

Trade costs, home bias and the unequal gains from trade

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December 17, 2021

Abstract

International trade affects consumption prices, with potentially different impacts on poor and rich consumers. We study these unequal impacts building on the Almost Ideal Demand System (AIDS) gravity model of Fajgelbaum and Khandelwal (2016). We augment the original model with a home bias in tastes or, alternatively, more complex trade costs. In this setup, we show that the structural parameters governing the welfare gains are highly sensitive to the determinants of spending on domestic goods. These extensions largely weaken the pro-poor bias of trade. Overall, we conclude that the AIDS gravity framework does not generate robust results about the distributive effects of trade within countries.

JEL classification: F10, F14, F61, D63.

keywords: International trade, welfare, non-homothetic preferences, home bias.

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[‡]Thanks to Pablo Fajgelbaum and Amit Khandelwal for sharing the replication material for Fajgelbaum and Khandelwal (2016). Thanks to Dennis Novy, Mathieu Parenti, Sjak Smulders, Burak Uras and participants of the KU Leuven-UC Louvain trade workshop for valuable comments. This work was supported by the Fonds de la Recherche Scientifique – FNRS under the CDR Grant J.0138.18 “Measuring inequality from trade data”. Declarations of interest: none.

1 Introduction

In the last decade, research in international trade put a strong focus on quantifying the welfare gains from trade using parsimonious models (Costinot and Rodríguez-Clare, 2014). These provide a simple way to calculate how a representative agent benefits from access to new or cheaper foreign goods. When preferences are non-homothetic, however, a household's consumption basket – and its gains from trade – depend on its position in the income distribution. If international trade reduces the relative price of the goods typically consumed by poor households, the poor stand to gain relatively more from trade than the rich. Fajgelbaum and Khandelwal (2016) provide one of the most elegant models to address this question, based on an Almost Ideal Demand System (AIDS), and find a strong pro-poor bias of international trade.

This paper revisits the distributional welfare effects of trade in an AIDS model. We extend the setup of Fajgelbaum and Khandelwal (2016) with an additional determinant of spending on domestic goods, which can be interpreted equivalently as a home bias in taste or as a border effect in the costs of trade. We quantify the gains from trade for four different specifications of the model, where each specification varies the degree to which the parameters governing domestic and foreign trade can differ. The results are very sensitive to our extension and point to rather equally distributed gains from trade, even reverting the direction of the gains from trade-bias in some cases. Overall, we see the AIDS gravity model as unable to generate robust conclusions on the distributive effects of international trade within countries.

Household-level gains from trade in the AIDS model are governed by the price elasticities and the income elasticities of different goods. Both sets of elasticities are estimated from a structural gravity equation, derived from the AIDS preferences, on aggregate data only. The identification of the income elasticity for a country's goods notably relies on the income per capita of its destinations. In line with the theory, the gravity equation is estimated on data that includes intra-national trade flows. In the basic AIDS model, the fact that a poor country like India spends much on its home goods contributes to identifying Indian goods as having a low income elasticity.

While income-driven spending allocation certainly plays a role, there are other possible explanations for a high proportion of spending on domestic goods. Two candidate explanations are a country-specific home bias in taste, or complex trade costs for for-

eign and domestic trade. For example, Indian products may be tailored to the taste of Indian consumers and trade costs domestically may be lower than for international shipments due to additional administrative burdens. We extend the model and allow for either explanation. The very flexible specification nests the original model as well as two intermediate cases. The first is one with a constant home bias across countries and symmetric trade costs, akin to adding an “international” dummy to the gravity regression like in Caron et al. (2014). The second is one with constant home bias but complex trade costs.

We estimate each version of our extended gravity equation and find that the income and the price-elasticities are highly sensitive to the model specification due to the different role of intra-national flows in the parameter identification. AIDS preferences generate an expenditure equation in which the dependent variable is an expenditure share – and not the logarithm of expenditure as is common in the international trade literature. This functional form and the fact that expenditures on domestic goods far exceed those on foreign goods give domestic observations a strong influence on the parameter estimates. In this context, the exact assumptions about the determinants of domestic spending take on an important role.

The large differences in parameter estimates across models translate into different distributions of the welfare gains from trade across income groups. The specification of Fajgelbaum and Khandelwal (2016) generates gains from trade that are biased towards the poor, and so does our first extension that introduces a constant home bias. The other two model specifications imply rather equally distributed gains from trade. For many countries, the most flexible model even predicts rich consumers to benefit relatively more once we introduce complex trade costs or heterogeneity in the home bias. One of the main reasons for these different conclusions is that the ranking of countries in terms of their associated income elasticity of exports changes.

We perform a number of additional exercises, using alternative data or extending our analysis to a multi-sector framework. These confirm a change in the strength or the shape of the pro-poor bias of international trade when introducing a flexible home bias in preferences, but especially point to the instability of the welfare conclusions.

We contribute to the vast literature on the welfare gains from trade (see Costinot and Rodríguez-Clare (2014) for an overview) and more specifically to the strand studying how those gains vary across the income distribution due to non-homothetic con-

sumption. The paper we are most closely related to is of course Fajgelbaum and Khandelwal (2016). In a similar spirit, Nigai (2016) emphasizes the role of consumer heterogeneity in income for quantifying the welfare gains from trade with Stone-Geary preferences. Borusyak and Jaravel (2018) and Carroll and Hur (2020) investigate the heterogeneous welfare gains from trade through the expenditure channel along with welfare gains through the income channel. See also Atkin (2021) for a recent literature review. Some works, such as Porto (2006) or Broda and Romalis (2009), take a more micro and less structural perspective to examine the impact of trade on the prices of goods consumed by rich or poor households.

Our extension of the Fajgelbaum and Khandelwal (2016) setup builds on an extensive literature that studies the home bias and its causes (see Caron et al. (2014)). A home bias in taste serves as an explanation for the empirical failure of the standard Heckscher-Ohlin-model (Trefler (1995) and Davis and Weinstein (2001)), and is a common ingredient of quantitative models in international macroeconomics (e.g. Gali and Monacelli (2005) among many others). Recent papers have also identified home biases empirically (e.g. Morey (2016), Cosar et al. (2018) or Atkin (2013) through habit formation). Related to our work, Zhang (2020) introduces a role for migrants' taste in the setup of Fajgelbaum and Khandelwal (2016) to explain the variation in home bias across countries.

A high domestic expenditure may also result from relatively high costs of trading across borders, a standard interpretation of the border effect identified by McCallum (1995). Gravity estimates on data that include domestic flows often allow for a dummy variable on international flows (Fally, 2015), sometimes with an exporter-specific coefficient to match the lower trade openness of poorer countries (Waugh (2010), Caron et al. (2014)). The effect of distance on trade costs may also differ depending on the nature of the flow (inter vs. intranational) and on the country considered. Ramondo et al. (2016) model how domestic trade costs vary across countries and highlight their role for different outcomes including welfare in gravity-like setups. In a recent survey of the literature, Yotov (2021) points to the importance of including domestic trade flows in gravity estimations and of properly accounting for them (see also Yotov (2012), Borchert and Yotov (2017), Anderson et al. (2018)). We relate to that literature by emphasizing the key role played by domestic trade flows in an AIDS gravity model, due to their disproportionate size. Our focus is however on a different outcome, namely

their role for the distributional effects of trade within countries.

Our discussion about log-log or share-log specifications in international trade relates to Novy (2013), who compares the performance of the translog to the constant elasticity of substitution gravity equations. The translog demand system is a special case of the AIDS when preferences are homothetic. We add to Novy (2013) by addressing the sensitivity of the translog gravity estimates to potential outliers in the data, in our case domestic trade. See also Feenstra and Weinstein (2017), Feenstra (2018) and Arkolakis et al. (2019) for recent work with translog demand in international trade.

Closely related is Anderson and Zhang (2020) who extend the model of Fajgelbaum and Khandelwal (2016) with the aim of explaining the large number of zero trade flows. They introduce variable price elasticities to the Fajgelbaum and Khandelwal (2016) model and add a uniform border effect to the set of trade costs proxies. Similar to our model specification featuring a homogeneous home bias, their set up addresses the special role of internal trade flows in the identification of the price elasticity but not in the identification of income elasticities. Finally, our analysis can also be of interest for papers which build on Fajgelbaum and Khandelwal (2016), for example Liu and Meissner (2019) and Sager (2019).

The structure of our paper is as follows. In section 2, we extend the AIDS model of Fajgelbaum and Khandelwal (2016) to allow for a home bias in preferences and more flexible trade costs. Section 3 presents the parameter estimates and the way they are identified in the different model specifications. Section 4 computes the welfare gains across the income distribution in the different versions of the model. In section 5, we conduct additional analyses with a different data set and investigate the multi-sector setting of the model. Section 6 concludes.

2 Theory

2.1 Setup

We extend the framework of Fajgelbaum and Khandelwal (2016) to include home bias in preferences and a border effect in trade costs. The economy consists of N countries. Each country produces one unique variety in an Armington sense, a variety being thus defined by the exporter. As in the original paper, we assume that preferences are

non-homothetic and represented by an Almost Ideal Demand System (AIDS). With the parameterization of the AIDS preferences chosen by Fajgelbaum and Khandelwal (2016)¹, the share of spending of individual h in country n for a variety from country i is given by:

$$s_{ni,h} = \alpha_{ni} - \gamma \left[\ln(p_{ni}) - \frac{1}{N} \sum_{i'=1}^N \ln(p_{ni'}) \right] + \beta_i \ln \left(\frac{x_h}{a(\mathbf{p})} \right) \quad (1)$$

where $a(\mathbf{p})$ is a homothetic price aggregator and x_h is the nominal income of individual h . The demand for a particular variety depends on a preference parameter α_{ni} , on the relative price of the variety from i in country n compared to the average of the other varieties, and the real income of individual h ($x_h/a(\mathbf{p})$). The coefficient β_i is capturing the non-homotheticity of demand. The parameters α_{ni} and β_i fulfill the following restrictions:

$$\sum_{i=1}^N \alpha_{ni} = 1 \quad \forall n, \quad \sum_{i=1}^N \beta_i = 0. \quad (2)$$

A key advantage of the AIDS preferences is their aggregation properties. Adding the demand over all individuals in country n gives:

$$S_{ni} = \frac{X_{ni}}{Y_n} = \alpha_{ni} - \gamma \left[\ln(p_{ni}) - \frac{1}{N} \sum_{i'=1}^N \ln(p_{ni'}) \right] + \beta_i y_n, \quad (3)$$

where y_n is a measure of inequality-adjusted real income:

$$y_n \equiv \left(\ln \left(\frac{\bar{x}_n}{a(\mathbf{p})} \right) + \Sigma_n \right). \quad (4)$$

$\bar{x}_n$ is the average income in country n , and $\frac{\bar{x}_n}{a(\mathbf{p})}$ is the average real income. Σ_n is the Theil index of income distribution in country n . Assuming that the price of a variety from i in country n is given by $p_{ni} = \tau_{ni} p_{ii}$ gives a gravity equation:

$$\frac{X_{ni}}{Y_n} = \alpha_{ni} - \gamma \left[\ln(\tau_{ni} p_{ii}) - \frac{1}{N} \sum_{i'=1}^N \ln(\tau_{ni'} p_{i'i'}) \right] + \beta_i y_n, \quad (5)$$

where $\tau_{ni} > 0 \quad \forall i$ measure the iceberg costs of trade between countries i and n .

Summing over all n , imposing that $Y_i = \sum_{n=1}^N X_{ni}$ and plugging back in the above equation gives an alternative way of writing (5), akin to the traditional gravity equation. We follow Fajgelbaum and Khandelwal (2016) and write:

$$\frac{X_{ni}}{Y_n} = A_{ni} + \frac{Y_i}{Y_W} - \gamma T_{ni} + \beta_i \Omega_n, \quad (6)$$

¹This choice is standard (see Deaton and Muellbauer (1980)). For more details see the appendix section A.

where Y_W denotes world income and:

$$A_{ni} = \alpha_{ni} - \sum_{n'=1}^N \frac{Y_{n'}}{Y_W} \alpha_{n'i} \quad (7)$$

$$T_{ni} = \ln(\tau_{ni}) - \frac{1}{N} \sum_{i'=1}^N \ln(\tau_{ni'}) - \sum_{n'} \frac{Y_{n'}}{Y_W} \left[\ln(\tau_{n'i}) - \frac{1}{N} \sum_{i'=1}^N \ln(\tau_{n'i'}) \right] \quad (8)$$

$$\Omega_n = y_n - \sum_{n'=1}^N \frac{Y_{n'}}{Y_W} y_{n'}. \quad (9)$$

The gravity equation (6) expresses the share of income that country n spends on variety i relative to the share spent on i at the world level (Y_i/Y_W). A country n spends a higher share of its income on i than the world if it has a stronger preference for the variety than the average country (A_{ni}), if it is closer to i than the average country (T_{ni}) or if it has an adjusted real income that is more conducive to consuming i ($\beta_i \Omega_n$), e.g. a richer or more unequal country than average for a high- β_i variety. The gravity equation allows to empirically identify the main parameters of the demand system: the price semi-elasticity γ and the vector of variety-specific income semi-elasticities $\{\beta_i\}$. These parameters play a key role in the computation of welfare effects (see Section 4) and are thus central for the quantitative results of the analysis.

It is worth pointing out that all the variables are demeaned across importers and across exporters, implicitly controlling for the multilateral resistance terms. T_{ni} for example captures bilateral trade costs between n and i compared to the cost for n of buying from other sources, and the costs for i of selling to other destinations. Equation (6) also mechanically fulfills the adding up constraints ($\sum_n X_{ni} = \sum_{n'} X_{in'} = Y_i$) usually captured by the multilateral resistance terms in the gravity literature (Anderson and van Wincoop, 2003).

2.2 Home bias and border effect

As in the original paper by Fajgelbaum and Khandelwal (2016), we need to impose some additional restrictions on the parameters before proceeding to the estimation of the gravity equation (6). Here we introduce the two innovations of our paper: a home bias in preferences and a border effect in trade costs.

Home bias in preferences. We assume that the parameter α_{ni} is given by:

$$\alpha_{ni} = \begin{cases} \alpha_i - \frac{\lambda_n}{N} & \text{if } n \neq i \\ \alpha_i + \frac{N-1}{N} \lambda_n & \text{if } n = i \end{cases} \quad (10)$$

with λ_n indexing the degree of home bias specific to importer n . A higher λ_n means that consumers in a country tend to prefer their domestic variety compared to the other varieties. This does not mean that the domestic varieties must have the highest preference parameter. If a country has a low α_i , its domestic consumers are still likely to have a higher preference parameter for other varieties but less so than foreign consumers. In Fajgelbaum and Khandelwal (2016), taste is symmetric across countries with $\lambda_n = 0$.² Plugging the above in the definition of A_{ni} in equation (7) gives:

$$A_{ni} = \lambda_i G_{D,ni} - \frac{1}{N} \left[\lambda_n - \sum_{n'} \frac{Y_{n'}}{Y_W} \lambda_{n'} \right] \quad (11)$$

where

$$G_{D,ni} = \begin{cases} -\frac{Y_i}{Y_W} & \text{if } i \neq n \\ 1 - \frac{Y_i}{Y_W} & \text{if } i = n \end{cases} \quad (12)$$

The variable A_{ni} captures the extent to which n has strong preferences for i compared to other countries. In the presence of a home bias, there is an asymmetry between domestic and foreign demand, reflected by $\lambda_n G_{D,ni}$.

Border effects in trade costs. The costs of trade τ_{ni} can be decomposed as follows:

$$\tau_{ni} = t_{ni} \prod_j g_{j,ni}^{-\delta_j} \tilde{\epsilon}_{ni}, \quad (13)$$

where $g_{j,ni}$ are dummies, indexed by j , that capture whether countries n and i share a common border or a common language. $\tilde{\epsilon}_{ni}$ is an error term. t_{ni} is a function of distance between n and i that allows for domestic trade costs to be lower and less sensitive to distance than international trade costs:

$$\ln(t_{ni}) = \begin{cases} \phi + \rho \ln(d_{ni}) & \text{if } i \neq n \\ \phi + \tilde{\phi} + (\rho + \tilde{\rho}) \ln(d_{ni}) & \text{if } i = n \end{cases} \quad (14)$$

where d_{ni} is the distance between countries i and n . We here allow both the level of trade costs and the marginal effect of distance on trade costs to differ between intra-national and international trade. Fajgelbaum and Khandelwal (2016) impose $\tilde{\rho} = \tilde{\phi} = 0$, i.e. no systematic difference between intra- and international trade costs.

Using (14), the demeaned trade costs T_{ni} , multiplied by $-\gamma$, become (see appendix

²The expression in (10) is different from Zhang (2020) who introduces heterogeneity across the consumer's country of origin and of residence to the taste parameter α_{ni} .

for derivation):

$$\begin{aligned}
-\gamma T_{ni} = & -\gamma \rho D_{ni} + \sum_{j \neq D} \gamma \delta_j G_{j,ni} + \epsilon_{ni} \\
& - \gamma \left(\tilde{\phi} + \tilde{\rho} \ln(d_{ii}) \right) G_{D,ni} + \frac{\gamma}{N} \left[\tilde{\phi} + \tilde{\rho} \ln(d_{nn}) - \sum_{n'} \frac{Y_{n'}}{Y_W} \left(\tilde{\phi} + \tilde{\rho} \ln(d_{n'n'}) \right) \right],
\end{aligned} \tag{15}$$

where $G_{D,ni}$ is a demeaned dummy for intra-national trade as defined in (34), and where:

$$D_{ni} = \ln(d_{ni}) - \frac{1}{N} \sum_{i'=1}^N \ln(d_{ni'}) - \sum_{n'} \frac{Y_{n'}}{Y_W} \left[\ln(d_{n'i}) - \frac{1}{N} \sum_{i'=1}^N \ln(d_{n'i'}) \right]. \tag{16}$$

$G_{j,ni}$ is the j th component of the demeaned gravity dummy, and ϵ_{ni} is $-\gamma$ times the demeaned error, where we apply the same demeaning as for D_{ni} . The first three terms in (15) correspond to the gravity terms in Fajgelbaum and Khandelwal (2016).

Combining. With a home bias in preferences, A_{ni} in (11) has a similar structure as the last two terms in (15). These can be combined as:

$$A_{ni} - \gamma T_{ni} = -\gamma \rho D_{ni} + \sum_{j \neq D} \gamma \delta_j G_{j,ni} + \epsilon_{ni} + \eta_i G_{D,ni} - \frac{1}{N} \left(\eta_n - \sum_{n'} \frac{Y_{n'}}{Y_W} \eta_{n'} \right), \tag{17}$$

where $\eta_i = \lambda_i - \gamma \tilde{\rho} \ln(d_{ii}) - \gamma \tilde{\phi}$, nesting both the heterogeneous home bias in preferences and our flexible specification of trade costs.

2.3 Estimating equations

Plugging (17) into equation (6) gives the augmented gravity equation to be estimated. With no additional structure on λ_i , η_i in (17) is a free parameter to be estimated. To make the difference between variables and parameters explicit in the last two terms of (17), we define N variables, indexed by k , such that, for any observation ni :

$$K_{ni}^k = \mathbb{1}_{k=i} \times G_{D,ni} - \frac{\mathbb{1}_{k=n}}{N} + \frac{1}{N} \frac{Y_k}{Y_W} \tag{18}$$

with $\mathbb{1}_{k=i}$ a dummy taking value one if k is the exporter (the importer for $\mathbb{1}_{k=n}$) and 0 otherwise. The variable K_{ni}^k maps how the strength of country k 's home bias (η_k) affects international trade for any pair ni of countries. By definition, a higher η_k raises the intra-national trade of country k ($K_{kk}^k > 0$). It also makes country k export and import less ($K_{nk}^k < 0$ for $n \neq k$, $K_{ki}^k < 0$ for $i \neq k$). With less of k 's goods available

on world markets, other countries turn to alternative sources or destinations, which stimulates bilateral trade for any pair ni with $n \neq k$ and $i \neq k$.

Plugging back in (17), we obtain:

$$A_{ni} - \gamma T_{ni} = -\gamma \rho D_{ni} + \sum_{j \neq D} \gamma \delta_j G_{j,ni} + \epsilon_{ni} + \sum_k \eta_k K_{ni}^k. \quad (19)$$

We collect each $G_{j,ni}$ and K_{ni}^k , into a vector $\mathbf{M}_{ni}$ and the corresponding parameters into a vector $\boldsymbol{\mu}$ and obtain the gravity equation:

$$\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} = \boldsymbol{\mu}' \mathbf{M}_{ni} - \gamma \rho D_{ni} + \beta_i \Omega_n + \epsilon_{ni}. \quad (20)$$

We estimate different versions of the gravity equation, which correspond to different sets of variables included in the vector $\mathbf{M}_{ni}$. In our most general model, $\mathbf{M}_{ni}$ includes all the variables present in (19) except for demeaned distance, and notably all the $\{K_{ni}^k\}_{k=1}^N$, which allow for a very flexible specification of home bias and trade costs. We refer to this specification as the **FLEX** model. We estimate it by OLS, the variables being demeaned in such a way that all constraints of the model are necessarily fulfilled³. Our general specification nests the original Fajgelbaum and Khandelwal (2016) estimation (**FK 2016**), with no home bias ($\lambda_i = 0$) and no border effect ($\tilde{\phi} = \tilde{\rho} = 0$), in which case $\mathbf{M}_{ni}$ only includes D_{ni} and the demeaned dummies $G_{j,ni}$.

We also consider two constrained versions of our most flexible model. The first assumes that if there is home bias, it is symmetric across countries ($\lambda_n = \lambda$) and that if there is a border effect, the elasticity of trade costs to distance is the same for international and intra-national flows ($\tilde{\rho} = 0$). Different levels of trade costs for domestic and international flows ($\tilde{\phi} \neq 0$) are isomorphic to the symmetric home bias. In that case, $\eta_i = \eta$ and we only need to augment the vector $\mathbf{M}_{ni}$ of the **FK 2016** model with a demeaned dummy for intra-national trade, $G_{D,ni}$. In the following, this model is referred to as the **constant home bias** specification. The second specification considers a case with symmetric home bias ($\lambda_n = \lambda$) and/or different trade cost levels ($\tilde{\phi} \neq 0$) but allows for a different elasticity of trade costs to distance for international and intra-national flows ($\tilde{\rho} \neq 0$). In this specification, we constrain η_i to be a constant times the intra-national distance of the exporter $\eta_i = \gamma \rho \ln(d_{ii})$. This corresponds to

³Summing the gravity equation over all i shows that the left hand side is zero while the right hand side boils down to $(\sum_i \beta_i) \Omega_n$, notably because $\sum_i K_{ni}^k = 0$. This ensures that the theoretical constraint $\sum_i \beta_i = 0$ holds empirically.

augmenting the vector $\mathbf{M}_{ni}$ of the *FK 2016* model with one variable, constructed as $\sum_k \ln(d_{kk})K_{ni}^k$. We refer to this specification as the *complex trade costs* version.

3 Gravity estimation

3.1 Data

To ease comparison, we use the same data as Fajgelbaum and Khandelwal (2016). All data sources are listed in Table 12 in the appendix. We estimate the four gravity models on data from the World Input Output Database (WIOD, Timmer et al. (2015)). The WIOD Release 2013 contains data on total expenditure in 35 sectors for 40 supplier and 40 user countries. Crucially, this data set contains observations on domestic expenditure by country⁴. We aggregate the expenditure data across sectors and take the average value over the years 2005 - 2007.

Trade costs are constructed using data on bilateral distance and indicators for a common language and a common border from Centre d'études prospectives et d'information internationales (CEPII). Bilateral distance is calculated as the population-weighted distance of the largest cities in the countries and internal distance is defined in a similar way (Mayer and Zignago, 2011). The dummies for common border and common language are set to 1 when trade is domestic.

Data on GDP per capita is obtained from Penn World Tables. The Theil index is computed using Gini data from the World Income Inequality Database and assuming log-normally distributed income. The Stone price index is constructed with data from Feenstra and Romalis (2014).

3.2 Results

Table 1 reports the results of our estimates for the four versions of the model.⁵ In all four empirical models, the coefficient on distance (D_{ni}) is negative and the coefficient on the border dummy is positive, both of them statistically significant. This is in

⁴ As argued in Borchert et al. (2021), the construction of the WIOD data relies on estimates to fill the missing data, making it not fully suited for estimation purposes. We however stick to using WIOD to ease comparison with the original paper of Fajgelbaum and Khandelwal (2016) and extend our analysis to use another dataset, which covers a larger number of countries, in section 5

⁵Table 7 in the appendix reports the full results including all 40 income elasticities.

line with the gravity literature. The coefficient on language however only appears significant in the empirical specification of Fajgelbaum and Khandelwal (2016). While qualitatively similar across models, the magnitude of the coefficients on distance and on the border dummy are much larger in the *FK 2016* specification. The estimate $\rho\gamma$ increases from -0.043 to -0.004 between the *FK 2016* and the *FLEX* version. With $\rho = 0.177$ as in Fajgelbaum and Khandelwal (2016)⁶, the implied price semi-elasticity γ changes from -0.24 to -0.02.

The estimated β 's also vary substantially across the different specifications, even if they are positively correlated across models (see Table 2). Their magnitude is again much larger in the *FK 2016* specification than in the other three. For example, the semi-elasticity of income for Indian varieties varies from -.048 in the most restricted specification (FK 2016) to .001 in the most flexible one. The same parameter for the United States goes down from .051 to .004. The standard deviation of these semi-elasticities across exporters (reported at the bottom of Table 1) falls from 0.016 in the most restricted model to 0.002 in the most flexible model. Despite their lower variance, we can reject the hypothesis that the β 's are jointly equal to zero in all models, as shown by the F-test at the bottom of Table 1. Studying non-homotheticity in welfare therefore remains possible.

⁶Fajgelbaum and Khandelwal (2016) take this value from Novy (2013), who estimates a CES gravity equation on a dataset without intra-national trade. Re-estimating a specification à la Novy (2013) in our dataset would give very similar values of ρ for different ways of treating domestic flows (which would be the CES counterparts of our different models). This can be seen from the first three columns of Panel a in Table 6 in the appendix, where the coefficient on distance is very stable and implies a ρ between .16 and .185. We therefore keep $\rho = 0.177$ throughout.

Table 1: Gravity estimation results

	FK 2016	Constant home bias	Complex trade costs	FLEX
Distance _{ni}	−0.0427*** (0.0045)	−0.0031** (0.0011)	−0.0048*** (0.0007)	−0.0038*** (0.0006)
Common Language _{ni}	0.1310*** (0.0213)	−0.0002 (0.0033)	0.0006 (0.0025)	0.0014 (0.0017)
Contiguity _{ni}	0.1346*** (0.0226)	0.0131*** (0.0032)	0.0103*** (0.0025)	0.0103*** (0.0024)
Domestic trade dummy $G_{D,ni}$		0.7969*** (0.0147)	0.4050*** (0.0460)	
Domestic distance			0.0700*** (0.0077)	
Non-homothetic term	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Country-specific home bias	<i>No</i>	<i>No</i>	<i>No</i>	<i>Yes</i>
Strd. Dev. β_i	0.016	0.004	0.002	0.002
p-value of F-test	0.00	0.00	0.00	0.00
aic	−2792	−8341	−9778	−10931
bic	−2582	−8131	−9568	−10721

Notes: Standard errors clustered by importer in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data: WIOD.

Table 2: Correlation of income elasticity estimates across models

	FK 2016	Constant home bias	Complex trade cost	FLEX
FK 2016	1			
Const. home bias	0.635***	1		
Complex trade cost	0.404***	0.860***	1	
FLEX	0.178***	0.600***	0.792***	1

Notes: Raw correlation coefficients for income elasticity estimates from four model versions. Data for estimation: WIOD.

Table 3 contrasts the ranking by income semi-elasticity across models for the ten largest countries in the sample. While the rank for the US, the largest country, is relatively stable across specifications, the ranking for Germany, the largest exporter, jumps from 35 in the *FK 2016* specification to rank 5 in the *FLEX* version. In the intermediate cases, its income elasticity is in midrange. Conversely, for Japan the rank stays stable around 2(3) in the *FK 2016* version and the intermediate models but falls to rank 20 in the most flexible version with country-specific home bias and border effects. Great Britain’s ranking jumps from 17 to 1 (2) in all novel specifications. To gauge whether the vector of β ’s is “plausible” in our most flexible model, we compute

Table 3: Rankings by income elasticity

Country	Share in world sales	Dom. share in total sales	Rank			
			FK 2016	Const.	Complex	FLEX
				home	trade	
				bias	costs	
USA	.288	.963	1	1	2	2
JPN	.099	.942	2	3	3	20
CHN	.098	.902	9	34	12	9
DEU	.063	.804	35	18	22	5
GBR	.054	.888	16	2	1	1
FRA	.049	.89	34	6	6	8
ITA	.044	.894	13	8	9	15
ESP	.029	.903	28	7	7	6
CAN	.027	.816	36	23	37	30
KOR	.025	.867	14	22	17	31

Notes: The table lists the 10 largest countries in the WIOD sample (by Y_i/Y_W), their domestic expenditure share (X_{ii}/Y_i), and the rank of their associated income elasticity by model. Data: WIOD.

the correlation between exporters' log GDP per capita and their estimated β . In line with the existing literature (e.g. Hallak (2006)), it is positive and significant at the 5% level, but substantially smaller than the one that Fajgelbaum and Khandelwal (2016) report (see Table 8 in the appendix).

We now turn to exploring the precise reasons for these large differences between the model specifications.

3.3 Identification of the coefficient on distance

Figure 1 depicts the variation used in each of the four models to identify the coefficient $\gamma\rho$. We estimate each model and obtain an adjusted residual of the dependent variable, equal to $\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} - \hat{\mu}M_{ni} - \hat{\beta}_i\Omega_n$, where the set of controls in M_{ni} varies across models. The adjusted residuals partial out the variation of all regressors other than

D_{ni} from the dependent variable⁷ and regressing these on distance gives the same value for $\gamma\rho$ as estimating the full model in equation (35).

Panel (a) corresponds to the specification in Fajgelbaum and Khandelwal (2016). The intra-national trade flow observations stand out with a much higher residual trade share compared to the international trade flows. The figure suggests that the identification of the parameters $\gamma\rho$ relies to a substantial part on the variation between intra-national and international trade flows rather than exploiting the variation of trade across distance. It is immediate that in all three alternative specifications the intra-national trade flows are much closer to the international trade observations than in the *FK 2016* version and the variation across trade flows is much reduced.

⁷This procedure is complementary to the Frisch-Waugh-Lovell theorem or Angrist and Pischke’s “regression anatomy” formula (Angrist and Pischke, 2008).

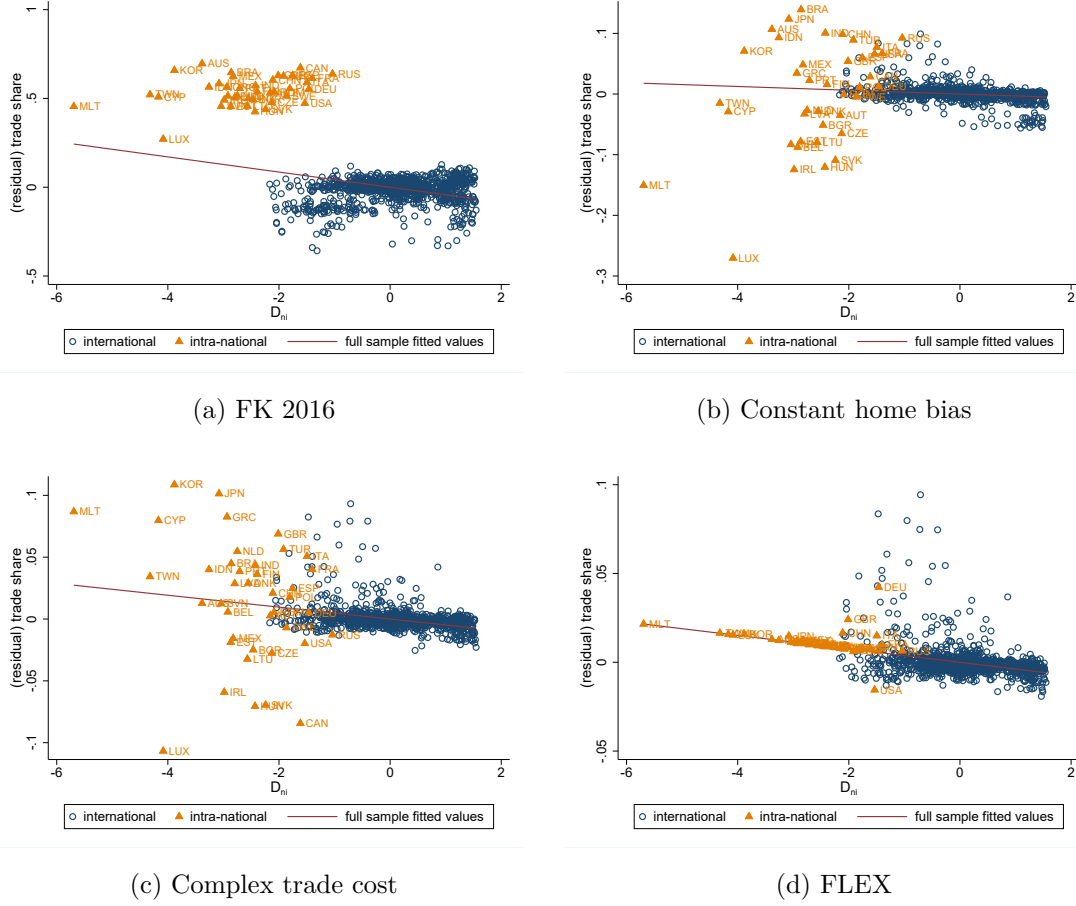


Figure 1: Identification of γ

Notes: The panels show the variation in trade shares exploited to identify the parameter $\gamma\rho$ across four models. The plot shows the residual adjusted trade share $\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} - \hat{\mu}M_{ni} - \hat{\beta}_i\Omega_n$, as a function of demeaned distance D_{ni} . The different panels correspond to different sets of controls in M_{ni} as explained in section 2.3.

A comparison between the AIDS-based gravity equation to a standard gravity equation, such as one derived from a CES utility, is instructive. The two models differ in three central aspects. First, the non-homothetic preferences imply non-unitary income elasticities across varieties and a role for the importer's income distribution in determining trade. Second, the dependent variable in the AIDS-based gravity is a share of trade flows and not the logarithm of trade flows as in most of the gravity literature. Third, in the AIDS model, the variables are demeaned by a weighted average across importers. As a result, exports from large countries in the sample are scaled down more than would be the case in a CES gravity model with fixed effects.

We modify an otherwise standard gravity equation according to each of these de-

viations in turn and estimate the distance elasticity with and without intra-national trade data in the regression sample. Details of this exercise are given in the appendix and results are reported in Table 6 in the appendix. The share-log structure of the gravity equation clearly is the main feature that makes the estimation sensitive to the treatment of intranational trade.

3.4 Identification of the income elasticities

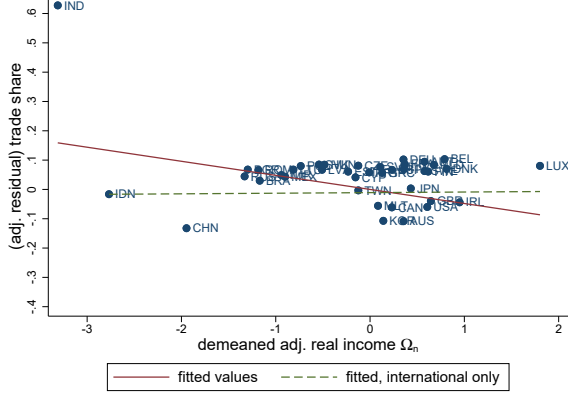
The second set of parameters, the income semi-elasticities $\{\beta_i\}$, are identified from the variation across the inequality-adjusted per capita income of importers. We present in Figures 2 and 3 the variation used in the four models to identify the income elasticity of different varieties. We choose as examples two countries, India and the United States. To construct these figures, we again estimate each model and obtain an adjusted residual of the dependent variable, $\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} - \hat{\mu}'M_{ni} + \hat{\rho}\gamma D_{ni}$, which we plot this time against the income variable Ω_n ⁸. Similar to γ , the income elasticities $\{\beta_i\}$ are highly sensitive to the treatment of intra-national trade flows in the estimation. We turn in the following to the two main changes in sources of variation between the models.

Domestic flows as outliers. In Panel (a) of each figure, we see the domestic flows as clear outliers. In the *FK 2016* model, Indian varieties are low-income elastic because India is relatively poor and is the principal buyer of its own goods. A similar effect makes US goods more high income-elastic. The impact of domestic observations on the estimated β of a country naturally depends on its income relative to the sample mean. The difference between domestic and foreign residual trade shares is decreasing as we add flexibility to the model. Panels (b) - (d) of Figures 2 and 3 show that the domestic trade flows stand out much less or not at all once we introduce flexibility in the home bias or in trade costs.

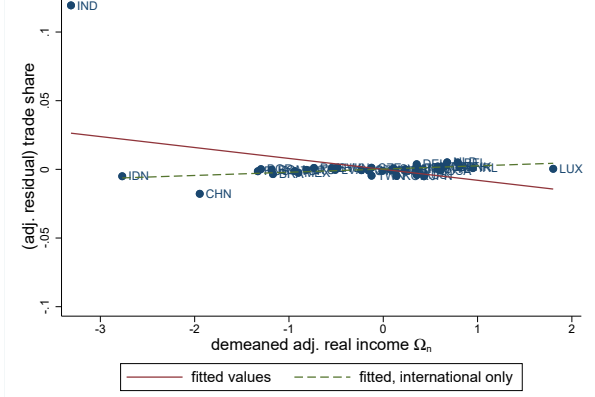
To measure the influence of outliers systematically, we calculate the change in coefficient β_i when excluding a given trade flow j , one trade flow at a time:

$$\text{dfb}_i = \frac{\hat{\beta}_i - \hat{\beta}_i^{(j)}}{s.e.(\hat{\beta}_i^{(j)})} \quad (21)$$

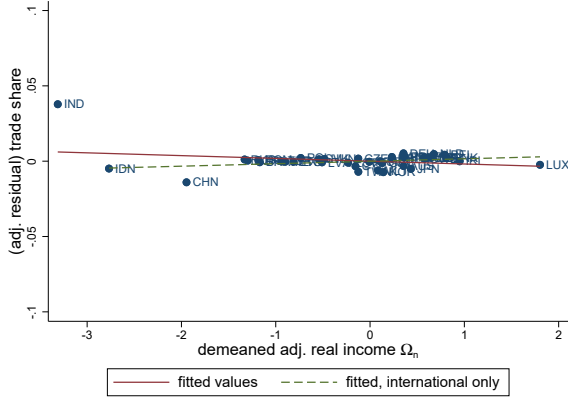
⁸By the structure of the model and the demeaning applied to the variables, the estimated β corresponds to a regression without constant, implying that the solid lines in Figures 2 and 3 go through 0.



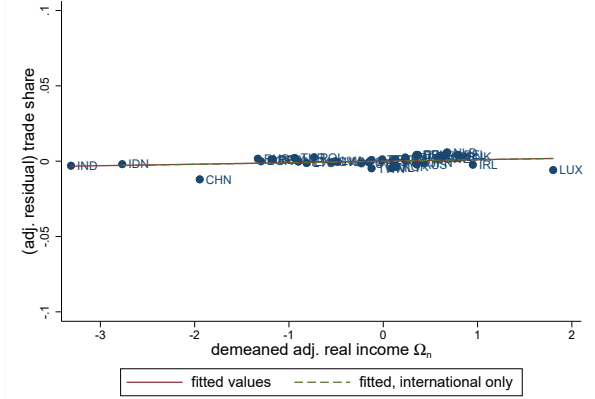
(a) FK 2016



(b) Constant home bias



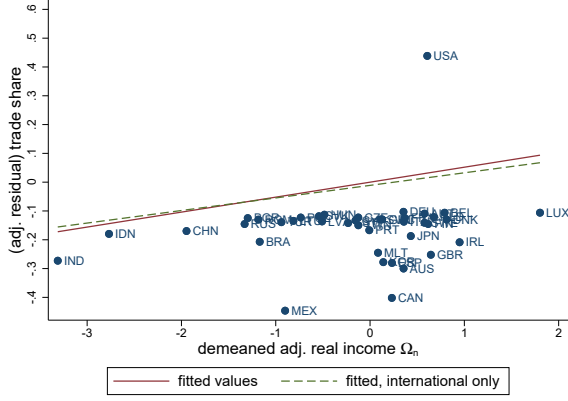
(c) Complex trade cost



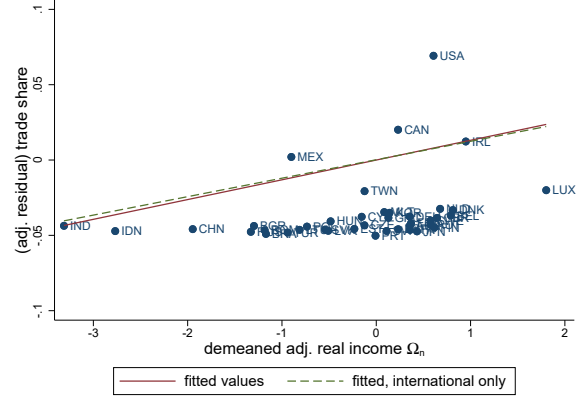
(d) FLEX

Figure 2: Identification of β_{IND}

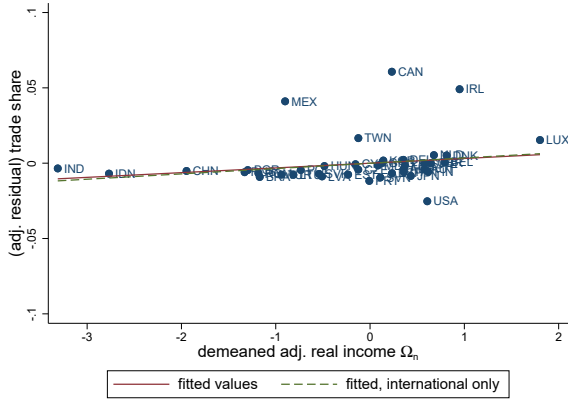
Notes: The plot shows the residual adjusted trade share $\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} - \hat{\mu}M_{ni} + \hat{\rho}\gamma D_{ni}$ for $i = \text{India}$, as a function of Ω_n . The different panels correspond to different sets of controls in M_{ni} as explained in section 2.3.



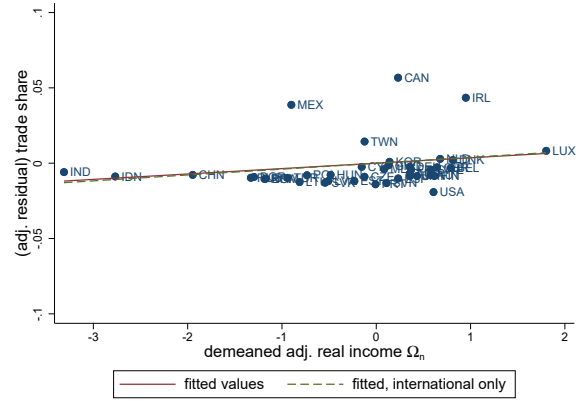
(a) FK 2016



(b) Constant home bias



(c) Complex trade cost



(d) FLEX

Figure 3: Identification of β_{USA}

Notes: The plot shows the residual adjusted trade share $\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} - \hat{\mu}M_{ni} + \hat{\rho}\gamma D_{ni}$ for $i=USA$, as a function of Ω_n . The different panels correspond to different sets of controls in M_{ni} as explained in section 2.3.

where $\hat{\beta}_i^{(j)}$ is the coefficient estimate when the j th trade flow is omitted from the sample. “dfb” stands for “difference in β ”.

Table 4 shows how the influence of single observations on the estimates for $\{\beta_i\}$ varies across models. The first row reports the number of cases in which the domestic flow is the single most important observation for the estimate of a country i ’s β_i . It is the case for 22 out of 40 countries in the *FK2016* or the *constant home bias* specifications, dropping to 16 and 0 respectively for the *complex trade cost* and the *FLEX* model. Only our most flexible specifications thus reduce the systematic impact of domestic flows on the estimated β_i .

Table 4: Influential observations in β_i estimation

	FK 2016	Constant home bias	Complex trade cost	FLEX
# dom. flows with highest dfb _{<i>i</i>}	22	22	16	0
# obs. dfb _{<i>i</i>} > 1	6	12	10	6

Notes: The table reports the number of observations with strong influence on the income elasticities for the four model specifications. dfb_{*i*} shows the sensitivity of an estimate to a single observation. See equation (21) for the formal definition.

Some bilateral trade flows however remain highly influential. The second row of Table 4 shows the number of observations that have an absolute value of dfb_{*i*} above 1, i.e. observations which, if removed, would change one of the estimated β_i by at least one standard deviation. While for the *FK 2016* model these influential data points are all domestic trade flow observations, in the *FLEX* model it is Great Britain’s income elasticity that is sensitive to the inclusion of a small number of destinations. Great Britain’s estimate depends much on the inclusion of India, Indonesia, Luxembourg, and Ireland. Luxembourg also has a high influence on Belgian’s and Germany’s β . These patterns appear however less systematic than the role of domestic trade in the *FK 2016* version.

Variation from the gravity coefficients. Another noteworthy feature of panel (a) of Figures 2 and 3 is the size of the variation on the y-axis compared to the other panels. The vertical axis plots predicted trade shares net of the gravity terms $\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} - \hat{\mu}M_{ni}$. The trade shares themselves vary little across foreign destinations, and the predicted gravity terms $(-\hat{\mu}M_{ni})$ explain the bulk of the variations on the y-

axis in panel (a). Since the magnitude of the gravity coefficients decreases when going to our more flexible specification, it compresses the variation on the y-axis, which reduces the magnitude of the β estimates in the model.

The change in the semi-elasticity of income between the *FK 2016* model and our more flexible models is a combination of the two channels above: domestic residuals being pulled down in Figures like 2 and 3, and the magnitude of trade cost elasticities being compressed. The first effect raises the β of poorer countries and decreases that of richer countries. The second raises the β of those countries for which international flows tend to make the β positive and vice-versa. It is worth noting that the *FK 2016* model typically overpredicts $\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} - \hat{\mu}'M_{ni} - \rho\gamma D_{ni}$ when n and i are proximate countries (by geography or language). If proximate destinations are rich, the model accounts for the lower actual trade with a low β for the exporter and vice-versa. This explains in part why countries such as Germany, France or Belgium have a low β in *FK 2016*.

3.5 Empirical performance

When comparing the empirical performance of the different models, the *FK2016* version has the advantage of being parsimonious but the strong and systematic influence of domestic flows on parameter estimates is unappealing. In the *constant home bias* model, we estimate a high coefficient on the domestic dummy (0.8) since most countries in the sample have a very high domestic share, implying a poor fit for small open economies like Luxembourg or Ireland. The *complex trade costs* specification allows for a different effect of internal compared to international distance. For small countries, which are typically more open, this additional effect is not enough to fit the data well. The *FLEX* version is the most flexible of all models. It accommodates large and small domestic expenditure shares as well as large and small areas. This version also is the preferred model according to the Akaike and Bayesian information criteria reported at the bottom of Table 1.

4 Welfare effects of trade

Once the parameters γ and $\{\beta_i\}$ are set, the AIDS model allows to calculate the aggregate and individual expenditure effect of trade using data on aggregate expenditure

shares and the country's income distribution. In the following, we present the method developed by Fajgelbaum and Khandelwal (2016) to quantify the distributional consequences of trade liberalization. While the welfare formula itself does not depend on the particular version of the model that we consider (with or without home bias and border effect), the quantitative results can be highly sensitive to the values of γ and $\{\beta_i\}$.

A household's welfare is defined in terms of its real income and so the welfare gains are split between an income and an expenditure component:

$$\hat{\omega}_h = \hat{x}_h - \sum_i \hat{p}_i s_{ih}, \quad (22)$$

where hats denote the percentage change of a variable ($\hat{b} = db/b$). As in Fajgelbaum and Khandelwal (2016), we abstract from income effects of trade⁹ ($\hat{x}_h = 0$) and decompose household welfare gains into an aggregate and an individual component,

$$\hat{\omega}_h = \hat{W}_n + \hat{\psi}_{nh} \quad (23)$$

where

$$\hat{W}_n = - \sum_{i=1}^N \hat{p}_{ni} S_{ni} \quad (24)$$

and

$$\hat{\psi}_{nh} = - \sum_{i=1}^N \hat{p}_{ni} (s_{ih} - S_{ni}). \quad (25)$$

Consumer h 's welfare gains differ from the aggregate welfare gains due to different spending allocation. A household's welfare rises more than average if the price of a good falls on which the household spends a disproportionately higher share than the country in the aggregate.

4.1 Welfare gains in the AIDS model

Combining equations (1) and (3) yields

$$s_{ih} - S_{ni} = \beta_i \ln\left(\frac{x_h}{\tilde{x}_n}\right) \quad \text{where } \tilde{x}_n = \bar{x}_n e^{\Sigma_n} \quad (26)$$

and household welfare gains are given by

$$\hat{\omega}_{nh} = \hat{W}_n - \sum_{i=1}^N \beta_i \hat{p}_{ni} \ln\left(\frac{x_h}{\tilde{x}_n}\right). \quad (27)$$

⁹Fajgelbaum and Khandelwal (2016) consider a trade shock originating abroad and rule out an effect on an individual's income as well as effects on the domestic goods' prices.

A household's welfare deviates from the aggregate welfare if its income differs from the inequality adjusted average income. Equation (3) implies

$$dS_{ni} = -\gamma \hat{p}_{ni} + \frac{\gamma}{N} \sum_{i'=1}^N \hat{p}_{ni'} + \beta_i dy_n, \quad (28)$$

where d is the difference operator. For a given change in income, changes in aggregate expenditure shares reflect the changes in prices. Rearranging equation (28) for $\hat{p}_{ni}$ and replacing in (27), one can express the change in welfare in terms of changes in expenditure shares. The domestic good is the numeraire so that domestic goods' prices do not change when moving from autarky to trade. The change in welfare becomes

$$\begin{aligned} \hat{\omega}_{nh} &= \hat{W}_n + \hat{\psi}_{nh} \\ &= \sum_i \frac{1}{\gamma} S_{ni} (dS_{ni} - dS_{nn}) + \sum_i \frac{1}{\gamma} S_{ni} (\beta_n - \beta_i) dy_n \\ &\quad - \left[\sum_i \frac{\beta_i}{\gamma} (dS_{nn} - dS_{ni} + (\beta_i - \beta_n) dy_n) \right] \ln\left(\frac{x_h}{\tilde{x}_n}\right), \end{aligned} \quad (29)$$

which correspond to equations (33)-(35) in Fajgelbaum and Khandelwal (2016). The aggregate component $\hat{W}_n$ sets the level of the welfare gains from trade in country n while $\hat{\psi}_{nh}$ determines the distribution of the welfare gains from trade across the income distribution. Non-homotheticities play a role for the aggregate as well as for the individual welfare gains from trade. The first term can be interpreted as the welfare gains of a representative consumer in n with homothetic preferences and a consumption vector S_{ni} . It corresponds to translog preferences. The second term adds the welfare effects of a representative consumer with non-homothetic preferences. The third term captures the differences in welfare gains across individuals within countries due to the non-homotheticity.¹⁰

We compare the welfare implications of the four model versions from a counterfactual experiment of moving the consumers from observed trade openness to autarky. Changing the price and income semi-elasticities matters for the predicted level and distribution of the welfare gains from trade. We begin the discussion with the implications for the aggregate, homothetic welfare component of equation (27), denoted W_{Hn} . We turn to the distributional welfare consequences thereafter.

¹⁰We account for the non-negativity constraint of expenditure shares at the household level in the welfare quantification. See Feenstra (2010) and the appendix in Fajgelbaum and Khandelwal (2016) for details.

4.2 The homothetic part of the welfare gains

When preferences are homothetic, $\beta_i = 0 \forall i$, the second and third term in equation (29) disappear and the model boils down to a translog model. The change in homothetic welfare given by¹¹

$$\hat{W}_{Hn} = \sum_i S_{ni} \frac{dS_{ni} - dS_{nn}}{\gamma} = \sum_i \frac{S_{ni} dS_{ni}}{\gamma} - \frac{dS_{nn}}{\gamma} \quad (30)$$

is equivalent to the welfare gains in a translog model. To quantify the change of welfare from autarky (W_{Hn}^A) to trade (W_{Hn}^T) in the translog model, we note that $W_{Hn}^T/W_{Hn}^A = \exp\left(\int_{W_{Hn}^A}^{W_{Hn}^T} d\ln(W)\right)$. The exact change in welfare from autarky to trade is thus

$$\begin{aligned} \frac{W_{Hn}^T}{W_{Hn}^A} &= \exp\left(\frac{1}{\gamma} \sum_i \int_{S_{ni}^A}^{S_{ni}^T} S_{ni} dS_{ni} - \frac{1}{\gamma} \int_{S_{nn}^A}^{S_{nn}^T} dS_{nn}\right) \\ &= \exp\left(\frac{1}{\gamma} \left[\frac{1}{2} + \frac{1}{2} \sum_i (S_{ni}^T)^2 - S_{nn}^T\right]\right). \end{aligned} \quad (31)$$

Feenstra and Weinstein (2017) derive a similar equation to (31) and discuss in detail how it compares to the welfare equation implied by a Constant Elasticity of Substitution-utility.¹²

Table 10 lists the aggregate, homothetic welfare loss when moving from observed trade openness to counterfactual autarky for all countries and using estimates of γ from the four different models. Using the γ estimate from the modified models, the aggregate welfare effects balloon in particular for the most open economies with the smallest domestic consumption. Whereas the welfare loss from autarky ranges from 0.4% for Brazil to 43% for Luxembourg when using the γ estimates from Fajgelbaum and Khandelwal (2016), Brazil's welfare loss is estimated to lie between 3.5% and 5.3% in the alternative models and Luxembourg is predicted to lose between 99.3% to 99.9% when moving from trade to autarky. The fact that the γ estimates are only a tenth of the γ estimate of the benchmark model, and that its inverse enters an exponential function create this stark sensitivity of the overall level of welfare gains from trade to the estimated parameters.

¹¹See also footnote 21 in Fajgelbaum and Khandelwal (2016).

¹²The difference with their framework is that we consider an Armington setup with no extensive margin and compute the gains from trade keeping domestic prices constant.

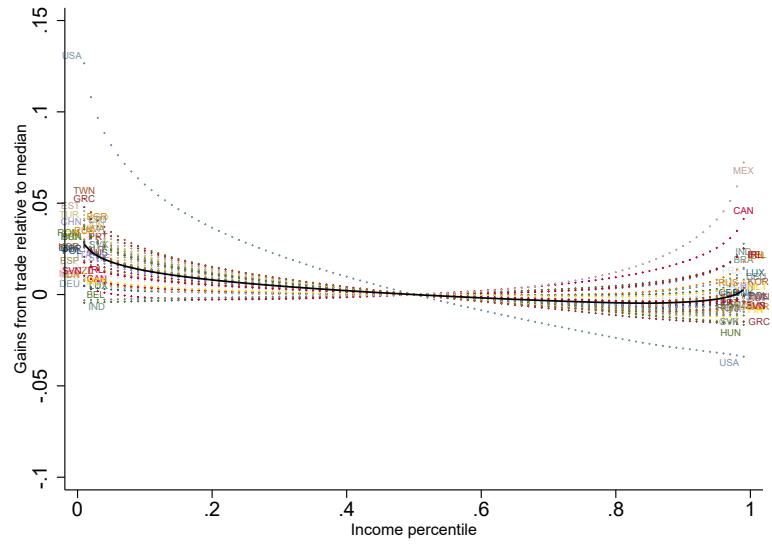
4.3 The unequal gains from trade

Turning to the distributional consequences, Figure 4 presents the gains from trade across percentiles of the income distribution corresponding to the four model specifications. To facilitate comparison, the gains from trade of each percentile are calculated as the difference to the median household's welfare effect per country. The figures show the welfare gains as $1 - \omega_{nh}$ which is the amount a household would be willing to pay to keep the current level of trade openness.

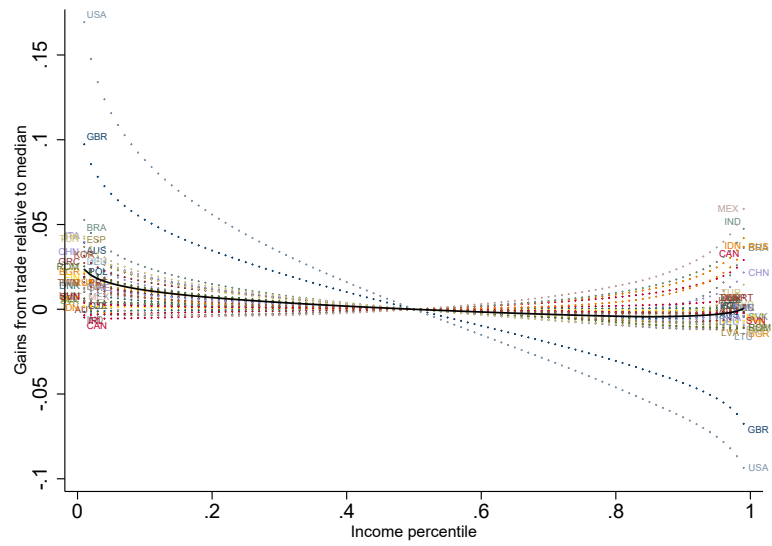
In spite of the differences in parameter estimates, the average welfare predictions across countries of the *FK 2016* model and the *constant home bias* model are hardly distinguishable. Since it is the ratio of the price and income elasticity parameters that matters, if both decrease by the same factor, the ratio stays (roughly) constant and there are no differences in welfare predictions. For many countries, the U-shape pattern of the welfare distribution is preserved which implies that poor and rich gain relatively more than the median household. ~~Great Britain and the US are two countries for which there is a more obvious change: in both countries, the pro-poor bias is more pronounced according to the *constant home bias* model. These are the two countries with the highest income elasticity estimates. Moving the countries from observed levels of trade openness to counterfactual autarky means that they will stop importing goods disproportionately consumed by poorer households.~~

When we allow for complex trade cost functions for domestic and international trade flows, the welfare pattern changes. Welfare gains in the US are predicted to be much more equally distributed. In other countries, the welfare gains at the tails of the distribution differ even less from the median's gains while the direction of the bias flips sign for many. For the UK, the pro-poor bias remains strong. As Great Britain's exports score the highest income elasticity estimate in this version, the poor in the UK are still predicted to gain disproportionately when opening to trade.

The results point even more to a flat or even pro-rich biased distribution of the gains from trade as we add flexibility to the model by introducing a heterogeneous home bias. The U-shape pattern found in Panels (a) and (b) is no longer present either, meaning that richer consumers benefit more from the price change of their consumption basket induced by opening to trade.



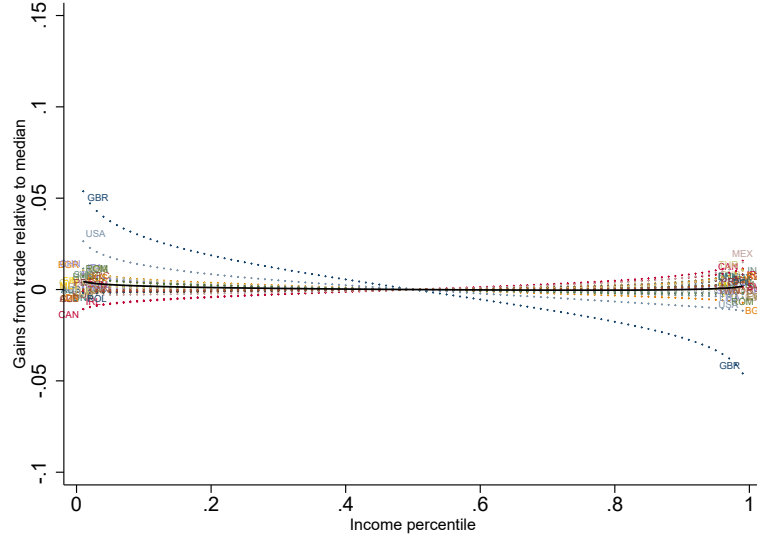
(a) FK 2016



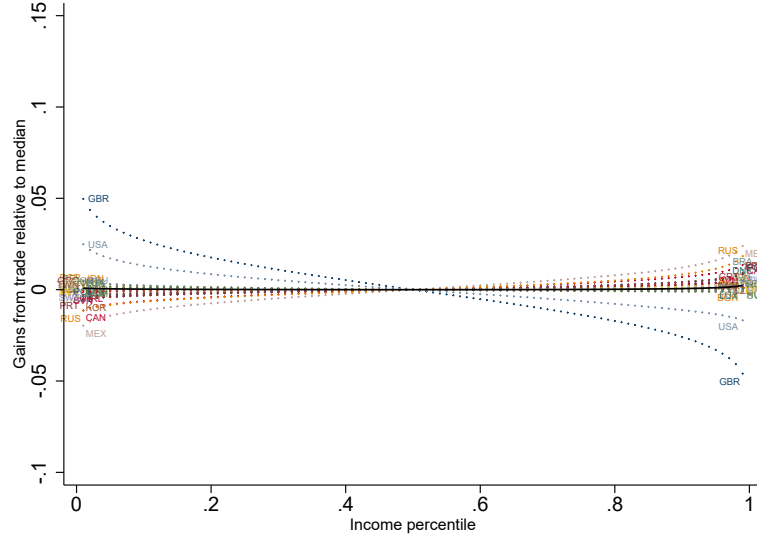
(b) Constant home bias

Figure 4: The distribution of welfare gains from trade

Notes: The black solid line show the mean welfare gains across 40 countries by percentile.



(c) Complex trade cost



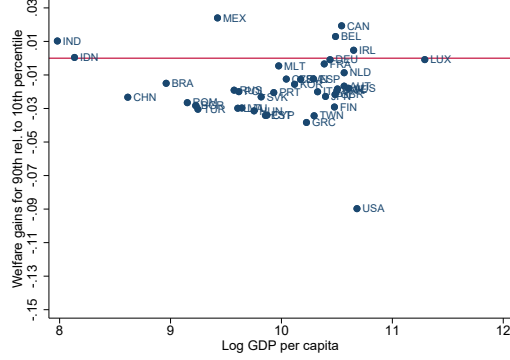
(d) FLEX

Figure 4: The distribution of welfare gains from trade

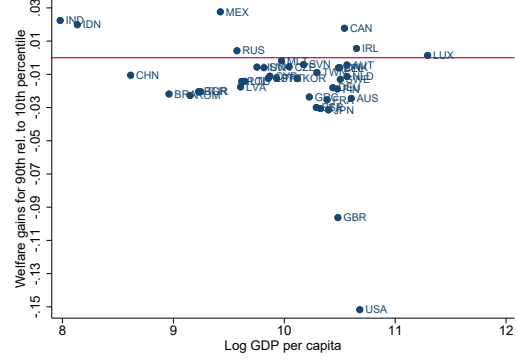
Notes: The black solid line shows the mean welfare gains across 40 countries by percentile.

The direction of the bias in gains from trade is summarized by the difference of welfare gains from trade of the top decile to the bottom decile of the income distribution. We show this difference for all countries in Figure 5 and Table 11 (in the appendix) and use it to trace the contrasting welfare predictions across models to changes in the income elasticity estimates. The difference is negative for most countries in the benchmark model. The fewer constraints we impose on the degree and form of home

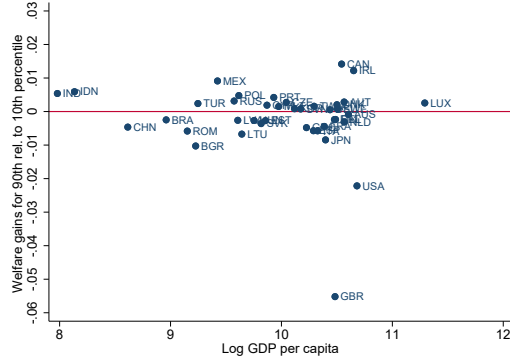
bias and trade costs, the more often the unequal, pro-poor gains from trade become equally distributed or even slightly pro-rich.



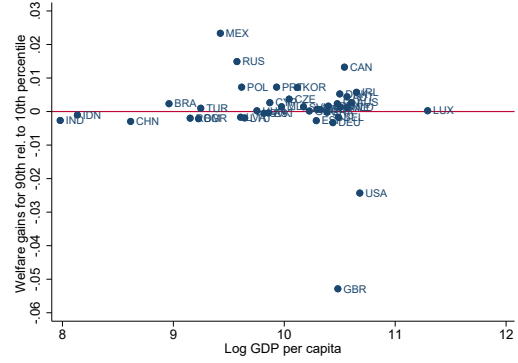
(e) FK 2016



(f) Constant home bias



(g) Complex trade cost



(h) FLEX

Figure 5: The relative gains from trade: 90th to 10th percentile

Notes: Plots show the difference in the welfare gains from trade of the 90th to the 10th percentile. The red solid line marks 0, where gains from trade are equally distributed. Table 11 in the appendix lists all countries and differences in welfare gains by model.

We finally decompose the relative welfare gains of the 90th US percentile to the 10th US percentile and contrast each exporter's contribution in FLEX with its contribution in FK 2016. The results are presented in Figure 6. The contribution of US products to the US welfare distribution is zero since the domestic goods prices are assumed to not change between trade and the counterfactual autarky. Imports from India are central to the change in welfare conclusions between the two model specifications. As Indian products take a smaller share of poor households' expenditure in FLEX than in FK 2016, due to their higher income elasticity, poor US households are less harmed by foregoing consumption of Indian goods under autarky.

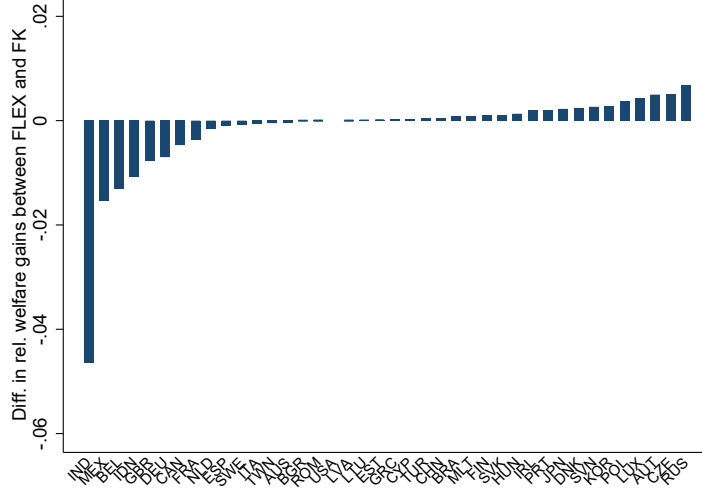


Figure 6: Decomposition of gains from trade-biases across models, for USA

Notes: Countries are sorted by the difference between the *FLEX* and *FK 2016* model in terms of the relative welfare gains at the 90th percentile to the 10th percentile. For the decomposition, we use the log-approximation of the welfare gains.

5 Extensions

5.1 ITPD-E data

The large impact of domestic trade flows that we emphasize in the AIDS gravity model may be an artifact of the small number of countries in the WIOD database. In a square matrix of trade flows with N countries, a fraction $1/N$ of flows are domestic and our conclusion could be driven as much by the small size of the dataset as by the method.

To gauge the robustness of our conclusion, we replicate our analysis using the ITPD-E data of Borchert et al. (2021), which increases the number of trading country pairs in our estimation data set to 113. We use data for the same time period as in the main analysis. The ITPD-E data has two additional advantages for our purpose. First, it covers substantially more poor countries compared to WIOD. The support of Ω_n (the adjusted real income), which is key to the identification of the β 's, is much broader.¹³ This can improve the precision of the income elasticity estimates. Second, as pointed out by Borchert et al. (2021), ITPD-E lends itself better to estimation

¹³The median GDP per capita drops to 7800 US\$ from 25500 US\$ in the WIOD data. Ω_n ranges from -7.5 to 2.2 in ITPD-E whereas it lies in the interval $[-3.3, 1.8]$ in WIOD.

purposes.

We outline in the following the main results of two specifications, *FK 2016* and *FLEX*, with the ITPD-E dataset. The role of domestic trade flows remains strong, and the coefficient on distance goes from -0.0135 in the *FK2016* specification to -0.0039 in the *FLEX* model. The coefficients on language and contiguity are similarly affected (see Table 9 in the appendix). Figure 7 depicts the identification of the distance coefficient and corresponds to panels (a) and (d) of Figure 1 with the new data.

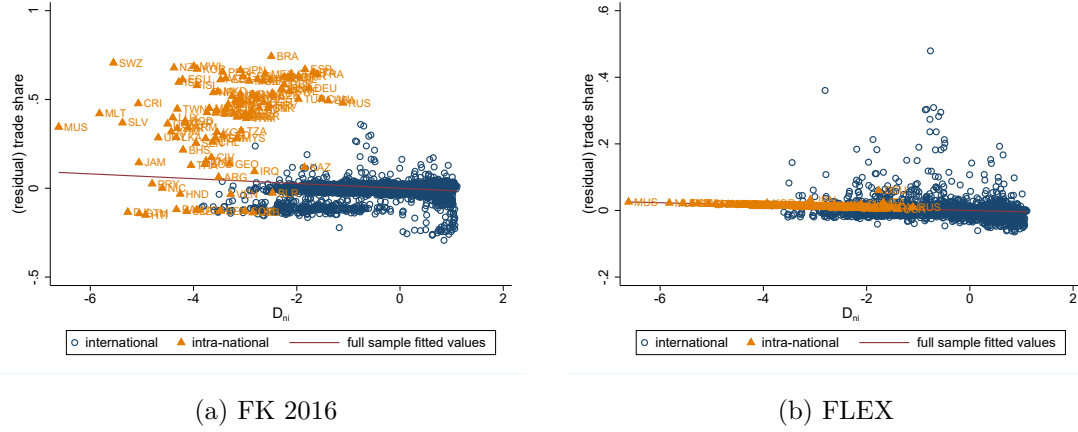


Figure 7: Identification of γ in ITPD-E

Notes: The panels show the variation in trade shares exploited to identify the parameter $\gamma\rho$ across two models in ITPD-E data. The plot shows the residual adjusted trade share $\frac{X_{ni}}{Y_n} - \frac{Y_i}{Y_W} - \hat{\mu}M_{ni} - \hat{\beta}_i\Omega_n$, as a function of D_{ni} . The different panels correspond to different sets of controls in M_{ni} as explained in section 2.3.

As in the analysis based on WIOD, our estimates of the vector β in the ITPD-E dataset markedly differ between the *FK 2016* and the *FLEX* specifications, the two being almost uncorrelated.¹⁴ Introducing a heterogeneous home bias thus seems to matter for the estimates, also in a larger dataset. To judge the role of intra-national flows for this result, we compute dfb_i , defined in equation (21) for each β_i . Figure 8 shows the distribution of these dfb_i 's in the two datasets under the *FK 2016* specification, separating observations that pertain to intranational (red, blank) and international flows (grey, filled). Panel (a) is similar to Table 4 and shows the large role in particular of intra-national flows for the estimates of β in Fajgelbaum and Khandelwal (2016). Panel (b) replicates this graph with the ITPD-E data and shows

¹⁴The full vector of estimated β with the ITPD-E dataset is available from the replication material or from the authors upon request.

that individual intra-national trade flows still matter disproportionately. As expected, the fact that i 's domestic trade is an outlier in the estimation of β_i matters somewhat less in a larger dataset. Collectively, however, domestic flows strongly impact the gravity coefficients.

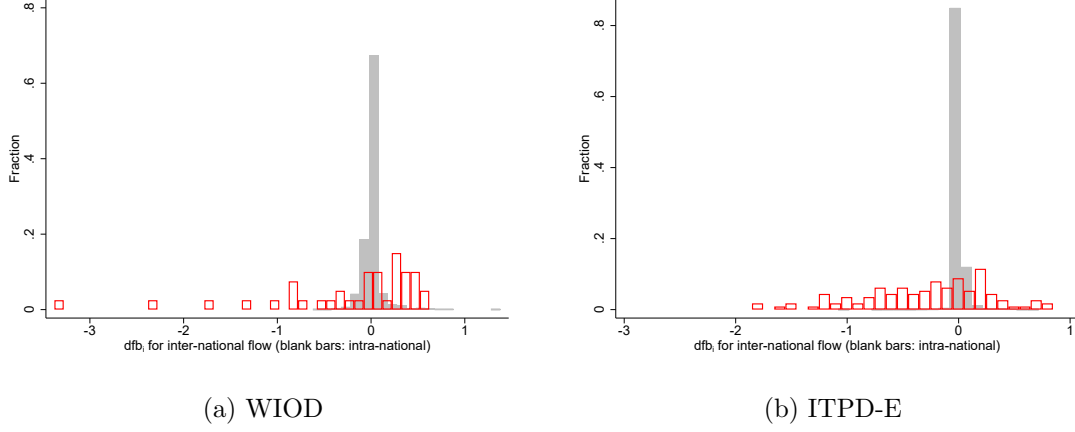


Figure 8: Distribution of dfb_i of intra-national flows in FK 2016 across data sets

Notes: The two panels show the distribution of the difference in the estimated β_i , scaled by standard errors (see (21)), when leaving out one ni observation. In red/blank: leaving an intra-national observation out ($n = i$), in grey/filled: leaving an international observation out.

With the ITPD-E data, the F-test of joint significance of the income elasticities again suggests that non-homotheticity is present in both the *FK 2016* and the *FLEX* versions of the model and we can extend the welfare analysis to this new data. We summarize the comparison between models and datasets in Table 5. We again consider the relative gains from trade at the 90th and at the 10th percentile. The first column shows the average of these relative gains across countries in the *FK2016* model. The first line restates the main result of Fajgelbaum and Khandelwal (2016), i.e. on average a pro-poor bias in international trade. The second line shows that this pro-poor bias is very much dampened in the ITPD-E data even if we focus only on the 40 WIOD countries as shown in the third line. The third column shows that in the *FLEX* model, the pro-poor bias is either 0 or very small on average regardless of the sample considered. While on average the welfare results in the *FK 2016* and *FLEX* specifications are similar in the ITPD-E data, the correlation of relative gains from trade is close to zero between the two models (last column). Cross-country variation in relative welfare is also lower in *FLEX* compared to *FK 2016*.

Table 5: Non-homothetic gains from trade: ITPD-E vs. WIOD

	FK 2016		FLEX		
	Mean	Strd. Dev.	Mean	Strd. Dev.	Correlation
WIOD	−0.017	0.019	0.000	0.011	0.410
ITPD	−0.003	0.022	−0.005	0.011	0.025
ITPD-40	−0.003	0.035	−0.004	0.012	−0.066

Notes: Summary statistics by and correlation across models of difference in gains from trade for 90th and 10th percentile. Row ITPD-40 reports results from ITPD-E data for 40 countries included in WIOD.

5.2 A multi-sector model

Our baseline setup, with only one sector, abstracts from potential differences in income elasticities across sectors. Fajgelbaum and Khandelwal (2016) find that such heterogeneity matters and reinforces the pro-poor effect of trade. To account for such effects, we extend our *FLEX* model to a multi-sector setting. The income elasticities β and taste parameters α may now vary across sectors. Formally, we assume that the taste parameter for goods from sector s , α_{ni}^s , is given by:

$$\alpha_{ni}^s = \begin{cases} \alpha_i(\alpha^s + \varepsilon_n^s) - \frac{\lambda_n^s}{N} & \text{if } n \neq i \\ \alpha_i(\alpha^s + \varepsilon_n^s) + \frac{N-1}{N}\lambda_n^s & \text{if } n = i \end{cases} \quad (32)$$

with λ_n^s indexing the degree of *sectoral* home bias specific to importer n . As shown in the appendix, plugging the above in the definition of A_{ni}^s , the sector-specific equivalent of (7), gives:

$$A_{ni}^s = \alpha_i \left[S_n^s - S_w^s - \bar{\beta}^s \Omega_n \right] + \sum_k \lambda_k^s K_{ni}^k \quad (33)$$

where K_{ni}^k is defined in (18), S_n^s and S_w^s are respectively the share of spending on s in country n and in the world, and:

$$\Lambda_n^s = \lambda_n^s - \sum_{n'} \frac{Y_{n'}}{Y_W} \lambda_{n'}^s, \quad \bar{\beta}^s \equiv \sum_i \beta_i^s \quad \text{and} \quad \sum_i \alpha_i = 1. \quad (34)$$

The parameter $\bar{\beta}^s$ is estimated from an Engel curve estimation at the country-sector level, that we take from Fajgelbaum and Khandelwal (2016). The estimating equation becomes:

$$\frac{X_{ni}^s}{Y_n} - \frac{Y_i^s}{Y_W} = \boldsymbol{\mu}^{s'} \mathbf{M}_{ni}^s + \beta_i^s \Omega_n + \epsilon_{ni}^s. \quad (35)$$

where the vector $\mathbf{M}_{ni}^s$ collects the trade cost and taste variables that now may vary across sectors. The constraints on β_i^s and α_i hold by construction.

As in our baseline estimation, the treatment of intra-national trade flows hugely matters for the gravity coefficients. In fact, if the price elasticity γ was allowed to vary across sectors, a few sectoral γ would turn negative. To avoid such a case, we constrain γ to be the same across sectors. This is in line with a specification in Fajgelbaum and Khandelwal (2016) that yields similar results to the case with sector-specific γ 's. In this case, the γ for each sector equals the γ of the single-sector model divided by the number of sectors. The discrepancy between the γ estimates in the *FK 2016* and *FLEX* thus remains the same as in the single-sector baseline.

The income elasticities still differ substantially between the *FLEX* and *FK 2016* models in the multi-sector setting. While the sector-specific $\bar{\beta}_s$ are by construction the same across models, the correlation of the estimated income elasticities β_i^s of the *FK 2016* and *FLEX* versions is 0.39.

We report the welfare gains from trade in the multi-sector model across percentiles of the income distribution in Figure 9, compared to those of the median household¹⁵. Panel (a) reports the results for the *FK 2016* model, panel (b) for the *FLEX* model. The shape of the figure in the *FLEX* model shows that trade effects are extremely penalizing for the richest households. In many countries, the richest households would need to receive several times their income in the trade situation to be as willing as the median household to maintain current levels of trade openness.

Adding a sector dimension gives an additional rationale for pro-poor effects of trade. In a multi-sector model, the third term in equation (29), which determines the slope of the welfare distribution, becomes (see appendix):

$$\hat{b}_n = \sum_s \frac{\bar{\beta}^s}{\gamma} dS_{nn}^s - \sum_s \sum_i \frac{\beta_i^s}{\gamma} dS_{ni}^s + \sum_{s=1}^S \sum_{i=1}^N \frac{\beta_i^s}{\gamma} (\beta_i^s - \beta_n^s) dy_n. \quad (36)$$

The first term in (36) is present only in the multi-sector case¹⁶ and characterizes the sector-composition of domestic spending. The second and third term are similar to the

¹⁵As in Fajgelbaum and Khandelwal (2016), the numerical solution for the welfare gains from trade does not converge for all percentiles of the income distribution in all countries. Due to the higher values of γ in *FLEX*, our quantification fails to converge in 275 of 3960 cases (99 percentiles times 40 countries), compared to 20 cases in *FK2016*. We only report results for which there is convergence in Figure 9.

¹⁶Note that $\bar{\beta}^s = 0$ in the single-sector model.

single-sector setting and capture the cross-country composition of expenditure (within sectors) and the change in income when moving to the counterfactual.

The first term in (36) is instrumental in explaining the large difference in the shape of the two panels in Figure 9. The income elasticity of each sector $\bar{\beta}^s$ is the same in *FK 2016* and *FLEX* but the price elasticity γ is around 12 times smaller in the *FLEX* version of the model. The first term thus becomes quantitatively much larger in the *FLEX* model, dominates any effect coming from the difference in β_i^s 's across exporters, and inflates $\hat{b}_n$ in the *FLEX* model. When moving from trade to autarky, $\hat{b}_n$ enters the welfare formula as a positive power over $x_h/\tilde{x}_n$, the income of a household divided by the adjusted average income. The large $\hat{b}_n$ of the *FLEX* model, combined with the fact that relative household income is smaller than one at the bottom of the income distribution and larger than one at the top, accounts for the shape observed in panel (b).

Overall, the treatment of domestic flows still hugely matters for the quantitative results in the multi-sector model by impacting the estimated γ , which takes on an even larger role than in the single-sector setting.

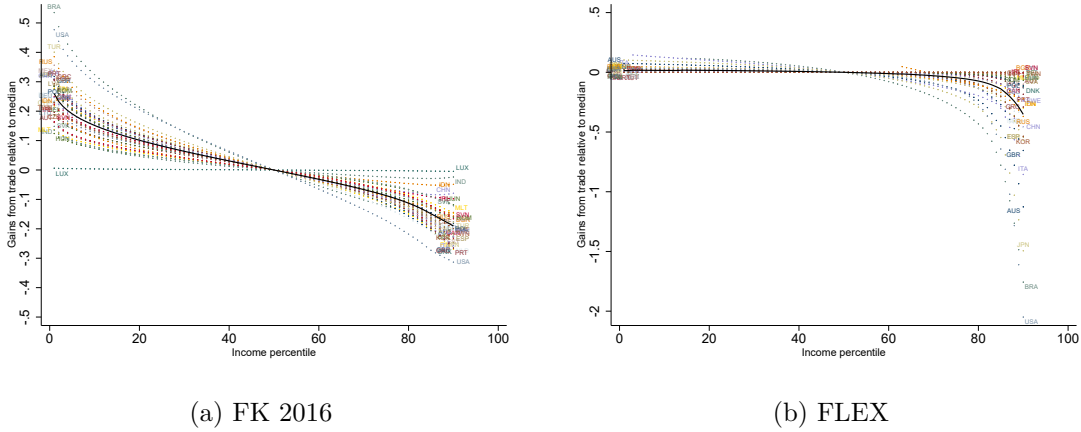


Figure 9: Distributional gains from trade in multi-sector setting

Notes: We report gains from trade up to the 90th percentile for readability. The welfare gain from trade for the 99th percentile in the US is below -100.

6 Conclusion

This paper revisits the welfare effects of trade across the income distribution when preferences are non-homothetic. We follow the approach of Fajgelbaum and Khan-

delwal (2016), who estimate a structural gravity equation based on an Almost Ideal Demand System using the World Input Output Database. In line with the theory, spending on domestic goods should be part of the gravity equation. We however show that the key parameter estimates are very sensitive to the way that we treat these domestic observations. We extend the framework of Fajgelbaum and Khandelwal (2016) to allow for additional determinants of a home bias in consumption, based on tastes or on more complex trade costs. These different assumptions effectively change the weight that intra-national flows carry in identifying the income elasticity of a country's products as well as the price elasticity.

The predictions about the distributional consequences of liberalizing trade are very sensitive to the exact model specification. They go from a pro-poor bias in Fajgelbaum and Khandelwal (2016) to a pro-rich bias, albeit small in magnitude, in the most flexible version featuring country-specific home bias in taste and complex trade costs for intra- and international flows. Additional analyses confirm the difficulty to reach a robust conclusion. Overall, we find that gravity models based on AIDS (or translog) preferences, when estimated with data including observations on domestic trade, should be interpreted with caution and their conclusions tested under different modeling structures.

Finally, the same caveats that apply to the analysis of Fajgelbaum and Khandelwal (2016) also apply to our work in that we do not account for the inter-sectoral linkages and income effects of trade liberalization which would be needed for a more comprehensive assessment of the welfare gains from trade. Including them would however go beyond the scope of this paper.

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Appendices

A Almost Ideal Demand System

Preferences are defined by the indirect utility function

$$v(x_h, \mathbf{p}) = F \left[\left(\frac{x_h}{a(\mathbf{p})} \right)^{\frac{1}{b(\mathbf{p})}} \right] \quad (37)$$

where the price aggregators $a(\mathbf{p})$ and $b(\mathbf{p})$ are defined by

$$a(\mathbf{p}) = \exp \left(\alpha + \sum_{j=1}^J \alpha_j \ln(p_j) + \frac{1}{2} \sum_{j=1}^J \sum_{k=1}^J \gamma_{jk} \ln(p_j) \ln(p_k) \right) \quad (38)$$

and

$$b(\mathbf{p}) = \exp \left(\sum_{j=1}^J \beta_j \ln(p_j) \right). \quad (39)$$

Applying Shephard's lemma, the expenditure share in good j for consumer h is given by

$$s_j(\mathbf{p}, x_h) = \alpha_j + \sum_{k=1}^J \gamma_{jk} \ln(p_k) + \beta_j \ln \left(\frac{x_h}{a(\mathbf{p})} \right) \quad (40)$$

for $j = 1, \dots, J$.

Fajgelbaum and Khandelwal (2016) parameterize the price semi-elasticities γ_{jk} as follows:

$$\gamma_{jk} = \begin{cases} - \left(1 - \frac{1}{N} \right) \gamma & \text{if } j = k \\ \frac{\gamma}{N} & \text{if } j \neq k. \end{cases}$$

B Derivation of equation (15)

Demeaning the different components of the trade costs as in (8), we obtain

$$\begin{aligned} \ln(t_{ni}) - \frac{1}{N} \sum_{i'=1}^N \ln(t_{ni'}) &= \rho \left(\ln(d_{ni}) - \frac{1}{N} \sum_{i'=1}^N \ln(d_{ni'}) \right) \\ &+ \begin{cases} \frac{1}{N} \left(-\tilde{\phi} - \tilde{\rho} \ln(d_{nn}) \right) & \text{if } i \neq n \\ \frac{N-1}{N} \left(\tilde{\phi} + \tilde{\rho} \ln(d_{nn}) \right) & \text{if } i = n \end{cases} \end{aligned} \quad (41)$$

and

$$\begin{aligned} \sum_{n'=1}^N \frac{Y_{n'}}{Y_W} \left(\ln(t_{n'i}) - \frac{1}{N} \sum_{i'=1}^N \ln(t_{n'i'}) \right) &= \rho \sum_{n'=1}^N \frac{Y_{n'}}{Y_W} \left(\ln(d_{n'i}) - \frac{1}{N} \sum_{i'=1}^N \ln(d_{n'i'}) \right) \\ &- \frac{\tilde{\phi}}{N} \left(1 - N \frac{Y_i}{Y_W} \right) \\ &+ \tilde{\rho} \left[\frac{Y_i}{Y_W} \ln(d_{ii}) - \frac{1}{N} \sum_{n'=1}^N \frac{Y_{n'}}{Y_W} \ln(d_{n'n'}) \right] \end{aligned} \quad (42)$$

Plugging back in the definition of T_{ni} in (8), using (13) and rearranging gives (15).

C Derivation of equations in multi-sector setting

To arrive at equation (33), note that $\sum_i \alpha_i = 1$ such that the sectoral expenditure equation is

$$S_n^s = \sum_i \frac{X_{ni}^s}{Y_n^s} = \alpha^s + \bar{\beta}^s y_n + \varepsilon_n^s, \quad (43)$$

where $\bar{\beta}^s \equiv \sum_i \beta_i^s$. Rearrange equation (43) and replace $\alpha^s + \varepsilon_n^s$ in equation (32). Then, plug the resulting expression into equation (7), the counterpart in the single sector setting to the definition of A_{ni}^s , which gives:

$$A_{ni}^s = \alpha_i \left[S_n^s - S_w^s - \bar{\beta}^s \Omega_n \right] + \lambda_i^s G_{D,ni} - \frac{1}{N} \Lambda_n^s. \quad (44)$$

By the definition of K_{ni}^k in (18), we can rewrite the above as:

$$A_{ni}^s = \alpha_i \left[S_n^s - S_w^s - \bar{\beta}^s \Omega_n \right] + \sum_k \lambda_k^s K_{ni}^k. \quad (45)$$

The gravity equation thus boils down to:

$$\frac{X_{ni}^s}{Y_n^s} - \frac{Y_i^s}{Y_W^s} = \boldsymbol{\mu}^{s'} \mathbf{M}_{ni}^s - \gamma \rho D_{ni} + \beta_i^s \Omega_n + \epsilon_{ni}^s \quad (46)$$

where $\mathbf{M}_{ni}^s$ consists of the two gravity dummies $G_{j,ni}$, interactions of a dummy for each exporter i with $(S_n^s - S_w^s - \bar{\beta}^s \Omega_n)$, and the 40 K_{ni}^k .

The term b_n in equation (36) is given by equation (35) in Fajgelbaum and Khandelwal (2016) and is the multisector counterpart of the square bracket in (29):

$$b_n = \sum_{s=1}^S \sum_{i=1}^N \frac{\beta_i^s}{\gamma} (dS_{nn}^s - dS_{ni}^s + (\beta_i^s - \beta_n^s) dy_n). \quad (47)$$

Noting that $\sum_i dS_{ni}^s = dS_n^s$ immediately gives (36).

D A simple comparison of AIDS gravity with a standard gravity

We contrast estimates from a standard gravity equation with results from modified versions of the standard model in line with the three central deviations of AIDS listed in the main text. The specific focus of this exercise is the impact of the inclusion of data on intra-national expenditure. To this end, we estimate each model on a sample

of international trade data first. We then include intra-national expenditure data and re-estimate the model. In a third regression, we add a control variable to account for the inclusion of intra-national data.¹⁷

The standard gravity model is of the following form,

$$\ln(X_{ni}) = \gamma^{std} \ln(dist_{ni}) + \sum_k \delta_k^{std} g_{ni,k} + \kappa_n + \xi_i + \varepsilon_{ni}, \quad (48)$$

where $g_{ni,k}$ are dummy variables indicating a common border or common language of the trade partners, κ_n and ξ_i are importer and exporter fixed effects, respectively, and ε_{ni} is an error term with mean zero. We estimate the model with Least Squares Dummy Variables.

Table 6 presents the results. In columns 1 to 3 of Panel A, the estimates obtained from the standard gravity estimation are presented. We note that the distance elasticity is qualitatively unchanged in the three specifications. The coefficients on the gravity dummies are more sensitive to the inclusion of domestic expenditure observations. In column 3 we explicitly control for domestic trade observations by adding an intra-national dummy and allow for different sensitivity of intra-national flows to distance. Explicitly controlling for domestic flows (column 3) moves all coefficients towards the values of the regression on the international expenditure data of column 1. The R squared is similarly high in all three regressions and lies between 0.86 and 0.9.

Columns 3 to 6 in Panel A present the results from the first modification of the standard gravity model. We add destination per capita income (in logs) interacted with exporter dummies to the set of regressors. The coefficients on distance, common border and common language are very close to the once from the standard gravity model and so is the R squared.

In Panel B, at the bottom of Table 6, we present the results from the remaining two modifications. First, in columns 1 to 3 we regress the share of trade flows - rather than the logarithm - on the set of trade cost proxies and fixed effects. While the sign and significance of the standard gravity estimates are preserved, the magnitude differs markedly¹⁸. More importantly, including data on domestic expenditure raises

¹⁷This exercise is related to Novy (2013). However, Novy (2013) does not include or discuss the implications of observations on domestic expenditure for the predictive power of a CES- relative to a translog-gravity model.

¹⁸In fairness, to compare the estimates from columns 1-3 of Panel B to the distance elasticities from

the coefficient by two thirds in absolute value, but controlling for intra-national trade flows lowers the coefficient by an order of magnitude. Extending the sample to include intra-national expenditure data lowers the R squared from 0.64 to 0.46. Adding the additional control variable, however, raises the R squared to almost 1. In contrast to the standard gravity, controlling for intra-national flows with exporter-specific intra-national dummies does not move the coefficient on distance back towards the value obtained in the international trade sample.

Lastly, columns 4 to 6 of Panel B in Table 6 demonstrate the impact of the different scaling implied by the AIDS model. We maintain the exporter fixed effects, but demean only the right-hand side variables with importer fixed effects. The R square is clearly lower compared to the standard model. The coefficients however are almost not affected by this change.

columns 1-3 of Panel A, we would need to multiply by the estimates by the trade share. Albeit, for the welfare calculation no such transformation takes place.

Table 6: Benchmarking AIDS

Panel A	Standard			Non-homothetic		
	(1)	(2)	(3)	(4)	(5)	(6)
Log distance	-1.164*** (-33.33)	-1.297*** (-35.83)	-1.136*** (-33.08)	-1.205*** (-33.33)	-1.334*** (-35.85)	-1.169*** (-33.03)
Common Border	0.384*** (4.21)	0.794*** (7.96)	0.406*** (4.36)	0.423*** (4.64)	0.819*** (8.20)	0.448*** (4.81)
Common Language	0.342*** (3.96)	0.948*** (10.51)	0.382*** (4.35)	0.333*** (3.85)	0.941*** (10.46)	0.385*** (4.39)
Dummy intranat.			1.701*** (2.90)			1.497** (2.55)
Dummy intranat. $\times$ Log dist.			0.209** (2.03)			0.235** (2.27)
Constant	5.161*** (14.61)	3.758*** (10.10)	0.881** (2.52)	7.110*** (3.93)	3.841** (2.07)	0.233 (0.14)
Dummies destination	Yes	Yes	Yes	Yes	Yes	Yes
Dummies origin	Yes	Yes	Yes	Yes	Yes	Yes
Destination inc. p.c.	No	No	No	Yes	Yes	Yes
Observations	1560	1600	1600	1560	1600	1600
Adjusted R^2	0.859	0.871	0.894	0.863	0.875	0.897

Panel B	Share-log			Fixed effects		
	(1)	(2)	(3)	(4)	(5)	(6)
Log distance	-0.030*** (-20.46)	-0.050*** (-11.61)	-0.005*** (-10.41)	-1.184*** (-30.54)	-1.297*** (-26.64)	-1.136*** (-23.43)
Common Border	0.037*** (9.73)	0.118*** (10.03)	0.010*** (6.87)	0.372*** (3.67)	0.794*** (5.92)	0.406*** (3.09)
Common Language	0.014*** (3.83)	0.159*** (14.95)	0.002* (1.70)	0.326*** (3.38)	0.948*** (7.81)	0.382*** (3.08)
Dummy intranat.			0.396*** (44.21)			1.701** (2.05)
Dummy intranat. $\times$ Log dist.			0.072*** (45.47)			0.209 (1.44)
Constant	0.278*** (18.93)	0.431*** (9.82)	0.043*** (8.05)	0.095*** (4.76)	-0.000 (-0.00)	-0.000 (-0.00)
Dummies destination	Yes	Yes	Yes	RHS	RHS	RHS
Dummies origin	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1560	1600	1600	1560	1600	1600
Adjusted R^2	0.638	0.465	0.993	0.479	0.570	0.610

Notes: t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

E Tables

Table 7: Full gravity estimation results with WIOD data

	FK 2016	Constant home bias	Complex trade costs	FLEX		FK 2016	Constant home bias	Complex trade costs	FLEX
Distance _{ni}	-0.0427*** (0.0045)	-0.0031** (0.0011)	-0.0048*** (0.0007)	-0.0038*** (0.0006)					
Language _{ni}	0.1310*** (0.0213)	-0.0002 (0.0033)	0.0006 (0.0025)	0.0014 (0.0017)					
Contiguity _{ni}	0.1346*** (0.0226)	0.0131*** (0.0032)	0.0103*** (0.0025)	0.0103*** (0.0024)					
Dummy domestic trade		0.7969*** (0.0147)	0.4050*** (0.0460)						
Domestic distance			0.0700*** (0.0077)						
β_{AUS}	0.0114 (0.0115)	0.0017 (0.0011)	0.0003 (0.0004)	-0.0001 (0.0003)	β_{IRL}	-0.0090 (0.0133)	-0.0034 (0.0034)	-0.0026 (0.0019)	-0.0007 (0.0004)
β_{AUT}	-0.0007 (0.0088)	-0.0016 (0.0009)	-0.0016** (0.0005)	-0.0016** (0.0006)	β_{ITA}	0.0058 (0.0064)	0.0017 (0.0018)	0.0007 (0.0014)	0.0001 (0.0014)
β_{BEL}	-0.0247* (0.0109)	-0.0004 (0.0033)	0.0008 (0.0023)	0.0011 (0.0021)	β_{JPN}	0.0278*** (0.0077)	0.0038* (0.0017)	0.0029 (0.0015)	-0.0002 (0.0006)
β_{BGR}	0.0042 (0.0162)	0.0029 (0.0022)	0.0017 (0.0016)	0.0002 (0.0008)	β_{KOR}	0.0056 (0.0116)	0.0002 (0.0005)	0.0003 (0.0006)	-0.0008 (0.0005)
β_{BRA}	-0.0102 (0.0167)	-0.0032 (0.0041)	-0.0011 (0.0011)	-0.0004 (0.0004)	β_{LTU}	0.0038 (0.0099)	0.0023 (0.0020)	0.0007 (0.0012)	-0.0003 (0.0007)
β_{CAN}	-0.0173 (0.0149)	0.0001 (0.0006)	-0.0016 (0.0008)	-0.0007* (0.0003)	β_{LUX}	-0.0124 (0.0065)	-0.0150 (0.0136)	-0.0080 (0.0058)	-0.0016** (0.0006)
β_{CHN}	0.0079 (0.0307)	-0.0017 (0.0051)	0.0007 (0.0010)	0.0004 (0.0007)	β_{LVA}	0.0058 (0.0090)	0.0011 (0.0008)	-0.0002 (0.0007)	-0.0002 (0.0007)
β_{CYP}	0.0158* (0.0076)	0.0008* (0.0003)	0.0003 (0.0006)	0.0002 (0.0006)	β_{MEX}	-0.0285 (0.0172)	-0.0011 (0.0011)	-0.0002 (0.0009)	-0.0010* (0.0004)
β_{CZE}	-0.0033 (0.0056)	-0.0009 (0.0007)	-0.0016* (0.0008)	-0.0017* (0.0008)	β_{MLT}	-0.0060 (0.0097)	-0.0002 (0.0005)	-0.0003 (0.0004)	-0.0006 (0.0005)
β_{DEU}	-0.0145 (0.0131)	0.0006 (0.0030)	-0.0001 (0.0028)	0.0008 (0.0025)	β_{NLD}	-0.0080 (0.0094)	0.0006 (0.0014)	0.0013 (0.0011)	0.0006 (0.0008)
β_{DNK}	0.0028 (0.0089)	-0.0011 (0.0009)	-0.0006 (0.0005)	-0.0009 (0.0006)	β_{POL}	-0.0013 (0.0111)	-0.0006 (0.0008)	-0.0014 (0.0007)	-0.0013 (0.0007)
β_{ESP}	-0.0041 (0.0062)	0.0020 (0.0010)	0.0009 (0.0007)	0.0007 (0.0006)	β_{PRT}	-0.0007 (0.0052)	-0.0002 (0.0003)	-0.0009* (0.0004)	-0.0008 (0.0005)
β_{EST}	0.0066 (0.0069)	0.0009 (0.0007)	-0.0000 (0.0006)	-0.0004 (0.0006)	β_{ROM}	0.0031 (0.0155)	0.0008 (0.0005)	0.0003 (0.0006)	-0.0000 (0.0007)
β_{FIN}	0.0130 (0.0100)	0.0002 (0.0005)	0.0001 (0.0006)	-0.0005 (0.0006)	β_{RUS}	-0.0029 (0.0224)	-0.0040 (0.0039)	-0.0012 (0.0017)	-0.0021 (0.0017)
β_{FRA}	-0.0131 (0.0110)	0.0021 (0.0011)	0.0010 (0.0007)	0.0005 (0.0006)	β_{SVK}	0.0052 (0.0099)	0.0016 (0.0017)	0.0006 (0.0013)	-0.0006 (0.0007)
β_{GBR}	0.0052 (0.0130)	0.0102 (0.0059)	0.0097 (0.0054)	0.0086 (0.0056)	β_{SVN}	-0.0021 (0.0048)	-0.0008 (0.0004)	-0.0010 (0.0006)	-0.0011 (0.0007)
β_{GRC}	0.0176 (0.0090)	0.0009 (0.0005)	0.0007 (0.0007)	0.0002 (0.0007)	β_{SWE}	0.0058 (0.0077)	0.0004 (0.0007)	-0.0002 (0.0005)	0.0000 (0.0006)
β_{HUN}	0.0080 (0.0120)	0.0015 (0.0016)	0.0004 (0.0012)	-0.0006 (0.0007)	β_{TUR}	0.0056 (0.0164)	-0.0016 (0.0022)	-0.0011 (0.0014)	-0.0003 (0.0006)
β_{IDN}	-0.0232 (0.0318)	-0.0060 (0.0062)	-0.0014 (0.0019)	0.0002 (0.0004)	β_{TWN}	0.0171 (0.0107)	0.0005 (0.0004)	0.0004 (0.0005)	0.0001 (0.0005)
β_{IND}	-0.0480 (0.0424)	-0.0080 (0.0083)	-0.0019 (0.0030)	0.0010 (0.0008)	β_{USA}	0.0520* (0.0216)	0.0131** (0.0041)	0.0031 (0.0021)	0.0036 (0.0018)
Country-specific home bias	No	No	No	Yes	Country-specific home bias	No	No	No	Yes
Strd. Dev. β_i	0.016	0.004	0.002	0.002					
p-value of F-test	0.00	0.00	0.00	0.00					
aic	-2792	-8341	-9778	-10931					
bic	-2582	-8131	-9568	-10721					

Notes: The table presents results of estimating four different versions of equation (19) on WIOD data. Standard errors are clustered by importer and reported in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 8: Correlation of β_i with exporter per capita income

	FK 2016	Constant home bias	Complex trade costs	FLEX
ln(GDP per capita _o)	0.0080*** (0.0005)	0.0014*** (0.0001)	0.0001 (0.0001)	0.0002** (0.0001)
Constant	-0.0797*** (0.0055)	-0.0143*** (0.0015)	-0.0014 (0.0008)	-0.0018** (0.0006)
Observations	1600	1600	1600	1600

Notes: Standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Income elasticities estimated on WIOD.

Table 9: Gravity estimation results with ITPD-E data

	FK 2016	Constant home bias	Complex trade costs	FLEX
Distance _{ni}	−0.0135*** (0.0013)	−0.0011 (0.0006)	−0.0026*** (0.0005)	−0.0039*** (0.0004)
Language _{ni}	0.0268*** (0.0045)	0.0063*** (0.0016)	0.0057*** (0.0015)	0.0046*** (0.0011)
Contiguity _{ni}	0.1239*** (0.0083)	0.0213*** (0.0033)	0.0191*** (0.0033)	0.0176*** (0.0033)
Dummy domestic trade		0.5191*** (0.0241)	0.1303 (0.1009)	
Domestic distance			0.0725*** (0.0180)	
Non-homothetic term	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>	<i>Yes</i>
Country-specific home bias	<i>No</i>	<i>No</i>	<i>No</i>	<i>Yes</i>
Strd. Dev. β_i	0.005	0.002	0.002	0.002
p-value of F-test	0.00	0.00	0.00	0.00
aic	−40296	−55610	−56458	−72457
bic	−39461	−54775	−55623	−71622

Notes: Standard errors clustered by importer in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Data: ITPD-E.

Table 10: Loss from autarky in a translog model

Country	Herfindahl	Dom. share (%)	model to estimate γ			
			FK 2016	Constant	Complex	FLEX
				home bias	trade costs	
LUX	.29	.51	43	100	99.3	99.8
MLT	.45	.66	23.7	97.5	90.9	95.3
IRL	.49	.68	22	96.7	89	94
HUN	.49	.69	20.1	95.4	86.4	92.1
SVK	.5	.7	18.8	94.3	84.3	90.5
BEL	.53	.72	16.4	91.4	79.5	86.7
EST	.54	.73	14.8	88.9	76	83.7
LTU	.54	.73	15.8	90.6	78.4	85.7
SVN	.54	.73	16.1	91	79.1	86.3
CZE	.56	.74	14.2	87.8	74.5	82.4
BGR	.57	.75	12.5	84	69.5	77.9
AUT	.61	.77	12.3	83.4	68.8	77.2
CYP	.61	.78	10.1	76.8	61.2	70
DNK	.62	.78	10.3	77.5	62	70.7
LVA	.61	.78	10.6	78.5	63.1	71.8
NLD	.62	.79	9.9	76.2	60.6	69.4
TWN	.64	.8	9.4	74.1	58.4	67.2
ROM	.66	.81	7.9	67.5	51.8	60.4
SWE	.65	.81	8	67.9	52.1	60.8
POL	.68	.82	7.1	63.3	47.8	56.2
DEU	.69	.83	6.1	57.6	42.7	50.7
FIN	.68	.83	6.5	60.1	44.9	53.1
PRT	.7	.83	6.5	60.4	45.1	53.4
CAN	.71	.84	6.9	62.6	47.2	55.6
GRC	.72	.85	5.2	51.9	37.8	45.3
MEX	.74	.86	5.2	52.1	38	45.5
ESP	.77	.88	3.5	38.3	26.8	32.8
FRA	.78	.88	3	34	23.6	29
GBR	.78	.88	3.1	35.1	24.4	29.9
KOR	.79	.89	3	34.2	23.8	29.2
ITA	.8	.9	2.4	28.8	19.8	24.4
TUR	.82	.9	2.1	25.1	17.1	21.2
RUS	.83	.91	1.9	22.6	15.3	19
AUS	.85	.92	1.4	17.5	11.7	14.6
IDN	.85	.92	1.4	17.4	11.7	14.6
CHN	.86	.93	1.1	14.7	9.8	12.2
IND	.88	.94	.8	10.6	7	8.9
USA	.88	.94	.8	10.9	7.2	9.1
JPN	.91	.95	.5	6.5	4.2	5.3
BRA	.92	.96	.4	5.4	3.5	4.5

Notes: Welfare gains from trade by model specification calculated according to equation (31).

Table 11: The relative loss from autarky of 90th to 10th percentile

Country	FK 2016	Constant home bias	Complex trade costs	FLEX
AUS	-.018	-.025	-.001	.003
AUT	-.017	-.004	.003	.004
BEL	.013	-.006	-.002	-.002
BGR	-.028	-.02	-.01	-.002
BRA	-.015	-.022	-.002	.002
CAN	.019	.018	.014	.013
CHN	-.023	-.011	-.005	-.003
CYP	-.034	-.011	.002	.003
CZE	-.012	-.005	.003	.004
DEU	-.001	-.018	.001	-.003
DNK	-.019	-.006	.002	.005
ESP	-.012	-.03	-.006	-.003
EST	-.034	-.012	-.003	0
FIN	-.029	-.019	-.002	.002
FRA	-.003	-.025	-.004	0
GBR	-.022	-.096	-.055	-.053
GRC	-.038	-.024	-.005	0
HUN	-.031	-.006	-.003	0
IDN	0	.02	.006	-.001
IND	.01	.022	.005	-.003
IRL	.005	.006	.012	.006
ITA	-.02	-.031	-.006	.001
JPN	-.023	-.031	-.008	.002
KOR	-.016	-.013	.001	.007
LTU	-.03	-.014	-.007	-.002
LUX	-.001	.001	.003	0
LVA	-.03	-.018	-.003	-.002
MEX	.024	.028	.009	.023
MLT	-.005	-.002	.002	.001
NLD	-.009	-.011	-.003	.001
POL	-.02	-.014	.005	.007
PRT	-.021	-.012	.004	.007
ROM	-.027	-.023	-.006	-.002
RUS	-.019	.004	.003	.015
SVK	-.023	-.006	-.004	-.001
SVN	-.013	-.004	.001	.001
SWE	-.018	-.013	.001	.001
TUR	-.03	-.02	.002	.001
TWN	-.034	-.009	.002	.001
USA	-.09	-.152	-.022	-.024

Notes: Difference in welfare gains from trade of 90th to 10th percentile by model.

F Data

Table 12: Data sources

Variable	Data source	Note
trade data	WIOD Release 2013	Average flows between 2005-2007. Total expenditure data.
distance	CEPII	
common official language	CEPII	
dummy		
shared border dummy	CEPII	
GDP per capita	Penn World Tables	
prices	Feenstra and Romalis (2014)	
Gini	World Income Inequality Database Version 2.0 (UNU - WIDER)	Average Gini using all available data 2001-2006.