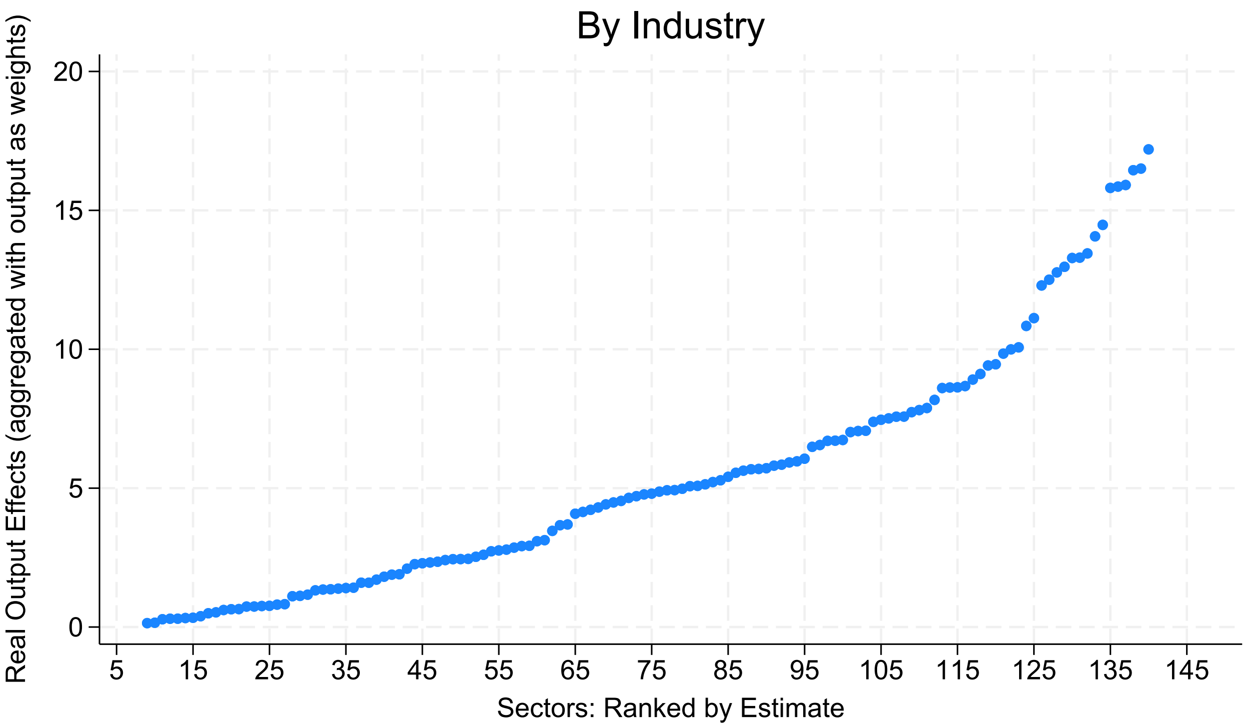
Notes: This figure plots the PPML gravity estimates and corresponding confidence intervals for the effects of globalization on industry-level trade. In addition, as dots, the figure plots the corresponding globalization estimates for the rich countries in our sample, as classified according to the 2000 World Bank income group classification. In each case, the dependent variable is nominal trade in levels from ITPD-E. All estimates are obtained with exporter-time fixed effects, importer-time fixed effects, pair fixed effects, and time-varying policy variables (e.g., WTO membership, EU membership, RTAs, and Sanctions). The globalization estimates are those for 2019, thus capturing the cumulated effects from the first year of the sample for each industry. For Agriculture, Mining and Energy, and Manufacturing the (omitted) reference year is 1991. For Services, it is 2000. Standard errors are clustered by country pair. The full set of estimates appears in Table 5. The top panel reports all estimates. The bottom panel keeps only the statistically significant estimates.

in each industry. All EU countries, the United States (USA), China (CHN), Russia (RUS), Canada (CAN), as well as the largest 70 other exporters in an industry are modeled individually. The rest of the countries are aggregated into the ROW. Therefore, each industry has around 100 countries instead of the 265 in ITPD-S. These countries cover, on average, 99.93% of total trade (with a minimum across industries of 98.72% and a maximum of 100%).

We obtain real output effects for each of the 148 industries for all countries available in this industry. As these are far too many numbers to report and digest, we provide two figures. The first, Figure 4, reports output-weighted averages of real output changes over all countries within an industry. The x-axis ranks the industries according to the size of the real output effects. For all figures, we cut all observations below the 5th percentile and above the 95th percentile for better readability. The figure reveals two important insights. First, for all industries besides one ('Mining of iron ores') we find positive effects of globalization in terms of real output effects. Second, there is substantial heterogeneity across sectors. The real output effects range from -1.04% to 28.58%. The results for the simple averages are reported in Online Appendix I in Figure 9. We also provide a comparison of the weighted and simple averages in Figure 10, which highlights that the results are qualitatively similar but larger in magnitude when using simple averages.

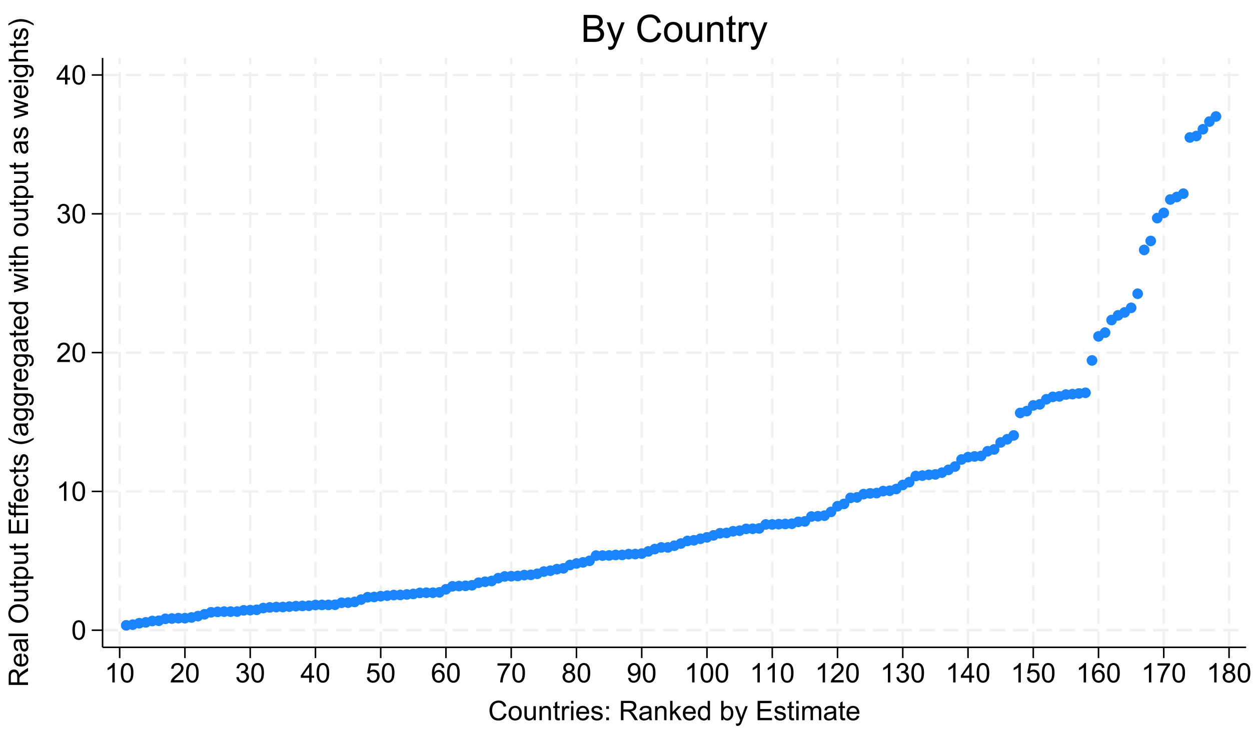
Second, we aggregate the obtained results per country by taking the weighted average over all industries for each country; that is, in aggregating up to the country level each industry is weighted by its relative contribution to country-level output. Again, we rank countries in Figure 5 by the size of their average real output effects. As over industries, we again see positive real output effects for nearly all countries (the only exception is Grenada with slight negative effects). Also across countries, we find substantial heterogeneity, ranging from $-.08\%$ to 117.48%. Hence, it seems that the effects across countries vary more than across industries. The results for the simple averages are reported in Online Appendix I in Figure 11. We also provide a comparison of the weighted and simple averages in Figure 12, which highlights again that the results are qualitatively similar. However, across countries,

Figure 4: The Effects of Globalization - Industry Results (output as weights)



also the magnitudes of the weighted and simple averages are quite similar.

Figure 5: The Effects of Globalization - Country Results



4.3 Distributional Implications

So far, we have seen that there is substantial heterogeneity both across industries and across countries, with the latter even more pronounced. We, therefore, next investigate the relationship between the real output gains from globalization relative to the size of countries, measured by average output over the years 2017-2019 without the impact of globalization as a baseline, which is also used in the quantification.

Figure 6 plots real output effects (using output as weights to aggregate) against the log of 2019 no-globalization output; as such, this is a type of 'convergence graph' that reveals how gains are distributed across pre-globalisation country size. Notwithstanding considerable heterogeneity, a negative overall relationship is apparent. Specifically, small economies—which are almost always poorer developing countries such as the Central African Republic, Samoa, Bhutan, Togo, and Myanmar—seem to have gained considerably more from globalization than more developed, larger countries such as the USA, China, Japan, or Germany. As a summary statistic, we calculate a correlation coefficient of -0.308.[21] We also provide plots using the simple averages in Figures 14 and 15 in Online Appendix I.

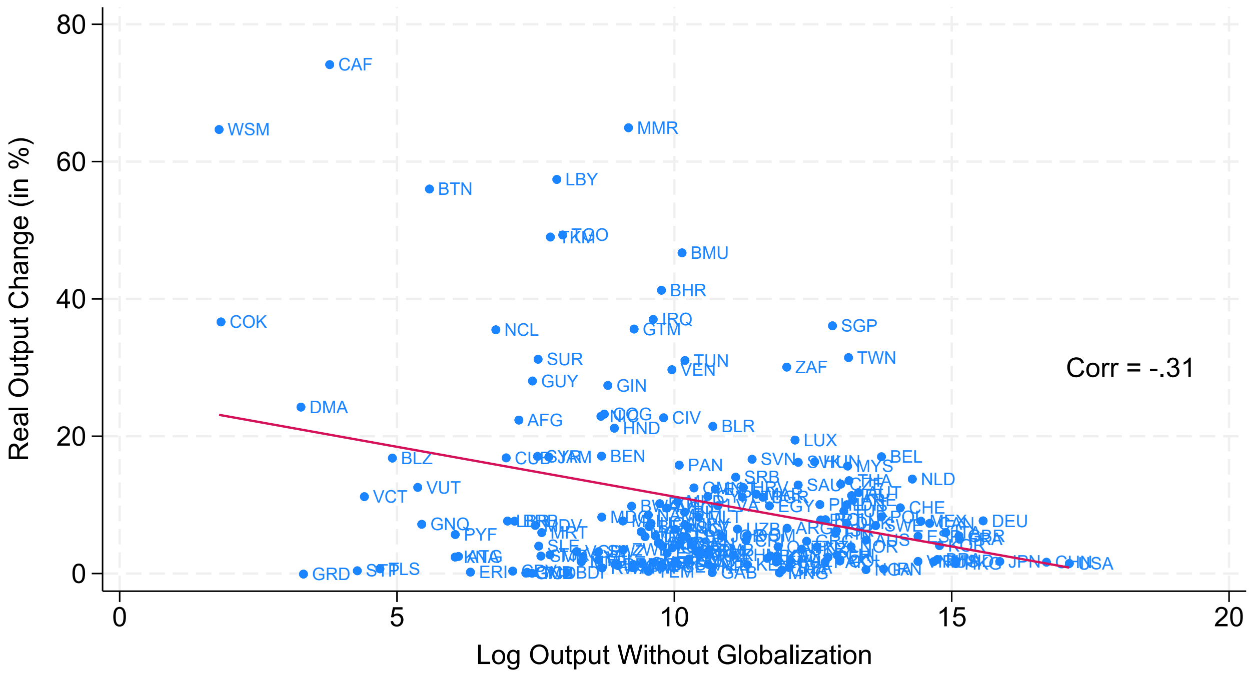
While the relationship between the real output effects and the level of output suggests that especially developing countries profited from globalization, it does not provide us with an overall assessment of the effects of globalization on inequality between countries. To investigate this, we first calculate the Gini index from the average output data used in the simulation. We obtain a value of 0.876. We then use our obtained counterfactual producer price changes to translate this output into output values without globalization. The Gini coefficient of output without globalization amounts to 0.884. This suggests that inequality between countries measured by the Gini index decreased from 0.884 to 0.876 based on our quantification of globalization.[22]

Figure 7 depicts this fall in equality for all countries in the left-hand side panel, in which

[21] St. Lucia appears as an outlier, and we provide the same figure ***including*** St. Lucia in Online Appendix I (Figure 13), which incidentally raises the correlation coefficient even further to -0.354.

[22] When translating the output into real output without globalization, we obtain a Gini coefficient of 0.881.

Figure 6: The Effects of Globalization - The Role of Country Size

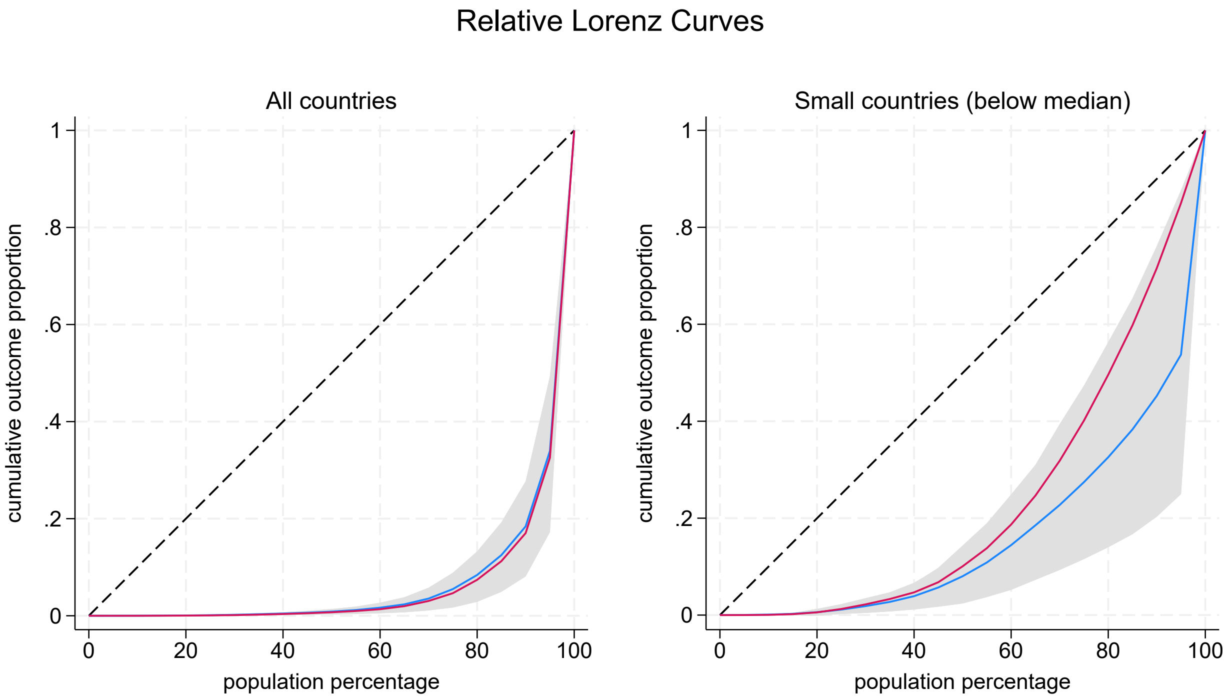


Note: St.Lucia omitted for expositional reasons (real output gain +117.5%).

the blue curve lies very slightly inside the red curve, which shows the distribution without globalization. Hence, counterfactually removing globalization effects would have increased cross-country inequality of output in the global sample. At the same time, inequality has increased for economies in the bottom quartile of the country size distribution, and to a lesser extent also in the second quartile, the combined effect across both quartiles shown in the right-hand side panel of Figure 7. Yet it is worth remembering that relative Lorenz curves do not show that globalization has overall increased output, i.e. the pie has grown, although economies differ appreciably in the extent to which they have benefited through international linkages, which is the reason why we see an increase in output inequality *within* the group of smaller countries but a fall in inequality overall, as the latter catch up.

We also plot the real output gains against countries' trade openness constructed from no-globalization trade and output data. Figure 8 contains two principal findings: firstly, it shows that higher gains accrue to more open economies, and the associated correlation

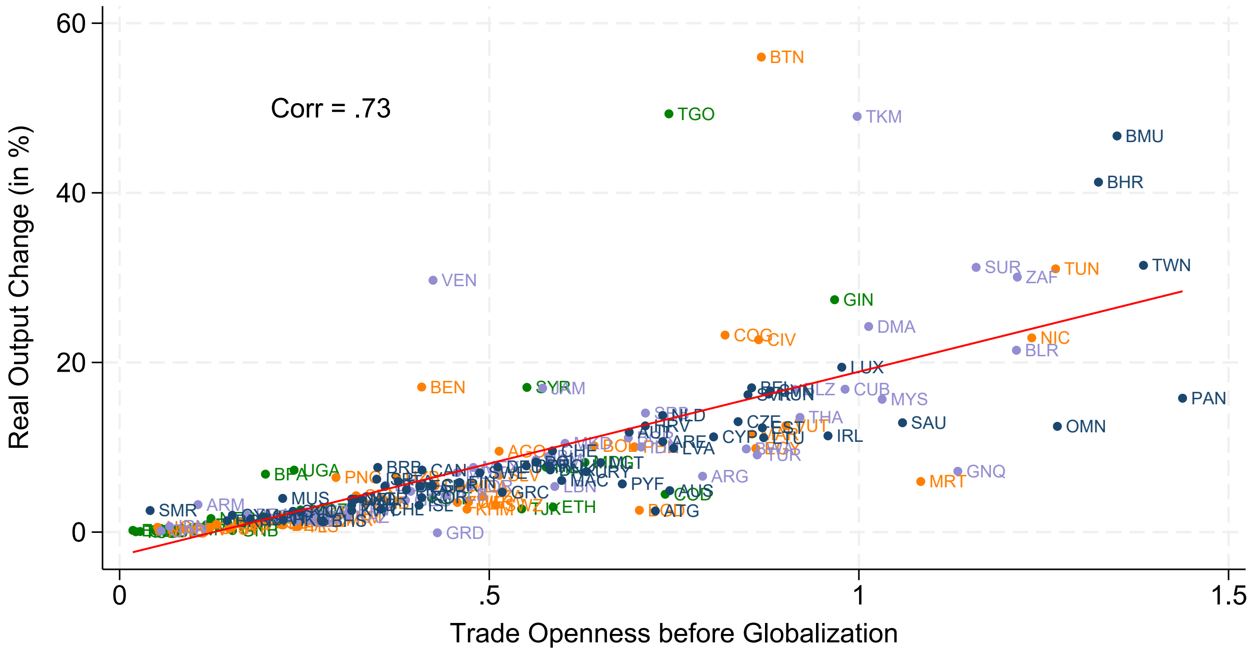
Figure 7: Output Concentration and Globalization



coefficient is strongly positive (+0.73). In part, this relationship simply reflects the nature of our counterfactual exercise, as the impact on real output of a counterfactual trade cost change is bound to be larger for countries that trade a larger share of their output. The second insight, though, which is perhaps less obvious, is that an economy can (will) benefit from trade openness no matter at which stage of development it is. Put differently, the positive correlation is *not* driven by any particular color group, which denotes a country's income per capita in 2019;[23] rather, countries from each income bracket are scattered around the fitted line in roughly the same manner. This implies that the benefits of more trade are in principle open to any economy whether it is poor or rich.

[23]Low income countries are green, lower-middle income is orange, upper-middle income is lavender, and high income countries are navy blue.

Figure 8: Distribution of Real Output Gains



Notes: Trade openness defined as (exports+imports)/output; values exceeding 150% omitted.
Countries color-coded according to 2019 income per capita brackets (see text).

5 Conclusions

In this paper, we introduce the *International Trade and Production Database for Simulation* (ITPD-S), which is a fully balanced database that covers 170 industries and 265 countries during the period 1990-2019. The ITPD-S is the most disaggregated dataset that is currently available that also has this breadth of countries and years for performing counterfactual simulations for trade policy analysis. To highlight these possibilities, we combine the ITPD-S with the *International Trade and Production Database for Estimation* (ITPD-E), which is of the same dimensions and can be used for estimation, and we quantify the impact of globalization on trade and welfare in the world over the period 1990-2019. To perform the analysis, we rely on well-established methods and we complement the ITPD datasets with several additional standard databases.

We start by obtaining partial equilibrium estimates of the effects of globalization at the industry level. To this end, we capitalize on the fact that the ITPD-E includes domestic trade flows. Several findings stand out. Most importantly, we obtain large, positive and statistically significant estimates of the effects of globalization on trade, which imply that, on average, bilateral globalization forces (other than trade agreements, WTO membership, and EU membership, which we control for in our analysis) have led to a remarkable increase of 570% in international trade relative to domestic sales over the period 1990-2019. In addition, we find that the globalization estimates that we obtain are very heterogeneous across the ITPD sectors, with larger effects for 'Services' and smaller effects for 'Agriculture'. Finally, even though we do not observe significant differences between the effects of globalization for the rich countries in our sample, we do see some intuitive variation across the broad sectors with stronger globalization benefits for the rich countries in 'Services' but smaller than the average effects in 'Agriculture'.

Our analysis reveals that the gains from globalization in terms of real industry output have been significant for most countries. At the same time, we also document substantial heterogeneity in these effects, which appear to be more pronounced across countries than across industries. Specifically, developing and smaller countries seem to have profited the most from increasing international trade. This finding is then reflected in decreasing global inequality measured by comparing Gini coefficients from current, observed output levels and output levels predicted if globalization had not taken place.

While these results are encouraging, they leave as yet unanswered deeper questions about the driving forces behind those globalization effects that manifest even after explicitly accounting for a variety of factors including regional integration agreements. For instance, globalization, as we define it, could be driven by *policy interventions* such as unilateral tariff and NTM reductions, or by *secular trends* such as ongoing deepening of production fragmentation, or by *(digital) technology*-induced reductions in transportation costs. Thus, we consider our findings, which have established the salience and evolution of globalization effects over time with the help of the new ITPD-E and ITPD-S databases, as a springboard for future research that could tackle these questions. On a methodological note, we also highlight that we have performed our quantification assuming endowment economies, which ignores, for example, any dynamic forces that may me channeled through asset accumulation. Future developments in terms of better data availability at the same dimensions as ITPD-S will hopefully help to overcome this shortcoming.

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Online Appendix I:

Table 4: Industry-Level Globalization Estimates

ID	Industry Description	Broad Sector	Estimate	Std. Err.
1	Wheat	Agriculture	0.770	(.25)***
2	Rice (raw)	Agriculture	1.430	(.22)***
3	Corn	Agriculture	1.150	(.28)***
4	Other cereals	Agriculture	0.990	(.19)***
5	Cereal products	Agriculture	.	(.)
6	Soybeans	Agriculture	1.910	(.68)***
7	Other oilseeds (excluding peanuts)	Agriculture	1.420	(.14)***
8	Animal feed ingredients and pet foods	Agriculture	.	(.)
9	Raw and refined sugar and sugar crops	Agriculture	1.830	(.39)***
10	Other sweeteners	Agriculture	1.700	(.23)***
11	Pulses and legumes, dried, preserved	Agriculture	2.280	(.18)***
12	Fresh fruit	Agriculture	1.340	(.16)***
13	Fresh vegetables	Agriculture	1.130	(.08)***
14	Prepared fruits and fruit juices	Agriculture	.	(.)
15	Prepared vegetables	Agriculture	.	(.)
16	Nuts	Agriculture	0.740	(.16)***
17	Live Cattle	Agriculture	.	(.)
18	Live Swine	Agriculture	.	(.)
19	Eggs	Agriculture	1.440	(.17)***
20	Other meats, livestock products, and live animals	Agriculture	1.880	(.25)***
21	Cocoa and cocoa products	Agriculture	0.930	(.75)
22	Beverages, nec	Agriculture	3.440	(.77)***
23	Cotton	Agriculture	.	(.)
24	Tobacco leaves and cigarettes	Agriculture	0.840	(.35)**
25	Spices	Agriculture	2.250	(.34)***
26	Other agricultural products, nec	Agriculture	1.730	(.27)***
27	Forestry	Agriculture	.	(.)
28	Fishing	Agriculture	.	(.)
29	Mining of hard coal	Mining and Energy	4.270	(1.16)***
30	Mining of lignite	Mining and Energy	.	(.)
31	Extraction crude petroleum and natural gas	Mining and Energy	.	(.)
32	Mining of iron ores	Mining and Energy	0.500	(.58)
33	Other mining and quarring	Mining and Energy	0.330	(.31)
34	Electricity production, collection, and distribution	Mining and Energy	.	(.)
35	Gas production and distribution	Mining and Energy	.	(.)
36	Processing/preserving of meat	Manufacturing	2.040	(.21)***
37	Processing/preserving of fish	Manufacturing	1.090	(.24)***
38	Processing/preserving of fruit and vegetables	Manufacturing	1.840	(.35)***
39	Vegetable and animal oils and fats	Manufacturing	2.150	(.25)***
40	Dairy products	Manufacturing	2.230	(.38)***
41	Grain mill products	Manufacturing	2.940	(.25)***
42	Starches and starch products	Manufacturing	0.930	(.29)***
43	Prepared animal feeds	Manufacturing	1.770	(.32)***
44	Bakery products	Manufacturing	1.930	(.27)***
45	Sugar	Manufacturing	0.800	(.49)
46	Cocoa chocolate and sugar confectionery	Manufacturing	2.410	(.22)***
47	Macaroni noodles and similar products	Manufacturing	3.170	(.52)***
48	Other food products n.e.c.	Manufacturing	1.980	(.2)***
49	Distilling rectifying and blending of spirits	Manufacturing	2.340	(.45)***
50	Wines	Manufacturing	5.290	(.7)***
51	Malt liquors and malt	Manufacturing	2.720	(.46)***
52	Soft drinks; mineral waters	Manufacturing	1.700	(.39)***
53	Tobacco products	Manufacturing	1.200	(.46)***
54	Textile fibre preparation; textile weaving	Manufacturing	1.420	(.22)***
55	Made-up textile articles except apparel	Manufacturing	2.200	(.3)***
56	Carpets and rugs	Manufacturing	2.250	(.25)***
57	Cordage rope twine and netting	Manufacturing	1.670	(.26)***
58	Other textiles n.e.c.	Manufacturing	1.210	(.24)***
59	Knitted and crocheted fabrics and articles	Manufacturing	3.750	(.26)***
60	Wearing apparel except fur apparel	Manufacturing	2.760	(.29)***
61	Dressing and dyeing of fur; processing of fur	Manufacturing	0.620	(.5)
62	Tanning and dressing of leather	Manufacturing	0.760	(.28)***
63	Luggage handbags etc.; saddlery and harness	Manufacturing	3.640	(.45)***
64	Footwear	Manufacturing	2.880	(.32)***
65	Sawmilling and planing of wood	Manufacturing	1.270	(.43)***
66	Veneer sheets plywood particle board etc.	Manufacturing	1.480	(.17)***
67	Builders' carpentry and joinery	Manufacturing	1.330	(.22)***
68	Wooden containers	Manufacturing	1.900	(.24)***
69	Other wood products; articles of cork/straw	Manufacturing	0.340	(.32)
70	Pulp paper and paperboard	Manufacturing	2.220	(.26)***
71	Corrugated paper and paperboard	Manufacturing	1.710	(.18)***
72	Other articles of paper and paperboard	Manufacturing	1.610	(.16)***
73	Publishing of books and other publications	Manufacturing	.	(.)
74	Publishing of newspapers journals etc.	Manufacturing	-1.240	(1.41)
75	Publishing of recorded media	Manufacturing	.	(.)
76	Other publishing	Manufacturing	4.180	(1.26)***
77	Printing	Manufacturing	1.510	(.2)***
78	Service activities related to printing	Manufacturing	0.730	(.31)**
79	Coke oven products	Manufacturing	4.540	(1.25)***
80	Refined petroleum products	Manufacturing	3.550	(.29)***
81	Processing of nuclear fuel	Manufacturing	.	(.)

Continued on next page

82	Basic chemicals except fertilizers	Manufacturing	1.060	(.15)***
83	Fertilizers and nitrogen compounds	Manufacturing	0.870	(.31)***
84	Plastics in primary forms; synthetic rubber	Manufacturing	2.920	(.21)***
85	Pesticides and other agro-chemical products	Manufacturing	2.780	(.27)***
86	Paints varnishes printing ink and mastics	Manufacturing	2.190	(.14)***
87	Pharmaceuticals medicinal chemicals etc.	Manufacturing	3.640	(.21)***
88	Soap cleaning and cosmetic preparations	Manufacturing	3.520	(.23)***
89	Other chemical products n.e.c.	Manufacturing	2.230	(.22)***
90	Man-made fibres	Manufacturing	2.090	(.37)***
91	Rubber tyres and tubes	Manufacturing	1.680	(.18)***
92	Other rubber products	Manufacturing	1.720	(.17)***
93	Plastic products	Manufacturing	1.540	(.13)***
94	Glass and glass products	Manufacturing	1.120	(.16)***
95	Pottery china and earthenware	Manufacturing	1.900	(.2)***
96	Refractory ceramic products	Manufacturing	1.620	(.24)***
97	Struct.non-refractory clay; ceramic products	Manufacturing	1.070	(.48)**
98	Cement lime and plaster	Manufacturing	0.490	(.57)
99	Articles of concrete cement and plaster	Manufacturing	1.720	(.24)***
100	Cutting shaping and finishing of stone	Manufacturing	-0.820	(.31)***
101	Other non-metallic mineral products n.e.c.	Manufacturing	1.320	(.17)***
102	Basic iron and steel	Manufacturing	2.110	(.17)***
103	Basic precious and non-ferrous metals	Manufacturing	2.870	(.21)***
104	Structural metal products	Manufacturing	0.970	(.24)***
105	Tanks reservoirs and containers of metal	Manufacturing	2.510	(.21)***
106	Steam generators	Manufacturing	1.950	(.34)***
107	Cutlery hand tools and general hardware	Manufacturing	1.910	(.14)***
108	Other fabricated metal products n.e.c.	Manufacturing	1.140	(.22)***
109	Engines and turbines (not for transport equipment)	Manufacturing	1.060	(.26)***
110	Pumps compressors taps and valves	Manufacturing	2.090	(.26)***
111	Bearings gears gearing and driving elements	Manufacturing	1.820	(.2)***
112	Ovens furnaces and furnace burners	Manufacturing	0.0800	(.29)
113	Lifting and handling equipment	Manufacturing	1.750	(.28)***
114	Other general purpose machinery	Manufacturing	1.950	(.13)***
115	Agricultural and forestry machinery	Manufacturing	1.490	(.17)***
116	Machine tools	Manufacturing	1.800	(.22)***
117	Machinery for metallurgy	Manufacturing	0.120	(.37)
118	Machinery for mining and construction	Manufacturing	1.360	(.18)***
119	Food/beverage/tobacco processing machinery	Manufacturing	1.710	(.26)***
120	Machinery for textile apparel and leather	Manufacturing	0.290	(.23)
121	Weapons and ammunition	Manufacturing	1.990	(.38)***
122	Other special purpose machinery	Manufacturing	1.970	(.2)***
123	Domestic appliances n.e.c.	Manufacturing	2.060	(.24)***
124	Office accounting and computing machinery	Manufacturing	1.550	(.53)***
125	Electric motors generators and transformers	Manufacturing	-0.150	(.16)
126	Electricity distribution and control apparatus	Manufacturing	2.330	(.38)***
127	Insulated wire and cable	Manufacturing	1.970	(.17)***
128	Accumulators primary cells and batteries	Manufacturing	4.070	(.3)***
129	Lighting equipment and electric lamps	Manufacturing	2.220	(.25)***
130	Other electrical equipment n.e.c.	Manufacturing	2.490	(.25)***
131	Electronic valves tubes etc.	Manufacturing	0.530	(.25)**
132	TV/radio transmitters; line comm. apparatus	Manufacturing	1.840	(.26)***
133	TV and radio receivers and associated goods	Manufacturing	0.970	(.36)***
134	Medical surgical and orthopaedic equipment	Manufacturing	1.350	(.2)***
135	Measuring/testing/navigating appliances etc.	Manufacturing	1.390	(.21)***
136	Optical instruments and photographic equipment	Manufacturing	1.630	(.3)***
137	Watches and clocks	Manufacturing	.	(.)
138	Motor vehicles	Manufacturing	1.950	(.21)***
139	Automobile bodies trailers and semi-trailers	Manufacturing	1.440	(.34)***
140	Parts/accessories for automobiles	Manufacturing	1.050	(.35)***
141	Building and repairing of ships	Manufacturing	0.150	(.4)
142	Building/repairing of pleasure/sport. boats	Manufacturing	2.340	(.44)***
143	Railway/tramway locomotives and rolling stock	Manufacturing	1.220	(.23)***
144	Aircraft and spacecraft	Manufacturing	-0.150	(.58)
145	Motorcycles	Manufacturing	3.560	(.36)***
146	Bicycles and invalid carriages	Manufacturing	1.390	(.39)***
147	Other transport equipment n.e.c.	Manufacturing	2.490	(.26)***
148	Furniture	Manufacturing	1.780	(.16)***
149	Jewellery and related articles	Manufacturing	2.030	(.42)***
150	Musical instruments	Manufacturing	0.940	(.15)***
151	Sports goods	Manufacturing	0.560	(.15)***
152	Games and toys	Manufacturing	1.410	(.48)***
153	Other manufacturing n.e.c.	Manufacturing	1.290	(.26)***
154	Manufacturing services on physical inputs	Services	.	(.)
155	Maintenance and repair services n.i.e.	Services	.	(.)
156	Transport	Services	0.390	(.06)***
157	Travel	Services	3.870	(.92)***
158	Construction	Services	-0.170	(.16)
159	Insurance and pension services	Services	1.300	(.17)***
160	Financial services	Services	2	(.16)***
161	Charges for use of intellectual property	Services	.	(.)
162	Telecom, computer, information services	Services	1.560	(.17)***
163	Other business services	Services	1.610	(.19)***
164	Heritage and recreational services	Services	11.68	(.66)***
165	Health services	Services	7.400	(1.47)***
166	Education services	Services	1.200	(.14)***
167	Government goods and services n.i.e.	Services	.	(.)
168	Services not allocated	Services	.	(.)
169	Trade-related services	Services	0.700	(.31)**
170	Other personal services	Services	13.82	(1.57)***

Continued on next page

Notes: This table reports PPML gravity estimates of the effects of globalization on industry-level trade. The dependent variable is nominal trade in levels from ITPD-E. All estimates are obtained with exporter-time, importer-time, and pair fixed effects. We do not show the estimates of fixed effects or the time-varying policy variables, which are included in the analysis. The globalization estimates are those for 2019, thus capturing the cumulated affects from the first year of the sample for each industry. For Agriculture, Mining and Energy, and Manufacturing the reference year is 1991. For Services, it is 2000. Estimates could not be obtained in 22 industries because they do not have any or too few domestic trade observations in ITPD-E. Standard errors are clustered by country pair. * $p < 0.10$, ** $p < .05$, *** $p < .01$.

Table 5: Industry-Level Globalization Estimates, Rich Countries

ID	Industry Description	Broad Sector	Estim. All	Std. Err. All	Estim. Rich	Std. Err. Rich
1	Wheat	Agriculture	0.770	(.25)***	0.340	(.23)
2	Rice (raw)	Agriculture	1.430	(.22)***	0.860	(.29)***
3	Corn	Agriculture	1.150	(.28)***	0.830	(.27)***
4	Other cereals	Agriculture	0.990	(.19)***	1.280	(.22)***
5	Cereal products	Agriculture	.	(.)	.	(.)
6	Soybeans	Agriculture	1.910	(.68)***	1.640	(1)*
7	Other oilseeds (excluding peanuts)	Agriculture	1.420	(.14)***	1.460	(.22)***
8	Animal feed ingredients and pet foods	Agriculture	.	(.)	.	(.)
9	Raw and refined sugar and sugar crops	Agriculture	1.830	(.39)***	1.630	(.36)***
10	Other sweeteners	Agriculture	1.700	(.23)***	1.720	(.25)***
11	Pulses and legumes, dried, preserved	Agriculture	2.280	(.18)***	2.040	(.24)***
12	Fresh fruit	Agriculture	1.340	(.16)***	0.960	(.2)***
13	Fresh vegetables	Agriculture	1.130	(.08)***	1.210	(.08)***
14	Prepared fruits and fruit juices	Agriculture	.	(.)	.	(.)
15	Prepared vegetables	Agriculture	.	(.)	.	(.)
16	Nuts	Agriculture	0.740	(.16)***	1.070	(.19)***
17	Live Cattle	Agriculture	.	(.)	.	(.)
18	Live Swine	Agriculture	.	(.)	.	(.)
19	Eggs	Agriculture	1.440	(.17)***	1.360	(.19)***
20	Other meats, livestock products, and live animals	Agriculture	1.880	(.25)***	2.320	(.41)***
21	Cocoa and cocoa products	Agriculture	0.930	(.75)	.	(.)
22	Beverages, nec	Agriculture	3.440	(.77)***	1.190	(.48)**
23	Cotton	Agriculture	.	(.)	.	(.)
24	Tobacco leaves and cigarettes	Agriculture	0.840	(.35)**	0.860	(.45)*
25	Spices	Agriculture	2.250	(.34)***	2.280	(.67)***
26	Other agricultural products, nec	Agriculture	1.730	(.27)***	0.640	(.35)*
27	Forestry	Agriculture	.	(.)	.	(.)
28	Fishing	Agriculture	.	(.)	.	(.)
29	Mining of hard coal	Mining and Energy	4.270	(1.16)***	7.330	(1.86)***
30	Mining of lignite	Mining and Energy	.	(.)	.	(.)
31	Extraction crude petroleum and natural gas	Mining and Energy	.	(.)	.	(.)
32	Mining of iron ores	Mining and Energy	0.500	(.58)	3.170	(.96)***
33	Other mining and quarring	Mining and Energy	0.330	(.31)	0.110	(.2)
34	Electricity production, collection, and distribution	Mining and Energy	.	(.)	.	(.)
35	Gas production and distribution	Mining and Energy	.	(.)	.	(.)
36	Processing/preserving of meat	Manufacturing	2.040	(.21)***	2.160	(.22)***
37	Processing/preserving of fish	Manufacturing	1.090	(.24)***	1.260	(.29)***
38	Processing/preserving of fruit and vegetables	Manufacturing	1.840	(.35)***	2.100	(.31)***
39	Vegetable and animal oils and fats	Manufacturing	2.150	(.25)***	2.520	(.29)***
40	Dairy products	Manufacturing	2.230	(.38)***	2.560	(.45)***
41	Grain mill products	Manufacturing	2.940	(.25)***	2.630	(.37)***
42	Starches and starch products	Manufacturing	0.930	(.29)***	0.560	(.29)*
43	Prepared animal feeds	Manufacturing	1.770	(.32)***	2.040	(.34)***
44	Bakery products	Manufacturing	1.930	(.27)***	1.890	(.31)***
45	Sugar	Manufacturing	0.800	(.49)	0.780	(.45)*
46	Cocoa chocolate and sugar confectionery	Manufacturing	2.410	(.22)***	2.200	(.2)***
47	Macaroni noodles and similar products	Manufacturing	3.170	(.52)***	3.950	(.37)***
48	Other food products n.e.c.	Manufacturing	1.980	(.2)***	1.960	(.2)***
49	Distilling rectifying and blending of spirits	Manufacturing	2.340	(.45)***	2.450	(.5)***
50	Wines	Manufacturing	5.290	(.7)***	5.330	(.7)***
51	Malt liquors and malt	Manufacturing	2.720	(.46)***	2.560	(.44)***
52	Soft drinks; mineral waters	Manufacturing	1.700	(.39)***	1.620	(.41)***
53	Tobacco products	Manufacturing	1.200	(.46)***	1.420	(.52)***
54	Textile fibre preparation; textile weaving	Manufacturing	1.420	(.22)***	1.600	(.21)***
55	Made-up textile articles except apparel	Manufacturing	2.200	(.3)***	2.050	(.33)***
56	Carpets and rugs	Manufacturing	2.250	(.25)***	1.950	(.26)***
57	Cordage rope twine and netting	Manufacturing	1.670	(.26)***	1.790	(.24)***
58	Other textiles n.e.c.	Manufacturing	1.210	(.24)***	1.210	(.22)***
59	Knitted and crocheted fabrics and articles	Manufacturing	3.750	(.26)***	3.810	(.3)***
60	Wearing apparel except fur apparel	Manufacturing	2.760	(.29)***	3.380	(.33)***
61	Dressing and dyeing of fur; processing of fur	Manufacturing	0.620	(.5)	0.390	(.59)
62	Tanning and dressing of leather	Manufacturing	0.760	(.28)***	1.700	(.35)***
63	Luggage handbags etc.; saddlery and harness	Manufacturing	3.640	(.45)***	3.680	(.38)***
64	Footwear	Manufacturing	2.880	(.32)***	3.410	(.38)***
65	Sawmilling and planing of wood	Manufacturing	1.270	(.43)***	1.280	(.41)***
66	Veneer sheets plywood particle board etc.	Manufacturing	1.480	(.17)***	1.440	(.19)***
67	Builders' carpentry and joinery	Manufacturing	1.330	(.22)***	1.370	(.23)***
68	Wooden containers	Manufacturing	1.900	(.24)***	1.910	(.25)***
69	Other wood products; articles of cork/straw	Manufacturing	0.340	(.32)	0.430	(.35)
70	Pulp paper and paperboard	Manufacturing	2.220	(.26)***	2.140	(.27)***
71	Corrugated paper and paperboard	Manufacturing	1.710	(.18)***	1.620	(.19)***
72	Other articles of paper and paperboard	Manufacturing	1.610	(.16)***	1.600	(.18)***
73	Publishing of books and other publications	Manufacturing	.	(.)	.	(.)
74	Publishing of newspapers journals etc.	Manufacturing	-1.240	(1.41)	-6.500	(7.45)
75	Publishing of recorded media	Manufacturing	.	(.)	.	(.)
76	Other publishing	Manufacturing	4.180	(1.26)***	6.030	(1.13)***
77	Printing	Manufacturing	1.510	(.2)***	1.280	(.19)***
78	Service activities related to printing	Manufacturing	0.730	(.31)**	0.800	(.34)**
79	Coke oven products	Manufacturing	4.540	(1.25)***	2.540	(2.15)
80	Refined petroleum products	Manufacturing	3.550	(.29)***	3.760	(.33)***
81	Processing of nuclear fuel	Manufacturing	.	(.)	.	(.)
82	Basic chemicals except fertilizers	Manufacturing	1.060	(.15)***	0.970	(.17)***
83	Fertilizers and nitrogen compounds	Manufacturing	0.870	(.31)***	1.250	(.36)***
84	Plastics in primary forms; synthetic rubber	Manufacturing	2.920	(.21)***	3.210	(.21)***
85	Pesticides and other agro-chemical products	Manufacturing	2.780	(.27)***	2.600	(.27)***
86	Paints varnishes printing ink and mastics	Manufacturing	2.190	(.14)***	2.250	(.15)***
87	Pharmaceuticals medicinal chemicals etc.	Manufacturing	3.640	(.21)***	3.720	(.23)***

Continued on next page

88	Soap cleaning and cosmetic preparations	Manufacturing	3.520	(.23)***	3.580	(.26)***
89	Other chemical products n.e.c.	Manufacturing	2.230	(.22)***	2.310	(.22)***
90	Man-made fibres	Manufacturing	2.090	(.37)***	2.550	(.36)***
91	Rubber tyres and tubes	Manufacturing	1.680	(.18)***	1.520	(.18)***
92	Other rubber products	Manufacturing	1.720	(.17)***	1.690	(.18)***
93	Plastic products	Manufacturing	1.540	(.13)***	1.480	(.14)***
94	Glass and glass products	Manufacturing	1.120	(.16)***	1	(.17)***
95	Pottery china and earthenware	Manufacturing	1.900	(.2)***	1.870	(.2)***
96	Refractory ceramic products	Manufacturing	1.620	(.24)***	1.560	(.25)***
97	Struct.non-refractory clay; ceramic products	Manufacturing	1.070	(.48)**	0.990	(.5)**
98	Cement lime and plaster	Manufacturing	0.490	(.57)	2.530	(.4)***
99	Articles of concrete cement and plaster	Manufacturing	1.720	(.24)***	1.780	(.24)***
100	Cutting shaping and finishing of stone	Manufacturing	-0.820	(.31)***	-0.890	(.31)***
101	Other non-metallic mineral products n.e.c.	Manufacturing	1.320	(.17)***	1.290	(.17)***
102	Basic iron and steel	Manufacturing	2.110	(.17)***	2.200	(.17)***
103	Basic precious and non-ferrous metals	Manufacturing	2.870	(.21)***	3.100	(.23)***
104	Structural metal products	Manufacturing	0.970	(.24)***	0.950	(.27)***
105	Tanks reservoirs and containers of metal	Manufacturing	2.510	(.21)***	2.690	(.21)***
106	Steam generators	Manufacturing	1.950	(.34)***	2.150	(.32)***
107	Cutlery hand tools and general hardware	Manufacturing	1.910	(.14)***	1.820	(.15)***
108	Other fabricated metal products n.e.c.	Manufacturing	1.140	(.22)***	1.190	(.25)***
109	Engines and turbines (not for transport equipment)	Manufacturing	1.060	(.26)***	1.110	(.27)***
110	Pumps compressors taps and valves	Manufacturing	2.090	(.26)***	2.140	(.26)***
111	Bearings gears gearing and driving elements	Manufacturing	1.820	(.2)***	1.750	(.22)***
112	Ovens furnaces and furnace burners	Manufacturing	0.0800	(.29)	0.0800	(.31)
113	Lifting and handling equipment	Manufacturing	1.750	(.28)***	1.860	(.3)***
114	Other general purpose machinery	Manufacturing	1.950	(.13)***	2.010	(.15)***
115	Agricultural and forestry machinery	Manufacturing	1.490	(.17)***	1.460	(.17)***
116	Machine tools	Manufacturing	1.800	(.22)***	1.920	(.24)***
117	Machinery for metallurgy	Manufacturing	0.120	(.37)	-0.290	(.37)
118	Machinery for mining and construction	Manufacturing	1.360	(.18)***	1.330	(.2)***
119	Food/beverage/tobacco processing machinery	Manufacturing	1.710	(.26)***	1.590	(.28)***
120	Machinery for textile apparel and leather	Manufacturing	0.290	(.23)	0.160	(.27)
121	Weapons and ammunition	Manufacturing	1.990	(.38)***	1.840	(.38)***
122	Other special purpose machinery	Manufacturing	1.970	(.2)***	2.090	(.2)***
123	Domestic appliances n.e.c.	Manufacturing	2.060	(.24)***	1.920	(.25)***
124	Office accounting and computing machinery	Manufacturing	1.550	(.53)***	1.970	(.49)***
125	Electric motors generators and transformers	Manufacturing	-0.150	(.16)	-0.200	(.17)
126	Electricity distribution and control apparatus	Manufacturing	2.330	(.38)***	2.520	(.64)***
127	Insulated wire and cable	Manufacturing	1.970	(.17)***	2.200	(.18)***
128	Accumulators primary cells and batteries	Manufacturing	4.070	(.3)***	4.320	(.31)***
129	Lighting equipment and electric lamps	Manufacturing	2.220	(.25)***	2.150	(.24)***
130	Other electrical equipment n.e.c.	Manufacturing	2.490	(.25)***	2.480	(.27)***
131	Electronic valves tubes etc.	Manufacturing	0.530	(.25)**	0.520	(.21)**
132	TV/radio transmitters; line comm. apparatus	Manufacturing	1.840	(.26)***	2.240	(.24)***
133	TV and radio receivers and associated goods	Manufacturing	0.970	(.36)***	0.600	(.48)
134	Medical surgical and orthopaedic equipment	Manufacturing	1.350	(.2)***	1.340	(.2)***
135	Measuring/testing/navigating appliances etc.	Manufacturing	1.390	(.21)***	1.500	(.23)***
136	Optical instruments and photographic equipment	Manufacturing	1.630	(.3)***	1.560	(.29)***
137	Watches and clocks	Manufacturing	.	(.)	.	(.)
138	Motor vehicles	Manufacturing	1.950	(.21)***	1.790	(.21)***
139	Automobile bodies trailers and semi-trailers	Manufacturing	1.440	(.34)***	1.320	(.36)***
140	Parts/accessories for automobiles	Manufacturing	1.050	(.35)***	1.020	(.35)***
141	Building and repairing of ships	Manufacturing	0.150	(.4)	0.260	(.41)
142	Building/repairing of pleasure/sport. boats	Manufacturing	2.340	(.44)***	2.200	(.46)***
143	Railway/tramway locomotives and rolling stock	Manufacturing	1.220	(.23)***	1.240	(.25)***
144	Aircraft and spacecraft	Manufacturing	-0.150	(.58)	-0.190	(.58)
145	Motorcycles	Manufacturing	3.560	(.36)***	3.290	(.38)***
146	Bicycles and invalid carriages	Manufacturing	1.390	(.39)***	1.350	(.44)***
147	Other transport equipment n.e.c.	Manufacturing	2.490	(.26)***	2.630	(.31)***
148	Furniture	Manufacturing	1.780	(.16)***	1.750	(.18)***
149	Jewellery and related articles	Manufacturing	2.030	(.42)***	1.910	(.46)***
150	Musical instruments	Manufacturing	0.940	(.15)***	0.940	(.16)***
151	Sports goods	Manufacturing	0.560	(.15)***	0.560	(.15)***
152	Games and toys	Manufacturing	1.410	(.48)***	1.510	(.51)***
153	Other manufacturing n.e.c.	Manufacturing	1.290	(.26)***	1.430	(.28)***
154	Manufacturing services on physical inputs	Services	.	(.)	.	(.)
155	Maintenance and repair services n.i.e.	Services	.	(.)	.	(.)
156	Transport	Services	0.390	(.06)***	0.390	(.06)***
157	Travel	Services	3.870	(.92)***	3.690	(.95)***
158	Construction	Services	-0.170	(.16)	-0.100	(.17)
159	Insurance and pension services	Services	1.300	(.17)***	1.300	(.17)***
160	Financial services	Services	2	(.16)***	1.980	(.16)***
161	Charges for use of intellectual property	Services	.	(.)	.	(.)
162	Telecom, computer, information services	Services	1.560	(.17)***	1.620	(.19)***
163	Other business services	Services	1.610	(.19)***	1.590	(.2)***
164	Heritage and recreational services	Services	11.68	(.66)***	11.71	(.46)***
165	Health services	Services	7.400	(1.47)***	7.290	(1.51)***
166	Education services	Services	1.200	(.14)***	1.250	(.16)***
167	Government goods and services n.i.e.	Services	.	(.)	.	(.)
168	Services not allocated	Services	.	(.)	.	(.)
169	Trade-related services	Services	0.700	(.31)**	0.680	(.3)**
170	Other personal services	Services	13.82	(1.57)***	14.53	(4.5)***

Notes: This table reports PPML gravity estimates of the effects of globalization on industry-level trade. The dependent variable is nominal trade in levels from ITPD-E. All estimates are obtained with exporter-time, importer-time, and pair fixed effects, whose estimates are omitted for brevity. We also omit the estimates of the time-varying policy variables (e.g., WTO membership, EU membership, RTAs, and Sanctions), which are included in the analysis. The globalization estimates are those for 2019, thus capturing the cumulated affects from the first year of the sample for each industry. For Agriculture, Mining and Energy, and Manufacturing the omitted/reference year is 1991. For Services, it is 2000. Estimates could not be obtained in 22 industries because they do not have any or too few domestic trade observations in ITPD-E. Standard errors are clustered by country pair. * $p < 0.10$, ** $p < .05$, *** $p < .01$.

Figure 9: The Effects of Globalization - Industry Results (simple average)

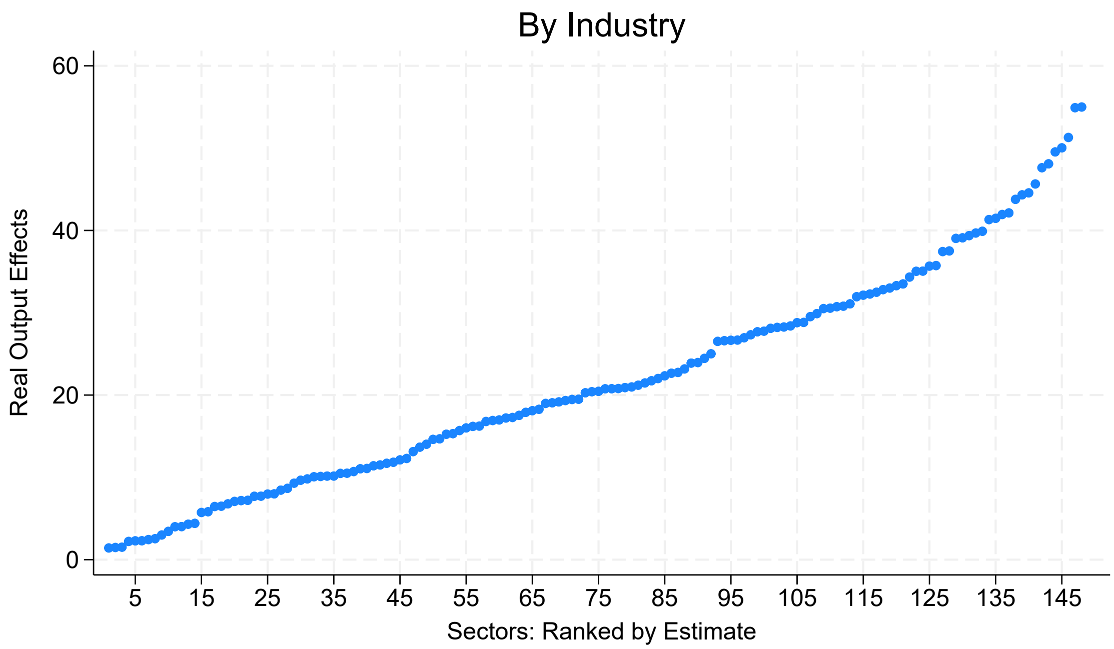

Figure 10: The Effects of Globalization - Industry Results; Comparison of Simple and Weighted Average

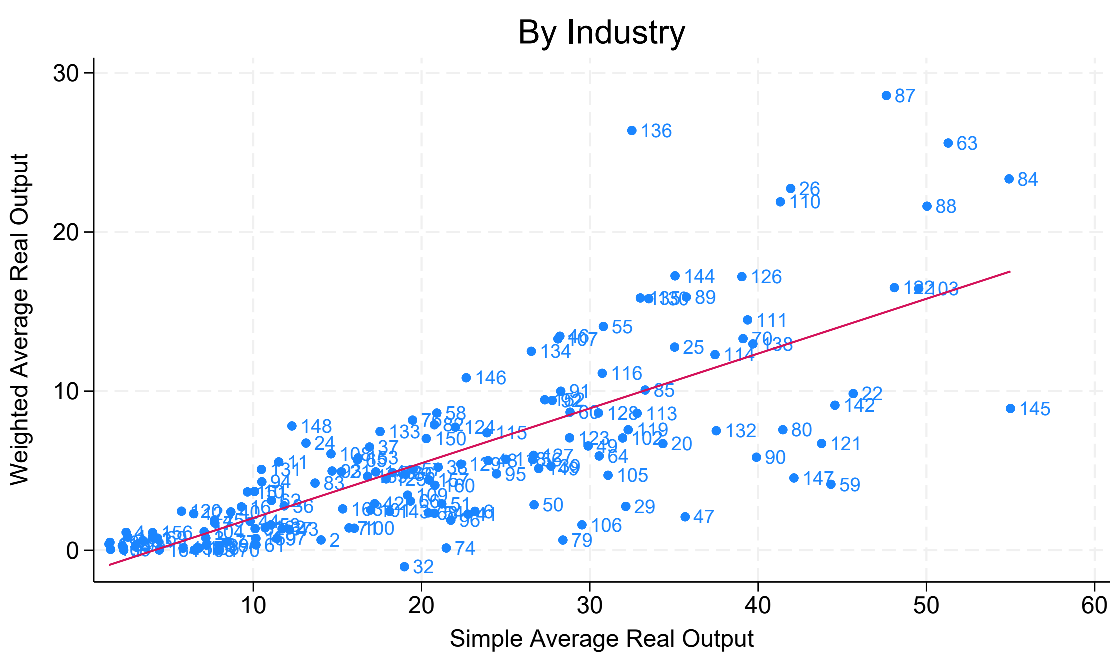

Figure 11: The Effects of Globalization - Country Results (simple average)

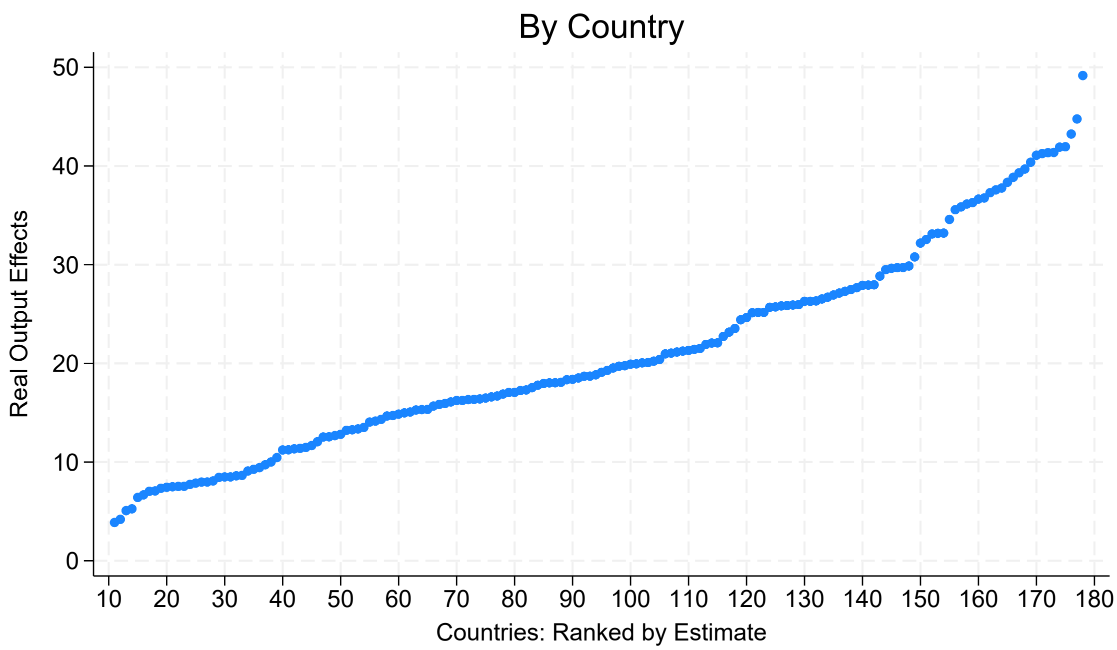

Figure 12: The Effects of Globalization - Country Results; Comparison of Simple and Weighted Average

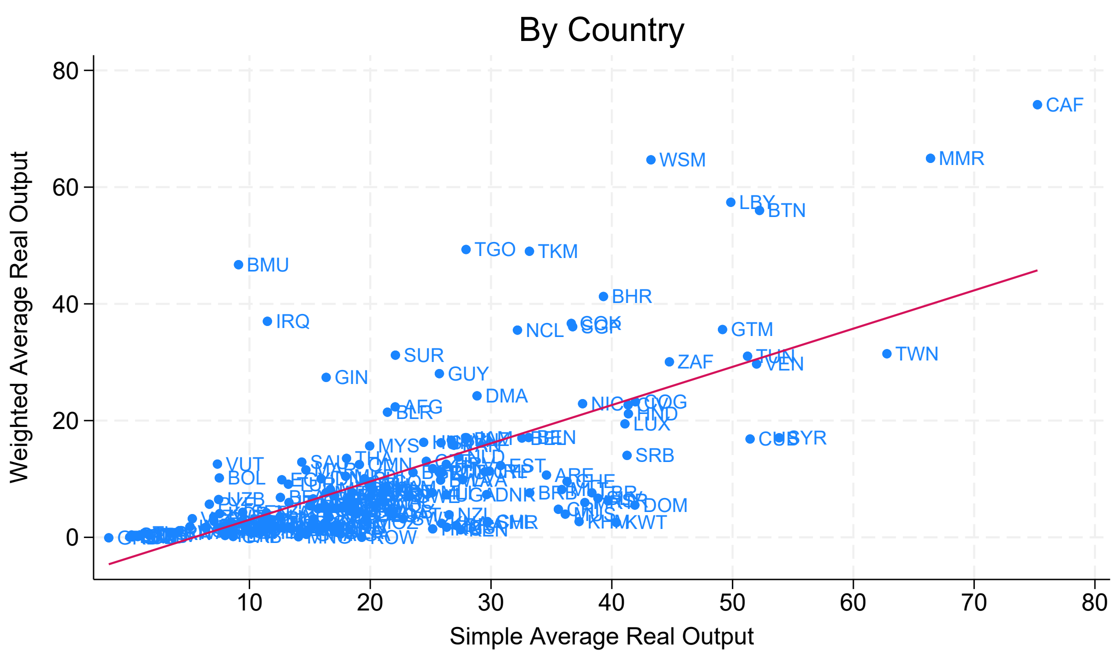

Figure 13: The Effects of Globalization - The Role of Country Size

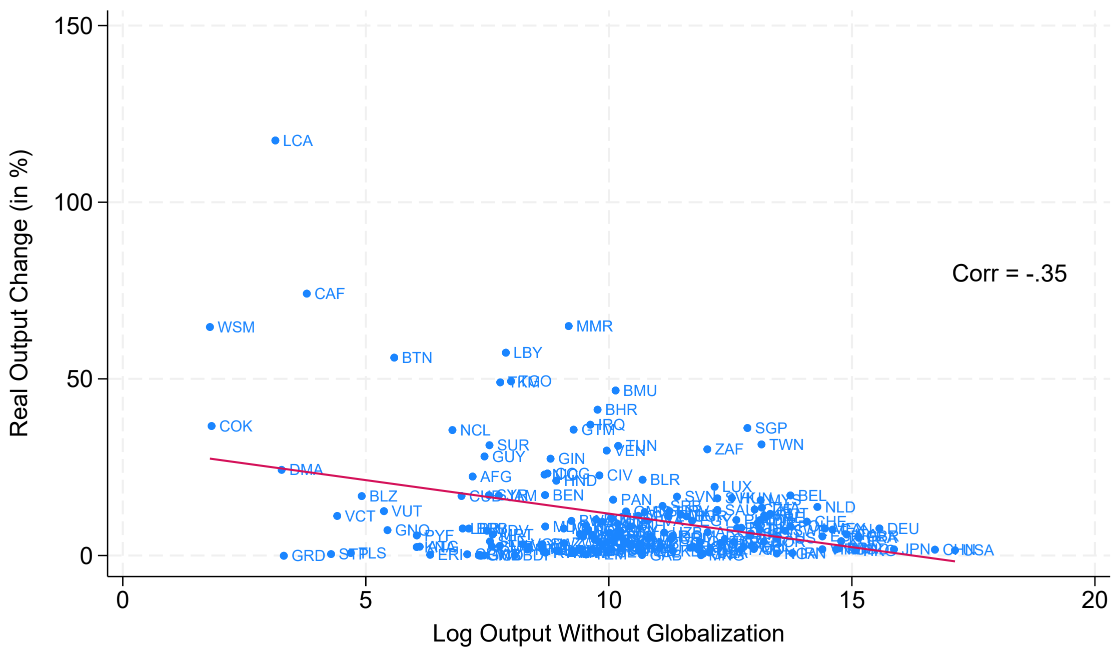

Figure 14: The Effects of Globalization - The Role of Country Size (simple average)

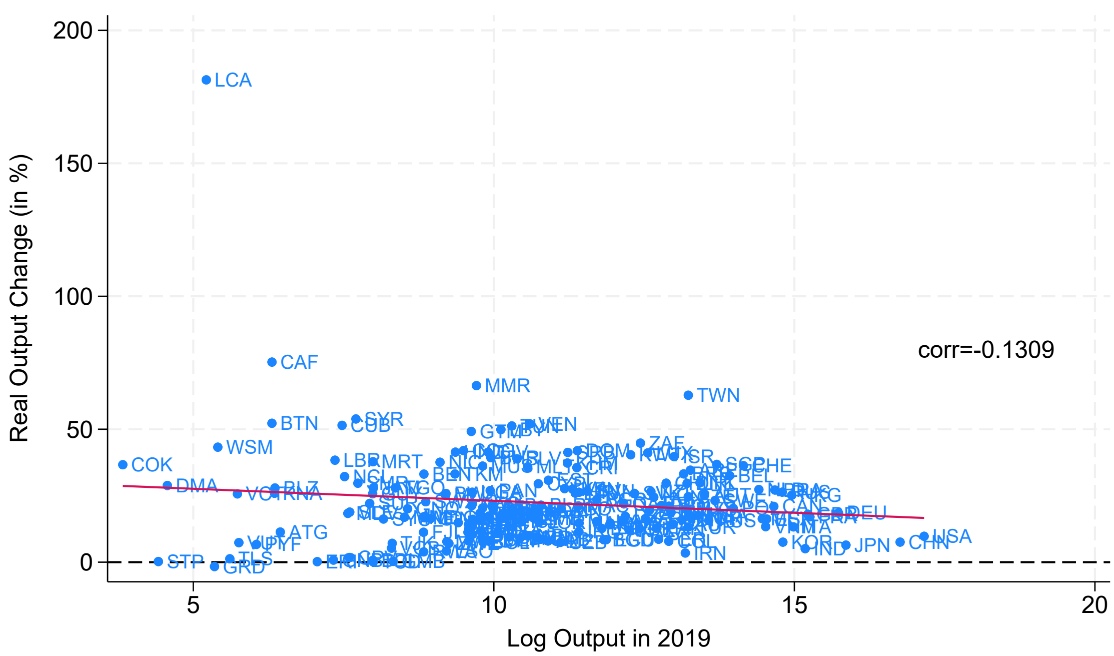

Figure 15: The Effects of Globalization - The Role of Country Size (simple average, without LCA)