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GRAVITY AND TRADE PARTNER INEQUALITY

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Abstract

The paper analyzes the effects of trade on income per capita and trade partner income per capita inequality, using a gravity dataset covering 128 exporters and 126 importers over the years 1982-2000. For analyzing income per capita, the trade instrument is constructed by aggregating predicted bilateral trade shares (bilateral trade as % of GDP) across the trading partners. The results show a negative average effect of import share (imports as % of GDP) on income per capita, and a positive average effect of export share (exports as % of GDP) on income per capita. The results also indicate that the differential effects of trade on income per capita have been more favorable to the more developed countries, for both the import share and the export share. The results are robust with the inclusion of geographical and institutional controls. Next, the paper extends the gravity analysis of trade, and models trade partner income per capita inequality as a function of bilateral trade and country-pair characteristics, by instrumenting bilateral trade with predicted bilateral trade shares. Trade partner inequality is measured with the Theil's L Index, as well as with the Range for robustness. The results show that bilateral trade has on average increased the income per capita inequality between the trading partners.

Keywords: Trade; Exports; Imports; Gravity; Income; Inequality; Differential Effects; OLS; IV

INTRODUCTION

This paper is an empirical gravity analysis of trade's impacts on income per capita and income per capita inequality between trading partners. The foundation of the gravity equation is rooted in the field of physics. Its application to social sciences can be traced back to Carey

(1865) who analyzed migration flows. The popularity of the gravity equation within "social physics" is largely attributed to Stewart (1948), with an analysis of demographic gravitation. Subsequent works of Isard (1954), Savage & Deutsch (1960), Tinbergen (1962), Anderson (1979), and Bergstrand (1985) promoted the use of gravity in the analysis of trade.

The paper will also use the gravity model to instrument for trade and model trade's effect on income per capita, similarly to Frankel & Romer (1999) who use cross-sectional data, and to Feyrer (2009) who uses panel data. I will first review the relevant literature dealing with the effect of trade on income per capita. The focus in the literature tends to be on the effect of trade share (exports plus imports as % of GDP) on income per capita, with a general assumption that a higher trade share on average raises the income per capita and lifts people out of poverty. However, it is important to recognize that trade may not necessarily make everyone better off. Trade can benefit some much more than others, and it can even raise the welfare of some while lowering the welfare of others (Stiglitz, 2006). The trade-induced inequality can occur within countries (intranational inequality), between countries (international inequality), and between trading partners (trade partner inequality). Furthermore, the effects of trade on welfare can differ significantly for imports and exports. In this paper, using panel gravity analysis, I analyze the effects of the import share and the export share on income per capita, as well as the effects of the bilateral import share on income per capita inequality between trading partners.

This paper's analysis of trade's effects on income per capita is a contribution to the existing studies that build a gravity-based instrument for trade to deal with the endogeneity of trade's impact on income per capita. It is important to instrument for trade when modeling its effects on income per capita, due to the endogeneity arising from higher income per capita leading to higher trade. The gravity approach, based on the country's geographical attributes and relationships with trading partners, provides an instrument to identify the impact of trade on incomes. Unlike the previous cross-sectional studies (Frankel & Romer, 1999; Irwin & Terviö, 2002; Noguer & Siscart, 2005), I use panel data and control for country and time heterogeneity (using country and time fixed effects), which allows for a more precise estimate of the effect of trade on income per capita. Furthermore, in building the gravity-based instrument, I include dummies for common language, colonial link, and GATT/WTO membership, in addition to the other commonly used gravity variables (populations, areas, distance, and common border). Another contribution of my estimations in the first part of the paper is that I decompose trade into imports and exports. The existing studies focus on the effect of the trade share (exports plus imports as % of GDP) on income per capita, while I consider the import share (imports as % of GDP) and the export share (exports as % of GDP) to see the effects of the different types of trade. I also involve interactions of trade with development dummies to test for potential differential effects of trade. This goes beyond looking at the average effects of trade and acknowledges that the effects may differ for different levels of development. I also test the robustness of my estimations with the inclusion of additional geographical and institutional controls, such as latitude, tropical exposure, and International Country Risk Guide (ICRG) Index. Then I extend the gravity-based analysis to model the effects of trade on income per capita inequality between trading partners.

To conduct the empirical study, I augment the large Dutt & Traca (2010) dataset with data on import shares, export shares, populations, areas, and GDP per capita values, from the World Development Indicators (WDI) Database (The World Bank, 2013). This results in 207,156 country-pair observations, covering 128 exporters and 126 importers, for years 1982-2000. After constructing a trade instrument based on a panel gravity dataset, I find that on average the effect of the import share on income per capita has been negative, while the effect of the export share has been positive. With both trade measures, the differential effects of trade on income per capita have been more favorable to the more developed countries. Furthermore, I find evidence that trade has increased the inequality between trading partners. These findings contribute to the literature by showing that: exports and imports can have different effects on income per capita; effects of trade can differ across different levels of development; and trade can increase the income per capita inequality between trading partners.

BACKGROUND

The relevant empirical gravity literature has been extensive, mostly focusing on cross-sectional analysis, with a more recent focus on panel analysis. In a key analysis of the effect of trade on income per capita, Frankel & Romer (1999) stress the importance of geographical characteristics. They use a constructed trade share in place of the actual trade share, along with population and area, to explain income per capita. They find that the positive (though not very significant) effect of the constructed trade share on income per capita from using instrumental variable (IV) regressions is larger than the (significant) effect of the trade share when using ordinary least squares (OLS), highlighting the downward bias of OLS.

Irwin & Terviö (2002) apply the methodology of Frankel & Romer (1999) without the use of interaction terms. Furthermore, they apply two stage least squares (2SLS), for several years. Namely, they add the additional step of first regressing the actual trade share on the constructed trade share, the population, and the area. Then the predicted values are used in the second stage regression to represent the trade shares, which along with population and area, are used to explain income per capita. They find that the positive effect of the trade share from the 2SLS regressions is also generally larger than the effect from the OLS regressions (even more than the effect from the Frankel-Romer IV regressions).

To examine and question the precision of previous results, Noguer & Siscart (2005) apply the methodology of Frankel & Romer (1999), building on the earlier contributions of Irwin & Terviö (2002). They use a fuller (cross-sectional) dataset to find a more statistically significant positive effect of the constructed trade share on income per capita. They also find that the magnitude of the effect decreases with the inclusion of latitude (while still remaining bigger than the OLS effect).

Feyrer (2009) proposes a time-variant instrument, along with country and time fixed effects. This reduces the bias from time-invariant variables such as latitude and historically determined institutions. He involves distance by air and distance by sea, with the motivation of creating a better instrument and eliminating the bias from the static geographic and institutional factors found in Frankel & Romer (1999). After using the predicted level of trade as an instrument for trade, he also finds that the positive effect of trade on income per capita is bigger in the IV regression than in the OLS regression.

Adding the time dimension within the gravity framework enriches the analysis. In doing so, Mátyás (1997) uses country and time specific effects, stressing the importance of recognizing the unobserved heterogeneity, as well as the time effects among countries. Egger & Pfaffermayr (2003) also use country and time effects, along with country-pair effects, noting their significance. Cheng & Wall (2005) demonstrate how cross-sectional analysis ignores important unobserved country heterogeneity and leads to biased results. They encourage the use of country and time fixed effects. Fidrmuc (2009) looks at a sample of OECD countries (for 1980-2002), using country-pair effects, showing that the fixed effects models perform relatively well (in comparison to panel cointegration techniques), given the non-stationarity in bilateral trade and output. Also, fixed effects models help lower the bias of the effect of trade on income per capita by controlling for unobserved influences on income per capita (Baier & Bergstrand, 2007).

I contribute to the existing literature in several ways. First, I develop a more informative instrument for measuring the effect of trade on income per capita. It is more informative because it uses more observations than previous studies (using a panel dataset), and because the estimations control for unobserved heterogeneity (using fixed effects). The instrument is designed using the standard gravity variables of distance and size (population and area). Instead of relying heavily on the contiguity dummy, I include dummies for common language, colonial link, and GATT/WTO membership. The additional exogenous variables are relevant in predicting trade between trading partners, as also found by Dutt & Traca (2010), and they allow for the IV regressions to more precisely estimate the effect of trade on income per capita. Moreover, I decompose the effect of trade by estimating the effects of the import share and the effects of the export share on income per capita, while recognizing potential differential effects. I find that on average the effect of the import share on income per capita has been negative, while the effect of the export share has been positive. Also, unlike the previous studies, I include development dummies and reveal that the differential effects of trade have been skewed in favor of more developed countries. I provide a novel approach to the gravity model, by estimating the income per capita inequality between trading partners. I find that trade has increased the income per capita inequality between trading partners. This paper serves as a contribution to the discussions of the benefits and costs of trade, and the implications of trade on the inequality between nations.

FRAMEWORK

The paper builds on the Frankel & Romer (1999) empirical methodology, which preceded a theoretical framework developed by Anderson & van Wincoop (2003). To make an appropriate econometric specification, it is important to consider the available data and the purpose of the analysis (Head & Mayer, 2015). Following the empirical literature, such as Noguer & Siscart (2005), I omit income variables when predicting trade, mainly due to the strong endogeneity and the form of the dependent variable. The main trade variable I use is the imports of country i from country j as share of country i's GDP (denoted by T_{ijt}). To provide a deeper analysis of the effects of trade on income per capita, I also consider the effect of exports, by expressing X_{jit} as the exports of country j to country i as share of country j's GDP.

When estimating trade, I include variables which directly influence trade flows, in the spirit of gravity. Namely, I relate the trade variable to the populations of the trading partners (N_{it},N_{jt}), their areas (A_i,A_j), and their country-pair vector of variables (Z_{ijt}). The country-pair vector of variables includes: trade partner distance, a language dummy, a common border dummy, a colonial dummy, and a GATT/WTO membership dummy. Distance is a common determinant of trade, as higher distance puts downward pressure on trade between countries (Disdier & Head, 2008). The dummy variables capture the differences in predicted trade between having the common characteristics and not having them.

The use of fixed effects complements the framework to suit the purpose and consistency of the estimation (Head & Mayer, 2015). The trade specification expressed in (1) includes country fixed effects (γ_i, λ_j) and time fixed effects (δ_t), to control for the unobserved heterogeneity (correlated with the explanatory variables), and to be consistent with the subsequent income per capita specification in (3).

$$\ln(T_{ijt}) = \theta_0 + \theta_1\ln(N_{it}) + \theta_2\ln(N_{jt}) + \theta_3\ln(A_i) + \theta_4\ln(A_j) + \theta_5 Z_{ijt} + \gamma_i + \lambda_j + \delta_t + w_{ijt} \quad (1)$$

The country fixed effects help control for the multilateral trade resistance terms (Rose & van Wincoop, 2001). The time fixed effects provide controls for cyclical changes, thus minimizing the bias of the results (Baldwin & Taglioni, 2006). Also, I consider country interactions with time fixed effects ($\gamma_i\delta_t$, $\lambda_j\delta_t$). These additional fixed effects can potentially account for the heterogeneity that may not be accounted for by the individual country fixed effects. For instance, the unobserved country-specific characteristics may change over time, so the interactions try to capture the unobserved trend.

Since T_{ijt} represents the imports of country i from country j as a share of country i's GDP, then summing the predicted values ($\ln(T_{ijt})$) from (1) in their exponential form across partners j gives country i's predicted import share:

$$T_{it} = \sum_j e^{\ln(T_{ijt})} \quad (2)$$

Modeling a country's income per capita (YPC_{it}) as a function of its import share (T_{it}), population (N_{it}), area (A_i), country fixed effects (γ_i), and time fixed effects (δ_t) gives:

$$\ln(YPC_{it}) = \alpha_0 + \alpha_1 T_{it} + \alpha_2\ln(N_{it}) + \alpha_3\ln(A_i) + \gamma_i + \delta_t + e_{it} \quad (3)$$

The above specification is similar to the one used by Frankel & Romer (1999), Irwin & Terviö (2002), and Noguer & Siscart (2005), with the major differences being presence of fixed effects (to control for unobserved heterogeneity), use of the import share, and recognition of differential effects of trade. Controlling for size (population and area) also reduces the bias of trade, since population and area also influence income per capita. Expression (3) is then estimated using IV regressions, with the predicted import share from (2) as the instrument for the import share.

Moreover, I include interactions of trade with development dummy variables. Namely, dividing the sample into rough thirds based on income per capita gives three groups of development: low, medium, and high. Thus, I include a Medium Development (M.D.) dummy and a High Development (H.D.) dummy, to test for the potential differential effects of trade on the country's development (income per capita). This models the potential differences that trade can have on income per capita, and how trade can potentially increase inequality between countries due to its different effects on development. I also consider land % in tropics, latitude, and ICRG Index as additional geographical and institutional controls for robustness.

For additional analysis, I estimate the effect of the export share (X_{jt}) on income per capita. So if T_{ijt} in (1) is instead expressed as the imports of country i from country j (exports of country j to country i) as share of country j's GDP, which can be denoted as X_{jit}, then summing the predicted values ($\ln(X_{jit})$) in their exponential form across partners i gives an estimate of country j's predicted export share (instrument for the export share):

$$X_{jt} = \sum_i e^{\ln(Xjit)} \quad (4)$$

The paper also uses the gravity framework to explain trade partner inequality. I first estimate the trade specification using a fixed-effects (within-group) estimator with country-pair fixed effects (μ_{ij}) and time fixed effects (δ_t) for the purpose of maintaining consistency when I subsequently model trade partner income per capita inequality in (6). The use of country-pair fixed effects drops the country-pair time-invariant variables, but accounts for important unobserved country-pair heterogeneity (Egger & Pfaffermayr, 2003). I model trade as a function of relative populations (ratio of importer's population to exporter's population), denoted by N_{ijt}, since trade and trade partner inequality are more dependent on relative (rather than absolute) size of trading partners. I also include a country-pair time-variant GATT/WTO membership dummy (M_{ijt}), while country-pair time-invariant variables (including relative areas) are captured by the country-pair fixed effects, as displayed in (5).

$$\ln(T_{ijt}) = \pi_0 + \pi_1\ln(N_{ijt}) + \pi_2 M_{ijt} + \mu_{ij} + \delta_t + w_{ijt} \quad (5)$$

I quantify income per capita inequality as Theil's L Index and Range. To model the impact of imports of country i from country j as share of country i's GDP (T_{ijt}) on income per capita inequality (Q_{ijt}), I use a fixed-effects (within-group) estimator and control for relative populations (N_{ijt}), country-pair fixed effects (μ_{ij}), and time fixed effects (δ_t):

$$Q_{ijt} = \beta_0 + \beta_1\ln(T_{ijt}) + \beta_2\ln(N_{ijt}) + \mu_{ij} + \delta_t + u_{ijt} \quad (6)$$

Expression (6) is then estimated with IV regressions using predicted trade from (5) as the trade instrument. The inequality regression is consistent with the first stage regression (5), which regresses bilateral trade on country-pair variables, while controlling for country-pair and time fixed effects. I also estimate expression (6) while including the capital stock ratio (importer's capital to exporter's capital), to control for the inequality of capital accumulation.

DATA

A large gravity dataset from Dutt & Traca (2010) contains 207,156 country-pair observations, covering 128 exporters and 126 importers over the 1982-2000 period. Roughly 29% of the observations are missing a country-pair trade value. Those blank entries are not included in the analysis, which leaves 146,149 observations available to be reasonably included in the estimations. I make use of the country-pair data for bilateral trade (imports), distance, language, border, colonial link, and GATT/WTO membership. I then augment the dataset by merging import shares, export shares, populations, areas, and GDP per capita values, from the WDI Database (The World Bank, 2013).

The paper's main bilateral trade variable is imports of country i from country j (exports of country j to country i) at time t, which I relate to the importer's GDP when estimating the bilateral import share (T_{ijt}), or to the exporter's GDP when estimating the bilateral export share (X_{jit}). The non-dummy variables include: real (constant 2000 U.S. dollars) income (GDP) per capita, population, surface area in km^2, and distance between i and j in km. The dummy variables include: language (1 if i and j have a common official language), border (1 if i and j share a border), colonial link (1 if i and j have a colonial link), and time-variant membership (1 if i and j are both members of GATT or WTO). Additional geographical and institutional controls for modeling income per capita, obtained from the Center for International Development (2001), include: land % in tropics, latitude, and ICRG Index. An additional control for modeling inequality is real capital stock from Easterly & Levine (2002). Table 1 presents the summary statistics of the available variables.

Table 1: Summary Statistics

DESCRIPTION	#	MEAN	S.D.	MIN.	MAX.
Ln(nominal imports of i from j)	146149	2.155	3.169	-4.605	12.342
Ln(real income per capita of i)	200697	7.724	1.633	4.463	10.871
Ln(real income per capita of j)	200870	7.733	1.616	4.463	10.871
Ln(population of i)	206483	16.339	1.514	12.362	20.956
Ln(population of j)	206416	16.331	1.519	12.362	20.956
Ln(surface area of i in km^2)	204879	12.493	1.806	6.522	16.654
Ln(surface area of j in km^2)	204860	12.508	1.802	6.522	16.654
Ln(partner distance between i and j in km)	207156	8.689	0.795	2.349	9.892
Import share	199838	35.241	21.692	2.982	187.972
Export share	200035	32.908	23.209	2.525	192.337
Common official language dummy	207156	0.148	0.355	0	1

Common border dummy	207156	0.026	0.159	0	1
Colonial link dummy	207156	0.018	0.134	0	1
GATT/WTO (i and j) membership dummy	207156	0.612	0.487	0	1
Land % in tropics	203114	0.501	0.474	0	1
Latitude	203114	20.114	25.010	-41.814	74.703
ICRG Index	171854	5.780	2.289	2.271	9.984
Ln(real capital of i)	53262	25.099	1.860	19.319	29.204
Ln(real capital of j)	52951	25.075	1.867	19.319	29.204

*NOTES: Data source for country-pair variables (imports of i from j, distance, language, contiguity, colonial link, and GATT/WTO membership) is Dutt & Traca (2010). Data source for country variables (total imports, total exports, income (GDP) per capita, population, and area) is WDI Database (The World Bank, 2013). Nominal values are all in current U.S. dollars. Real GDP is in constant 2000 U.S. dollars. Partner distance is in km measured as distance from the partner's centers. Import share is 100*Imports/GDP, while Export share is 100*Exports/GDP. Common official language dummy is 1 if i and j have a common official language (0 otherwise). Common border dummy is 1 if i and j share a border (0 otherwise). Colonial link dummy is 1 if i and j have a colonial link (0 otherwise). GATT/WTO membership dummy is 1 if i and j are both members of GATT or WTO (0 otherwise). Additional controls are obtained from the Center for International Development (2001). Land % in tropics captures percent land area in the geographic tropics. Latitude is the latitude of country's centroid. ICRG Index (1982) is an indicator of quality of institutions. Data for real capital is obtained from Easterly & Levine (2002).*

To create development groups, I divide the sample based on the country's real income per capita into rough thirds with similar amount of observations: low ($87-944), medium ($945-5,214), and high ($5,215-52,628). A relevant inequality measure is the Theil's L Index, capturing mean log deviation, which applied to two non-log values (Y_{it} and Y_{jt}) becomes:

$$\text{Theil's L Index}_{ijt} = \ln((Y_{it} + Y_{jt})/2) - \ln(Y_{it}Y_{jt})/2 \qquad (7)$$

Alternatively, for robustness, I consider the Range (a simpler inequality measure):

$$\text{Range}_{ijt} = (\max(Y_{it},Y_{jt}) - \min(Y_{it},Y_{jt})) / ((Y_{it} + Y_{jt})/2) \qquad (8)$$

Theil's L Index is generally a more comprehensive and common inequality measure than Range, since it is affected by middle values and transfers that occur between the minimum and the maximum values.

RESULTS

Trade

This section estimates expressions (1) and (5), which relate imports of country i from country j as share of GDP_i to relevant gravity variables. Results are presented in Table 2.[1] Out of the specifications using country and time fixed effects, specification [1] of Table 2 is most significant and consistent with gravity theory. Importer's population increases the bilateral import share by 0.72%, while exporter's population decreases it by 0.55%. Importer's area decreases the bilateral import share by 3.74%, while exporter's area decreases it by 2.10%. Signs of the effects are consistent with the findings by Frankel & Romer (1999) and Noguer & Siscart (2005).[2] The effect of distance on trade is significant and robust. All else constant, a 1% increase in the partner distance has a predicted effect of lowering trade by 1.27%. This estimate is similar to some earlier findings, such as by: Frankel & Rose (2002), Rauch & Trindade (2002), Martínez-Zarzoso (2003), Rose (2004), and Disdier & Head (2008).

Specification [5] of Table 2, which estimates (5), is significant and consistent with the income per capita inequality expression in (6) which also uses country-pair and time fixed effects. It is worthy to note that the relative population of the importer to the population of the exporter has a positive effect on bilateral trade. So the bigger the importer is relative to the exporter in terms of population, the bigger the demand for imports (as % of importer's GDP). Specifically, a 1% increase in the population ratio increases the import share by 0.69%. This effect of the relative size of trading partners (in specification [5]) is more significant than the individual effects of the absolute size of trading partners (in specification [4]). Also, the significant membership dummy in specification [5] indicates that if both partners are members of GATT or WTO, then trade is predicted to be roughly 18% higher than if they are not both members. Given the significance of specification [5] and its use of country-pair and time fixed effects, it is the preferred first stage bilateral trade regression for the subsequent income per capita inequality IV regressions.

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1 The use of interactions between time and importer fixed effects along with interactions between time and exporter fixed effects simultaneously was not executable due to the large number of countries and years.

2 Note that Frankel & Romer (1999) and Noguer & Siscart (2005) use i to denote exporter and j to denote importer, while I use the opposite notation, since i is importing from j. Moreover, they use the total bilateral trade between partners, while I use unidirectional trade (import share and export share separately), consistent with recent literature and the subsequent estimations of income per capita and inequality. Also, I use country and time fixed effects with a larger dataset, so some results are expected to be different.

Table 2: Bilateral Import Share

DEPENDENT VARIABLE	Ln(imports of i from j as share of GDP_i)				
SPECIFICATIONS	[1]	[2]	[3]	[4]	[5]
Ln(population of i to j)					0.668***
					(0.034)
Ln(importer's population)	0.722***	-0.311	0.441***	1.275***	
	(0.072)	(513.761)	(0.072)	(0.039)	
Ln(exporter's population)	-0.552***	-0.386***	1.673***	-0.041	
	(0.080)	(0.081)	(0.305)	(0.039)	
Ln(importer's surface area)	-3.738***	-0.044	-3.634***	-3.597***	
	(0.767)	(174.367)	(0.766)	(0.574)	
Ln(exporter's surface area)	-2.101**	-2.051**	-0.128	-1.047*	
	(0.856)	(0.855)	(0.173)	(0.549)	
Ln(partner distance)	-1.264***	-1.265***	-1.265***		
	(0.008)	(0.008)	(0.008)		
Common language dummy	0.597***	0.593***	0.594***		
	(0.016)	(0.016)	(0.016)		
Common border dummy	0.436***	0.430***	0.433***		
	(0.030)	(0.030)	(0.030)		
Colonial link dummy	0.923***	0.923***	0.924***		
	(0.026)	(0.026)	(0.026)		
Membership dummy	0.010	-0.034	0.084***	-0.010	0.181***
	(0.018)	(0.025)	(0.021)	(0.013)	(0.012)
Constant	84.315***	45.077	24.477	34.174***	-3.923***
	(16.388)	(6785.171)	-	(10.076)	(0.009)
country fixed effects (γ_i and λ_j)	yes	yes	yes	no	no
country-pair fixed effects (μ_{ij})	no	no	no	yes	yes
time fixed effects (δ_t)	yes	yes	yes	yes	yes
interaction i fixed effects ($\gamma_i\delta_t$)	no	yes	no	no	no
interaction j fixed effects ($\lambda_j\delta_t$)	no	no	yes	no	no
observations	141511	141511	141511	141511	141511
Root-MSE	1.61	1.59	1.59	1.00	1.00

Income Per Capita

When estimating the effect of trade on income per capita, as expressed in (3), it is important to recognize the endogeneity of trade. As such, the import share is instrumented using the aggregation of the predicted bilateral import share values of specification [1] from Table 2, as expressed in (2). The inclusion of a Medium Development (M.D.) dummy and a High Development (H.D.) dummy accounts for differential effects of trade among the three development groups (which are divided as before into rough thirds based on real income per capita). For robustness tests, I include additional geographical and institutional controls. For additional analysis of trade's effects on income per capita, I analyze the effect of the export share on income per capita. The export share is instrumented using the aggregation of the predicted bilateral export share values, as expressed in (4). Tables 3 and 4 show the import share and the export share results from modeling income per capita using fixed effects. Specification [3] in each table uses all the available data from the WDI Database (for 184 countries), while the other specifications only include data with an available predicted trade share. Thus, specification [3] also includes those (generally less developed) countries which are excluded in the other specifications (since they lack gravity data).

The IV results in Table 3 show that a higher import share has a negative average effect on income per capita, as found by Ondrich, Richardson, & Zhang (2003). As specification [4] shows, increasing the import share by 1 percentage point has an average effect of decreasing income per capita by 3.4%. Furthermore, the use of development dummies reveals differential effects of trade in favor of more developed countries. As specification [5] shows, the average effect on income per capita from increasing the import share of a low development country by 1 percentage point is -3.2%. The average effect is -2.5% for a medium development country, and -1.8% for a high development country. The differential effects are also present with the inclusion of geographical and institutional controls.

The asymmetric trade effects are further confirmed in specification [3], which includes all the countries with actual import share values, but for which the predicted import share values do not exist (due to unavailable gravity data). Across the specifications, the effect of population on income per capita is negative, while the effect of surface area is generally positive, implying that having more people decreases income per capita, while having more land increases it, other things constant.

Table 3: Income Per Capita and Import Share

DEPENDENT VARIABLE	Ln(real income per capita)					
SPECIFICATIONS	[1]	[2]	[3]	[4]	[5]	[6]
Import share	0.000	-0.001**	-0.003***	-0.034**	-0.032**	-0.007
	(0.000)	(0.001)	(0.001)	(0.015)	(0.013)	(0.016)
Import share * M.D. dummy		0.002***	0.005***		0.007***	0.008***
		(0.001)	(0.001)		(0.002)	(0.002)
Import share * H.D. dummy		0.004***	0.007***		0.014***	0.020***
		(0.001)	(0.001)		(0.002)	(0.002)
Ln(population)	-0.740***	-0.682***	-0.474***	-1.231***	-0.956***	-0.736***
	(0.059)	(0.059)	(0.056)	(0.240)	(0.213)	(0.090)
Ln(surface area)	0.094**	0.107***	0.152***	-0.118	-0.037	0.405***
	(0.038)	(0.038)	(0.037)	(0.140)	(0.123)	(0.080)
Land % in tropics						-1.160**
						(0.503)
Latitude						0.005
						(0.004)
ICRG Index						0.280***
						(0.042)
Constant	19.892***	18.512***	13.638***	33.977***	26.947***	12.310***
	(0.658)	(0.711)	(0.456)	(6.320)	(5.646)	(2.888)
method	OLS	OLS	OLS	IV	IV	IV
country fixed effects (γ_i)	yes	yes	yes	yes	yes	yes
time fixed effects (δ_t)	yes	yes	yes	yes	yes	yes
observations	1858	1858	3012	1858	1858	1579
countries	120	120	184	120	120	88
Root-MSE	0.12	0.12	0.15	0.29	0.25	0.13
F statistic on T_{it} (first stage)	-	-	-	58.60	44.79	15.27

*NOTES: Estimations of equation (3) for (importer's) Income per capita are done using country and time dummies (not reported); specification [3] uses all available data from the WDI Database, while the other estimations only use available data for countries with an available predicted import share; dependent variable is Ln of real (constant 2000 U.S. dollars) income per capita; non-dummy explanatory variables include: Import share (100*Imports/GDP), Ln of importer's population, Ln of importer's surface area in km^2, Land % in tropics, Latitude, ICRG Index; Medium Development (M.D.) dummy equals 1 if Ln(real income per capita) is greater than 6.850 and is lower than 8.559; High Development (H.D.) dummy equals 1 if Ln(real income per capita) is greater than 8.559; robust standard errors are in parentheses; **

*p<0.1, ** p<0.05, *** p<0.01; IV estimations use predicted import share ($T_{it} = \sum_j e^{ln(Tijt)}$), with predicted values of Ln(imports of i from j as share of GDP$_i$), denoted by ln(T_{ijt}), from Table 4 Specification [1] seen below using country and time dummies (not reported)*

ln(T_{ijt}) = 84.315*** + 0.722*** Ln(importer's population) - 0.552*** Ln(exporter's population) - 3.738*** Ln(importer's surface area) 2.101** Ln(exporter's surface area) - 1.264*** Ln(partner distance) + 0.597*** Common language dummy + 0.436*** Common border dummy + 0.923*** Colonial link dummy + 0.010 Membership dummy

N = 141511, Root-MSE = 1.61

Table 4 results show that the effects of the export share on income per capita are quite different from the effects of the import share (thus confirming the importance of decomposing the effects of the trade share). The IV results in specification [4] show that increasing the export share by 1 percentage point has an average effect of increasing income per capita by 2.6%. As specification [6] reveals, the differential effects are such that the effect of the export share is negative for a low development country and positive for a high development country. The use of differential effects in specification [6] reveals what is hidden by just looking at the average effect in specification [4]. Since specification [4] is giving the average effect of all the countries, and since more developed countries export more, then their positive effect of the export share largely influences the average effect of the export share, thus making it positive. However, in specification [6] the negative coefficient for less developed countries is present since their ability to export (albeit less than more developed countries) comes with high relative imports (since they import more than they export compared to more developed countries), and thus the negative effect of imports is present for the less developed countries. The asymmetric trade effects are also revealed in specification [3], which includes all the 184 countries that have actual export share values. It should also be noted that the negative effect of population, positive effect of surface area, negative effect of land % in tropics, positive effect of latitude, and positive effect of ICRG Index are all consistent with existing literature and generally significant across the specifications in Tables 3 and 4.

The larger effect of instrumented export share over actual export share is consistent with the studies by Frankel & Romer (1999), Irwin & Terviö (2002), and Noguer & Siscart (2005) who analyze the effect of the trade share. As discussed, the smaller coefficient of actual export share reflects its positive correlation with the downward pressures on income per capita. Overall, the results of the income per capita analysis conducted here are significant: the average effect of the import share is negative, the average effect of the export share is positive, and the differential effects of trade are in favor of more developed countries. These findings have important implications regarding trade's effects on income and inequality.

Table 4: Income Per Capita and Export Share

DEPENDENT VARIABLE	Ln(real income per capita)					
SPECIFICATIONS	[1]	[2]	[3]	[4]	[5]	[6]
Export share	0.002***	0.000	-0.000	0.026**	0.006	-0.015**
	(0.001)	(0.001)	(0.001)	(0.011)	(0.008)	(0.007)
Export share * M.D. dummy		0.001***	0.004***		0.004*	0.014***
		(0.001)	(0.001)		(0.002)	(0.003)
Export share * H.D. dummy		0.003***	0.006***		0.013***	0.024***
		(0.001)	(0.001)		(0.003)	(0.003)
Ln(population)	-0.719***	-0.671***	-0.439***	-0.503***	-0.452***	-0.666***
	(0.058)	(0.058)	(0.057)	(0.163)	(0.097)	(0.078)
Ln(surface area)	0.104***	0.117***	0.134***	0.372***	0.245***	0.334***
	(0.038)	(0.038)	(0.037)	(0.127)	(0.079)	(0.048)
Land % in tropics						-1.174***
						(0.092)
Latitude						0.006***
						(0.001)
ICRG Index						0.299***
						(0.014)
Constant	19.305***	18.103***	13.219***	10.173**	11.462***	12.154***
	(0.653)	(0.710)	(0.471)	(4.558)	(2.752)	(0.905)
method	OLS	OLS	OLS	IV	IV	IV
country fixed effects (λ_j)	yes	yes	yes	yes	yes	Yes
time fixed effects (δ_t)	yes	yes	yes	yes	yes	Yes
observations	1902	1902	3013	1902	1902	1612
countries	122	122	184	122	122	89
Root-MSE	0.12	0.12	0.15	0.22	0.14	0.14
F statistic on X_{jt} (first stage)	-	-	-	164.74	70.07	69.15

*NOTES: Estimations of equation (3) for (exporter's) Income per capita are done using country and time dummies (not reported); estimation [3] uses all available data from the WDI Database, while the other estimations only use available data for countries with an available predicted export share; dependent variable is Ln of real (constant 2000 U.S. dollars) income per capita; non-dummy explanatory variables include: Export share (100*Exports/GDP), Ln of exporter's population, Ln of exporter's surface area in*

*km^2, Land % in tropics, Latitude, ICRG Index; Medium Development (M.D.) dummy equals 1 if Ln(real income per capita) is greater than 6.850 and is lower than 8.559; High Development (H.D.) dummy equals 1 if Ln(real income per capita) is greater than 8.559; robust standard errors are in parentheses; * p<0.1, ** p<0.05, *** p<0.01; IV estimations use predicted export share ($X_{jt} = \sum_i e^{ln(X_{jit})}$), with predicted values of Ln(exports of j to i as share of GDP_j), denoted by $ln(X_{jit})$, from the specification seen below using country and time dummies (not reported)*

$ln(X_{jit})$ = 92.692*** - 0.339*** Ln(importer's population) + 0.430*** Ln(exporter's population) - 0.522 Ln(importer's surface area) - 5.847*** Ln(exporter's surface area) - 1.263*** Ln(partner distance) + 0.598*** Common language dummy + 0.447*** Common border dummy + 0.912*** Colonial link dummy - 0.004 Membership dummy

N = 141511, Root-MSE = 1.61

Inequality

This section models the effect of trade (imports of i from j as share of GDP_i) on income per capita inequality between trading partners, as expressed in equation (6). Consistent with the trade expression in equation (5), I use a fixed-effects estimator with country-pair and time fixed effects, which also allows me to control for relative populations. Trade in the IV regressions is instrumented with predicted trade from specification [5] of Table 2. Trade partner inequality results are presented in Table 5, using the Theil's L Index measure, as well as the Range measure for robustness tests. The instrument's F statistics are higher than in some of the first stage regressions in related literature, because the instrument in Table 5 has more observations than the related literature, it controls for unobserved heterogeneity using country-pair fixed effects, and it uses relative populations, which are more significant than individual populations when using country-pair fixed effects.

The OLS estimations show a negative effect of trade (imports of i from j as share of GDP_i) on inequality. Actual trade is expected to exhibit downward bias on trade partner inequality, since non-trade elements (such as country characteristics not captured by country-pair fixed effects) can be positively associated with trade, but negatively associated with trade partner inequality (such as country's internal policies). Also, there can be reverse causality, where the higher inequality between trading partners causes the trade between them to be lower. If one trading partner (i) starts to experience a rise in income per capita (due to internal economic growth) that causes the trade partner inequality to rise, then this may decrease imports of the now more developed country (i) from some of its trading partners, denoted by j, as share of GDP_i (due to changing incomes, prices, lifestyles, policies, and other elements that determine trade). Rising average incomes in a country can alter the types of goods the country imports, away from less expensive goods towards more expensive goods supplied by another trading partner or supplied domestically. This can therefore cause the country that is experiencing a rise in its income per capita to import less from its old trading partner.

Table 5: Trade Partner Income Per Capita Inequality

DEPENDENT VARIABLE	Income per capita inequality between i and j							
SPECIFICATIONS	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Lag of dependent variable							0.929***	0.891***
							(0.002)	(0.001)
Ln(imports of i from j as share of GDP_i)	-0.004***	-0.002**	0.108***	0.075***	0.139***	0.236***	0.008***	0.007***
	(0.000)	(0.001)	(0.008)	(0.007)	(0.035)	(0.057)	(0.001)	(0.002)
Ln(population of i to j)	0.001	-0.002	-0.073***	-0.053***	-0.190***	-0.309***	-0.006***	-0.005***
	(0.009)	(0.011)	(0.007)	(0.006)	(0.048)	(0.079)	(0.001)	(0.002)
Ln(capital of i to j)					0.059***	0.100***		
					(0.016)	(0.027)		
Constant	0.507***	1.247***	0.930***	1.538***	0.901***	1.905***	0.072***	0.165***
	(0.002)	(0.003)	(0.030)	(0.028)	(0.105)	(0.175)	(0.004)	(0.007)
Method	OLS	OLS	IV	IV	IV	IV	IV	IV
inequality measure (Q_{ijt})	Theil's L	Range	Theil's L	Range	Theil's L	Range	Theil's L	Range
country-pair fixed effects (μ_{ij})	yes	yes	yes	yes	yes	yes	yes	yes
time fixed effects (δ_t)	yes	yes	yes	yes	yes	yes	yes	yes
observations	139322	139322	138310	138310	21683	21683	127321	127321
country-pair groups	13069	13069	12057	12057	2451	2451	10586	10586
Root-MSE	0.056	0.087	0.129	0.120	-	-	0.020	0.032
F statistic on $\ln(T_{ijt})$ (first stage)	-	-	244.45	244.45	76.94	76.94	292.60	244.11

NOTES: Estimations of equation (6) for Income per capita inequality are done using fixed effects (within-group) estimator with country-pair groups and time; dependent variable is income per capita inequality (Theil's L Index or Range), using real (constant 2000 U.S. dollars) income per capita values of i and j; explanatory variables include: Ln(100(imports of i from j)/GDPi), Ln of population i to j, Ln of capital i to j; robust standard errors are in parentheses for regressions [1]-[2]; conventional standard errors, using derived variance estimator for generalized least-squares, are in parentheses for regressions [3]-[8]; * p<0.1, ** p<0.05, *** p<0.01; IV regressions use predicted bilateral import share (ln(Tijt)) from Table 2 Specification [5] seen below using country-pair and time fixed effects*

$$\ln(T_{ijt}) = -3.923^{***} + 0.668^{***}\ \text{Ln(population of i to j)} + 0.181^{***}\ \text{Membership dummy}$$

$$N = 141511,\ \text{Root-MSE} = 1.00$$

The IV estimations, which address the endogeneity of trade, show a significant positive effect of trade (imports of i from j as share of GDP_i) on inequality, for both inequality measures. The results imply that higher trade has on average increased the income per capita inequality between trading partners. This complements the findings in the previous section which showed trade's differential effects on income per capita. Since the differential effects were on average skewed more favorably towards more developed countries, then higher trade puts pressure on the income per capita inequality between countries to rise. The results of the IV estimations also indicate that relative population of the importer to the exporter has a negative effect on inequality. The positive effect of trade on inequality is robust with the inclusion of the relative capital stock of the importer to the exporter, as seen in specifications [5] and [6]. Thus, even after controlling for the divergence in capital accumulation (which has a positive effect on inequality), trade has a significant positive effect on inequality.

Specifications [7] and [8] control for the lag of the dependent variable to acknowledge the dynamics of inequality. With the inclusion of the lag of inequality there is still a significant positive effect of trade on inequality. The results in this section acknowledge the significant persistence of trade partner inequality, and they confirm that contemporary trade has on average increased trade partner inequality.[3]

CONCLUSION

The focus of this paper's panel analysis is modeling trade's effects on income per capita and trade partner income per capita inequality in the context of gravity. With the available data covering 128 exporters and 126 importers over the years 1982-2000, the analysis shows that the bilateral import share generally falls with higher surface areas and distance, while it rises with higher relative populations. Also, the bilateral import share is generally higher if trade partners share a common language, common border, colonial link, or GATT/WTO membership. The paper then displays import share's negative average effect on income per capita and export share's positive average effect on income per capita. Trade share's decomposition using panel analysis is a relevant contribution to the related cross-sectional analyses that estimate trade

3 Results are robust when trade is instrumented using Table 4 Specification [1] instead, while controlling for populations, areas, distance, and (country and time) fixed effects. Trade instrumented using Table 4 Specification [2] or [3] with country and time fixed effects interactions was not executable due to the large number of countries and years. Note that Table 4 Specification [5] is the preferred first stage specification, since it controls for country-pair and time fixed effects in line with the subsequent inequality specification.

share's average effect on income per capita (Frankel & Romer, 1999; Irwin & Terviö, 2002; Noguer & Siscart, 2005). Furthermore, with the use of development dummy variables the paper reveals differential effects of trade in favor of more developed countries, for both the import share and the export share. The asymmetric trade effects are also exhibited in the trade partner income per capita inequality analysis, which shows the important inequality-inducing impact of contemporary trade. Scope for further studies could test more recent data and examine how the effects of trade compare to the effects of trade during the period of study in this paper. Furthermore, in the context of gravity and trade, it would be interesting to study how intranational (within-country) inequality impacts international (between-country) inequality.

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