

# Growth, trade, institutions, and geography: new empirical evidence

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## Abstract

**Purpose** – This study investigates the implications of trade, institutional and geographical variables on economic growth. The proposed analytical framework extends the seminal works of Frankel and Romer (1999), Rodrik *et al.* (2004), Silva and Tenreiro (2006) and Squalli and Wilson (2011).

**Design/methodology/approach** – Applying a comprehensive panel database that includes 133 countries during the period 1996–2014. Our estimators encompass three dimensions (fixed effects) and use the Pseudo Poisson Maximum Likelihood (PPML) approach to create an instrument for trade. This approach effectively addresses the issues associated with endogenous regressors.

**Findings** – Findings from this study demonstrate a significant correlation between economic growth and the variables of trade, institutions and geography, with trade surfacing as the most influential factor. Notably, the impact of these factors appears to be diminished in low-income countries, especially in the parameters that reflect the role of institutions on per capita income.

**Originality/value** – The originality of the study is underscored by four key aspects: the employment of a unique econometric approach, the use of a three-dimensional panel database with fixed effect estimators and PPML, the inclusion of a novel measure of trade openness diverging from the conventional literature in the bilateral trade equation, and finally, the implementation of robustness tests probing the sensitivity of per capita income to institutions, trade and geography.

**Keywords** Growth, Trade, Institutions, Geography, Endogeny

**Paper type** Research paper

## 1. Introduction

Economic growth drivers, particularly those contributing to disparities in per capita income across nations, remain a compelling topic in economics. Scholars referred to here (Bosker & Garretsen, 2009) have emphasized trade, geography, and institutional development levels as primary influences on a nation's per capita income, subsequently termed as deep determinants of economic growth.

Early empirical studies exploring these deep determinants were conducted by Rodrik, Subramanian, and Trebbi (2004) and Dollar and Kraay (2003), intending to address endogeneity [1] criticisms put forth by Rodriguez and Rodrik (2000). However, these studies

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yielded disparate results. While [Rodrik \*et al.\* \(2004\)](#) presented solid empirical evidence supporting institutions' significance for economic growth, with trade appearing insignificant and geography indirectly affecting per capita income, the opposite was suggested in other studies. Divergent results were found by [Dollar and Kraay \(2003\)](#), suggesting that the coefficient related to institutions would be less elastic than that of trade. In the study by [Rodrik \*et al.\* \(2004\)](#), a cross-section approach estimated by OLS and instrumental variables was applied, while [Dollar and Kraay \(2003\)](#) study utilized cross-section data and a dynamic panel.

Further studies intending to mitigate endogeneity bias were carried out by [Frankel and Romer \(1999\)](#), [Hall and Jones \(1999\)](#), [Acemoglu, Johnson, and Robinson \(2001\)](#), [Gallup, Jeffrey, and Mellinger \(1999\)](#), and [Sachs \(2001\)](#), with each focusing on a specific determinant of growth. For instance, [Frankel and Romer \(1999\)](#) used instrumental variables [2] to estimate trade's impact on income, which addressed the endogeneity problem by utilizing geographic characteristics as an instrumental variable for measuring international trade.

Empirical exploration of the relationship between institutions and economic performance is largely rooted in the work of [Hall and Jones \(1999\)](#) and [Acemoglu \*et al.\* \(2001\)](#) [3]. Additionally, the importance of geography as a growth determinant has been underscored by [Gallup \*et al.\* \(1999\)](#) and [Sachs \(2001\)](#), who argue that geographical factors, including natural resource endowment, disease prevalence, transport costs, and climate, influence per capita income, productivity, and human resource quality.

On the other hand, several studies, such as [Ojeaga, George, Alege, and Ogundipe \(2014\)](#), [Matthew, Oduntan, and Adediran \(2017\)](#), [Çestepe, Yildiz, and Avci \(2019\)](#), [Heo, Huyen, and Doanh \(2021\)](#), [Akobeng \(2016\)](#), [Bergh and Nilsson \(2010\)](#), [Ngouhouo, Nchofoung, and Kengdo \(2021\)](#), and [Jacob and Osang \(2020\)](#), have employed panel data and dynamic panel data methodologies to explore the intricate relationships between institutions, trade, and economic growth. Many of these studies utilize dynamic panel data models to address the issue of endogeneity, offering a more comprehensive analysis than cross-sectional models by controlling for time-invariant factors and unobserved heterogeneity.

Recent methodological advances in addressing endogeneity include the use of instrumental variable (IV) approaches, fixed effects models, and the generalized method of moments (GMM). IV methods, such as those employed by [Frankel and Romer \(1999\)](#), provide a way to mitigate endogeneity by using exogenous instruments. Fixed effects models help control unobserved heterogeneity by eliminating time-invariant factors, while GMM techniques, as used in dynamic panel settings, account for both endogeneity and autocorrelation. These methods enhance the robustness of empirical results by offering more accurate and consistent estimations.

In contrast, the Poisson Pseudo Maximum Likelihood (PPML) estimator, introduced by [Silva and Tenreiro \(2006\)](#), differs from these approaches by being particularly suited for data with many zeros, such as trade data, and for estimating gravity models, where heteroscedasticity and measurement errors can bias results in ordinary least squares (OLS) and other methods. PPML not only corrects for these biases but also accommodates heteroscedasticity in trade data, making it a powerful tool in empirical trade analysis.

Thus, this paper aims to quantify the impact of institutions, trade, and geography on nations' per capita income levels, building on the initial model proposed by [Rodrik \*et al.\* \(2004\)](#). Instrumental variables are employed to lessen endogeneity bias, and estimators, particularly those developed by [Silva and Tenreiro \(2006\)](#), are utilized. This study's novelty lies in four aspects: the unique econometric approach, the construction of a three-dimensional panel database with fixed effect estimators and Poisson's Pseudo Maximum Likelihood (PPML) for the trade instrument estimation suggested by [Frankel and Romer \(1999\)](#), the inclusion of a trade openness measure suggested by [Squalli and Wilson \(2011\)](#) in the bilateral trade equation, and the implementation of three robustness tests examining per capita income sensitivity to institutions, trade, and geography.

Apart from the introduction, this paper is organized into three more sections. The second section presents the reference econometric model, estimators, instruments, and data. The

third section delves into robustness tests and their main findings. The final section concludes.

## 2. Empirical strategy

The reference model of this study aims to measure the impact of determinants of growth – trade, institution, and geography – on per capita income. As presented in Equation (1), the model is based on the framework proposed by Rodrik *et al.* (2004) [4].

$$y_{it} = \varphi_0 + \varphi_1 INST_{it} + \varphi_2 INTSW_{it} + \varphi_3 GEO_i + c_i + \varepsilon_{it} \quad (1)$$

In this equation,  $y_{it}$  represents the per capita income of country  $i$  in year  $t$ . The symbol  $INST_{it}$  denotes the level of institutional development in countries during year  $t$ , utilizing property rights as a proxy [5],  $INTSW_{it}$  symbolizes the trade instrument, using trade openness as proposed by Squalli and Wilson (2011) and drawing from the bilateral trade equation of Frankel and Romer (1999),  $GEO_i$  represents the geographic feature related to country  $i$ 's location, measured in latitude.  $c_i$  captures the time-invariant characteristics of each country  $i$  as a fixed effect. The parameters to be estimated are represented by  $\varphi_k$  and  $\varepsilon_{it}$  stands for the stochastic error term.

However, including the fixed effect in Equation (1) poses a challenge for estimating the geography-related variable, which is time-invariant. This study adopts the strategy proposed by Hui & Wall (2005) to ascertain the magnitude of the parameter associated with geography. This strategy employs a two-level hierarchical model to measure the coefficient of the geography variable, which remains constant over time. The first level estimates Equation (1), while the second level utilizes a cross-section data model, which incorporates variables constant over time. These effects are illustrated in Equation (2).

$$c_i = \gamma_0 + \gamma_1 Geo_i + \alpha_i \quad (2)$$

In Equation (2),  $c_i$  represents the fixed effect of unobserved characteristics that remain constant over time, as estimated by Equation (1). The vector of the parameter of variable  $i$  (which denotes the geography of the countries, in this case, the absolute normalized latitude) is represented by  $\gamma_1$ . The stochastic error vector is represented by  $\alpha_i$ .

Beyond the variables previously utilized by Rodrik *et al.* (2004) in studies on trade and institutions, we have incorporated additional indicators related to democracy, official language, colonial history, and ease of doing business. This inclusion aims to minimize the risk of omitted variable bias, a strategy employed in earlier research by authors such as Bonnal and Yaya (2015), who argued for the importance of democracy and investment freedom, Auer (2013), who emphasized the role of the rule of law, and Hall and Jones (1999), who highlighted aspects related to colonization and the English language, and corroborated by Ahmad and Hall (2023) [6].

Additionally, our trade-related instrument uses the measure of economic openness proposed by Squalli and Wilson (2011). This trade openness measure is more robust than traditional measures because it captures two critical dimensions of trade openness. The first dimension is a country's trade share relative to its GDP, and the second is its share in global trade flows. Traditional measures, such as the ratio of exports and imports to GDP, often penalize large economies by classifying them as closed, even when they are major contributors to global trade. The author's measure, known as the Composite Trade Share (CTS), addresses this limitation by combining the traditional trade share with a country's contribution to total world trade. This provides a more accurate representation of trade openness, particularly for large economies, which are often misrepresented by traditional measures as having low openness. By accounting for both the internal and external dimensions of trade flows, this

composite measure offers a more comprehensive and nuanced understanding of a country's trade integration with the global economy.

The instruments implemented in our reference model are depicted in equations [7] 3 and 4.

$$INST_{it} = \gamma_0 + \gamma_1 SM_{it} + \gamma_2 FRA_{it} + \gamma_3 GEO_i + \gamma_4 Rle_{it} + \gamma_5 Invfre_{it} + \gamma_6 Eng_i + \gamma_7 CGbr_i + \gamma_8 Dem_{it} + \omega_{it} \quad (3)$$

$$INTSW_{it} = \frac{(X + M)_i}{\frac{1}{n} \sum_{j=1}^n (X + M)_j} \frac{(X + M)_i}{Y_i} = \beta_0 + \beta_1 SM_{it} + \beta_2 FRA_{it} + \beta_3 GEO_i + \beta_4 Rle_{it} + \beta_5 Invfre_{it} + \beta_6 Eng_i + \beta_7 CGbr_i + \beta_8 Dem_{it} + \vartheta_{it} \quad (4)$$

In this study, variable  $SM_{it}$  represents the mortality rate of country  $i$  in period  $t$ . This variable is used as a proxy to explain the quality of institutions in countries, as developed in the prior study by [Acemoglu et al. \(2001\)](#).  $FRA_{it}$  serves as the instrumental variable for representing the trade of country  $i$  in year  $t$ . In estimating the impact of trade on per capita income, we utilized various estimators based on the flow of bilateral trade, as developed by [Frankel and Romer \(1999\)](#). Our analysis also incorporated several other variables. These include  $Eng_i$ , a binary variable with a value of 1 assigned if English is an official language in country  $i$ , and 0 otherwise;  $CGbr_i$ , another binary variable with a value of 1 assigned if country  $i$  was an English colony and 0 otherwise. Variable  $Rle_{it}$ , represents the rule of law [8] in country  $i$  in year  $t$ , while,  $Invfre_{it}$  signifies the degree of freedom in investments [9] in country  $i$  in year  $t$ . Additional variables are  $Dem_{it}$ , a binary variable assigned the value of 1 if the country is a full democracy;  $(X + M)_i$ , which represents the exports and imports of country  $i$ ;  $\sum_{j=1}^n (X + M)_j$ , denoting the exports and imports of the rest of the world; and  $Y_i$ , representing the income of country  $i$ ; 'n' is the total number of countries included in the sample. The parameters to be estimated are represented by  $\sum_{k=0}^8 \gamma_k$  and  $\sum_{k=0}^8 \beta_k$  with  $\omega_{it}$  and  $\vartheta_{it}$ , constituting the vectors of the stochastic error terms. As highlighted by [Ahmad and Nayan \(2020\)](#), institutions are a multi-faceted concept, and based on this idea, democracy and the rule of law may not serve as suitable determinants for the INST instrument. Since the primary contributions of this study are related to the trade integration instrument, this critique can be incorporated into future research focused on improving the institutional instrument.

For this study, we constructed a trade instrument using the bilateral trade flow, denoted by [Equation \(5\)](#). This variable, ( $FRA_{it}$ ), was also used in the instruments constructed from [Equations \(3 and 4\)](#). To address the criticisms related to heteroscedasticity and zero trade flows, as highlighted by [Silva and Tenreiro \(2006\)](#), we incorporated solutions into the equation and estimated them using Poisson Pseudo Maximum Likelihood (PPML).

$$FRA_{it} = \frac{\tau_{ijt}}{Y_{it}} = e^{\left[ \begin{array}{l} \theta_j + \theta_{11} + \theta_{12} + \theta_{13} \ln D_{ij} + \theta_2 \ln N_{it} + \theta_3 \ln A_i + \theta_4 \ln N_{jt} + \theta_5 \ln A_j + \theta_6 (L_i + L_j) + \theta_7 B_{ij} + \theta_8 \ln D_{ij} + \theta_9 B_{ij} \ln N_{it} \\ + \theta_{10} B_{ij} \ln A_i + \theta_{11} B_{ij} \ln N_{jt} + \theta_{12} \ln A_j + \theta_{13} B_{ij} (L_i + L_j) + \theta_{14} I_{ij} + \theta_{15} Col_{ij} + \theta_{16} r_{\alpha_{ijt}} \end{array} \right] + v_{ijt}} \quad (5)$$

In this study, variable  $\tau_{ijt}$  represents the bilateral trade between countries  $i$  and  $j$  over time, while  $Y_{it}$  denotes the Gross Domestic Product (GDP) of country  $i$  over time. The variable  $D_{ij}$  signifies the distance between countries  $i$  and  $j$ ,  $N_{it}$  corresponds to the population of country  $i$  over time, and  $A_i$  is the area of country  $i$ . Variables  $N_{jt}$  and  $A_j$  represent the population and area of country  $j$ , respectively.

A series of binary variables are also used in the study. The variable  $L_i$  holds a value of 1 if country  $i$  has a coastline and 0 otherwise. Similarly,  $L_j$  takes a value of 1 if country  $j$  has a coastline and 0 otherwise. The variable  $B_{ij}$  is assigned a value of 1 if country  $i$  shares a border with country  $j$  and 0 otherwise. Additionally,  $I_{ij}$  is assigned a value of 1 if countries  $i$  and  $j$  have the same official language and 0 otherwise, [10] while  $Col_{ij}$  takes a value of 1 if countries  $i$  and  $j$  were or are colonies and 0 otherwise. Lastly,  $rt_{a_{ij}}$  is set to 1 if countries  $i$  and  $j$  have regional, multilateral, or bilateral trade agreements over time and 0 otherwise.

The parameters to be estimated are represented by  $\sum_{k=1}^{16} \theta_k$ . The parameter  $\theta_{ii}$  represents the fixed effect of the importing country, while  $\theta_{ji}$  denotes the fixed effect of the exporting country and  $\theta_{ij}$  is the fixed effect related to the pair of countries. Finally,  $v_{ijt}$  represents the vectors of the stochastic error terms.

It should be noted that the bilateral trade equation put forth by Frankel and Romer (1999), as depicted in Equation (5), considers variables linked to parameters.  $\theta_1$  through  $\theta_{13}$ . The incorporation of additional variables in the equation draws upon empirical literature. For instance, we include a dummy variable pertaining to regional trade agreements [11], facilitating the assessment of their influence on bilateral trade. This variable has been applied in the models of numerous researchers, such as Vicard (2011), Carrere (2006), Baier and Bergstrand (2007) and Ghosh and Yamarik (2004), among others.

The introduction of fixed effects in the bilateral trade equation addresses criticisms forwarded by Silva and Tenreyro (2006) regarding the utilization of cross-section data, grouped data, or panel data from log-linearized models to examine trade relationships and economic growth. This methodological approach has been employed by Frankel and Romer (1999), Mullings and Mahabir (2018), and Iyke (2017), among others.

However, as underscored by Silva and Tenreyro (2006), this approach is not without estimation issues. The first concern pertains to heteroscedasticity, which, when estimated by Ordinary Least Squares (OLS) in the log-linearized model, introduces biased parameters, a critique also emphasized by Egger (2005).

The second issue pertains to estimating the bilateral equation in cases of zero trade flows. These criticisms have been addressed by employing two strategies in the study: first, the incorporation of fixed effects, and second, the management of zero trade flows. As Anderson and Van Wincoop (2003) indicate, traditional models that measure bilateral trade flows often neglect nations' bilateral heterogeneity and multilateral resistance. Anderson and Van Wincoop (2003) and Baldwin and Taglioni (2006), using panel data with fixed effects, provides an alternative to enhance the specification of these models. Accordingly, Magee (2008) advocates for the inclusion of a fixed effect representing consistent factors between pairs of nations over time, denoted as  $(\theta_{ij})$ . This coefficient captures the enduring impact on trade of specific factors unique to the pair of countries. Including these fixed effects leads to more robust estimates, as the model adjusts for the endogeneity of trade policies and accounts for bilateral heterogeneity, as stated by Baier and Bergstrand (2007).

However, Magee (2008) points out that the inclusion of fixed effects  $(\theta_{ij})$  and  $(\theta_{ji})$  falls short of capturing time-specific shocks for both importing and exporting countries. By controlling these shocks, the accuracy of the estimates can be improved, particularly by managing multilateral resistance. An effective approach to quantifying these trade-affecting factors, specific to the exporter and importer within a specific period, involves introducing time-varying fixed effects for both the exporting  $(\theta_{ji})$  and importing  $(\theta_{ii})$  countries in the bilateral trade equation. Therefore, these three fixed effects  $(\theta_{ij}, \theta_{ji}, \text{ and } \theta_{ii})$  have been included in Equation (6), with the fixed effect related to country pairs. It is important to note that including the fixed effect for pairs of countries omits variables that do not vary over time from the estimates, as demonstrated in Equation (6).

$$FRA_{it} = e^{[\theta_{ij} + \theta_{it} + \theta_{jt} + \theta_1 \ln N_{it} + \theta_2 \ln N_{jt} + \theta_3 B_{ij} \ln N_{it} + \theta_4 B_{ij} \ln N_{jt} + \theta_5 rta_{ijt}]} + v_{ijt} \quad (6)$$

While there is consensus in the literature on utilizing fixed effects in a panel data approach, challenges in estimating log-linearized parameters in the presence of zero trade flows have been highlighted by [Silva and Tenreyro \(2006\)](#), particularly due to assumptions related to homoscedasticity. As underscored by [Magee \(2008\)](#), prevalent solutions include either excluding pairs of countries with no trade from the sample or adding 1 to the bilateral trade flow before performing the logarithmic transformation [12], a strategy employed by [Eichengreen and Irwin \(1995\)](#). Nevertheless, [Silva and Tenreyro \(2006\)](#) argue that these estimates are inefficient and biased in the presence of heteroscedasticity. Consequently, the proposed solution uses the Poisson Pseudo Maximum Likelihood (PPML) estimator, which generates robust estimates despite heteroscedastic errors and with zeros present in bilateral flows between countries. The efficiency of the PPML estimator compared to other types of estimators [13] is further emphasized by [Magee \(2008\)](#).

### 2.1 Data

Our sample includes data from 133 countries [14] spanning the years 1996 to 2014. These nations represented approximately 99% of worldwide trade during this period. By employing the approach proposed by [Frankel and Romer \(1999\)](#), we constructed bilateral trade flows, resulting in 333,564 observations, of which 17,556 are annual. We measured dependent variables, including imports, exports, and income, in millions of current US dollars [15], with population and area data procured from UNCTADstat and the World Bank. Distance, expressed in kilometers, was obtained from the Center d'Etudes Prospectives et d'Informations Internationales (CEPII), and we also incorporated dummy variables for borders, coastlines, language, and colonial relations. The dummy variable for regional, multilateral, or bilateral agreements was sourced from Mario Larch's [16] database.

We constructed our instruments using annual data from 133 countries over 19 years, yielding 2,527 observations. In this sample, we sourced per capita income and mortality rates from the World Bank, property rights and investment freedom from the Heritage Foundation, the democracy indicator from Polity IV's political regime index, and the rule of law indicator from the Worldwide Governance Indicators. It is worth noting that we log-linearized the models and normalized the variables for the econometric estimation.

We employed several instrumental models to elucidate countries' level of integration, institutional quality, and mortality rates, as recommended by [Rodrik et al. \(2004\)](#). These models include [Rodrik et al. \(2004\)](#) with standard trade opening (RST), [Rodrik et al. \(2004\)](#) with trade opening proposed by [Squalli and Wilson \(2011\)](#) (RSTSW), [Rodrik et al. \(2004\)](#) with standard trade openness and estimated trade using PPML (RSTPPML), and [Rodrik et al. \(2004\)](#) with trade opening proposed by [Squalli Wilson \(2011\)](#) and estimated trade using PPML (RSTPPMLSW). Furthermore, we utilized paired models, Alternative model based on [Rodrik et al. \(2004\)](#) with standard trade opening (RSTAlt), [Rodrik et al. \(2004\)](#) with trade opening proposed by [Squalli and Wilson \(2011\)](#) (RSTAltSW), [Rodrik et al. \(2004\)](#) with standard trade openness and estimated trade using PPML (RSTPPMLAlt), and reference model used in the study with trade liberalization proposed by [Rodrik et al. \(2004\)](#) and estimated trade using PPML (REFMODSW), which account for a broader array of variables related to countries' commercial integration and institutions and mortality rates. The instruments utilized in the models are outlined in [Equations \(3 and 4\)](#).

We adopted two measures to assess countries' degree of integration. The first measure, standard openness, calculated by the sum of imports and exports relative to GDP, is widely accepted in the literature and was implemented in the RST, RSTAlt, RSTPPML, and RSTPPMLAlt models. The second measure, which accounts for a country's significance in

international trade, offers a more comprehensive metric of openness and was suggested by [Squalli and Wilson \(2011\)](#). This measure was incorporated into the RSTSW, RSTAltsW, RSTPPMLSW, and REFMODSW models. The [Supplementary materials](#) provide a detailed description of each model used in our study.

### 3. Results

Our study's reference model, REFMODSW, estimated via [Equations \(1–6\)](#), is detailed in [Table 1](#). The model reveals inelastic yet statistically significant parameters for the three determinants of per capita income. The trade variable yielded the highest coefficient, indicating that, given the weight of a country in global trade and the log-linear model, a one-percentage-point increase in economic openness is associated with an average rise in per capita income of approximately 0.8%. Conversely, the estimated coefficients for both institutions and geography were notably more inelastic, at just above 0.1 for both variables. This parameter suggests that for every one-percentage-point rise in the quality of a country's institutions and its distance from the Equator, per capita income tends to increase on average by about 0.1%.

Our findings agree with those of [Dollar and Kraay \(2003\)](#) and [Alcalá and Ciccone \(2004\)](#), who also identified trade as the primary determinant of economic growth. A trade-related coefficient of approximately 1.02 and 0.7 for institutions by [Alcalá and Ciccone \(2004\)](#). However, [Rodrik et al. \(2004\)](#), [Borrmann, Busse, and Neuhaus \(2006\)](#), [Freund and Bolaky \(2008\)](#), and [Mamoon and Murshed \(2017\)](#) emphasized institutions as the primary determinants of economic performance. In the primary model proposed by [Rodrik et al. \(2004\)](#), the effects associated with trade and geography were negative and insignificant, while the impact of institutions on per capita income demonstrated a positive and significant sign, approximately 1.9. The results of the reference model also diverge from those of [Angeles \(2010\)](#), who found no significant effects related to the impact of institutions on economic growth using a panel data approach.

The results of our study's reference model align with parameters found in previous research by [Dollar and Kraay \(2003\)](#), such as the direction of the trade impact on per capita income compared to institutions and geography in the short term. The findings suggest that countries with higher-quality institutions, greater trade openness, and a location further from the tropics tend to possess higher income levels, echoing the findings of other studies. For instance, [Rodrik et al. \(2004\)](#) and [Acemoglu, Johnson, and Robinson \(2005\)](#) identified trade, access to the ocean, and the strengthening of institutions as vital factors in explaining the economic growth of Western European countries. Furthermore, after accounting for geographic and institutional variables in the trade instrument, [Noguer and Siscart \(2005\)](#) posit that trade remains significant economically and statistically. In addition, [Gervais \(2015\)](#) found that trade is essential in determining per capita income, even when considering regional characteristics related to institutions.

The primary differences between the results found by studies that emphasize institutions over trade and this study relate to the data approach [\[17\]](#), the measurement of economic openness, and the construction of the trade instrument, particularly in the bilateral trade equation. In estimating the reference model, we addressed criticisms related to (1) heteroscedasticity by using the PPML estimator to estimate models with zeroed trade flows, (2) endogeneity by employing instruments for institutions and trade, and (3) bilateral heterogeneity and multilateral resistance by estimating the instrument related to bilateral trade flows with fixed effects for the importing country, the exporting country, and the pair of countries. According to [Baier and Bergstrand \(2007\)](#), including these effects reduce endogeneity problems. In addition, the reference model sought to minimize criticisms related to (4) omitted variable bias by including more variables in the instrument for trade and institutions than proposed by [Rodrik et al. \(2004\)](#). Finally, the reference model also addressed the criticisms of [Squalli and Wilson \(2011\)](#) regarding the measurement of economic openness.

**Table 1.** Reference model results

Variables	RST	RSTAlt	RSTSW	RSTAltSW	RSTPPML	RSTPPMLAlt	RSTPPMLSW	REFMODSW
lnstitution	0.275 (0.213)	0.088 (0.071)	0.648*** (0.121)	0.083*** (0.021)	3.615* (1.785)	0.143* (0.069)	0.933*** (0.160)	0.115*** (0.021)
lnIntegration	1.657*** (0.210)	1.432*** (0.095)			4.403** (1.596)	1.302*** (0.087)		
lnGeography	0.374* (0.150)	0.423** (0.136)	-0.143 (0.083)	0.123* (0.050)	-0.543 (0.502)	0.410** (0.127)	-0.271* (0.112)	0.111* (0.050)
lnIntegrationSW			1.079*** (0.064)	0.790*** (0.016)			1.208*** (0.084)	0.799*** (0.016)
Constant	0.105*** (0.018)	0.087*** (0.012)	0.008 (0.006)	0.006 (0.004)	0.271** (0.103)	0.082*** (0.011)	0.008 (0.008)	0.005 (0.004)
<i>N</i>	2,361	2,334	2,361	2,334	2,361	2,334	2,361	2,334
<i>R</i> <sup>2</sup>	0.022	0.010	0.589	0.560	0.139	0.015	0.578	0.569
<i>EstEqBiCom</i>								
Fixed effect	Yes	Yes	Yes	Yes	No	No	No	No
PPML	No	No	No	No	Yes	Yes	Yes	Yes
<i>Trade opening</i>								
Standard	Yes	Yes	Yes	Yes	No	No	No	No
Squalli Wilson	No	No	No	No	Yes	Yes	Yes	Yes
<i>Instrument</i>								
Base on RST	Yes	No	Yes	No	Yes	No	Yes	No
Alternative	No	Yes	No	Yes	No	Yes	No	Yes

**Note(s):** ESTEqBiCom: Bilateral Trade Equation Estimators. The natural logarithm is represented by “ln” before the independent variables. IntegrationSW is the integration measure proposed by [Squalli and Wilson \(2011\)](#). Standard errors are in parentheses. Significance levels are as follows: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

**Source(s):** Elaborated by the authors

The estimated parameters for the other models indicate that institutions, commerce, and geography are vital in explaining differences in per capita income. As the literature suggests, the coefficients display the expected signs and are statistically significant in most cases. The exception pertains to the estimated geographical parameters, specifically in the RSTSW, RSTPPML, and RSTPPMLSW models. Although statistical significance is observed only in the RSTPPMLSW model at the 10% level, the other models demonstrate a positive sign, statistical significance, and low geographic income elasticity of coefficients. As the latitude increases, the per capita income observed in the countries also rises. Notably, trade exerts a more robust effect on per capita income levels than institutions' performance.

The parameters related to trade [18] are elastic, statistically significant, and bear the expected sign to explain changes in countries' per capita income over time, consistent with findings from [Brueckner and Lederman \(2015\)](#) previous studies. On the other hand, institutions present inelastic coefficients, except for Model 5. Six models show statistical significance, and all have positive signs, which were anticipated a priori.

### 3.1 Robustness tests

This subsection estimates the sensitivity of per capita income to institutions, trade, and geography through three different specifications. The first specification (1) deploys alternative econometric approaches to estimate the trade-related instrument. The second specification (2) considers the parameters' structural break by scrutinizing diverse sample periods. The third specification (3) probes the sensitivities about country income level variations. The models employed to assess the robustness of the reference model are displayed in the [Supplementary materials](#), all of which were estimated using PPML.

In assessing the robustness of the estimates, the model specification was modified in terms of the construction of instruments correlated to countries' trade. In particular, the fixed effect pertinent to the pair of countries ( $\theta_{ij}$ ), was removed from the reference and other models. It is important to note that some criticisms about the omission of such fixed effects exist. For instance, the utilization of trade policies to control endogeneity and the incapacity to address heterogeneity within the bilateral trade equation has been underscored in prior studies such as those by [Baier and Bergstrand \(2007\)](#) and [Egger \(2005\)](#), which center on the gravity model.

The models estimated, which do not incorporate the fixed effect of the pair of countries, are denoted as alternative model defined of [Rodrik et al. \(2004\)](#) with standard trade openness and estimated trade via PPML with two fixed effects (RSTPPML2Alt). The reference model used in the study with trade openness proposed by [Squalli and Wilson \(2011\)](#) and trade estimated via PPML estimated with two fixed effects (REFMOD2SW) is shown in the [Supplementary materials](#). A marginal difference is detected in the differentials between the estimated parameters, observing smaller effects for the coefficients correlated to institutions and larger effects for the coefficients tied to trade and geography when compared to the RSTPPMLAlt and REFMODSW models. The direction and statistical significance of the parameters remain consistent, except for the significance of the institutions in the RSTPPML2Alt model, which experiences an insignificant alteration in the magnitude of the estimated coefficients. It is crucial to acknowledge that models only considering the fixed effects of the importing and exporting countries could be subject to bias, grounded on criticisms posited by preceding studies such as those by [Baier and Bergstrand \(2007\)](#) and [Egger \(2005\)](#).

The second robustness test is designed to discern whether the coefficients associated with institutions and trade manifest structural breaks when elucidating nations' per capita income alterations. This estimation is pivotal to evaluating if institutions and trade's effects vary across the 19-year span investigated in the sample. Accordingly, new parameters were determined considering shorter intervals instead of estimating the model for the comprehensive period. The sample was partitioned into three subperiods to authenticate coefficient differences: the first encompasses the period from 1996 to 2001, the second from 2002 to 2007, and the third from 2008 to 2014. As the sample spans 19 years, the first two periods each account for six

years, with the final period comprising a seven-year sample for the countries. The results are displayed in the [Supplementary materials](#).

The estimated parameters, primarily those connected to trade, display an upward trajectory with positive and statistically significant coefficients, excluding the significance detected in the alternative model proposed by [Rodrik et al. \(2004\)](#) with standard trade openness and estimated trade via PPML considering the period from 1996 to 2001 (RSTPPMLAlt2001) model. This result implies that countries have been liberalizing their economies over time, and such economic policies promote elevated levels of per capita income. The principal impacts of trade on per capita income transpired in the concluding period between 2008 and 2014, with heightened elasticities, as indicated by the reference model used in the study with trade liberalization proposed by [Squalli and Wilson \(2011\)](#) and estimated trade via PPML considering the period from 2008 to 2014 (REFMODSW2014) and alternative model proposed by [Rodrik et al. \(2004\)](#), with standard trade openness and estimated trade via PPML considering the period from 2008 to 2014 (RSTPPMLAlt2014) models. The findings of the reference model deviate from the coefficients identified by [Le \(2009\)](#) in the short term; namely, trade did not yield significant results within briefer periods. The significant results for trade, with the short-term elasticity being less than unity and becoming elastic over the long term, were revealed by [Brueckner and Lederman \(2015\)](#).

The coefficients correlated with institutions exhibited positive signs, barring the alternative model proposed by [Rodrik et al. \(2004\)](#) with standard trade openness and estimated trade via PPML considering the period from 2002 to 2007 (RSTPPMLAlt2007) model, and were primarily statistically significant. For example, during the 2008–2014 period, the coefficients associated with institutions, while not significant concerning standard trade openness (0.630), were positive and significant for the entire duration (0.143). Similarly, when moderating for trade employing the measure of [Squalli and Wilson \(2011\)](#), the institutions displayed a positive sign and statistical significance for the entire span (0.115) and a positive sign, albeit without statistical significance, for the 2002–2007 period (0.233). These findings are presented in the REFMODSW, and reference model used in the study with trade liberalization proposed by [Squalli and Wilson \(2011\)](#) and estimated trade via PPML considering the period from 2002 to 2007 (REFMODSW2007) models, respectively.

An additional determinant of economic growth pertains to geography, which exhibited a positive sign for all periods and statistical significance in most of the presented models. The coefficients appear inflated when standard trade openness is integrated into the model. A plausible explanation is associated with the inclusion of the weight a given country carries in international trade, i.e. trade openness, when gauged in this manner, tends to mitigate the endogeneity problem, as underscored by [Squalli and Wilson \(2011\)](#).

Upon integrating the standard trade openness measure into the model, the period with the highest coefficient for geography (0.436) emerges during 2002–2007, a value closely aligning with the estimated coefficient for the entire period (0.410). In the models that incorporate the trade openness measure proposed by [Squalli and Wilson \(2011\)](#), the impact of geography on nations' per capita income fluctuates from (0.372) for the period 1996–2001 to (0.065) for the period 2002–2007, despite the latter period not exhibiting statistical significance. Notably, the coefficient for geography for the entire period was (0.111), which is positive and statistically significant.

The final robustness test examined the divergent income levels of countries, following the classification [19] by the World Bank. The sample was segregated into three subgroups: high-income countries, middle-income countries [20], and low-income countries. The first group encompasses 49 countries, the second comprises 63 countries, and the third consists of 21 countries. It is expected that institutions are more advanced in high-income countries and that a positive relationship exists between trade openness and per capita income across all three groups of countries. In other words, countries with superior institutions tend to engage in more trade and have higher per capita income levels, as suggested by prior studies such as [Dollar and Kraay \(2003\)](#) and [Levchenko \(2007\)](#).

However, as underscored by Frick and Rodríguez-Pose (2016), Noguera and Siscart (2005), and Kim (2011), the impact of trade liberalization on developing nations remains an unresolved question, given that empirical evidence does not conclusively determine the effect of trade on economic growth. Levchenko (2007) also asserts that research conducted by Acemoglu *et al.* (2001) and Acemoglu, Johnson, and Robinson (2002) indicates that developed countries possess superior institutions to their developing counterparts. Based on this observation, differences in institutions may serve as a source of comparative advantage in trade, as articulated by Levchenko (2007).

Broadly, the findings in Table 2 affirm that better institutions correlate with elevated levels of per capita income, especially in countries with the highest income brackets, as demonstrated by the alternative model proposed by Rodrik *et al.* (2004) with standard trade openness and estimated trade via PPML considering high-income countries (RSTPPMLAltHigh) and reference model used in the study with trade liberalization proposed by Squalli and Wilson (2011) and trade estimated via PPML considering high-income countries (REFMODSWHigh) models. The coefficients estimated for this subgroup of countries range from (0.326), utilizing the standard trade openness measure, to (0.307), using the trade reference measure proposed in this study. These results suggest that high-income countries harbor better institutions, contributing to economic growth.

In terms of nations classified as low per capita income, the inferior quality of institutions adversely affects economic performance, as indicated by negative and statistically significant coefficients. Mitton (2016) also reported similar findings concerning the negative impact of institutional quality when regional institutions are subordinated to national institutions. Additionally, Kim (2011) underscores that countries with subpar institutional quality may not fully reap the benefits of economic openness. Moreover, Angeles (2010) found no evidence to suggest that robust institutions stimulate economic growth. The low institutional quality observed in these countries also influences their export portfolio, as mentioned by Méon and Sekkat (2008) [21]. Similarly, in analyzing the dynamics of exporting firms, Araujo, Mion, and Ornelas (2016) posit that enduring trade relationships between firms and nations materialize only in the presence of solid institutional quality in the countries.

Openness constitutes a pivotal factor in determining per capita income, even after adjusting for institutions and geography, irrespective of a country's income level. Table 2 illustrates that all the coefficients are positive and statistically significant, signifying that amplified trade positively influences per capita income levels, even in low-income countries. However, middle, and high-income countries reap more benefits from trade, as quantified by Squalli and Wilson (2011), with coefficients of (0.921) and (0.896), respectively. In contrast, the impact of trade on low-income countries sits at (0.406), less than half of the influence observed in other countries. These findings align with those of Tahir and Azid (2015), who emphasize the importance of trade openness in fostering economic growth in developing nations using diverse measures of economic openness.

The robustness tests reaffirm the validity of the results derived from the reference model and the pertinence of trade, institutions, and geography in explicating countries' per capita income levels. The impact of these variables is more pronounced in high-income countries and less so in low-income countries, particularly concerning the institutional coefficient. Trade is pivotal in nations' economic performance, with heightened significance for middle and high-income countries. Therefore, the results indicate that low-income countries must enhance the quality of their institutions and advocate economic openness, as this would contribute to elevating their per capita income.

#### 4. Conclusion

This study aimed to evaluate the impact of trade, institutions, and geography on economic growth. To mitigate the bias induced by endogeneity, we applied an instrument devised based on the research of Frankel and Romer (1999) and the estimator put forth by Silva and Tenreiro

**Table 2.** Differences in coefficients based on the income level of countries

Variables	RSTPMLALow	RSTPMLAItAverage	RSTPMLAItHigh	RSTPMLAIt	REFMODSWLow	REFMODSWAverage	REFMODSWHigh	REFMODSW
lnstitution	−0.229*** (0.062)	0.116 (0.111)	0.326 (0.182)	0.143* (0.069)	−0.104** (0.037)	0.132*** (0.028)	0.307*** (0.048)	0.115*** (0.021)
lnIntegration	0.366*** (0.032)	1.480*** (0.212)	0.868*** (0.177)	0.302*** (0.087)				
lnGeography	0.083 (0.116)	0.025 (0.167)	0.934** (0.330)	0.410** (0.127)	0.076 (0.059)	−0.054 (0.080)	0.116 (0.225)	0.111* (0.050)
lnIntegrationSW					0.406*** (0.020)	0.921*** (0.029)	0.896*** (0.022)	0.799*** (0.016)
Constant	−1.367*** (0.044)	−0.160* (0.063)	0.543*** (0.156)	0.082*** (0.011)	0.911*** (0.040)	−0.180*** (0.015)	0.169*** (0.046)	0.005 (0.004)
N	330	1,130	874	2,334	330	1,130	874	2,334
R <sup>2</sup>	0.066	0.007	0.029	0.015	0.256	0.181	0.360	0.569
<i>EstEqBiCom</i>								
Fixed effect	No	No	No	No	No	No	No	No
PPML	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Trade opening</i>								
Standard	Yes	Yes	Yes	Yes	No	No	No	No
Squalli Wilson	No	No	No	No	Yes	Yes	Yes	Yes
<i>Instrument</i>								
Base on RST	No	No	No	No	No	No	No	No
Alternative	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
<i>Income level</i>								
Low	Yes	No	No	No	Yes	No	No	No
Average	No	Yes	No	No	No	Yes	No	No
High	No	No	Yes	No	No	No	Yes	No
All	No	No	No	Yes	No	No	No	Yes

**Note(s):** ESTEqBiCom: Bilateral Trade Equation Estimators. The natural logarithm is represented by “l” placed before the independent variables. IntegrationSW is the measure of integration calculated using Squalli and Wilson’s (2011) proposal. Standard errors are shown in parentheses. Significance levels: \* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.001$

**Source(s):** Prepared by the authors

(2006). Additionally, the economic openness measure recommended by Squalli and Wilson (2011) and the model proposed by Rodrik *et al.* (2004) were employed to lessen the bias arising from endogeneity. This study distinguished itself from the extant literature in its econometric methodology, leveraging a panel database with estimators that accounted for three dimensions (fixed effects) and employed Poisson's Pseudo Maximum Likelihood (PPML) in forming the trade instrument.

The outcomes of the econometric model suggest that trade, institutions, and geography play significant roles in elucidating countries' per capita income levels. Most of the estimated coefficients bear positive signs and are statistically significant. The coefficients of trade are notably high, implying that commercial interactions between countries constitute the principal driver of economic growth. Even after adjusting for null trade flows, fixed effects associated with importing and exporting countries and pairs of countries, and trade liberalization proposed by Squalli and Wilson (2011), the growth determinants remain positively significant. The findings underscore the collective role of trade, institutions, and geography in explaining variations in per capita income. While the results resonate with some aspects of the literature, such as Dollar and Kraay (2003) and Alcalá and Ciccone (2004), they diverge in their emphasis on the importance of institutions and trade for economic growth. The study underlines the prominence of trade as the primary catalyst for augmenting per capita income, while a significant portion of the literature, such as Rodrik *et al.* (2004), Borrmann *et al.* (2006), Freund and Bolaky (2008) and Mamoon and Murshed (2017), regards institutions as the chief determinant and trade as a vehicle for enhancing institutional quality. One plausible explanation for these findings is using estimators to devise the trade proxy based on bilateral trade flows. Another potential explanation might be tied to the temporal nature of the data utilized, which deviates from other studies, and the employment of panel data as opposed to the prevalent use of cross-sectional data in the literature for coefficient measurement.

The findings derived from the reference model are further corroborated by the robustness tests executed in this study. Removing the fixed effect of pairs of countries results in marginal alterations to the coefficients, which remain positive and statistically significant upon incorporating the weight of a country's international trade into the economic openness measure. Regarding the model's temporal stability, the upward trajectory observed in trade suggests that policies promoting trade liberalization effectively stimulate increases in countries' per capita income levels. For the three periods under consideration, institutions and geography also possess positive signs and statistical significance for most coefficients.

However, the impacts of trade, institutions, and geography appear less pronounced in low-income countries, particularly in parameters reflecting the influence of institutions on per capita income. In contrast, trade impacted countries of all income levels, including low-income ones, with greater elasticity observed in middle-income and high-income nations. These results suggest that institutional policies and trade openness transpire asymmetrically in countries, contingent on their degree of economic development. Therefore, the results illustrate that it is essential for countries, especially low-income ones, to enhance institutional quality and advocate economic policies geared towards trade liberalization to elevate per capita income levels.

Future research should explore the use of dynamic panel estimations, which can account for the temporal dynamics and feedback effects between institutions, trade, and economic growth. Additionally, a multilevel modeling approach could offer valuable insights into how institutional and trade policies affect distinct levels of economic development across regions and countries. Further refinement of the institutional instrument equation, particularly through the inclusion of more robust, historically based variables, could also improve the accuracy of the institutional measures, as highlighted by previous critiques.

## Notes

1. Endogeneity presents itself when a correlation occurs between one or multiple explanatory variables and the stochastic error term. For example, both fiscal and monetary policies influence a country's per capita income.
2. An estimator is employed to tackle the concern associated with endogeneity. An instrument can be characterized as a variable that is not included in the initially proposed equation, yet it is correlated with one or more explanatory variables. Two pivotal characteristics of instrumental variables deployment are: (1) the necessity of the instrument to be correlated with one or more explanatory variables, and (2) its requirement to be uncorrelated with the stochastic error term.
3. The discussion on the significance of institutions in economic performance started with North's (1990) research, which emphasized that institutional change elucidates how society evolves and the variations in the long-term income growth of distinct countries.
4. The details of the empirical strategy used by [Rodrik \*et al.\* \(2004\)](#) are in the [Supplementary materials](#).
5. The methodology introduced by the Index of Economic Freedom (2020) evaluates the degree to which a country's legal framework permits individuals to obtain, possess, and use private property secured by law. The higher a country's index, the more effective the legal protection of property, and the lower the likelihood of government property expropriation. The indicator's value is an average of the scores of five indicators, including (1) physical property rights, (2) intellectual property rights, (3) investor protection, (4) risk of expropriation, and (5) quality of management agrarian. [Mittton \(2016\)](#), and other researchers employed this indicator as a proxy for institutions.
6. The rule of law, as emphasized by [Auer \(2013\)](#), is a cornerstone of stable institutions, directly influencing contract enforcement and overall economic stability. Its inclusion as an instrument for institutions is essential, particularly in former colonies where legal systems shaped by colonial history have left lasting impacts on institutional quality. Stronger rule of law leads to better governance and lower levels of corruption, fostering environments conducive to economic growth, making it a critical determinant of institutional frameworks and economic performance. Investment freedom and democracy are also key instruments for explaining both institutions and trade. As noted by [Bonnal and Yaya \(2015\)](#), stronger investment freedom promotes a dynamic market by reducing barriers, thus enhancing trade openness. Democracy, on the other hand, ensures political stability and accountability, which are crucial for institutional robustness. It strengthens the rule of law, creating an environment that promotes growth and trade by reducing risks for investors and traders. These factors, along with the historical role of British colonization and the adoption of the English language, as highlighted by [Hall and Jones \(1999\)](#), provide strong justifications for their inclusion as instruments in measuring the quality of institutions and trade integration.
7. No multicollinearity issues were detected for [Equations \(6 and 7\)](#), as the VIF results, including rule of law and democracy, were below 2.82, with none exceeding the critical threshold of 10. It is important to note that the VIF results were estimated using pooled OLS.
8. The index captures the perceptions of trust and compliance with societal norms among agents. It evaluates the quality of contract enforcement, property rights, police, justice, crime, and violence. The index can range from  $-2.5$  to  $2.5$ .
9. The index assesses seven indicators of regulatory restrictions that countries typically impose on investments. These indicators include (1) how foreign investment is treated, (2) the level of bureaucracy and transparency, (3) restrictions on land ownership, (4) sectorspecific investment restrictions, (5) expropriation of investments without fair compensation, (6) exchange control, and (7) capital control.
10. The body of research, including studies by [Vicard \(2011\)](#), [Baldwin and Taglioni \(2006\)](#), [Magee \(2008\)](#), indicates that trade tends to escalate when countries share a common language and historical ties.
11. Regional trade agreements typically involve lower tariffs or quotas to benefit the participating countries, at the expense of countries that did not take part in the agreement. The literature debate on these issues is linked to the concepts of trade creation and diversion first developed by [Viner \(1950\)](#). More recently, [Crawford and Laird \(2001\)](#) argue that concerns are associated with the impact of regional trade agreements on the multilateral system and their long-term effects on free trade.

12. This strategy was implemented to estimate models that were not estimated using PPML.
13. For instance, the approach proposed by [Helpman, Melitz, and Rubinstein \(2008\)](#) to estimate efficient parameters by estimating the probability that bilateral trade flow equals zero is based on the Probit model. This estimator, known as HMR, is valid when the random components of a given model are homoscedastic. Santos [Silva and Tenreyro \(2006\)](#) indicate that HMR estimates are highly sensitive in the presence of heteroscedasticity. Therefore, the reference model employed the PPML estimator to estimate the instrument related to countries' trade.
14. Listed in [Supplementary materials](#).
15. [Baldwin and Taglioni \(2006\)](#) contend that in instances where fixed effects associated with importing and exporting countries are included in the equation, using current values is preferable to real values.
16. Database source: The Regional Trade Agreements Database by Mario Larch, as presented in [Egger and Larch \(2008\)](#).
17. Works that emphasize the role of institutions over trade typically use cross-sectional data in most studies.
18. The parameters related to trade are elastic when using the standard economic openness in all models, and in half of the proposed models when economic openness is measured with the indicator proposed by [Squalli and Wilson \(2011\)](#).
19. This refers to the 2020 ranking.
20. Upper-middle-income and lower-middle-income countries were included in this group.
21. Specifically, countries with inferior-quality institutions tend to export more non-manufactured goods than manufactured goods.

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**Supplementary material**

The supplementary material for this article can be found online.

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