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Diminishing Gains from Trade across Countries:

Interaction between Trade Elasticity and Openness

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Diminishing Gains from Trade across Countries: Interaction between Trade Elasticity and Openness*

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Abstract

This paper theoretically shows that when the trade elasticity is allowed to be country specific and it increases with trade openness across countries, it is possible for the gains from trade to decrease with trade openness across countries under certain conditions, which we call as the *diminishing gains from trade*. In order to empirically test this possibility, country-specific trade elasticity measures are estimated by using quarterly time-series data for 40 countries, where the model-implied macroeconomic relationship between the home expenditure share and the real income per capita is employed. The average trade elasticity is estimated about 2.7, with a range between 0.3 and 11.9 across countries, which corresponds to the gains from trade of about 30% for the average country. Instead, when a common trade elasticity of 2.7 is used for all countries, the gains from trade are underestimated by about 8% for the average country, showing the importance of using country-specific trade elasticity measures. In a secondary cross-country analysis, the country-specific trade elasticity estimates are shown to increase and the gains from trade are shown to decrease with trade openness measures. It is implied that there are diminishing gains from trade across countries with respect to their trade openness.

JEL Classification: F14, F41

Key Words: Trade Elasticity; Gains from Trade; Trade Openness

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1 Introduction

For a large class of structural trade models, the welfare gains from trade of a country can be measured by using the trade elasticity and the home expenditure share as shown by Arkolakis, Costinot, and Rodríguez-Clare (2012). When the trade elasticity is common across countries, these models imply that the gains from trade increase with trade openness (that is defined as one minus the home expenditure share). This paper theoretically shows that when trade elasticity measures are allowed to be country specific and decreasing with home expenditure shares across countries, the gains from trade can decrease with trade openness across countries, which we call as the *diminishing gains from trade* with respect to trade openness.

In search for the diminishing gains from trade, this paper first estimates country-specific trade elasticity measures by using the model-implied macroeconomic relationship between the home expenditure share and the real income per capita. The reason behind using the model-implied macroeconomic relationship is that it directly considers the relationship between the variables of interest, namely the home expenditure share and the real income per capita, where the latter is considered as the measure of welfare in the literature.

In contrast, studies in the existing literature use trade data to estimate the trade elasticity. These estimations are either achieved by considering the relationship between bilateral trade data and price data (e.g., as in Eaton and Kortum (2002), Simonovska and Waugh (2014) and Giri, Yi, and Yilmazkuday (2021)) or the relationship between bilateral trade data and markup data (e.g., as in Yilmazkuday (2012) and Yilmazkuday (2014)) or the relationship between bilateral trade data and trade costs data (e.g., as in Yilmazkuday (2019)).

Once trade elasticity measures are estimated in one of these ways, together with data on home expenditure shares, they are further inserted into the model-implied macroeconomic relationship between the home expenditure share and the real income per capita, without using any data on the real income per capita. Accordingly, the welfare gains from trade in the literature are calculated in a way that ignores the developments in the real income per capita, which is the key variable used to measure the welfare itself. Estimating the model-implied macroeconomic relationship between the home expenditure share and the real income per capita, this paper contributes to this literature by directly testing this relationship, where data on the welfare measure of the real income per capita are in fact utilized.

As Arkolakis, Costinot, and Rodríguez-Clare (2012) show that the welfare gains from trade of a country can be measured by using the trade elasticity and the home expenditure share for a large class of structural trade models, we can utilize any model within this large class for our investigation. As Giri, Yi, and Yilmazkuday (2021) further show that having alternative model specifications results in similar gains from trade as long as model-consistent trade elasticity estimates are used, as we have in this paper, we consider an Armington (1969) economy as our theoretical motivation for its convenience regarding the corresponding empirical analysis and data availability. Based on the model introduced, we estimate the macroeconomic relationship between the home expenditure share and the real income per capita for 40 countries by using structural vector autoregression models with quarterly time-series data covering the period between 2005q1 and 2021q4. The estimation results suggest that the average (across countries) trade elasticity is about 2.7, with a range between 0.3 and 11.9 across countries. This average trade elasticity (of 2.7) is consistent with earlier studies that have estimated a common elasticity across countries; e.g., Simonovska and Waugh

(2014) have estimated a common trade elasticity of about 2.8 using the Economist Intelligence Unit (EIU) price data, whereas Giri, Yi, and Yilmazkuday (2021) have estimated a common trade elasticity of about 2.4 using Eurostat price data. Regarding the heterogeneity across countries, in a secondary cross-country analysis, trade elasticity estimates are shown to be increasing with trade openness, which brings up the theoretical possibility of having diminishing gains from trade with respect to trade openness.

The corresponding gains from trade in this paper (based on country-specific trade elasticity estimates) range between 4% and 65% across countries, with an average of about 30%. Instead, when a common trade elasticity of 2.7 is used for all countries, the gains from trade are underestimated by about 8% for the average country, showing the importance of using country-specific trade elasticity measures. The average gains from trade (across countries) of about 30% are in line with earlier studies such as by Ossa (2015), who has considered an industry-level investigation to estimate country-specific gains from trade. Regarding the heterogeneity across countries, in a secondary cross-country analysis, the gains from trade in this paper are in fact shown to decrease with trade openness, suggesting evidence for the diminishing gains from trade with respect to trade openness across countries.

Overall, the positive cross-country relationship trade elasticity and trade openness is the main reason behind the diminishing gains from trade with respect to trade openness. Regarding the economic intuition behind this result, as we consider an Armington (1969) economy where trade is driven by the love of variety for products coming from different sources, the trade elasticity corresponds to the elasticity of substitution between these products according to the corresponding microfoundations. Therefore, having a more open economy may be associated with consumers getting more exposed to foreign products and thus substituting more between them (and thus higher trade elasticity).[1]

Although the empirical investigation in this paper is based on an Armington (1969) model within the large class of structural trade models discussed by Arkolakis, Costinot, and Rodríguez-Clare (2012), as shown during the robustness checks, using a macroeconomic approach in the estimation of trade elasticity makes the empirical results robust to the consideration of alternative microfoundations as well, including *the missing gains from trade* as in Melitz and Redding (2014) or *the pro-competitive effects of trade* as in Arkolakis, Costinot, Donaldson, and Rodríguez-Clare (2019).

The rest of the paper is organized as follows. The next section surveys the literature and discusses the contribution of this paper. Section 3 provides a theoretical motivation for the empirical macroeconomic investigation. Section 4 introduces the estimation methodology and data. Section 5 depicts empirical results of the country-specific trade elasticity estimations. Section 6 discusses the implications for the gains from trade. Section 7 checks the robustness of results. Section 8 concludes with policy suggestions.

2 Contribution to the Literature

This paper has the following contributions to the literature. First, it is theoretically shown that the gains from trade can decrease with trade openness across countries, when trade

[1] An an other example within the large class of structural trade models discussed by Arkolakis, Costinot, and Rodríguez-Clare (2012), consider an Eaton and Kortum (2002) economy, where trade is driven by productivity differences across countries. According to the microfoundations of such an economy, as trade elasticity corresponds to the degree of firm heterogeneity within a country (regarding their productivity), with higher trade elasticity meaning lower heterogeneity, having a more open economy may be associated with domestic firms getting more exposed to foreign technology and thus getting closer to each other regarding their productivity (and thus higher trade elasticity).

elasticity measures are allowed to be country specific and decreasing with home expenditure shares across countries. Second, the trade elasticity estimations are achieved by using the model-implied macroeconomic relationship that is used to measure the gains from trade. Third, country-specific trade elasticity estimates are shown to increase with trade openness across countries, which brings up the possibility of the gains from trade decreasing with trade openness across countries. Fourth, this possibility is empirically tested, and it is shown that the gains from trade in fact decrease with trade openness across countries, suggesting evidence for the diminishing gains from trade with respect to trade openness.

Regarding the details, the literature based on a large class of structural trade models is theoretically summarized by Arkolakis, Costinot, and Rodríguez-Clare (2012) who have shown that the welfare gains from trade of a country decreases with the home expenditure share and thus increases with trade openness. This relationship holds for several influential structural trade models in the literature, including those by Armington (1969), Krugman (1980), Eaton and Kortum (2002), and Melitz (2003). In this literature, the trade elasticity, which is common across countries, is just a scale parameter that governs the common (across countries) magnitude of the gains from trade; therefore, the difference in the gains from trade between two countries is only explained by the difference in their trade openness.

With respect to these studies, this paper challenges the assumption of having a common trade elasticity across countries as in studies such as by Yilmazkuday (2015a) and Yilmazkuday (2023). Specifically, when trade elasticity measures are allowed to be country specific and decreasing with home expenditure shares, it is theoretically shown and empirically proved in this paper that the gains from trade can decrease with trade openness. This is not only in contrast to earlier studies such as by Simonovska and Waugh (2014) who have considered a common (across countries) trade elasticity to measure the gains from trade in a one-sector model, but also in contrast to earlier studies such as by Ossa (2015) who has considered industry-level trade elasticity estimates to measure country-specific gains from trade.

When it comes to the estimation of trade elasticity, the literature uses gravity models of international trade. In these estimations, the relationship between bilateral trade and price changes are empirically tested, where price changes can be measured by consumer prices, markups, or trade costs as in studies such as by Eaton and Kortum (2002), Simonovska and Waugh (2014), Yilmazkuday (2012), Yilmazkuday (2014), Yilmazkuday (2019) and Giri, Yi, and Yilmazkuday (2021). As the gains from trade (measured by real income per capita) can be calculated by using the trade elasticity and the home expenditure share according to Arkolakis, Costinot, and Rodríguez-Clare (2012), the literature combines the trade elasticity with the home expenditure share to measure the gains from trade, without using any data on the real income per capita itself (e.g., see Yilmazkuday (2020) and Yilmazkuday (2021)).

In contrast, rather than estimating the trade elasticity through gravity models using bilateral trade data, which does not have any empirical test on the real income per capita, this paper estimates the trade elasticity by using the model-implied macroeconomic relationship between the home expenditure share and the real income per capita by using the corresponding data on the very same variables. This macroeconomic estimation approach is supported by our empirical results in terms of the average trade elasticity estimates (across countries) and the average gains from trade (across countries), as they are in line with earlier studies. Moreover, as the estimation is achieved by using structural vector autoregression models, any potential endogeneity between the variables used (i.e., the home expenditure share and real income per capita) are controlled for due to the way that the corresponding shocks are identified through the time dimension.

3 Theoretical Motivation

As Arkolakis, Costinot, and Rodríguez-Clare (2012) show that the welfare gains from trade of a country can be measured by using the trade elasticity and the home expenditure share for a large class of structural trade models (e.g., including Armington (1969) and Eaton and Kortum (2002)), we can utilize any model within this large class for our investigation. Accordingly, this section provides a theoretical motivation based on Armington (1969) for the empirical macroeconomic investigation of the following section by showing the relationship between the gains from trade, the trade elasticity, and the home expenditure share.

The economic model consists of individuals consuming products coming from different countries (including the home country). Production in each country is achieved by using labor only, which is supplied by the individuals of that country, and thus, individuals only have labor income. With respect to the existing literature that considers common elasticity measures across countries, the main innovation of the model in this paper is through having country-specific elasticity measures in the utility function as in studies such as by Yilmazkuday (2015a) and Yilmazkuday (2023), representing heterogeneity of individual preferences across countries. These country-specific elasticity measures are in turn reflected in the welfare measure of countries, as we detail next.

It is important to emphasize that in the literature (e.g., see Giri, Yi, and Yilmazkuday (2021)), the gains from trade are shown to be similar across model specifications (e.g., including an aggregate model, a sectoral model with input-output linkages, or another one with intermediate inputs, etc.) when model-consistent trade elasticity estimates are used. Accordingly, although the model introduced below has a production function using labor only (due to data availability for the corresponding empirical investigation), as we consider model-consistent trade elasticity measures for the calculation of the gains from trade, the corresponding results would be similar to those with other model specifications.

3.1 Economic Model

The utility C_n of a typical individual in country n is given by:

$$C_n = \left(\sum_i (C_{ni})^{\frac{\varepsilon_n - 1}{\varepsilon_n}} \right)^{\frac{\varepsilon_n}{\varepsilon_n - 1}} \tag{1}$$

where C_{ni} represents products coming from country i (with C_{nn} representing home products), and ε_n is the elasticity of substitution across products of source countries in country n. The optimization results in the following value of imports from country i:

$$P_{ni}C_{ni} = \left(\frac{P_{ni}}{P_n} \right)^{-\theta_n} P_n C_n \tag{2}$$

where P_{ni} and P_n are prices per unit of C_{ni} and C_n, respectively, and $\theta_n = \varepsilon_n - 1$ is the country-specific trade elasticity as it represents the relationship between prices and trade.

When the source country is country n itself (i.e., $i = n$), the home expenditure share λ_n is implied as follows:

$$\lambda_n = \frac{P_{nn}C_{nn}}{P_n C_n} = \left(\frac{W_n}{P_n} \right)^{-\theta_n} \tag{3}$$

where $W_n = P_{nn}$ is the price of the country-n good. In this expression, W_n represents labor income (wages) due to the production function of $X_n = N_n$, with N_n representing the labor input. When the labor supply is normalized to 1 unit to convert the variables into per capita terms, labor market equilibrium implies $N_n = 1$, which corresponds to a budget constraint of $P_n C_n = W_n$, implying the following expression for individual utility:

$$C_n = \frac{W_n}{P_n} = (\lambda_n)^{-\frac{1}{\theta_n}} \tag{4}$$

which can also be represented by the real income per capita $\left(y_n = \frac{W_n}{P_n}\right)$, and it depends on the home expenditure share λ_n and the trade elasticity θ_n.

3.2 Gains from Trade

When the case of autarky is defined as having a home expenditure share of one (i.e., $\lambda_n^@ = 1$), the gains from trade G_n (with respect to the case of autarky) of country n is implied as follows:

$$G_n = \frac{C_n}{C_n^@} = (\lambda_n)^{-\frac{1}{\theta_n}} \tag{5}$$

where $C_n^@ = \frac{W_n^@}{P_n^@} = \left(\lambda_n^@\right)^{-\frac{1}{\theta_n}}$ is the utility in the case of autarky. Hence, the gains from trade is a function of the home expenditure share λ_n and the country-specific trade elasticity θ_n. This is an expression that is very similar to the one provided by Arkolakis, Costinot, and Rodríguez-Clare (2012) to measure the gains from trade for a large class of structural trade models, where the only difference is that the trade elasticity of θ_n is country-n specific in this paper.

3.3 Cross-Country Interaction of Trade Elasticity and Openness

In terms of economic intuition, Equation 5 suggests that for a given common trade elasticity across countries (i.e., when $\theta_n = \theta$ for all n), the (log of) gains from trade decrease with the (log of) home expenditure share across countries. In formal terms, using $\theta > 0$, this negative relationship across countries can be expressed as follows:

$$Cov\left(\log G_n, \log \lambda_n\right) = -\frac{1}{\theta} Var\left(\log \lambda_n\right) < 0 \tag{6}$$

where Cov and Var represent the covariance and the variance across countries, respectively.

In comparison, when trade elasticity measures are country specific (i.e., when $\theta_n \neq \theta$), the cross-country relationship between the (log of) gains from trade and the (log of) home expenditure share can be written as follows (with E representing the expectation across countries):

$$\begin{aligned} Cov\left(\log G_n, \log \lambda_n\right) = &-E\left(\frac{1}{\theta_n}\right) Var\left(\log \lambda_n\right) - E\left(\log \lambda_n\right) Cov\left(\frac{1}{\theta_n}, \log \lambda_n\right) \\ &- E\left(\left(\frac{1}{\theta_n} - E\left(\frac{1}{\theta_n}\right)\right)\left(\log \lambda_n - E\left(\log \lambda_n\right)\right)^2\right) \end{aligned} \tag{7}$$

which reduces to Equation 6 when $\theta_n = \theta$ for all n.[2] In Equation 7, as $\log \lambda_n < 0$ when $\lambda_n < 1$, it is possible to have $Cov\left(\log G_n, \log \lambda_n\right) > 0$ when $Cov\left(\frac{1}{\theta_n}, \log \lambda_n\right) > 0$. Therefore, when there is a sufficiently strong positive relationship between the inverse of trade elasticity $\frac{1}{\theta_n}$ and home expenditure share $\log \lambda_n$ (or equivalently, a sufficiently strong positive relationship between trade elasticity and trade openness), the gains from trade can be smaller for more

[2] See Bohrnstedt and Goldberger (1969) for the derivation of this expression.

open economies. We call this possibility as *the diminishing gains from trade* with respect to trade openness across countries.

Theoretically, as the cross-country positive relationship between trade elasticity and trade openness is the main reason behind the diminishing gains from trade with respect to trade openness, in terms of economic intuition, having diminishing gains from trade corresponds to consumers getting more exposed to foreign products and thus substituting more between them (and thus higher trade elasticity) in relatively more open economies. In the following sections, we test this possibility by estimating country-specific trade elasticity measures and comparing them with the corresponding trade openness measures.

4 Estimation Methodology and Data

As data for the home expenditure share λ_n are already available, estimating the trade elasticity is the main idea behind estimating the gains from trade. Accordingly, we separately estimate the trade elasticity θ_n for each country n by using the following log-difference version of Equation 3:

$$\underbrace{\Delta \log \lambda_n}_{\text{\% Change in Home Expenditure Share}} = - \underbrace{\theta_n}_{\text{Trade Elasticity}} \times \underbrace{\Delta \log (y_n)}_{\text{\% Change in Real Income Per Capita}} \tag{8}$$

where $\Delta \log$ represents year-on-year percentage changes (to control for seasonality by construction).

The trade elasticity is estimated for each country individually by using structural vector autoregression (SVAR) models, where quarterly time-series data are employed. The main advantage of using this estimation methodology is that it can control for any potential endogeneity between the variables used (i.e., the home expenditure share and real income per capita) due to the way that the corresponding shocks are identified through the time dimension. We therefore utilize a macroeconomic approach to estimate the trade elasticity, where country-specific data are used.

Our macroeconomic estimation approach is in contrast to the existing international trade literature, where the trade elasticity is mostly identified through the cross-country dimension by using a bilateral trade expression similar to (the log version of) Equation 2. However, such an approach is not enough to estimate the trade elasticity, because either the corresponding data for prices are not available or the estimation is subject to endogeneity in their existence.[3] Having a macroeconomic approach as in this paper is robust to any of these issues by construction.

4.1 Estimation Methodology

After dropping the country notation of n for simplicity and denoting each quarter with t for the time-series investigation, the SVAR model of $z_t = (\Delta y_t, \Delta \lambda_t)'$ is used, where Δy_t represents year-on-year percentage changes in the real income per capita, and $\Delta \lambda_t$ represents year-on-year percentage changes in the home expenditure share. In formal terms, the SVAR

[3] To estimate the trade elasticity through the cross-country dimension, studies such as by Feenstra and Romalis (2014), Yilmazkuday (2015b) or Yilmazkuday (2016) have used instrumental variables approach to incorporate price data, Eaton and Kortum (2002), Simonovska and Waugh (2014) or Giri, Yi, and Yilmazkuday (2021) have used data on micro prices to measure trade costs (as a part of prices), Yilmazkuday (2012) has used additional data on markups (as a part of prices), and Yilmazkuday (2019) has used data on actual trade costs (as a part of prices).

model for each country is given by:

$$A_o z_t = a + \sum_{k=1}^{4} A_k z_{t-k} + u_t \quad (9)$$

where u_t is the vector of serially and mutually uncorrelated structural innovations.[4] For estimation purposes, the model is expressed in reduced form as follows:

$$z_t = b + \sum_{k=1}^{4} B_k z_{t-k} + e_t \quad (10)$$

where $b = A_o^{-1} a$, $B_k = A_o^{-1} A_k$ for all k. It is postulated that the structural impact multiplier matrix A_o^{-1} has a recursive structure such that the reduced form errors e_t can be decomposed according to $e_t = A_o^{-1} u_t$, where the sizes of shocks are standardized to unity (i.e., the identification is by triangular factorization).

The recursive structure imposed on A_o^{-1} requires an ordering of the variables used in the estimation for which we use the one already given by $z_t = (\Delta y_t, \Delta \lambda_t)'$. The motivation behind this ordering comes from the theoretical model, where changes in the real income per capita affect the home expenditure share through the corresponding demand function given by $\lambda_n = \left(\frac{W_n}{P_n}\right)^{-\theta_n}$ in the main text. In technical terms, the real income per capita can have an immediate impact on the home expenditure share, whereas the home expenditure share can start affecting the real income per capita after one quarter.

The estimation is achieved by a Bayesian approach with Minnesota priors. This corresponds to generating posterior draws for the structural model parameters by transforming

[4] The number of lags (of 4) has been determined by comparing the Deviance Information Criterion across alternative models. The model variables are confirmed to be stable and no root lies outside the unit circle.

each reduced-form posterior draw. In particular, for each draw of the covariance matrix from its posterior distribution, the corresponding posterior draw for A_o^{-1} is constructed by using by triangular factorization so that the sizes of shocks are standardized to unity.

In the Bayesian framework, a total of 2,000 samples are drawn, where a burn-in sample of 1,000 draws is discarded. The remaining 1,000 draws are used to estimate the trade elasticity as the cumulative impulse response of the home expenditure share to a shock in the real income per capita after five years. While the median of each distribution is considered as the Bayesian estimator, the 16th and 84th quantiles of distributions are used to construct the 68% credible sets (which is the standard measure considered in the Bayesian literature).

4.2 Data

The sample covers the quarterly period between 2005q1 and 2021q4 for 40 countries, where the sample period has been chosen to maximize the number of countries included in the investigation.[5] The publicly available data have been obtained from the International Financial Statistics (IFS) of the International Monetary Fund and the World Development Indicators (WDI).

The real income per capita for each country is measured by "Gross Domestic Product, Real, Unadjusted, Domestic Currency" obtained from IFS divided by the population data obtained from WDI.

The home expenditure share of each country is constructed by using $\lambda_t = \frac{GDP_t - X_t}{GDP_t - X_t + M_t}$, where GDP_t is measured by "Gross Domestic Product, Nominal, Unadjusted, Domestic Currency," X_t is measured by "Exports of Goods and Services, Nominal, Unadjusted, Domestic

[5] The list of countries is given in the Online Appendix Table A.1.

Currency," and M_t is measured by "Imports of Goods and Services, Nominal, Unadjusted, Domestic Currency" obtained from IFS.

5 Trade Elasticity Estimates

Based on Equation 8, the trade elasticity is estimated as the cumulative impulse response of the home expenditure share to a shock in the real income per capita. The corresponding results are given in Figure 1 for each country, where the reaction of the home expenditure share is depicted over time following a shock in the real income per capita. These country-specific figures are consistent with earlier studies distinguishing between short-run and long-run trade elasticity measures.[6]

As is evident, the trade elasticity estimates are statistically significant based on the corresponding 68% credible sets for all countries in the short-run (for about two years) and almost all countries in the long-run (after five years); the only exception is the United Kingdom that has an insignificant trade elasticity estimate in the long-run.

The trade elasticity estimates measured as the cumulative impulse response of the home expenditure share to a shock in the real income per capita after five years are used in our calculations for the gains from trade. The corresponding summary of empirical results across countries is given in Table 1 (after ignoring the insignificant estimate for the United Kingdom), whereas country-specific results are given in the Online Appendix Table A.1.

The average trade elasticity across countries is about 2.7, which is consistent with earlier studies such as by Simonovska and Waugh (2014) with an estimate of about 2.8 using EIU

[6] For example, see Yilmazkuday (2019), Boehm, Levchenko, and Pandalai-Nayar (2020), Alessandria and Choi (2021) and Anderson and Yotov (2022)).

price data and by Giri, Yi, and Yilmazkuday (2021) with estimate of about 2.4 using Eurostat price data. However, different from these studies, this paper shows that there is significant evidence for heterogeneity across countries as statistically significant trade elasticity measures have a range between 0.3 and 11.9. This is supported by differences between estimated trade elasticity measures of countries being statistically significant from each other based on the corresponding 68% credible sets.

In order to justify country-specific trade elasticity measures, we first check whether they are different from each other in a statistically significant way by having a pairwise test across countries. Specifically, for 780 ($= 40 \times 39/2$) independent country pairs, we test whether the trade elasticity estimates are different from each other in a statistically significant way. To do so, we compare the 68% credible sets for each country pair. If these credible sets overlap, the trade elasticity measures are not different from each other, whereas if they don't overlap, the trade elasticity measures are different from each other in a statistically significant way. Based on the empirical results shown in the Online Appendix Table A.1, for 393 country pairs (out of 780), the trade elasticity estimates are different from each other in a statistically significant way. Therefore, there is significant evidence for country-specific trade elasticity measures, which supports the main contribution of the paper.

On top of the pairwise test, we also consider another formal test based on all Bayesian draws within the 68% credible sets of countries. Specifically, as each country-specific trade elasticity has its own 68% credible set due to the Bayesian estimation (consisting of 680 estimates out of 1,000 draws), one approach is to take into account all of these 680 estimates from each country while making a comparison across countries. Accordingly, we employ the Friedman test which can compare 680 draws coming from each country (represented by the rows of a matrix) across 40 countries (represented by the columns of a matrix). Hence, the Friedman test can compare the trade elasticity estimates (680 of them) coming from each country (40 of them) by comparing the columns of this matrix, which has a size of 680×40. The Friedman test has the null hypothesis that the column effects (representing countries) are all the same against the alternative that they are not all the same. Therefore, if the null hypothesis is accepted, there is not any statistically significant difference across country-specific trade elasticity estimates, whereas if the null hypothesis is rejected, country-specific trade elasticity estimates are different from each other in a statistically significant way. The Friedman test results suggest that the null hypothesis is rejected (with a p-value of around zero), and thus, country-specific trade elasticity estimates are different from each other in a statistically significant way, which, once again, supports the main contribution of the paper.

When we further investigate the reasons behind this heterogeneity in a secondary analysis, we observe in Figure 2 that trade elasticity estimates increase with trade openness (measured by one minus the home expenditure share). We also formally investigate this relationship in Table 2, where it is implied that having 0.1 (i.e., 10%) of an increase in trade openness across countries is associated with a trade elasticity measure that is about 1 unit higher.

Overall, the trade elasticity increases with trade openness (or it decreases with the home expenditure share) across countries, which suggests that the positive relationship between the gains from trade increase and trade openness (for a common trade elasticity across countries) may not hold anymore as discussed above. We next investigate the corresponding implications for the gains from trade.

6 Implications for the Gains from Trade

The gains from trade in percentage terms are estimated by using the log version of Equation 5 for each country n, where we use our long-run trade elasticity measures (after five years) together with the long-run average of the home expenditure share (during the sample period). The corresponding summary of empirical results across countries is given in Table 1 (after ignoring the United Kingdom due to its insignificant trade elasticity estimate in the long-run), whereas country-specific results are given in the Online Appendix Table A.1.

The gains from trade have a range between 4% (Korea, Rep. of) and 65% (Argentina) across countries, with an average of 30%. The average gains from trade (across countries) are in line with earlier studies such as by Ossa (2015), who has considered an industry-level investigation to estimate country-specific gains from trade.

In order to show the importance of having country-specific trade elasticity measures, we also show the gains from trade of countries when they have a common trade elasticity of 2.7 (i.e., the average estimate across countries). As shown in Table 1, having a common trade elasticity underestimates the gains from trade by about 8%, with a range of underestimating them by 59% and overestimating them by 42% across countries. Country-specific differences between using a common trade elasticity and country-specific trade elasticities (under the title of "bias") are given in the Online Appendix Table A.1.

When we investigate the reasons behind different gains from trade across countries, Figure 3 suggests that the gains from trade are negatively related to trade elasticity and trade openness measures across countries. These cross-country negative relationships are confirmed by univariate regression results depicted in Table 2, where having 0.1 (i.e., 10%) of an increase in trade openness (trade elasticity) across countries is associated with 2.5% (0.3%) of more gains from trade.

Therefore, having country-specific trade elasticity measures result in a negative cross-country relationship between the gains from trade and trade openness (due to the positive relationship between the trade elasticity and trade openness). In other words, there is evidence for *diminishing gains from trade* with respect to trade openness, when trade elasticity is allowed to be country specific. It is implied that having a common trade elasticity across countries can suppress the actual relationship between the gains from trade and trade openness, since the possibility of country-specific trade elasticity measures being associated with the corresponding trade openness measures is ignored in such a case.

Regarding the economic intuition behind this result, having diminishing gains from trade across countries (in the context of our economic model) is possible when consumers get more exposed to foreign products and thus substitute more between them in relatively more open economies. As the trade elasticity is directly related to the elasticity of substitution, more open economies can in fact have higher trade elasticity measures, which is exactly what we find empirically.

7 Robustness Checks

This section considers three alternative specifications to measure the gains from trade in the literature. In the first alternative specification, we include productivity in the model and the estimation of the trade elasticity, although this inclusion reduces the number of countries in the sample due to data availability. In the second alternative specification, we consider *the missing gains from trade* as in Melitz and Redding (2014), where we allow trade-induced productivity to be affected by the home expenditure share. In the third alternative specification, we consider *the pro-competitive effects of trade* by using the welfare formula developed by Arkolakis, Costinot, Donaldson, and Rodríguez-Clare (2019) to study the gains from trade liberalization in models with monopolistic competition, firm-level heterogeneity, and variable markups.

7.1 Including Productivity Data in the Estimation

Productivity can be included in the model by replacing the production function with $X_n = A_n N_n$, where A_n represents productivity. In such a case, the home expenditure share given in Equation 3 is replaced with the following expression:

$$\lambda_n = \frac{P_{nn}C_{nn}}{P_n C_n} = \left(\frac{W_n}{P_n A_n}\right)^{-\theta_n} \tag{11}$$

where, this time, $\frac{W_n}{A_n} = P_{nn}$ is the price of the country-n good. The log version of this expression replaces Equation 8 when productivity is included:

$$\underbrace{\Delta \log \lambda_n}_{\text{\% Change in Home Expenditure Share}} = -\underbrace{\theta_n}_{\text{Trade Elasticity}} \times \underbrace{\Delta \log\left(\frac{y_n}{A_n}\right)}_{\substack{\text{\% Change in Real Income Per Capita} \\ \text{Adjusted for Productivity}}} \tag{12}$$

where the only difference with respect to Equation 8 is that the percentage change in real income per capita is now adjusted for productivity. In addition to the existing data, the estimation is achieved by using the "Labor Productivity Forecast" data obtained from the Organisation for Economic Co-operation and Development (OECD). Due to data availability, this reduces the number of countries to 17 (from 40) for the quarterly period between 2005q1 and 2021q4.

The corresponding country-specific results are given in the Online Appendix Table A.2, where for 14 out of 17 countries included in the estimations, the estimated trade elasticity measures are not statistically different from the benchmark estimation results (based on the 68% credible sets). Therefore, the benchmark estimation of the trade elasticity measures is robust to the inclusion of productivity data for most (82%) of the countries considered.

7.2 Missing Gains from Trade

Although the previous subsection provides a useful robustness check for the estimation of trade elasticity, it is silent on the implications for the gains from trade. Specifically, when productivity is included in the model, as the home expenditure share is given by Equation 11, the corresponding gains from trade can be written as follows (replacing Equation 5):

$$G_n = \frac{C_n}{C_n^{@}} = \frac{A_n}{A_n^{@}} \left(\lambda_n\right)^{-\frac{1}{\theta_n}} \tag{13}$$

With respect to Equation 5, this expression additionally requires the knowledge of productivity changes when an economy moves to the case of autarky (i.e., A_n versus $A_n^{@}$).

As data for productivity in the case of autarky $A_n^{@}$ are not readily available, the only other alternative way is to show the implications of having productivity in the gains from trade from a theoretical perspective as in earlier studies in the literature. Accordingly, following the main idea of Melitz and Redding (2014) who suggest that *trade-induced productivity can be affected by the home expenditure share*, we consider the following expression representing productivity as a function of the home expenditure share:

$$A_n = \kappa_n \left(\lambda_n\right)^{\phi_n} \tag{14}$$

where κ_n is an exogenous productivity parameter that is independent of the home expenditure share, and ϕ_n is a country-specific parameter governing the strength of home expenditure share affecting productivity. Inserting Equation 14 into Equation 13 results in the following expression for the gains from trade:

$$G_n = \left(\lambda_n\right)^{-\frac{1-\phi_n\theta_n}{\theta_n}} \tag{15}$$

where κ_n has been cancelled out as it is an exogenous parameter . This expression suggests that the gains from trade is not only a function of the home expenditure share λ_n and the trade elasticity θ_n as in Equation 5 but also a function of the strength of home expenditure share affecting productivity ϕ_n. In technical terms, the trade elasticity θ_n in Equation 5 in the absence of productivity has been replaced by $\frac{\theta_n}{1-\phi_n\theta_n}$ in Equation 15 with the inclusion of productivity. This can also be confirmed as the special case of $\phi_n = 0$ reduces Equation 15 into Equation 5 as κ_n is an exogenous parameter.

When it comes to the estimation of the trade elasticity, combining Equations 11 and 14 implies the following expression:

$$\lambda_n = \left(\frac{W_n}{P_n \kappa_n \left(\lambda_n\right)^{\phi_n}} \right)^{-\theta_n} \tag{16}$$

which can be simplified as follows:

$$\lambda_n = \left(\frac{W_n}{P_n \kappa_n} \right)^{-\frac{\theta_n}{1-\phi_n \theta_n}} \tag{17}$$

The log version of this expression replaces Equation 8 as follows:

$$\underbrace{\Delta \log \lambda_n}_{\text{\% Change in Home Expenditure Share}} = - \underbrace{\frac{\theta_n}{1-\phi_n \theta_n}}_{\text{New Coefficient}} \times \underbrace{\Delta \log \left(y_n\right)}_{\text{\% Change in Real Income Per Capita}} \tag{18}$$

where $y_n = \frac{W_n}{P_n}$ is the real income per capita as before, and $\Delta \log \kappa_n = 0$ as κ_n is an exogenous parameter. Compared to the benchmark estimation of Equation 8, the only difference is replacing the (minus) country-specific coefficient of trade elasticity θ_n with the (minus) new country-specific coefficient of $\frac{\theta_n}{1-\phi_n \theta_n}$.

Hence, the macroeconomic relationship between the home expenditure share and the real income per capita remains the same when trade-induced productivity is affected by the home expenditure share as suggested by Melitz and Redding (2014). Specifically, except for replacing θ_n with $\frac{\theta_n}{1-\phi_n \theta_n}$, including productivity as a function of the home expenditure share (due to Equation 14) does not change anything in the calculation of the gains from trade or the estimation of the relationship between the home expenditure share and the real income per capita. The only difference is that the interpretation of the coefficient representing the relationship between the home expenditure share and the real income per capita is not the trade elasticity θ_n anymore but a function of it, together with ϕ_n, represented by $\frac{\theta_n}{1-\phi_n\theta_n}$. Therefore, only the interpretation of the coefficient would change in this new case, without changing any of the benchmark empirical results (regarding the gains from trade) obtained in the absence of productivity.

In sum, due to considering the macroeconomic relationship between the home expenditure share and the real income per capita, the benchmark empirical results (e.g., the evidence for *diminishing gains from trade* with respect to trade openness) are robust to the consideration of missing gains from trade, when productivity is a function of the home expenditure share.

7.3 Pro-Competitive Effects of Trade

In this subsection, independent of the model that we considered so far, we utilize the welfare formula in [**Proposition 1**] of Arkolakis, Costinot, Donaldson, and Rodríguez-Clare (2019) to study the gains from trade liberalization in models with monopolistic competition, firm-level heterogeneity, and variable markups from a theoretical perspective. By considering country-specific elasticity measures, we rewrite their welfare formula by representing the macroeconomic relationship between the home expenditure share and the real income per capita to have a direct comparison with our Equation 8 as follows (in terms of this paper's notation):

$$\underbrace{\Delta \log \lambda_n}_{\text{\% Change in Home Expenditure Share}} = - \underbrace{\frac{\theta_n}{1-\eta_n}}_{\text{New Coefficient}} \times \underbrace{\Delta \log (y_n)}_{\text{\% Change in Real Income Per Capita}} \tag{19}$$

where η_n is a country-specific parameter governing the effects of markup changes.

As is evident, once again, the macroeconomic relationship between the home expenditure share and the real income per capita remains the same, even after considering the gains from trade liberalization in models with monopolistic competition, firm-level heterogeneity, and variable markups. As in the case of including productivity as a function of the home expenditure share above, the only difference with respect to the benchmark case is the interpretation of the coefficient representing the macroeconomic relationship between the home expenditure share and the real income per capita, where the benchmark empirical results regarding the gains from trade are not affected. It is implied that the benchmark empirical results (e.g., the evidence for *diminishing gains from trade* with respect to trade openness) are robust to the consideration of *pro-competitive effects* as well.

8 Conclusion

This paper has estimated the gains from trade by using a macroeconomic analysis. The main idea has been to estimate the country-specific trade elasticity measures by using the model-implied macroeconomic relationship between the home expenditure share and the real income per capita. The estimations have been achieved by using structural vector autoregression models with quarterly time-series data covering the period between $2005q1$ and $2021q4$. The average (across countries) trade elasticity estimate has been estimated about 2.7, corresponding to the gains from trade about 30%.

When the gains from trade are compared across countries, having a common trade elasticity across countries has *theoretically* been shown to result in a positive relationship between trade openness and the gains from trade across countries, whereas having country-specific trade elasticity measures (that increase with trade openness) has *empirically* been shown to result in a negative relationship between trade openness and the gains from trade across countries. This negative cross-country relationship has been called as the *diminishing gains from trade* with respect to trade openness in this paper. One caveat is that due to data availability, this paper has focused on the implications of a relatively simple trade model, where production is achieved by using labor only. Future studies can focus on the implications of other model specifications based on data availability, although Giri, Yi, and Yilmazkuday (2021) have already shown that the gains from trade would be similar across model specifications as long as model-consistent trade elasticity estimates are used.

Regarding policy implications, the current trade openness of a country is an important indicator for future potential gains from trade. Specifically, a percentage point increase in the trade openness of a relatively more closed economy would result in higher gains from trade with respect to that of a relatively more open economy. It is implied that international trade policies to improve the global welfare gains from trade should focus more on relatively more closed economies, which are mostly developing countries. This is in line with international policy prescriptions such as *the Washington Consensus* to improve the welfare of developing countries (e.g., see Williamson et al. (1990)), where openness to trade is an essential policy reform to promote growth and higher incomes. In practice, Estevadeordal and Taylor (2013) have empirically shown that such policy reforms can be achieved by liberalizing tariffs on imported capital and intermediate goods, which seems to be a key international policy prescription for improving the welfare of developing countries.

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Table 1 - Summary of Empirical Results across Countries

	Mean	Median	Minimum	Maximum
Trade Elasticity	2.712	1.616	0.261	11.933
Openness	0.412	0.384	0.133	0.809
Gains from Trade with Country-Specific Trade Elasticities	30%	26%	4%	65%
Gains from Trade with a Common Trade Elasticity	22%	18%	5%	61%
Bias in Gains with Common Elasticity	-8%	-10%	-59%	42%

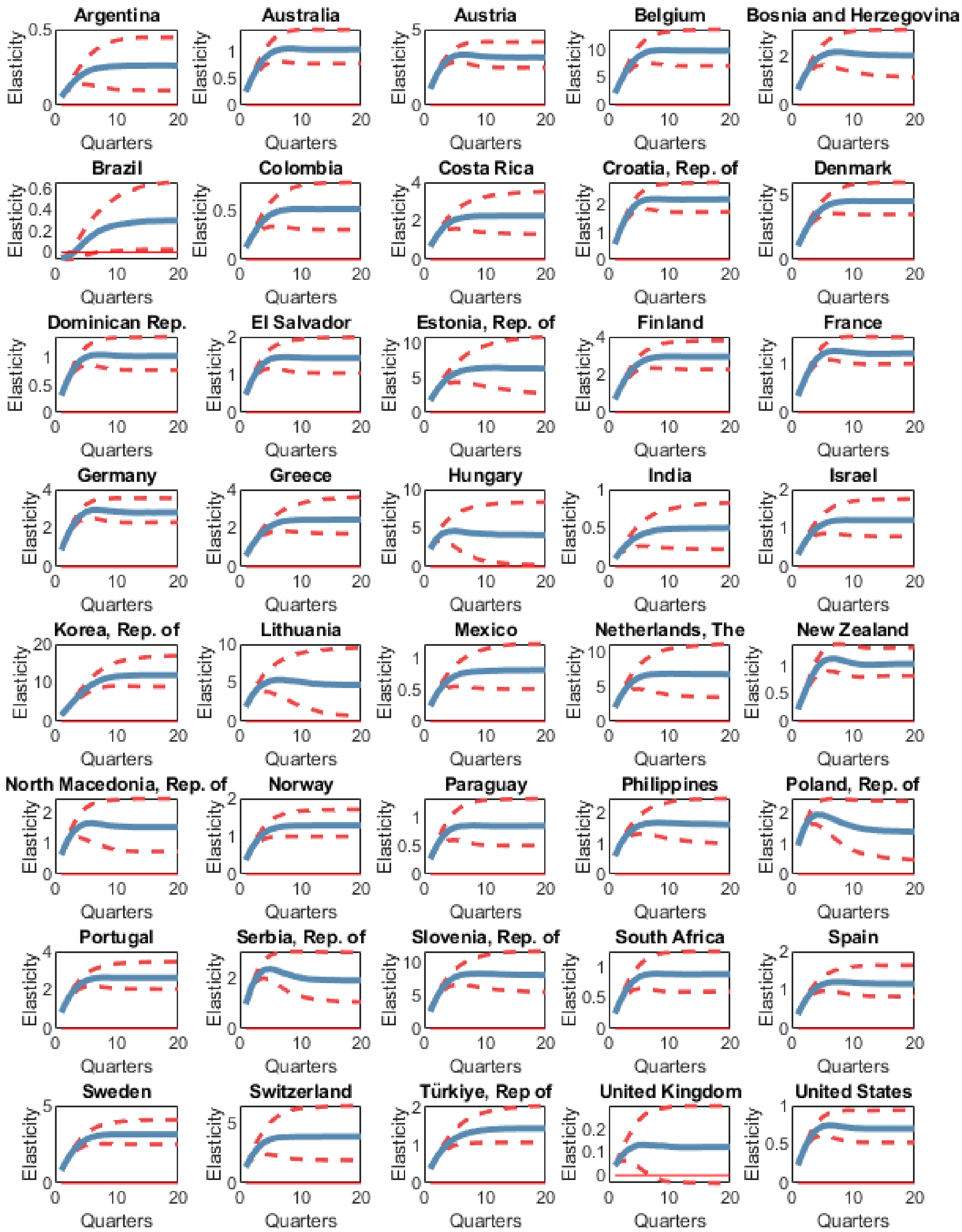
Notes: For each country, trade elasticity is measured by the cumulative impulse response of home expenditure share to a shock in the real income per capita after five years. Trade openness is measured by imports divided by GDP minus exports plus imports. Gains from trade are estimated by using country-specific trade elasticity estimates and the average (across countries) trade elasticity of 2.712 to show the importance of having country-specific trade elasticity measures. The bias is the difference between the gains from trade obtained by using the average trade elasticity of 2.712 for all countries and those obtained by using country-specific trade elasticity measures. Countries with insignificant trade elasticities (based on the 68% credible sets) are ignored.

Table 2 - Cross-Country Univariate Regressions

Dependent Variable	Explanatory Variable: Trade Openness	Explanatory Variable: Trade Elasticity
Trade Elasticity	10.471***	
	(1.697)	
Gains from Trade (%)	-25.329*	-3.184***
	(11.565)	(0.652)

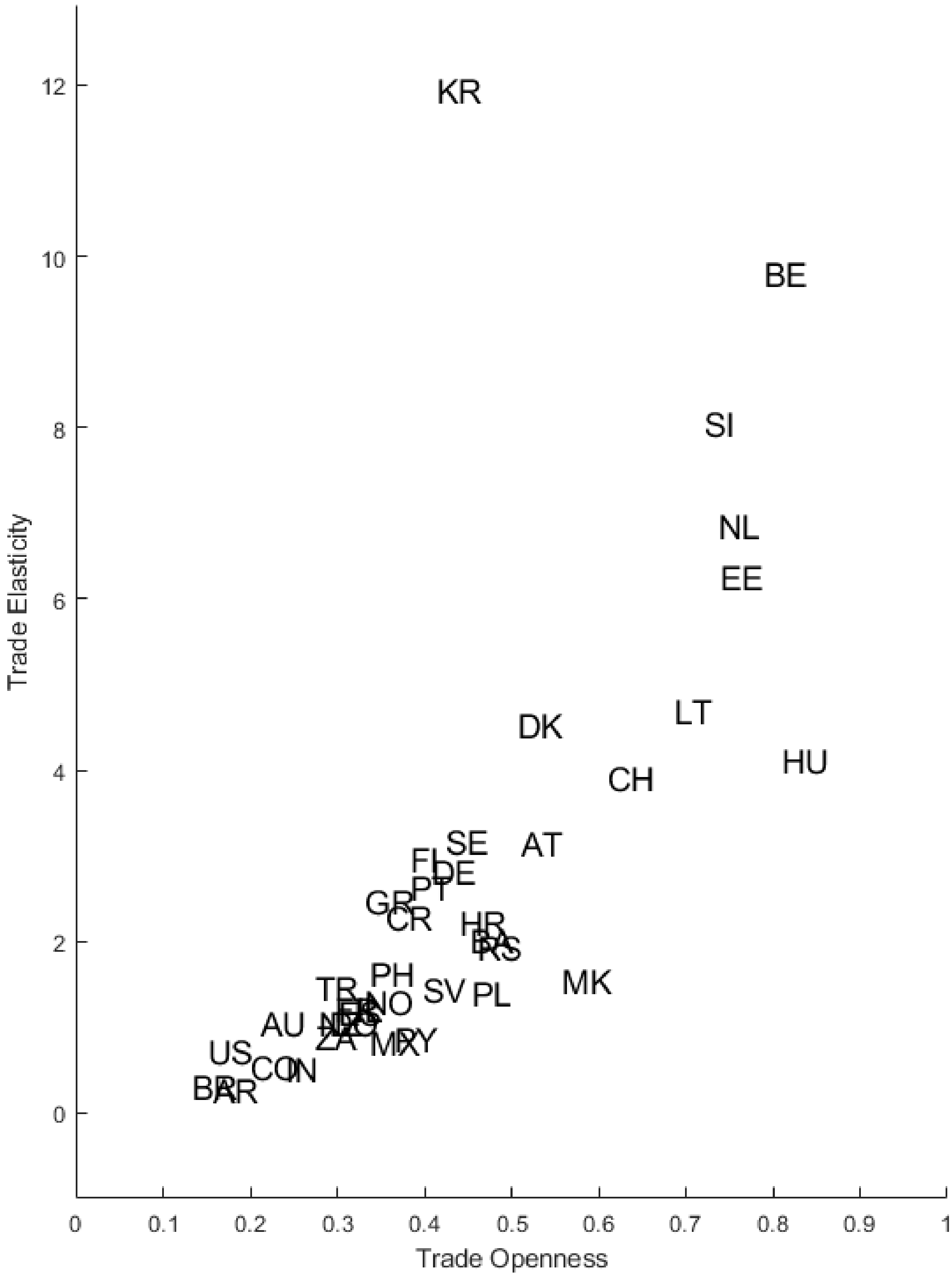
Notes: * and *** represent significance at the 0.1% and 5% levels. Standard errors are given in parentheses. The coefficients represents those estimated by cross-country univariate regressions. For each country, trade elasticity is measured by the cumulative impulse response of home expenditure share to a shock in the real income per capita after five years. Trade openness is measured by imports divided by GDP minus exports plus imports. Gains from trade estimate is based on country-specific trade elasticity measures. Countries with insignificant trade elasticities (based on the 68% credible sets) are ignored.

Figure 1 – Country-Specific Trade Elasticity Estimates



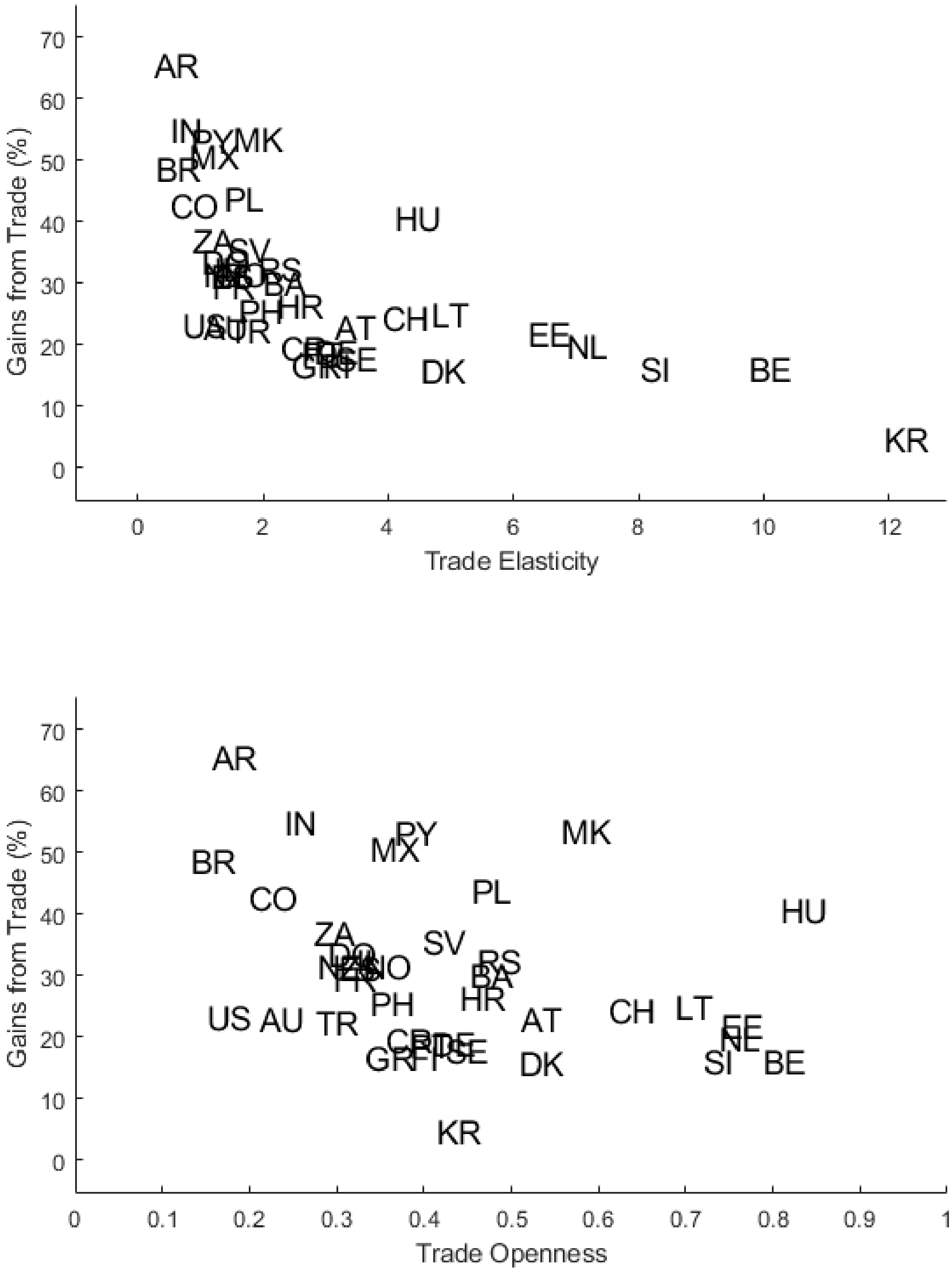
Notes: Figures represent country-specific trade elasticity estimates measured by the cumulative impulse response of home expenditure share to a shock in the real income per capita. Estimations are achieved for each country separately. Solid lines represent the median across 1,000 draws, whereas dashed lines represent lower and upper bounds measured by the 68% credible sets.

Figure 2 – Trade Elasticity Estimates versus Trade Openness



Notes: For each country, trade elasticity is measured by the cumulative impulse response of home expenditure share to a shock in the real income per capita after five years. Trade openness is measured by imports divided by GDP minus exports plus imports. Countries with insignificant trade elasticities (based on the 68% credible sets) are ignored.

Figure 3 – Gains from Trade: Country-Specific Trade Elasticity



Notes: For each country, trade elasticity is measured by the cumulative impulse response of home expenditure share to a shock in the real income per capita after 5 years. Trade openness is measured by imports divided by GDP minus exports plus imports. Countries with insignificant trade elasticities (based on the 68% credible sets) are ignored.

Online Appendix Table A.1 - Country-Specific Results

Country		Trade Elasticity				Gains from Trade		
Name	Code	Estimate	Lower Bound	Upper Bound	Openness	Country-Specific Trade Elasticity	Common Trade Elasticity	Bias
Argentina	AR	0.261	0.096	0.449	0.157	65%	6%	-59%
Australia	AU	1.039	0.775	1.407	0.211	23%	9%	-14%
Austria	AT	3.139	2.472	4.172	0.511	23%	26%	4%
Belgium	BE	9.778	7.053	13.566	0.789	16%	57%	42%
Bosnia and Herzegovina	BA	2.010	1.131	3.071	0.452	30%	22%	-8%
Brazil	BR	0.295	0.026	0.654	0.133	49%	5%	-43%
Colombia	CO	0.521	0.307	0.798	0.199	43%	8%	-34%
Costa Rica	CR	2.267	1.315	3.520	0.356	19%	16%	-3%
Croatia, Rep. of	HR	2.211	1.744	2.834	0.440	26%	21%	-5%
Denmark	DK	4.511	3.484	5.967	0.508	16%	26%	10%
Dominican Rep.	DO	1.029	0.772	1.383	0.291	33%	13%	-21%
El Salvador	SV	1.438	1.039	1.989	0.398	35%	19%	-17%
Estonia, Rep. of	EE	6.246	2.582	10.859	0.739	22%	50%	28%
Finland	FI	2.950	2.278	3.802	0.384	16%	18%	1%
France	FR	1.200	0.988	1.530	0.296	29%	13%	-16%
Germany	DE	2.814	2.296	3.557	0.408	19%	19%	1%
Greece	GR	2.453	1.717	3.637	0.332	16%	15%	-2%
Hungary	HU	4.102	0.254	8.425	0.809	40%	61%	21%
India	IN	0.502	0.228	0.831	0.240	55%	10%	-45%
Israel	IL	1.209	0.787	1.760	0.322	32%	14%	-18%
Korea, Rep. of	KR	11.933	8.986	16.917	0.414	4%	20%	15%
Lithuania	LT	4.684	0.657	9.535	0.688	25%	43%	18%
Mexico	MX	0.816	0.513	1.232	0.338	51%	15%	-35%
Netherlands, The	NL	6.843	3.468	11.259	0.737	20%	49%	30%
New Zealand	NZ	1.036	0.820	1.332	0.278	31%	12%	-19%
North Macedonia, Rep. of	MK	1.528	0.738	2.460	0.558	53%	30%	-23%
Norway	NO	1.286	0.993	1.715	0.331	31%	15%	-16%
Paraguay	PY	0.860	0.510	1.352	0.366	53%	17%	-36%
Philippines	PH	1.616	0.986	2.479	0.337	25%	15%	-10%
Poland, Rep. of	PL	1.388	0.462	2.374	0.455	44%	22%	-21%
Portugal	PT	2.628	2.047	3.472	0.384	18%	18%	-1%
Serbia, Rep. of	RS	1.923	1.057	3.046	0.460	32%	23%	-9%
Slovenia, Rep. of	SI	8.036	5.482	11.644	0.721	16%	47%	31%
South Africa	ZA	0.872	0.592	1.240	0.274	37%	12%	-25%
Spain	ES	1.155	0.828	1.640	0.302	31%	13%	-18%
Sweden	SE	3.154	2.501	4.084	0.425	18%	20%	3%
Switzerland	CH	3.907	1.911	6.504	0.611	24%	35%	11%
Türkiye, Rep of	TR	1.439	1.069	2.038	0.275	22%	12%	-10%
United Kingdom	GB	0.122	-0.033	0.299	0.298	290%	13%	-277%
United States	US	0.704	0.524	0.942	0.151	23%	6%	-17%
Mean		2.712	1.679	4.089	0.412	30%	22%	-8%
Median		1.616	0.993	2.479	0.384	26%	18%	-10%
Minimum		0.261	0.026	0.449	0.133	4%	5%	-59%
Maximum		11.933	8.986	16.917	0.809	65%	61%	42%

Notes: For each country, trade elasticity is measured by the cumulative impulse response of home expenditure share to a shock in the real income per capita after five years. Trade elasticity estimate is the median measure across 1,000 draws, whereas the lower and upper bounds correspond to the 68% credible sets. Trade openness is measured by imports divided by GDP minus exports plus imports. Gains from trade are estimated by using country-specific trade elasticity estimates and the average (across countries) trade elasticity of 2.712 to show the importance of having country-specific trade elasticity measures. The bias is the difference between the gains from trade obtained by using the average trade elasticity of 2.712 for all countries and those obtained by using country-specific trade elasticity measures. Countries with insignificant trade elasticities (based on the 68% credible sets) are ignored in the summary statistics.

Online Appendix Table A.2 - Robustness with Productivity Data

Country			Trade Elasticity		
Name	Code		Estimate	Lower Bound	Upper Bound
Australia	AU	*	1.206	0.841	1.665
Belgium	BE	*	22.742	-6.110	52.678
Colombia	CO	*	0.229	0.063	0.430
Estonia, Rep. of	EE	*	-0.700	-7.291	4.989
Finland	FI	*	3.985	2.727	5.614
France	FR		4.164	2.616	5.989
Germany	DE	*	4.065	2.524	5.767
Israel	IL		-1.029	-2.285	-0.064
Korea, Rep. of	KR	*	13.544	6.526	22.858
Lithuania	LT	*	-4.592	-15.902	4.426
Netherlands, The	NL	*	2.217	-8.787	11.530
New Zealand	NZ	*	1.455	0.707	2.354
Norway	NO	*	1.152	0.768	1.664
Portugal	PT	*	3.617	1.327	6.565
Sweden	SE	*	4.874	3.471	6.736
United Kingdom	GB		-1.228	-2.484	-0.349
United States	US	*	0.326	0.163	0.530
Mean			3.511	1.976	5.470
Median			3.617	1.327	5.614
Minimum			0.229	0.063	0.430
Maximum			13.544	6.526	22.858

Notes: * means that the trade elasticity measures obtained by including productivity data in the estimation process are not statistically different from the benchmark results given in the Online Appendix Table A.1 based on the 68% credible sets. In this table, for each country, trade elasticity is measured by the cumulative impulse response of home expenditure share to a shock in the real income per capita (adjusted by productivity) after five years. Trade elasticity estimate is the median measure across 1,000 draws, whereas the lower and upper bounds correspond to the 68% credible sets. Countries with insignificant (based on the 68% credible sets) or negative trade elasticities are ignored in the summary statistics.