Geography, Institutions or Economic Integration?

An Econometric Analysis of the Fundamental Determinants of Economic Development in Latin America

Abstract

This essay analyses the role of geography, institutions and economic integration as fundamental determinants of economic development in Latin America. To account for the endogeneity of economic integration and institutions, I exploit the time dimension of panel data by using a set of internal instruments consisting of past observations of the instrumented variables. The results suggest that cross-country differences in institutional and geographical factors account to a large extent for the differences in economic development observed among Latin American countries. In particular, the analysis suggests that there are channels through which landlockedness, malaria, latitude, political rights and civil liberties, and the rule of law influence income levels in Latin America.

Keywords: economic development, institutions, geography, economic integration, Latin America.

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1 Introduction

> "The factors we have listed (innovation, economies of scale, education, capital accumulation, etc.) are not causes of growth; they *are* growth"
>
> —Douglass North and Robert Thomas

One can note large disparities when comparing cross-country economic performance in Latin America. For instance, Chile and Bolivia, two neighbouring countries, differ in their income levels by a factor greater than three[1]. The Solow model provides a framework that suggests that cross-country differences in physical and human capital may be the drivers of such disparities in income levels. This hypothesis has been empirically supported by Mankiw, Romer and Weil (1992), who found that cross-country differences in these factors explain to a large extent differences in economic performance.

One limitation of the Solow model is that it takes a country's physical and human capital as exogenous. Thus, North and Thomas (1973) suggest that these are at best proximate determinants of economic growth and development. In particular, the Solow model does not offer an explanation about the factors that determine the quality of human and physical capital, and thus are fundamental or 'deep' determinants of a country's economic development.

The literature has suggested three main factors as 'deep determinants' of economic development: geography, institutions, and economic integration. Traditionally, these hypotheses were studied as if they were mutually exclusive. In a seminal paper, Rodrik, Subramanian and Trebbi (2004) proposed a cross-sectional strategy to empirically analyse these three hypotheses simultaneously. Bleanley and Dimico (2010), Bhattacharyya (2004), Presbitero (2006) among others have followed Rodrik *et al.*'s (2004) cross-sectional framework to study the role of geography, institutions and economic integration as 'deep determinants' of economic development.

This paper aims to extend Rodrik *et al.*'s (2004) cross-sectional analysis by: (1) using various proxies to measure each 'deep determinant', (2) using panel data techniques to control for unobserved country heterogeneity and (3) focusing the analysis on Latin America[2]. Jacob and Osang (2015) and Brodzicki and Ciolek (2008) propose an estimation strategy for panel data using the Hausman—Taylor estimator. One of the weaknesses of the analysis by Brodzicki and Ciolek (2008) is that it does not account for the possibility of reverse causality[3] . Jacob and Osang (2015) address this concern by using the lagged values of institutional and economic integration proxies as the regressors themselves—since it is unlikely that present economic development can influence past institutions and economic integration. Instead of following the empirical approach in these studies, I propose a two-stage instrumental variables

[1] According to the International Labour Organization, Chile's GDP per capita in constant 2011 international USD was 22,197 whilst that of Bolivia was 6,531 (2015 data).
[2] List of countries available in appendix A.
[3] Where a country's economic development may influence its economic integration and institutional quality.

approach. The findings suggest that both geography and institutions are key fundamental determinants of economic development in Latin America.

This paper proceeds as follows. Section 2 discusses the econometric issues in estimating the causality of the ‘deep’ determinants on economic development and proposes an empirical strategy to account for these. In section 3, I describe the data used in this paper as well as the variables analysed. Section 4 proceeds by presenting and interpreting the results from our empirical strategy. In section 5, these are compared to other results from the literature and, where applicable, potential reasons for differences in these results are discussed. Section 5 also contains a discussion on using the results from the ‘deep determinants’ literature to identify policy recommendations and provides suggestions for the direction of future research. Finally, section 6 concludes.

2 Empirical Strategy

Our purpose is to simultaneously estimate the effect of the three 'deep determinants' on economic development. Hence, the static panel data model to estimate is of the form:

$$\ln y_{it} = \beta_0 + \beta_1 INST_{it} + \beta_2 GEO_i + \beta_3 INT_{it} + \lambda t + \alpha_i + \varepsilon_{it} \qquad (1)$$

$$i = 1, 2, \dots, N; t = 1, 2, \dots, T$$

In equation (1), $INST_{it}$, GEO_i, INT_{it} correspond to the institutions, geography and economic integration of country i at time t, and y_{it} is its income per capita. The variable t represents a time trend. The term α_i represents unobserved country heterogeneity and ε_{it} is the idiosyncratic error. Our purpose is to find consistent estimates for β to infer the relationships between the deep determinants and income per capita levels. However, geography, institutions and economic integration are composed of multiple dimensions and cannot be observed directly, so it is appropriate to use proxies. I decide to base my core specification on that proposed by Rodrik *et al.* (2004). In particular, our core specification includes the rule of law indicator from the World Governance Indicators, latitude and the trade to GDP ratio as proxies for institutions, geography and economic integration respectively. Subsequently, other proxies from the literature are be analysed.

The Random-Effects (RE) estimator is not appropriate to obtain β estimates in (1) as its assumption that α_i is uncorrelated with the explanatory variables is not likely to hold in our specifications[4]. A Fixed-Effects (FE) estimator could be used, but this approach would come at the cost of not obtaining estimates for the coefficients on geographical proxies, as these are time-invariant and would be eliminated by the within transformation. Therefore, I use the instrumental variables estimator derived by Hausman and Taylor (1981), which relaxes the RE assumptions and allows to estimate the coefficient on time-invariant variables. The Hausman–Taylor (HT) estimator distinguishes between four types of explanatory variables X_1, X_2, Z_1 and Z_2; where X_1 and X_2 are time-variant and Z_1 and Z_2 are time-invariant. The variables indexed with a 1 are assumed not to be correlated with α_i nor ε_{it}, whilst those indexed with a 2 are allowed to be correlated with α_i, but not ε_{it}[5]. To address the correlation with α_i, the HT estimator instruments X_2 with its deviation from individual means, and Z_2 with the individual average of X_1 (Verbeek, 2004). For the model to be identified, it is required that there are at least as many time-variant variables uncorrelated with α_i (X_1) as time-invariant variables correlated with α_i (Z_2) (Baltagi, Bresson and Pirotte, 2003). This condition is satisfied, as t is X_1, and none of our specifications contain Z_2.

[4] In a Hausman specification test, we reject the null hypothesis that the RE estimator is consistent in our specifications.

[5] Following Jacob and Osang (2015), geographical proxies are classified as Z_1, and institutional and economic integration proxies are classified as X_2.

One limitation of the Hausman–Taylor estimator is that its assumption that the explanatory variables are uncorrelated with the idiosyncratic error may be violated in equation (1). Particularly, a country's income levels may influence its institutional quality and level of economic integration[6] (Chang, 2011, Helpman, 1988). If this is the case, then the β estimates obtained from the Hausman–Taylor estimator are biased. To address this concern, we require valid instrumental variables. In particular, these should be correlated with the instrumented variables but uncorrelated with the idiosyncratic error term ε_{it}. Rodrik *et al.* (2004) use the Frankel-Romer instrument and potential settler mortality as instrumental variables in a Two-Stage Least Squares regression.

I decide not to use these instruments for two main reasons. Firstly, as a time-invariant instrument, potential settler mortality cannot explain changes in institutional quality over time. In addition, the accuracy of these estimates has been criticised. For example, Albouy (2012) notes that the mortality rates for 7 Latin American countries were assumed to be identical to that of Mexico based on the premise that these countries share similar disease environments. Secondly, the Frankel-Romer instrument was constructed only for one year and has not been updated to cover Latin American countries for the period I intend analyse. Furthermore, Rodriguez and Rodrik (2001) argue that it may be correlated with channels, other than economic integration, through which geography may influence income levels, so it may not be a valid instrument.

Instead of using external instruments, I exploit the time dimension of panel data by using the second and third lagged values of the institutional and economic integration proxies as instrumental variables[7]. These satisfy the first condition of valid instruments, namely that they are correlated with the endogenous variables [8]. This result is intuitive if we consider that the quality of a country's institutions and the level of its economic integration in a given year are influenced by past levels of institutional quality and economic integration respectively[9]. The second condition, that the instruments are exogenous in equation (1), cannot be formally tested. Nonetheless, it is sensible to assume that a country's past institutional quality and economic integration levels cannot directly influence current levels of income per capita. Hence, any effect that past institutional quality and economic integration levels may have on current income per capita levels must come via current institutions and economic integration respectively.

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[6] Formally speaking, this implies that institutional and economic integration proxies are correlated with the idiosyncratic error ε_{it}. Hence, the Hausman–Taylor estimator assumptions that $COV(X_{it}, \varepsilon_{it}) = 0$ and $COV(Z_{it}, \varepsilon_{it}) = 0$ are violated.

[7] Reed (2015) discusses this identification strategy.

[8] Their coefficient of correlation is reported in appendix B.

[9] In other words, strong institutions today will likely translate into strong institutions tomorrow; just as weak institutions today will likely translate into weak institutions tomorrow. The same reasoning applies to economic integration.

We model unobserved heterogeneity as random effects and use the Generalized Two-Stage Least Squares (G2SLS) estimator proposed by Balestra and Varadharajan-Krishnakumar (1987)[10]. Our reduced form equations and structural equation are the following:

$$INST_{it} = \pi_0 + \pi_1 INST_{i,t-2} + \pi_2 INST_{i,t-3} + \pi_3 GEO_i + \pi_4 INT_{i,t-2} + \pi_5 INT_{i,t-3} + \omega_i + \theta t + \nu_{it} \quad (2.1)$$

$$i = 1, 2, \dots, N; t = 1, 2, \dots, T$$

$$INT_{it} = \gamma_0 + \gamma_1 INST_{i,t-2} + \gamma_2 INST_{i,t-3} + \gamma_3 GEO_i + \gamma_4 INT_{i,t-2} + \gamma_5 INT_{i,t-3} + \psi_i + \varphi t + \eta_{it} \quad (2.2)$$

$$i = 1, 2, \dots, N; t = 1, 2, \dots, T$$

$$\ln y_{it} = \beta_0 + \beta_1 INST_{it} + \beta_2 GEO_i + \beta_3 INT_{it} + \lambda t + \alpha_i + \varepsilon_{it} \quad (2.3)$$

$$i = 1, 2, \dots, N; t = 1, 2, \dots, T$$

The first stage in G2SLS consists on estimating the reduced form equations (2.1) and (2.2), in which the endogenous variables $INST_{it}$ and INT_{it} are a function of the instrumental variables and the exogenous variables. The estimates from the first stage are used to obtain the fitted values $\widehat{INST}_{it}$ and $\widehat{INT}_{it}$. These are then used as regressors in the second stage, which proceeds by estimating equation (2.3) to obtain consistent estimates for β. Intuitively, this strategy addresses simultaneity since y_{it} does not influence $\widehat{INST}_{it}$ nor $\widehat{INT}_{it}$.

Bond, Hoefler, and Temple (2001) address simultaneity in a growth regression by using the system Generalised Method of Moments (GMM) estimator from Arellano and Bover (1995) and Blundell and Bond (1998). Including period-specific intercepts λ_t, the dynamic panel data growth model to estimate becomes:

$$\Delta \ln y_{it} = \lambda_t + (1 - \delta) \ln y_{i,t-1} + \beta_1 INST_{it} + \beta_2 GEO_i + \beta_3 INT_{it} + \alpha_i + \varepsilon_{it} \quad (3)$$

$$i = 1, 2, \dots, N; t = 1, 2, \dots, T$$

In equation (3), $\Delta \ln y_{it}$ represents the first difference in $\ln y_{it}$ ($\ln y_{it} - \ln y_{i,t-1}$) and can be interpreted as a growth rate approximation. This method builds a system of equations consisting of equation (3) in levels and in first-differences. The endogenous regressors[11] are instrumented by a set of instruments consisting of their lagged levels and differences. Since

[10] In a Hausman specification test, we cannot reject the null hypothesis that the G2SLS estimator is consistent in our specifications.

[11] i.e. $\ln y_{i,t-1}$, $INST_{it}$ and INT_{it}.

the focus of this paper is on income levels rather than their growth rates, the system GMM results are reported in appendix C.

Finally, potential autocorrelation and heteroskedasticity should be considered as, otherwise, the standard errors derived for our estimates may be incorrect for statistical inference. To account for these issues, we use cluster-robust standard errors. These allow the regression errors to have an arbitrary correlation within countries, but assume that they are uncorrelated across countries (Cameron and Miller, 2015). As cluster-robust inference relies on asymptotic theory, having a small number of clusters could potentially be problematic[12]. I tried bootstrap techniques as recommended by Cameron and Miller (2015) for these cases, but given no differences in statistical inference from using either technique, cluster-robust standard errors are preferred due to computational efficiency.

[12] In our case, we analyse 19 clusters.

3 Data and Variables

This study focuses on an unbalanced panel of 19 Latin American countries[13] during the period 1996-2015. A discussion on the variables of interest is presented below. Summary statistics and bivariate scatterplots are available in appendices D and E respectively.

Economic Development

- GDP per capita (LnGDP):

  The International Labour Organization estimates this variable based on primary official sources, and presents it in constant 2011 international U.S. dollars. Following the literature, we use its natural logarithm.

Institutions

- Rule of Law (Rule):

  Except for 1997, 1999 and 2001, the World Governance Indicators (WGI) have been published by the World Bank annually since 1996. They are produced by Daniel Kaufmann and Aart Kraay and consist of 6 indicators[14] which focus on different dimensions of the "traditions and institutions by which authority in a country is exercised" (Kaufmann, Kraay and Mastruzzi, 2011 p. 222). The indicators are calculated from perceptions-based surveys to firms and households, and from assessments made by commercial business information providers, public sector data providers and NGOs. The WGI are standardised so that every year, they range from approximately -2.5 to 2.5, with greater values indicating stronger institutions, and have a zero country mean. There is a strong positive correlation[15] between all indicators, indicating that different institutional dimensions are likely to be inter-related. Following Rodrik *et al.* (2004), we use the rule of law indicator. This indicator captures the "perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence" (World Bank, 2017). The coefficient on this variable is expected to be positive.

- Freedom Rating (Freedom):

  Freedom House has annually published the Freedom in the World report since 1973. In each edition, analysts score countries in regards to 7 criteria which include the electoral process and individual rights (Freedom House, 2017). These scores are used to create an index of political rights and one of civil liberties. The average of these two

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[13] List available in Appendix A.
[14] These are: Voice and Accountability, Political Stability and Absence of Violence/Terrorism, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption.
[15] Pairwise correlations available in appendix F.

indices, known as the Freedom Rating, ranges from 1 to 7 with 1 corresponding to the best freedom rating. This data is obtained partly from the Economic Commission for Latin America and the Caribbean's database and from Freedom House. As higher values indicate weaker institutions, the coefficient on this variable is expected to be negative.

- Contract-Intensive Money (CIM):

  The term contract-intensive money was coined by Clague, Keefer, Knack and Olson (1999) who proposed it as an "objective measure of the enforceability of contracts and the security of property rights" (p.186). It is the proportion of the money supply held as non-currency money and is calculated as $CIM = \frac{M_2 - C}{M_2}$, where M_2 is a monetary aggregate and C represents the currency not held in banks. I calculate this measure using data from the International Monetary Fund's International Financial Statistics database available through the UK Data Service. Clague *et al.* (1999) argue that a lower CIM indicates weaker institutional quality because a weak third-party enforcement of contracts leads citizens to prefer currency as there would be no assurance that their money would be safe if held by financial institutions. On the other hand, in countries with adequate third-party enforcement of contracts and secure property rights citizens would be more likely to "invest their currency in bank deposits and financial instruments" (Clague *et al.,* 1999). Therefore, the coefficient on CIM is expected to be positive.

Geography

- Latitude:

  This variable reports the distance between a country's centroid and the equatorial line and comes from the Center for International Development at Harvard University. As indicated by Gallup, Sachs and Mellinger (1999), "relative to temperate regions, tropical regions are hindered in development by higher disease burdens and limitations on agricultural productivity" (p.184). Therefore, as temperate regions are located away from the equator, the coefficient on this variable is expected to be positive.

- Landlockedness (Landlocked):

  This is a dummy variable that comes from the Center for International Development at Harvard University. It takes the value of one for the two landlocked Latin American countries, Bolivia and Paraguay, and a value of zero for the other countries. Gallup *et al.* (1999) develop a theoretical model that explains how landlockedness can hinder a country's economic performane via increased transport costs that raise the cost of imported capital. Furthermore, Smith (1776) notes that "it is upon sea-coast, and along the banks of navigable rivers, that industry of every kind naturally begins to subdivide and improve itself" (p. 25). Therefore, the coefficient on this variable is expected to be negative.

- Malaria Stability Index (MSI):

  This variable comes from Gordon McCord's personal webpage. The MSI was developed by Kiszewski *et al.* (2004) to indicate the intensity of malaria transmission in a country. The index is derived from studying the malaria vectors that are most abundant in a given region during each month of the year. It is calculated from data on the proportion of the abundant vector that bites people, its daily survival rate and length of the extrinsic incubation period. It relates to geography as it "explicitly depicts the effects of ambient temperature on the force of transmission of malaria, as expressed through the length of the extrinsic incubation period, and the proportion of the vector population able to survive long enough to become infectious" (Kiszewski *et al.,* 2004 p. 491). Unlike measures of malaria prevalence, it has the advantage that it is not influenced by government intervention nor a country's income level. Since a higher index value indicates greater malaria transmission force, the coefficient on the MSI is expected to be negative.

Economic Integration

- Openness (LnOpen):

  This represents the ratio of a country's exports plus imports to GDP. The data comes from the World Bank and is available through the UK Data Service. Following Rodrik *et al.* (2004), we take its natural logarithm. As higher values are indicative of greater integration in the global economy, the coefficient on this variable is expected to be positive.

4 Results

The results for the Hausman–Taylor estimations are reported in Table 1 below.

Table 1. Hausman–Taylor Results.

	HT1	HT2	HT3	HT4	HT5
Rule	0.127 (0.046)***			0.126 (0.045)***	0.127 (0.045)***
LnOpen	-0.026 (0.055)	-0.058 (0.052)	-0.050 (0.044)	-0.026 (0.055)	-0.026 (0.055)
Latitude	0.012 (0.007)*	0.015 (0.007)**	0.021 (0.009)**		
Freedom		-0.027 (0.013)**			
CIM			0.424 (0.237)*		
MSI				-0.311 (0.133)**	
Landlocked					-0.504 (0.158)***
t	0.025 (0.002)***	0.024 (0.002)***	0.018 (0.003)***	0.025 (0.002)***	0.025 (0.002)***
Constant	8.853 (0.268)***	8.963 (0.282)***	8.403 (0.218)***	9.272 (0.225)***	9.114 (0.239)***
Observations	319	376	193	319	319

Notes: The dependent variable is the natural logarithm of GDP PPP in constant 2011 international USD. Cluster-robust standard errors are in parentheses. Statistical significance at the 10, 5 and 1 percent levels is denoted by *, **, and *** respectively.

Our core specification HT1 includes latitude as a geography proxy, the rule of law indicator as an institutions proxy, and the trade to GDP ratio as an economic integration proxy. In this specification, the coefficient on latitude is positive and statistically significant. It implies that a one-degree deviation of a country's centroid from the equatorial line is associated with a 1.2 percent increase in income per capita levels. Moreover, the coefficient on Rule is statistically significant at the 1 percent level, and indicates that a unit increase in the index is associated with a 13.5 percent increase in income per capita levels. Finally, the coefficient estimate on LnOpen is statistically insignificant.

In specifications HT2 and HT3, we find that considering the freedom in the world index and contract-intensive money does not change our inference of institutions as statistically significant determinants of income per capita levels. Specifically, a unit improvement in Freedom and a percentage-point increase[16] in CIM are associated with a 2.7 percent and 0.53 percent increase in income levels respectively. Furthermore, latitude is statistically significant determinant of income levels and a one-degree deviation of a country's centroid from the equatorial line is associated with a 1.5 to 2.1 percent increase in income per capita levels. Economic integration, measured by the trade to GDP ratio, continues as a statistically insignificant determinant of income levels.

Finally, in specifications HT4 and HT5 we consider the malaria stability index and landlockedness as alternative geography proxies. Both of these are statistically significant determinants of income per capita levels. A unit increase in the malaria stability index is associated with a 26.7 percent decrease in income per capita levels. Furthermore, controlling for institutions and economic integration, landlocked countries are expected to have income per capita levels 39.6 percent lower than countries with access to the sea, *ceteris paribus*. Finally, economic integration, proxied by LnOpen, remains a statistically insignificant determinant of income levels.

One of the limitations of these estimates is that they do not address simultaneity concerns such as a country's economic development influencing its economic integration and institutions (Chang, 2011, Helpman, 1988). To address this issue, we use a G2SLS procedure with the second and third lagged values of institutional and economic integration proxies as instrumental variables. The results are reported in Table 2.

[16] Equivalent to a 0.01 unit increase in the $M_2 - C$ to M_2 ratio.

Table 2. G2SLS Results.

	G2SLS1	G2SLS2	G2SLS3	G2SLS4	G2SLS5
Rule	0.324 (0.096)***			0.314 (0.090)***	0.324 (0.100)***
LnOpen	0.153 (0.168)	0.031 (0.069)	0.059 (0.070)	0.144 (0.160)	0.165 (0.175)
Latitude	0.007 (0.008)	0.014 (0.007)**	0.021 (0.010)**		
Freedom		-0.063 (0.022)***			
CIM			0.248 (0.617)		
MSI				-0.279 (0.130)**	
Landlocked					-0.498 (0.203)**
t	0.026 (0.004)***	0.027 (0.002)***	0.023 (0.003)***	0.026 (0.004)***	0.026 (0.004)***
Constant	8.310 (0.733)***	8.683 (0.305)***	8.060 (0.535)***	8.642 (0.721)***	8.422 (0.766)***
Sargan-Hansen statistic	0.416	0.396	0.263	0.425	0.413
Observations	205	319	148	205	205

Notes: The dependent variable is the natural logarithm of GDP PPP in constant 2011 international USD. Cluster-robust standard errors are in parentheses. Statistical significance at the 10, 5 and 1 percent levels is denoted by *, **, and *** respectively. Reported Sargan-Hansen statistics are p-values.

Our core specification G2SLS1 includes latitude as a geography proxy, the rule of law indicator as an institutions proxy, and the trade to GDP ratio as an economic integration proxy. The coefficient estimate on rule of law is statistically significant at the 1 percent level. Its coefficient estimate implies that a one-unit increase in the index is associated with a 38.3 percent increase in income per capita levels. The other determinants, namely economic integration, proxied by the trade to GDP ratio, and geography, proxied by latitude, enter as statistically insignificant determinants of income.

In specifications G2SLS2 and G2SLS3, we consider the freedom in the world index and contract-intensive money as alternative proxies for institutions. The results show that a one-unit improvement in a country's freedom rating is associated with a 6.5 percent increase in income per capita levels. Furthermore, a one-degree deviation of a country's centroid from the equatorial line is associated with a 1.4 to 2.1 percent increase in income per capita levels The coefficient estimates on CIM and LnOpen are both statistically insignificant.

In specifications G2SLS4 and G2SLS5, we use proxies other than latitude to analyse the geography hypothesis. As in specification HT4, the coefficient estimate on the malaria stability index remains statistically significant and of the expected negative sign. A one-unit increase in the index is associated with a 24.3 percent decrease in income per capita levels. The results also suggest that landlockedness is a statistically significant determinant of income levels and that landlocked countries have income levels 39 percent lower than those with coastal access, *ceteris paribus*. Moreover, economic integration, proxied by the trade to GDP ratio, remains as a statistically insignificant determinant of income levels. The coefficient on the rule of law indicator remains statistically significant, and its magnitude is similar to that of core specification G2SLS1. Finally, the Sargan-Hansen statistic p-values suggest that our instruments are valid and satisfy the exclusion restriction.

5 Discussion

5.1 Empirical Findings

In section 4 we used two estimation procedures to infer the relationships between the 'deep determinants' and economic development. Since the literature on this area has not reached a consensus, this section aims to compare our results to those found in the literature and, where applicable, suggest potential reasons for differences in results.

Our results for Rule indicate a coefficient estimate ranging from 0.126 to 0.324, which is robust to the inclusion of alternative geographical proxies in the specification. This is consistent with the cross-sectional findings from Bleaney and Dimico (2010), Kaufmann *et al.* (1999), Rodrik *et al.* (2004), Sachs (2003), and Yamarik, Johnson and Compton (2010) in terms of statistical significance. However, our coefficients' magnitude differs from those found in these cross-sectional studies, but is closer to the panel data findings from Brodzicki and Ciolek (2008)[17]. These differences could be partially due to unobserved country heterogeneity being considered in panel data studies, but not in cross-sectional studies, and due to our sample solely including Latin American countries.

Our HT and G2SLS results that latitude is a statistically significant determinant of income levels with a coefficient estimate ranging from 0.007 to 0.021 are consistent with the findings from Yamarik *et al.* (2010), Hall and Jones (1999), Easterly and Levine (2003), and Brodzicki and Ciolek (2008)[18]. Nevertheless, Acemoglu *et al.* (2001), Presbitero (2006), Rodrik *et al.* (2004), Bleaney and Dimico (2010), Bhattacharyya (2004), and Masters and McMillan (2001) find that, consistent with G2SLS1, latitude is a statistically insignificant determinant of income levels and their growth rates.

Brodziki and Ciolek (2008) and Easterly and Levine (2003) find coefficients ranging from -0.58 to -0.71 for landlockedness. These empirical results are similar in statistical and economical significance to our -0.49 and-0.50 coefficient estimates obtained in HT5 and G2SLS5. Nevertheless, contrary to our findings, Presbitero (2006) and Easterly and Levine (2003) find that in some specifications, landlockedness is a statistical insignificant determinant of income levels.

The results from Alcalá and Ciccone (2004), Brodzicki and Ciolek (2008), Yamarik *et al.* (2010), and Jacob and Osang (2015), suggest that openness is a statistically significant determinant of income levels[19]. Frankel and Romer (1999) indicate a stronger association between income levels and the trade to GDP ratio[20]. This could be partially explained by their omission of other possible determinants of income in their regressions. On the other hand, Bleaney and Dimico

[17] The coefficients found in the cross-sectional studies range from 0.6 to 1.9 whereas Brodzocki and Ciolek's (2008) coefficient ranges from 0.02 to 0.08.

[18] These studies find a coefficient estimates ranging from 0.009 to 0.058.

[19] The estimates from these studies imply that a percentage increase in the trade to GDP ratio is associated with a 0.1 to 0.31 percentage increase in income levels.

[20] Frankel and Romer (1999) indicate that a one percentage point increase in the ratio is associated with a 2.96 percent increase in income levels.

(2010), Rodrik *et al.* (2004), and Rodriguez and Rodrik (2001), find that, consistent with our results, this variable is a statistically insignificant determinant of income levels.

5.2 On Policy Implications and Future Research

The contrasting results found in the empirical literature exemplify the complexity of the process that determines income levels. As such, it is not straightforward to formulate policy based on these empirical findings. Let us first analyse the institutional proxies Rule, CIM and Freedom. From our results, we found a positive association between institutional quality and income levels, but we have not determined the desirable characteristics that make institutions strong. Since the World Governance Indicators and Freedom Rating are largely based on perception-based surveys, it is difficult to quantify a unit difference in these indices in terms of institutional quality. Similarly, although contract intensive money is a more objective measure of institutions and gives us an idea of relative institutional differences between countries, the characteristics of the underlying institutions it proxies cannot be inferred. Finally, there is no reason to believe that each unit difference in these proxies has a constant effect on income levels (Chang, 2011). Therefore, future research could investigate the existence of nonlinearities. Also, Munshi (2014) recognises the impact that community networks, as substitutes for human capital, can have on enhancing economic efficiency in developing countries. It would be interesting to incorporate this dimension of informal institutions into future research.

In terms of geography, we identified a positive association between income levels and distance from the equator. Gallup, Sachs and Mellinger (1999) suggest that this is because tropical regions suffer from higher disease burdens and limitations on agricultural productivity. On the other hand, Acemoglu *et al.* (2001) argue that these results may be caused by the correlation between latitude and institutional quality that is central to their hypothesis on the differences of institutional quality among countries colonized by Europeans. Therefore, future research should focus on identifying the channels through different geographical characteristics may affect income levels. Identifying these will be essential to formulate policy through which countries can capitalise on their geographical advantages and limit the channels through which geographical factors may negatively influence their development.

We did not find a statistically significant association between the trade to GDP ratio and income levels, whereas Frankel and Romer (1999), among others, suggest that it does influence a country's income levels. Nevertheless, these latter results deserve careful analysis before being used to formulate policy. As Rodriguez and Rodrik (2001) note, a country's trade volume is influenced by both geographical factors and trade policy, and policy implications to address these can be different in practice. For example, whereas geographical barriers that restrict trade volume may negatively affect income levels, policy-induced trade restrictions that target market failures may have a positive effect on incomes and their growth rates (Rodriguez and Rodrik, 2001). Furthermore, when using the trade to GDP ratio as a unique economic integration proxy, we overlook other aspects that may influence economic development such as the quality of trade, and the political and institutional dimensions of economic integration. Therefore, future research should include these various dimensions of economic integration into the analysis.

Finally, as Sachs (2003) notes, there is no reason to believe that institutions, geography and economic integration, especially when observed through a few proxies only, can alone explain the complex process of economic development. This is due to the multi-dimensional nature of the 'deep determinants' as well as the existence of other potential fundamental determinants of economic development which are not considered in this analysis. Therefore, future research should focus on identifying other factors that may fundamentally determine income levels.

6 Concluding Remarks

This study focused on analysing the role of institutions, geography and economic integration as fundamental determinants of economic development in Latin America. I extended Rodrik *et al.*'s (2004) cross-sectional analysis by proposing a panel data framework based on the Hausman–Taylor and G2SLS estimators that addresses empirical concerns including the estimation of time-invariant variables and the endogeneity of economic integration and institutions.

After analysing various proxies for the 'deep determinants', the results indicate that both geography and institutions play a substantial role in the economic development of Latin American countries. In particular, the results suggest that there are underlying mechanisms through which landlockedness, malaria, latitude, political rights and civil liberties, and the rule of law influence the income levels of Latin American countries.

The nature of these underlying mechanisms of causality remains unclear. Thus, future research should focus on identifying these. A better understanding of these is of fundamental importance to formulate policy recommendations. Only on this basis will we be able to recommend the desirable characteristics that a country's institutions should have, and identify the ways in which countries can capitalise on their comparative geographical advantages.

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Appendix

Appendix A: Countries in Sample

1. Argentina
2. Bolivia
3. Brazil
4. Chile
5. Colombia
6. Costa Rica
7. Cuba
8. Dominican Republic
9. Ecuador
10. El Salvador
11. Guatemala
12. Honduras
13. Mexico
14. Nicaragua
15. Panama
16. Paraguay
17. Peru
18. Uruguay
19. Venezuela

Appendix B: Pairwise Correlations between Endogenous Variables and their Lagged Values

	$LnOpen_{t-2}$	$LnOpen_{t-3}$
$LnOpen_t$	0.957	0.936

	$Rule_{t-2}$	$Rule_{t-3}$
$Rule_t$	0.979	0.969

	$Freedom_{t-2}$	$Freedom_{t-3}$
$Freedom_t$	0.956	0.939

	$CIM_{\ t-2}$	CIM_{t-3}
CIM_t	0.979	0.976

Appendix C: System GMM Growth Regressions

	GMM1	GMM2	GMM3	GMM4
$y_{i,t-1}$	-0.017	0.002	-0.019	-0.013
	(0.014)	(0.016)	(0.016)	(0.014)
Rule	0.025		0.018	0.018
	(0.008)**		(0.006)***	(0.006)***
LnOpen	0.011	0.020	0.011	0.016
	(0.009)	(0.008)**	(0.010)	(0.007)**
Latitude	-0.001	-0.001		
	(0.000)**	(0.001)*		
Freedom		-0.005		
		(0.004)		
MSI			-0.008	
			(0.006)	
Landlocked				0.002
				(0.010)
Time Fixed Effects	Yes	Yes	Yes	Yes
Sargan-Hansen statistic	0.896	0.955	0.905	0.905
AR(2) test	0.115	0.118	0.113	0.113
Observations	110	110	110	110

Notes: The dependent variable is the first-difference of the natural logarithm of GDP PPP in constant 2011 international USD. Cluster-robust standard errors are in parentheses. Statistical significance at the 10, 5 and 1 percent levels is denoted by *, **, and *** respectively. Reported Sargan-Hansen statistics and Arellano-Bond AR(2) tests are p-values. A description of the variables of interest is found in section 3. CIM is omitted due to insufficient observations. Time period: 2010-2015

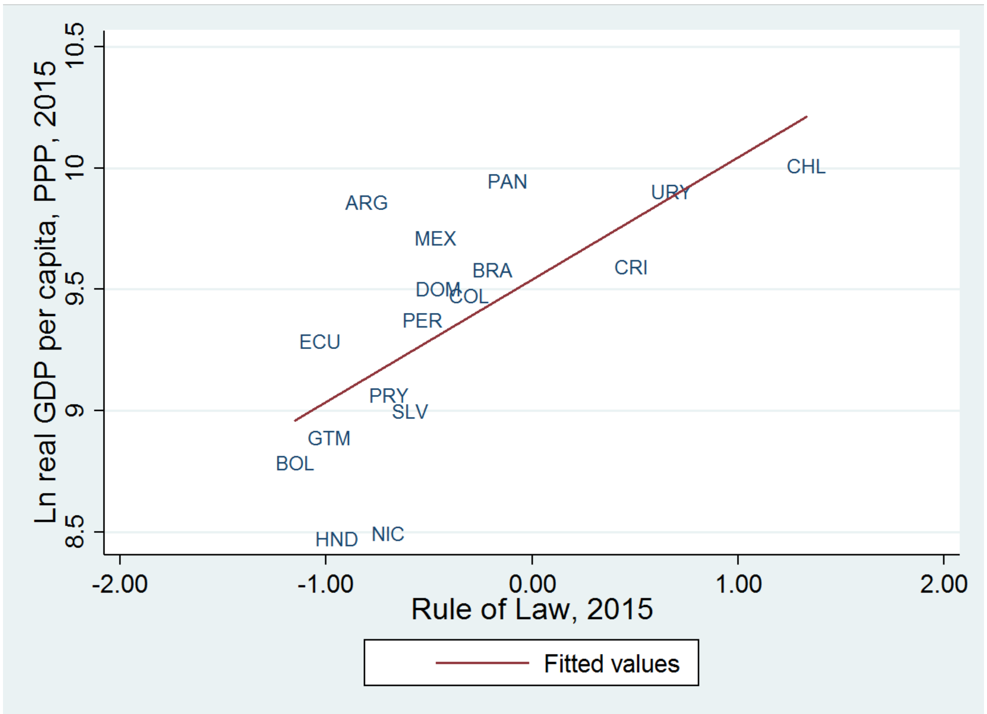
Appendix D: Summary Statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
LnGDP	overall	9.159	0.490	8.037	10.007	N = 377
	between		0.476	8.250	9.766	n = 19
	within		0.157	8.802	9.617	T = 19.842
Rule	overall	-0.492	0.655	-1.991	1.419	N = 323
	between		0.649	-1.432	1.275	n = 19
	within		0.171	-1.051	0.138	T = 17
Freedom	overall	2.840	1.322	1	7	N = 380
	between		1.278	1.1	6.825	n = 19
	within		0.442	1.316	4.466	T = 20
CIM	overall	0.792	0.151	0.355	0.996	N = 193
	between		0.153	0.404	0.991	n = 15
	within		0.028	0.719	0.919	T = 12.867
Latitude	overall	16.674	9.797	1.463	35.816	N = 380
	between		10.052	1.463	35.816	n = 19
	within		0	16.674	16.674	T = 20
Landlocked	overall	0.105	0.307	0	1	N = 380
	between		0.315	0	1	n = 19
	within		0	0.105	0.105	T = 20
MSI	overall	0.675	0.635	0	2.327	N = 380
	between		0.651	0	2.327	n = 19
	within		0	0.676	0.676	T = 20
t	overall	10.5	5.774	1	20	N = 380
	between		0	10.5	10.5	n = 19
	within		5.774	1	20	T = 20
LnOpen	overall	4.054	0.461	2.750	5.108	N = 376
	between		0.444	3.166	4.924	n = 19
	within		0.163	3.619	4.445	T = 19.790

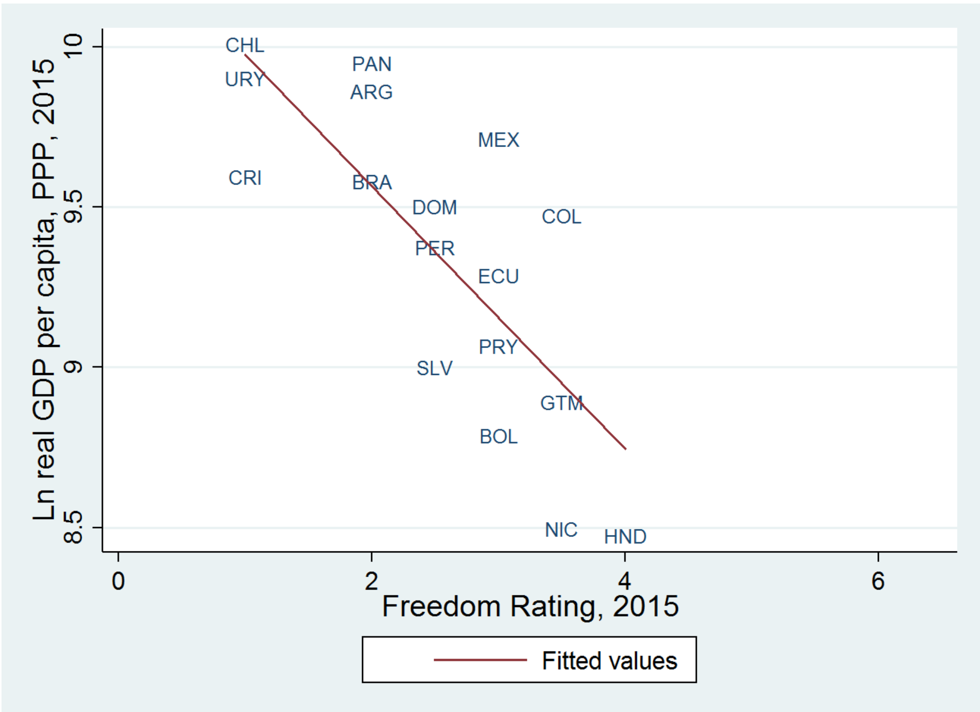
Appendix E: Bivariate Scatterplots

Institutions

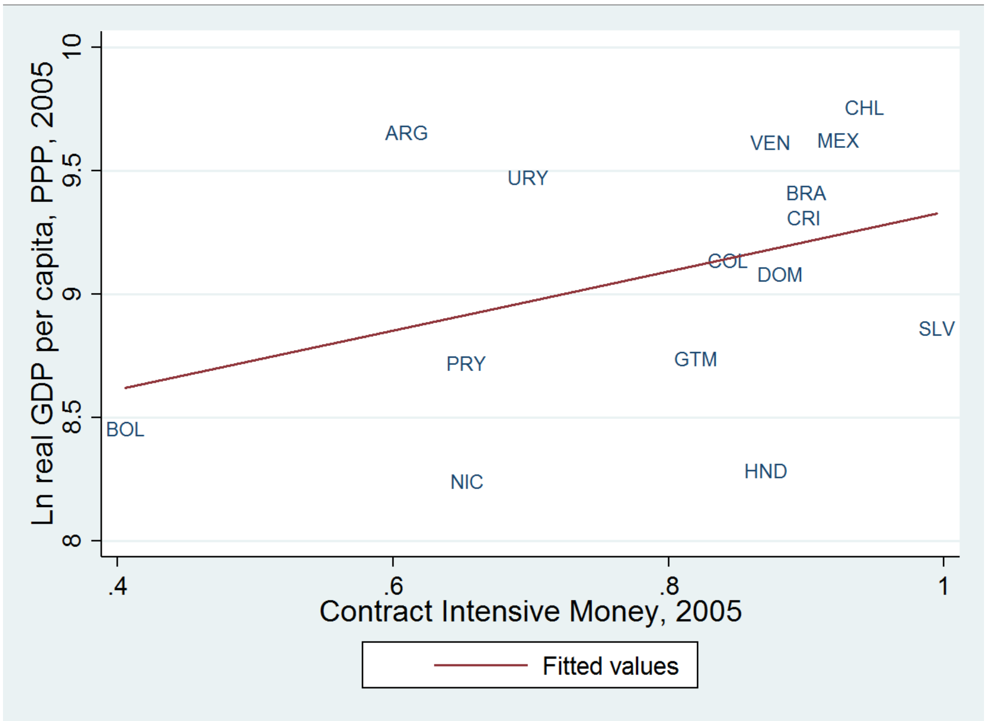
- Rule of Law



- Freedom Rating

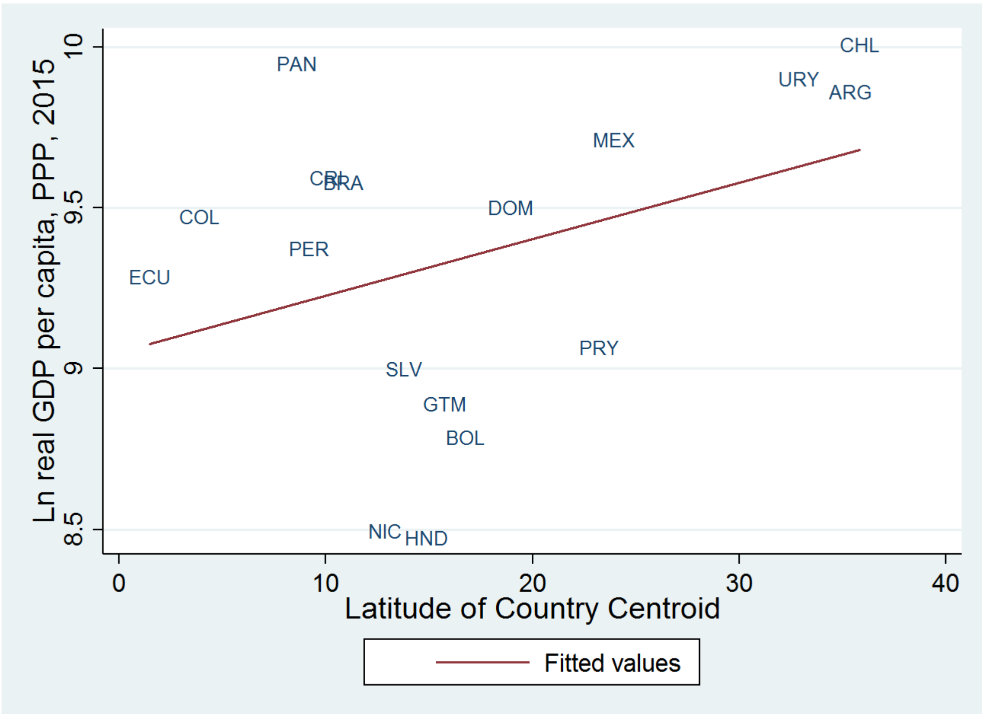


- Contract-Intensive Money

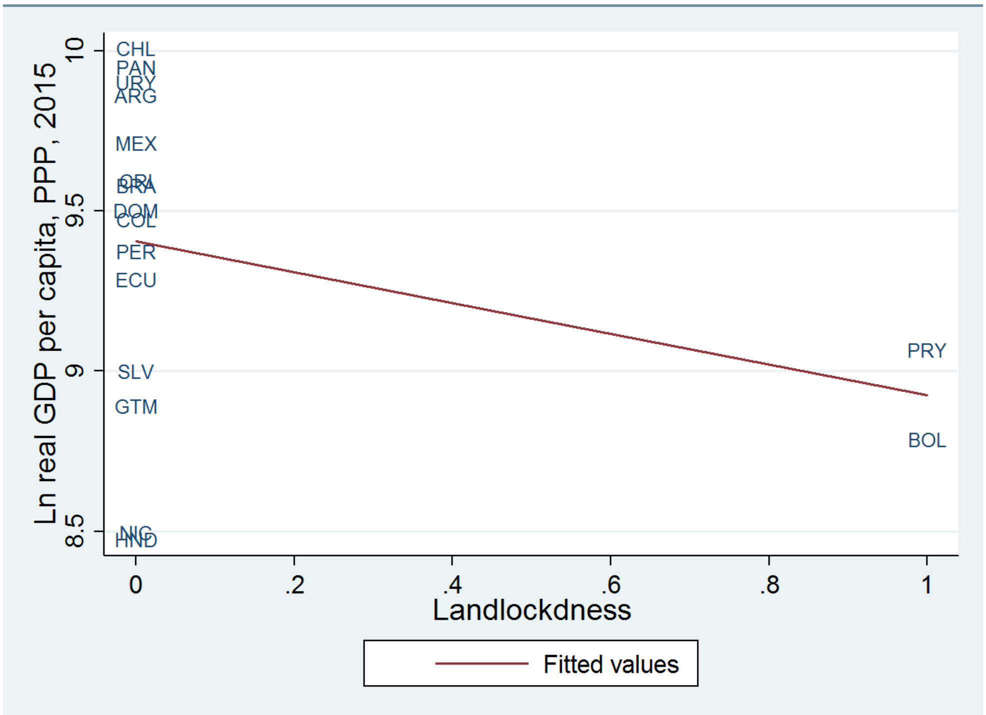


Geography

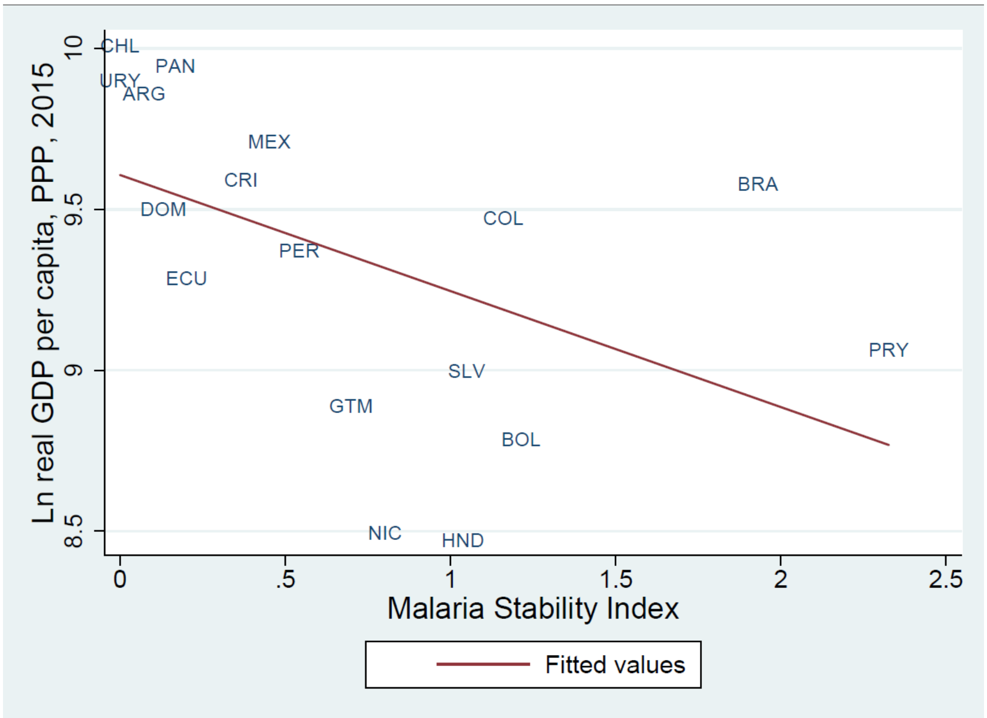
- Latitude



- Landlockedness

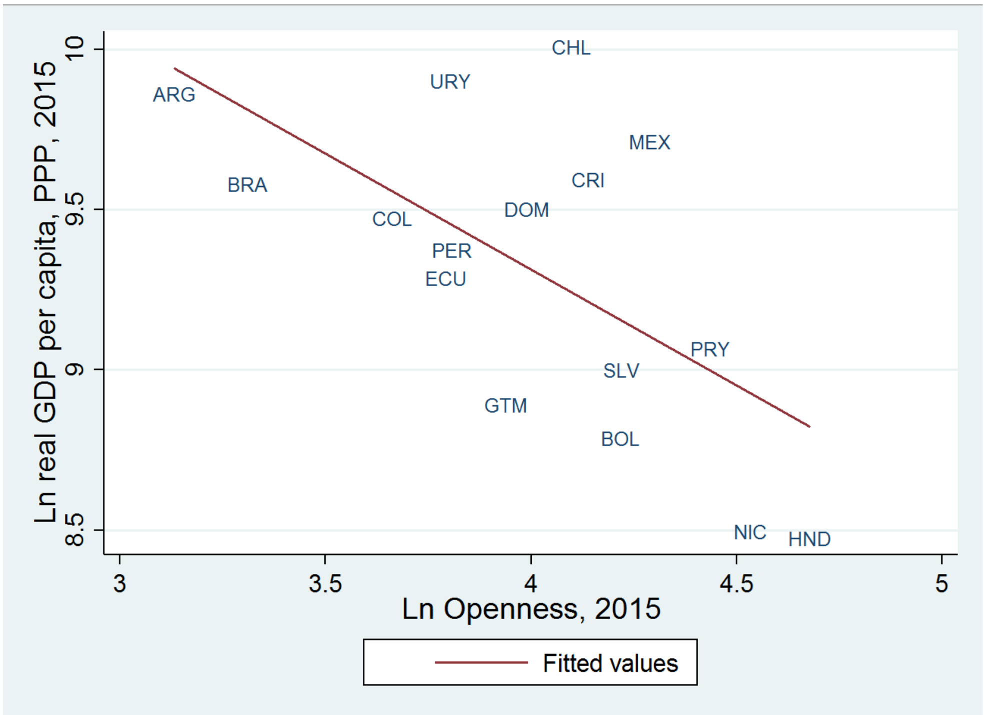


- Malaria Stability Index



Economic Integration

- Openness



Appendix F: Pairwise Correlations between World Governance Indicators

	Voice and Accountability	*Rule of Law*	*Political Stability*	*Government Efficiency*	*Regulatory Quality*	*Control of Corruption*
Voice and Accountability	1					
Rule of Law	0.778	1				
Political Stability	0.474	0.661	1			
Government Efficiency	0.693	0.893	0.559	1		
Regulatory Quality	0.773	0.787	0.309	0.774	1	
Control of Corruption	0.539	0.871	0.655	0.854	0.575	1