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## Article

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## ECONOMETRICS | RESEARCH ARTICLE

# Trade openness, income, and role of institutions: A revisit using heterogeneous panel data models

Jayanthi Thennakoon<sup>1\*</sup> and Jagath Dissanayake<sup>2</sup>

**Abstract:** The positive association between trade openness and income has been debated over years due to serious estimation flaws prevailing in the cross-country empirical trade literature. The present paper contributes to this debate by re-examining the long-run relationship between trade openness and income per capita focusing on role of institutions. It does so by estimating a heterogeneous panel data model with 97 countries over the period 1980–2012 taking unobserved common factors into consideration. Our method is a more appropriate approach to estimate this relationship given the potential cross-section dependence and parameter heterogeneity associated with cross-country growth regressions. The results have found evidence to suggest that trade openness is positively and significantly associated with income per capita even after controlling for parameter heterogeneity, cross-section dependence and possible endogeneity. Results further suggest that better quality institutions complement the effects on income underscoring the significance of institutions in benefiting more from trade openness. This study provides more reliable estimates to support the claim that trade openness has significant and robust role on economic growth and development.

**Subjects:** International Trade (incl. trade agreements & tariffs); Econometrics; Development Economics

**Keywords:** common factor models; cross-section dependence; international trade; economic growth of open economies

**JEL classifications:** F1; F43; C21; C23

### ABOUT THE AUTHORS

Authors' research interests include economics and political economy of trade policy interventions and applied econometrics including panel data modeling. Authors intend to bring the discussion on common factor modeling into mainstream trade literature.

### PUBLIC INTEREST STATEMENT

International trade is considered vital in economic growth and development. While trade policy-makers continue to advice on trade liberalization, the empirical validity of existing quantitative evidence on the subject remains debatable due to serious estimation problems. The empirical model of this study employs a superior approach to re-estimate the trade-income relationship. It provides more reliable estimates to support the claim that trade openness has significant and robust role on economic growth, particularly for countries, which are yet to acknowledge the benefits of more open trade. Results also suggest that countries with better quality institutions benefit more from trade openness. The findings of this paper, which reinforce policy advocates on liberalizing trade and strengthening institutions including the legal system and political governance, are of public policy importance.

## 1. Introduction

Since the work, for instance by Grossman and Helpman (1990), Romer (1993), Young (1991), and Frankel and Romer (1999), a great deal of trade literature has attributed an important role to trade openness in generating economic growth, and policy-makers have continued to advocate on benefits of trade liberalization. Empirical validity of the positive association between trade openness and income has nevertheless been debated over years due to serious estimation flaws prevailing in the cross-country empirical literature. Rodriguez and Rodrik (2001) argue that trade-income literature seriously suffers from estimation problems including endogeneity. Yet, another argument is that the trade-income relationship becomes insignificant once the institutions are accounted for (Rodrik, Subramanian, & Trebbi, 2004). While cross-country regressions have been subject to the criticism of assuming parameter homogeneity across countries, recent strand of empirical literature suggests that cross-section dependency is another important issue that should be considered in estimation (Pesaran, 2004).

Considering the importance of accounting for these issues in empirical estimations, the late literature has attempted to control for institutions in trade-income estimation, and has addressed the possible bias associated with endogeneity focusing on instrumental variable approach. Especially pertinent in this regard include Frankel and Romer (1999), Lin and Sim (2012), Feyrer (2009) and Bruckner and Lederman (2012), which have primarily focused on finding an instrumental variable that can generate an exogenous variation for trade. Frankel and Romer (1999) use geographic distance between countries as an instrument for bilateral trade arguing that the distance is associated with trade costs, and is an exogenous variable. Feyrer (2009) suggests that the closing and re-opening of the Suez canal during 1967–1975 provide two major direct shocks to transport costs, and those shocks can be used to identify the exogenous variation in trade. Lin and Sim (2012) use cost of utilizing bulk carriers, as represented by the Baltic Dry Index (BDI), as an instrumental variable for trade in least developed countries (LDCs) arguing that BDI reflects trade cost of primary goods mainly traded by LDC with no market power to influence its variation. These studies rely on pooled estimators implicitly assuming parameter homogeneity across countries. Importantly, however, if the underlying true model is parameter heterogeneous, this assumption affects the consistency of regression estimates. Furthermore, a use of an instrumental variable to tackle the issues associated with endogeneity does not necessarily solve other estimation flaws arising from unobserved common factors. In the presence of cross-section dependence and the fact that trade is unlikely to have homogenous impacts across countries, the results of the existing studies therefore remain debatable for their empirical validity and interpretation.

Despite that there is little empirical evidence accounting for cross-section dependence and parameter heterogeneity in estimation of trade-income relationship,<sup>1</sup> recent literature is aware of the econometric importance of cross-section independence and parameter heterogeneity in empirical analysis. Pesaran (2004) provides evidence of cross-section dependence in GDP series, and suggests that it should be taken into account in cross-country studies. Cross-section dependence in per capita GDP data can arise when unobserved common shocks, such as technology shocks and financial crisis, affect income in all countries in the sample (Bai, 2009). Since these unobserved shocks are likely to be correlated with trade variables, it is likely that trade is endogenous in income determination. Parameter heterogeneity also has potentially serious implications for cross-country growth regressions where underlying slope parameters are unlikely to vary randomly across countries and distribute independently from the variables in the regression and the disturbances (Durlauf, Johnson, & Temple, 2005). Empirical literature suggests that heterogeneity can be better addressed by employing panel data methods than cross-section data methods (Baltagi & Hashem Pesaran, 2007; Baltagi & Moscone, 2010; Eberhardt & Teal, 2011).

In this paper, we propose an alternative approach to re-estimate the trade-income relationship with a focus on role of institutions by relaxing two major restrictive assumptions prevailing in the existing cross-country trade literature: parameter homogeneity and cross-section independence. It

does so by estimating a heterogeneous panel data model with multi-factor error structure controlling for unobservable common factors. We also attempt to address the issue of endogeneity associated with trade-income determination in this context through a multi-factor error structure by allowing unobserved common factors to be correlated with observed factors. Furthermore, we not only control for institutions in our estimation, but also estimate the effects of institutions when accompanying with trade openness.

We find that trade is positively and significantly associated with income per capita, and better quality institutions complement the effect of trade on income. We believe that our method involving common factor modeling is more appropriate in estimating trade-income association given the potential cross-section dependence and parameter heterogeneity associated with cross-country regressions. To the best of our knowledge, this study is the first study in the cross-country trade-growth literature that estimates elasticities by allowing parameter heterogeneity in both observables and un-observables while controlling for endogeneity of trade in income determination with a focus on the role of institutions.

The paper is organized as follows. Section 2 introduces the econometric model, and Section 3 explains data. The results are discussed in Section 4. Section 5 concludes.

## 2. The econometric model

We follow standard trade literature, for instance Frankel and Romer (1999), to construct our reduced form model of trade and income, and rely on Pesaran (2006) and Kapetanios, Pesaran, and Yamagata (2011) for our estimation. We estimate the following panel regression model accounting for parameter heterogeneity.

$$\ln Y_{it} = \alpha_i + d_t + \beta_i X_{it} + u_{it}, \quad i = 1, \dots, N; \quad t = 1, \dots, T \quad (1)$$

where  $Y_{it}$  is Real GDP per capita in the  $i$ th country at time  $t$ ,  $X_{it}$  is the  $k \times 1$  vector consisting of regressors,  $\alpha_i$  is a country specific intercept,  $d_t$  is a time dummy, and  $u_{it}$  is the error term.

In response to the recent criticisms on cross-country estimation of trade-income association, we incorporate cross-section dependence in Equation 1 assuming the following multifactor structure.

$$u_{it} = \gamma_i f_t + \varepsilon_{it} \quad (2)$$

where  $f_t$  is a  $m \times 1$  vector of unobserved common effects and  $\varepsilon_{it}$  is a country specific error, which is assumed to be identically and independently distributed. This framework allows having a correlation between cross-sectional units (country pairs in this study). Here correlations between cross-sectional units are resulted from responses to common external shocks, which are similar but not identical across countries. Furthermore,  $X_{it}$  are assumed to be correlated with unobserved effects  $f_t$ , and hence, income per capita is affected by common factors directly through the factor structure as well as through the regressors indirectly.

As for the baseline specification, we include *Trade Openness* in the vector of  $X_{it}$  to find out the effects of trade openness on Real GDP per capita. In the second specification, we estimate the same model including *Law and Order* as a proxy variables for *Institutions* ( $I_i$ ) to assess the claim whether the estimated effect becomes insignificant once the institutions are accounted for. In the third specification, we attempt to assess whether better institutions strengthen the effect of openness on income by incorporating an interaction term between *Trade Openness* and *Institutions*.

We begin with estimating a pooled regression model with a homogenous panel. Next, the respective models are estimated with a heterogeneous panel model addressing parameter heterogeneity. Then, we address the issues of cross-section dependence and endogeneity by estimating common correlated effects mean group estimator (MGCE) proposed by Pesaran (2006) and Kapetanios et al. (2011).

Finally, we not only control for *Institutions* but also attempt to assess whether better institutions strengthen the effect of openness on income per capita by incorporating an interaction term between *Trade Openness* and *Institutions*.

### 3. Data

The key variables used in the analysis are *Real GDP* per capita, *Trade Openness* and *Law and Order*. The GDP per capita data measured in constant 2005 US\$ are obtained from World Development Indicators of World Bank (World Bank, 2013). Following the standard norm in trade-income literature, trade openness is measured as the the sum of exports and imports in constant 2005 US\$ over constant PPP GDP available from the same database. To assess the role of institutions in determining trade-income relationship, we employ data on *Law and Order* obtained from International Country risk Guide (The PRS Group, 2012). This variable represents strength and impartiality of the legal system and popular observance of the law. Its score ranges from 0 to 6 with a higher score indicating a better quality legal system. We also make use of data on *Polity2*, as an alternative measure of institutions for comparison purpose, obtained from Polity IV database of Marshall and Jaggers (2009), which ranges from –10 to 10 where higher figures indicating more democratic countries.

From the above available data, we select a sample of countries with 20 or more observations for each country so that our main estimation technique involving common factor model with a multi-factor error structure retains its better data properties. Our sample consists of 97 countries over the period 1980–2012. Table 1 reports summary statistics for the variables.

Given that our data-set is an unbalanced panel with *Law and Order* consisting of lower number of observations compared to *Trade Openness*, a reduced number of observations are used for the scenarios with *Law and Order*. The key variable of interest in this study is *Trade Openness*, and thus, for the baseline scenario testing trade-income association without controlling for institutions, we keep all observations of *Trade Openness* in the estimation.

### 4. Results and discussion

Table 2 presents the results obtained from homogenous panel data model by assuming homogeneous impacts of trade and institutions on income. Estimates in column (1) and (2) suggest that there is a positive association between trade openness and income per capita. In response to Rodrik et al. (2004), we then test whether the trade-income relationship would change with inclusion of *Law and Order* in the model. Looking at the results in column (3) and (4), the relationship between trade and income per capita remains significantly positive despite accounting for institutions. Nevertheless, pooled estimates assume slope homogeneity, and therefore the results in Table 2 could be biased and inconsistent.

We next employ heterogeneous panel models allowing slope heterogeneity in mean group estimation. We do not econometrically test for heterogeneity to support the use of a heterogeneous panel data model. Instead, we rely on the existing literature, for instance, Harberger (1987), Pesaran and Smith (1995) and Durlauf, Kourtellos, and Minkin (2001) to justify the presence of heterogeneity in cross-country data. The assumption of homogeneity is a common criticism for estimations involving cross-country growth regressions (Durlauf et al., 2001). Harberger (1987) questions the homogeneity assumption mentioning that “what do Thailand, the Dominican Republic, Zimbabwe, Greece, and Bolivia have in common that merits their being put in the same regression?” (Harberger, 1987; p. 256).

**Table 1. Summary statistics of the key variables**

Variable	Number of observations	Mean	SD
ln Real GDP per capita	3122	8.188081	1.640744
Trade Openness	2978	.4811129	.471347
Law and Order	2762	3.783646	1.499376
Polity2	3013	3.55692	6.759173

**Table 2. Estimation results for homogenous panel model**

Dependent variable: ln (GDP per capita)				
	FE	2FE	FE	2FE
	(1)	(2)	(3)	(4)
Trade Openness	.6429937*** (.12081)	.2296661*** (.0739366)	.6332904*** (.1127267)	.2088776*** (.0718565)
Law and Order			.0461112*** (.0149796)	.039467*** (.0130473)
Time FE	No	Yes	No	Yes
Country FE	Yes	Yes	Yes	Yes
Number of observations	2976	2976	2624	2624
Number of groups	97	97	97	97

Note: The method of estimation is least squares. FE: fixed effects, 2FE: fixed effects with time effects. Robust standard errors are given in the parenthesis.

\*\*\*Significantly different from zero at 1%.

From their experience, Pesaran and Smith (1995) claim that the hypothesis of homogeneity is always rejected when they are tested. The results are presented in Table 3. First two columns reporting the results for the baseline specification suggest that the estimated effect of trade is positive and significant even after relaxing the assumption of homogeneity. Third and fourth columns with the variable *Law and Order* claim that the relationship between trade and income per capita remains significantly positive despite accounting for institutions.

We have found evidence of cross-sectional dependence in the panels (Table 4) indicating that it ought to be accounted for consistent estimation. Moreover, panel unit root tests accounting for cross-section dependence indicate that data series are non-stationary (Table 5). If cross-section dependence and parameter heterogeneity are present in the data, the usual methods to estimate the trade-income relationship may fail to produce unbiased results. Thus, both heterogeneity and

**Table 3. Estimation results for heterogeneous panel model**

Dependent variable: ln (GDP per capita)				
	MG	MG	MG	MG
	(1)	(2)	(3)	(4)
Trade Openness	1.376913*** (.227698)	.7444219*** (.1320468)	1.55909*** (.2019188)	.478983*** (.1371125)
Law and Order			.0032991 (.010376)	-.0014522 (.0070101)
Trend	No	Yes	No	Yes
Number of observations	2976	2976	2624	2624
Number of groups	97	97	97	97

Note: MG: Mean group estimator. Standard errors are given in the parenthesis.

\*\*\*Significantly different from zero at 1%.

**Table 4. Cross-section dependence of the main variables**

Variable	CD-test value	Test-p value
ln Real GDP per capita	192.72	.000
Trade Openness	144.44	.000

Note: The test is done under the null hypothesis of cross-section independence.

**Table 5. Pesaran's CADF test for panel unit root tests**

	Number of lags			
	0	1	2	3
With an intercept only				
ln Real GDP per capita	.825	−1.203	−.545	−.730
Trade Openness	2.407	2.790	5.320	1.891
Law and Order	1.265	.353	2.422	3.217
With an intercept and trend				
ln Real GDP per capita	1.676	−1.282	1.410	.970
Trade Openness	3.077	3.083	5.639	3.201
Law and Order	−.576	−1.127	3.359	4.593

Note: Table presents the z-values with the null hypothesis assuming that all series are non-stationary.

**Table 6. Estimation results for heterogeneous factor model**

Dependent variable: ln (GDP per capita)				
	MGCCE	MGCCE	MGCCE	MGCCE
	(1)	(2)	(3)	(4)
Trade Openness	.7537701***	.524323***	.5491221***	.421144***
	(.181189)	(.0997246)	(.1162439)	(.112554)
Law and Order			.020579***	.0154229**
			(.0059936)	(.0063543)
Trend	No	Yes	No	Yes
Number of observations	2976	2976	2624	2624
Number of groups	97	97	97	97

Note: MGCCE: Common correlated effects mean group estimator. Standard errors are given in the parenthesis.

\*\*\*Significantly different from zero at 1%.

\*\*Significant at 5% level.

cross-section dependence are accounted in our next estimation while endogeneity is addressed in the same context of multi-factor error structure. The results obtained from MGCCE estimation are presented in Table 6. Generally, these results indicate that there continues to be a significant positive effect of trade openness on real income per capita both in the baseline estimation (column 1 and 2) and in the second model accounting for institutions (column 3 and 4). These coefficients are similar in the sign and magnitude to those obtained in the existing literature that employs homogenous IV estimators. Nevertheless, in the presence of cross-section dependence and the fact that trade is unlikely to have homogenous impact across countries, the existing evidence remains debatable for their empirical validity and interpretation. Despite that our MGCCE estimation addresses cross-section dependence and parameter heterogeneity, one could still question the robustness of our results given that the data are non-stationary. However, if the relationship is co-integrated, our results are not spurious even though the data used in the estimation is non-stationary. As such, Maddala and Wu (1999) panel unit root test (MW), and Pesaran (2007) panel unit root test (CIPS) are conducted in the post-estimation. The results, in general, indicate that errors are stationary and there is a cointegrating relationship, which is sufficient to confirm that results are not spurious. Hence, from all models that we have estimated in this paper, we believe that a common factor model with MGCCE estimation provides a superior approach to estimating trade-income association.

Table 7 illustrates the results with the interaction term associated with trade openness and institutions to examine whether better institutions strengthen the effect of openness on income per capita. The coefficient of the interaction term is positive and significant, particularly, when a trend is included.



**Table 7. Estimation results for heterogeneous factor model with an interaction term of institutions**

	MGCCE	MGCCE
	(1)	(2)
<i>Trade Openness × Law and Order</i>	.1073716 (.1919723)	.3803887** (.1693357)
<i>Trade Openness</i>	.0304397 (.7514781)	−1.201091* (.6670121)
<i>Law and Order</i>	−.0455744 (.0499352)	−.0804804* (.0423719)
Trend	No	Yes
Number of observations	2624	2624
Number of groups	97	97

Note: MGCCE: Common correlated effects mean group estimator. Standard errors are given in the parenthesis.

\*\*Significant at 5% level.

\*Significant at 10% level.

This suggests that better quality institutions have a stronger impact on income per capita when institutions are accompanied with trade openness. In other words, better quality institutions complement the positive effects of trade openness on income. Given that the interaction term, the variable of interest in this case, is showing the correct sign, we are less concerned about the negative coefficients associated with *Trade Openness* and *Law and Order* because when an interaction term is included in the model, the variables involving the interaction term are not interpretable in isolation. The coefficients, in this case, show the conditional effect.

Following the existing literature, for instance by, Lin and Sim (2012) and Bruckner and Lederman (2012), we make use of *Polity2* as an alternative variable for institutions as a robustness check, and the results are presented in Table 8. The estimated results for the main specification between trade and income per capita are positive and significant supporting the main conclusions of the analysis. Despite that the coefficient for *Polity2* is negative, the main finding provides evidence against the claim of Rodrik et al. (2004) that trade–income association changes when institutions are accounted for. From Table 8, we demonstrate that the main findings are robust even when the analysis employs an alternative variable to control for institutions.

**Table 8. Estimation results for heterogeneous factor model with *Polity2* as an alternative variable for institutions**

Dependent variable: ln (GDP per capita)		
	MGCCE	MGCCE
	(1)	(2)
<i>Trade Openness</i>	.7122959*** (.1106792)	.5140405*** (.1029652)
<i>Polity2</i>	−.0014757 (.0022875)	−.0047219* (.0026391)
Trend	No	Yes
Number of observations	2828	2828
Number of groups	92	92

Note: MGCCE: Common correlated effects mean group estimator. Standard errors are given in the parenthesis.

\*\*\*Significantly different from zero at 1%.

\*Significant at 10% level.



## 5. Concluding remarks

This paper contributes to the existing debate on the empirical validity of trade–income association by re-examining the long-run relationship between trade and income per capita focusing on the role of institutions. In our estimation, we allow parameter heterogeneity, cross-section dependence, and possible endogeneity of trade in income determination. The results have found evidence to suggest that trade is positively and significantly related to income in the long run even after controlling for parameter heterogeneity, cross-section dependence, and endogeneity. We believe that our method involving common factor modeling is a more appropriate approach to estimating trade–income association given the potential cross-section dependence and heterogeneity associated with cross-country data. Our findings, by providing more reliable empirical evidence, support the conventional consensus that trade is one of the significant factors explaining growth and development. Our results further suggest that better quality institutions complement and contribute to higher income when the institutions are associated with more open trade. Thus, the results of this paper underscore the importance of institutions in benefiting more from trade openness.

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### Note

1. Sakyi, Villaverde, Maza, and Chittedi (2012) have attempted to study the trade growth relationship using a heterogeneous panel data model, but their estimation does not control for institutions. Their sample is also limited to middle-income countries.

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## Appendix

### List of countries in the analysis

Albania, Algeria, Argentina, Australia, Austria, Bahamas, Bangladesh, Belgium, Bolivia, Botswana, Brazil, Brunei Darussalam, Bulgaria, Burkina Faso, Cameroon, Canada, Chile, China, Colombia, Dem. Rep. Congo, Rep Congo, Costa Rica, Cote d'Ivoire, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Arab Rep Egypt, El Salvador, Ethiopia, Finland, France, Gabon, Gambia, Germany, Greece, Guatemala, Haiti, Honduras, China Hong Kong SAR, Hungary, Iceland, India, Indonesia, Islamic Rep Iran, Italy, Japan, Jordan, Kenya, Korea, Rep., Luxembourg, Madagascar, Malaysia, Mali, Malta, Mexico, Morocco, Mozambique, Namibia, Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Senegal, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syrian Arab Republic, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Yemen Rep, Zambia.



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