The Effect of Quality of Institutions on Agricultural Productivity

Omer Kara
Department of Economics
Eskisehir Osmangazi University
okara@ogu.edu.tr

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Abstract

The main objective of this paper is to test the effect of quality of institutions on agricultural productivity. The paper utilizes from two different measures of quality of institutions—World Governance Indicator (WGI) and Quality of Institutions of International Country Risk Guide (ICRG_QOG) throughout the estimations. The paper utilizes from several different estimation methods: OLS, LASSO, Post LASSO, 2SLS IV, and a combination of 2SLS IV and LASSO. Our results suggest that quality of institutions is ineffective on agricultural productivity, and this result is very robust throughout the several different estimation methods. On the other hand, the findings of this paper indicate that agricultural land, average annual precipitation, geographic location and population density are significant and robust throughout the estimations.

JEL Code:
Keywords: Agricultural productivity, total factor productivity (TFP), quality of institutions, LASSO, post LASSO, instrumental variables.

1. Introduction

The agricultural sector is the main driver of growth in most developed and developing countries, and comprehending the determinants of agricultural productivity growth is essential in making policies that help to enhance growth prospects. Furthermore, according to World Bank (2007) report, growth driven from agricultural sector gives rise to a larger welfare effect than the growth driven from non-agricultural sectors, particularly for the poorest 20% of the population. Therefore, the main question arises what determines the productivity in agriculture.

In the last couple of decades, although the agricultural productivity growth has increased in the developed and less developed countries mainly through the technological improvements, we still see huge differences in both agricultural productivity levels and growth rates across countries. Figure 1 visualizes this difference clearly in terms of agricultural productivity per hectare harvested. In order to explain these differences, agricultural economics literature examined a vast set of determinants. Based on the micro and macro studies the most mentioned and significant determinants of agricultural productivity are poverty, infrastructure, trade and openness, R&D, technology, knowledge (as human capital), financial development, health, climate, and location. Very few of these studies try to make inferences about the effect of quality of institutions on agricultural productivity through examining the effect of government policies on agricultural productivity. That means previous research mimics the broad concept of quality of institutions with a very narrow concept of government policies. One noteworthy point that should have been considered is that the quality of institutions can not be easily and accurately measured only by government policies. A correct measurement of quality of institutions should not only cover government policies but also rule of law, voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality and control of corruption.

This paper aims to examine the "so-called" deep parameters, by which we are meant broad concept of the quality of institutions as aforementioned, on agricultural productivity by using several different estimation methods such as OLS, instrumental variables (IV) method, least absolute shrinkage and selection operator

(LASSO), Post LASSO, and a combination of IV and LASSO methods.

To our knowledge, in the previous literature there has been no empirical work that investigated the broad effect of quality of institutions on agricultural productivity; therefore, the main contribution of this paper to the literature is using the political, economic and legal determinants of institutions as a whole in measuring their quality. The second contribution of this paper is using LASSO method and a combination of IV and LASSO methods in estimations.

The paper proceeds as follows: Section 2 presents a very brief literature review of previous papers relevant to the development of this research; Section 3 presents and accounts for the underlying motivations in selecting the empirical model and necessary variables; Section 4 presents the empirical models; Section 5 presents the relevant data sources; Section 6 presents the estimation results and discussion; Section 7 concludes.

2. Literature Review

As aforementioned, the existing work about the effect of quality of institutions—as a whole—on agricultural productivity is quite low. However, there are some works which examined the effect of a part of institutions on agricultural productivity. Headey (2010) is one of these papers that attract attention, for instance. By using OLS and controlling some of agricultural and macro determinants—poverty, agricultural employment and labor—the authors claim that government stability, democracy index, public agricultural expenditure and proagricultural price policy reforms separately have a positive and statistically significant effect on agricultural productivity.

The rest of the literature about this matter basically attempts to identify the most important determinants of agricultural productivity in a three main categories: economic, knowledge related and others. The significant economic determinants are: macroeconomic stability, foreign direct investment, and financial sector development (Khan, 2005); poverty (Schneider, 2011; Thirtle, 2001); trade and globalization (Kirwan, 2005). The significant knowledge related determinants are: R&D (Coe, 2009; Ascari, 2004; Morrow, 2010; Griffith et al., 2000; Kneller, 2002), human capital (Griffith, 2000;

Kneller, 2002). The other significant determinant suggested by the literature are: climate change (Gornal, 2010), health (Cole, 2004; Cole, 2006), Infrastructure (Antle, 1983; Bravo-Ortega, 2004) and geographic location (Heady, 2010).

For one part of the estimation method, this paper utilizes from least absolute shrinkage and selection operator (LASSO). LASSO method has attracted great attention in literature and various versions of it have been extensively used. This paper uses the LASSO, proposed and used by Tibshirani (1996), is a type of regulized regression which minimizes the residual sum of squares subject to the sum of the absolute value of the coefficients being less than a constant.

3. Determinants and TFP

Although this paper is interested primarily in the effect of quality of institutions on agricultural productivity, we need to control for a number of other factors that have been identified, especially by economists, as important determinants of agricultural productivity. Thus , this paper uses four different sets of variables as determinants of agricultural productivity and several variables for each set of determinants. The sets of variables are: economic and agricultural, institutional, legal and cultural, and others.

3.1. Total Factor Productivity (TFP)

A broad concept of agricultural productivity is total factor productivity (TFP). TFP takes into account all of the land, labor, capital, and material resources employed in farm production and compares them with the total amount of crop and livestock output. If total output is growing faster tan total inputs, it is called an improvement in total factor productivity. TFP differs from measures like the crop yield per acre or agricultural value-added per worker because it takes into account a broader set of inputs used in production. TFP encompasses the average productivity of all of these inputs employed in the production of all crop and livestock commodities. The methodology and data used to calculate the TFP across countries, which is also used in this paper, are fully described in Fuglie (2012). The approach describes in Fuglie (2012) gives agricultural TFP growth rates, but not TFP levels. Since the calculation methodology of TFP is beyond the scope of this paper, and due to available TFP data calculated by Fuglie's

approach, agricultural TFP growth across countries will be used in this research.

3.2. Economic and Agricultural

Following the methodology used in the calculation of TFP in Fuglie's research, proxies for land, labor and capital inputs for TFP are used. The agricultural land % of land area, employment in agriculture % of total employment and agricultural machinery (tractors per 100 sq. km of arable land) are used as a proxy for land, labor and capital inputs respectively as an explanatory variable for TFP.

Agricultural production is sensitive to changes in energy prices, either through energy consumed directly or through energy-related inputs such as fertilizer. Thus, the pump price for diesel fuel in US dollars per liter (diesel_usa) and fertilizer consumption in kilograms per hectare of arable land (fer_khal) are used as determinants of TFP.

3.3. Institutional

In testing the effect of quality of institutions, this paper utilizes from two separate indices, and each one is used separately in the regressions to not to give rise multicollinearity problem. The first index for quality of institutions is The Worldwide Governance Indicators (WGI). The WGI compile and summarize information from 31 existing data sources that report the views and experiences of citizens, entrepreneurs, and experts in the public, private and NGO sectors from around the world, on the quality of various aspects of governance in six categories: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. As discussed before to test the effect of the quality of the institution the researcher should take into account all aspects of institutions. Thus, this paper uses the basic average of WGI score from six categories for each country. The second index for quality of institutions is The International Country Risk Quide (ICRG) Quality of Government Index (icrg_qog). This index represents the mean value of the ICRG variables "corruption", "law and order", and "bureaucracy quality"—scaled between 0 and 1.

3.4. Legal and Cultural

Legal and cultural type of variables is used in IV and IV related methods as an instrument for institutional variables due to the fact that using institutional variables—

either *wgi* or *icrg_qog*—as a regressor on TFP would might cause endonegeneity problem—that is quality of institutions effect TFP and TFP affects quality of institutions since TFP increases agricultural growth which leads to high economic growth as mentioned before; and thus quality of institutions.

In his seminal work La Porta et al. (1999) assess government performance using measures of government intervention, public sector efficiency, political freedom and public good provision. First, they show that legal rules and regulations differ systematically across countries and these differences are accounted for to a significant extent by legal origins[1]. Then, they show that legal origin of a country's law is a significant determinant of government performance. Moreover, La Porta et al. (2008) provide statistical evidence that legal origin of a country's law matters for economic and social outcomes. Following these two papers, legal origin of a country is used as a candidate instrumental variable in IV method and the combination of LASSO and IV methods.

In the literature, it has been widely discussed that the degree of conflict in a society is an important determinant of the political economy in many countries. The principle idea is that greater social fractionalization, proxies the degree of conflict in society, leads to political instability, poor quality of institutions and low economic performance. The traditional measure of fractionalization is given by the probability that two randomly drawn individuals from the population belongs to two different groups. The commonly used ones are ethnic, linguistic, ethnolinguistic and religious fractionalization indices. In his empirical study, the determinants of the quality of government, La Porta et al. (1999) provide evidence that ethnic fractionalization is important for quality of government. Alesina et al. (2003) find a negative effect of ethnic fractionalization on economic growth, and a negative effect of ethnic and linguistic fractionalization on the quality of government. Conversely, their results suggest that religious fractionalization displays a positive relationship with measures of good government. Hence, following these studies, ethnic, linguistic and religious fractionalization indices are used as

[1] Legal origin is the historical origin of a country's laws.

candidate instrumental variables in the estimation of IV related methods.

3.5. Others

The other set of determinants to be controlled for as potential determinants of TFP are: precipitation, environment, infrastructure, geographic location, population density, globalization, human capital, and poverty.

The precipitation and environmental variables control the effect of climate and environmental conditions on TFP. Thus, for precipitation and environmental variables, this paper uses average annual precipitation in depth (mm per year) and Environmental Performance Index (EPI). The EPI is a method of quantifying and numerically benchmarking the national environmental results of a country's policies by using the best data available. The intention of the usage of the EPI is to provide a more reliable overall picture of sustainability levels around the world than any single indicator would provide taken independently.

The other control variables are: logistic performance index which accounts the quality of trade and transport related infrastructure; the absolute value of the latitude of the capital city (divided by 90 to take values between 0 and 1) as geographic location; population density—people per sq. km of land area; overall KDF Index of Globalization which accounts the economic, social and political globalization effect on TFP; Human Capital Index accounts effect of knowledge on TFP; and percentage rural population below nation poverty line.

4. Empirical Models

Combining the economic and agricultural, institutional, legal and cultural and other possible determinants of TFP just described in the previous section, the paper estimates several different models such as OLS with robust standard errors, two stage least squares (2SLS) IV method, LASSO , Post LASSO, and a combination of LASSO and IV methods.

4.1. OLS

The paper estimates the following empirical model by OLS with robust standard errors.

$$TFP_i = \beta_1 * \{Econ\ and\ Ag \text{ Variables}\}_i + \beta_2 * \{Institutional \text{ Variables}\}_i + \beta_3 * \{Other \text{ Variables}\}_i + \varepsilon_i$$

There are two main problems with the OLS method: the high multicollinearity with fully saturated or almost saturated models and endogeneity problem with TFP and the quality of institutions variables. For the former problem: Although perfect multicollinearity is a violation of the OLS assumptions, having a less-than-perfect multicollinearity is not. In another meaning, if the goal is simply to predict the response variable from a set of independent variables, then multicollinearity is not a problem—the estimated coefficients will still be unbiased. However, in empirical studies multicollinearity might be a big problem in OLS since the main goal of the researchers is to understand how the various independent variables partially affect the response variable. Some of the important consequences of multicollinearity in OLS are: (1) standard errors of the affected coefficients tend to be larger which induces t-statistic of independent variables to be much lower, and so leads to acceptance of the null hypothesis more readily; (2) estimates will be very sensitive to changes in the specification of the model; (3) it becomes difficult to uncover the partial effect of each independent variable (Wooldridge, 2009; Greene, 2003).

Multicollinearity is a matter of degree, not a matter of presence or absence. The higher the degree of multicollinearity, the greater the estimates suffer from the consequences of multicollinearity. Therefore, the degree of multicollinearity is critical for our results and will be examined in all regressions. In the econometric literature, several techniques have been proposed for detecting as well as measuring the degree of multicollinearity. A commonly used technique is to calculate the Variance Inflation Factor (VIF) which quantifies the degree of multicollinearity in OLS regression analysis. The VIF for each independent variable shows us how much the variance of the coefficient estimate is being inflated by multicollinearity; and hence; shows the degree of multicollinearity (Greene, 2003). A common rule of thumb is that values of 5 or 10 has been recommended as the maximum level of VIF and higher values indicate that the associated coefficients are poorly estimated because of severe multicollinearity (Kennedy, 2003).

In our analysis, a VIF value of 10 is used as a threshold value for detecting severe multicollinearity. If the severe multicollinearity is detected in any of our

estimations, we will try to remedy it by the suggested techniques of econometric literature.

4.2. 2SLS IV Method

As mentioned before there might be a possible endogeneity problem between TFP and quality of institutions variables—*wgi* and *icrg_qog*—that is quality of institutions effect TFP and TFP affects quality of institutions since TFP increases agricultural growth which leads to high economic growth as mentioned before; and thus quality of institutions. In this situation, OLS generally produces biased and inconsistent estimates. A suggested and mostly used solution to this problem is to use instrumental variable approach. Thus, if an instrument is available, consistent estimates may still be obtained.

An instrumental variable does not itself belong in the explanatory equation and is correlated with the endogenous explanatory variables, conditional on the other covariates. For selecting the candidate instrumental variables, the univariate correlation is used. Table 3 presents correlation of quality of institutions variables with candidate instrumental variables.

IV method is used in the 2SLS. In the first stage either one of the quality of institutions is regressed on the selected instrumental variables. In the second stage TFP is regressed on the rest of the possible determinants.

First Stage: with *wgi*

$$wgi_i = \beta_1 * \left\{ \begin{matrix} Selected\ Legal\ and \\ Cultural\ Variables \end{matrix} \right\}_i + \nu_i$$

Second Stage:

$$TFP_i = \beta_2 * \{Econ\ and\ Ag\ \text{Variables}\}_i + \beta_3 * \left\{ \hat{wgi}_i \right\} + \beta_4 * \{Other\ \text{Variables}\}_i + \varepsilon_i$$

4.3. LASSO

LASSO (Least Absolute Shrinkage and Selection Operator) selection arises from a constrained form of ordinary least squares where the sum of the absolute values of the regression coefficients is constrained to be smaller than a specified parameter. More precisely let $X = (x_1, x_2, x_3, ..., x_m)$ denote the matrix of covariates and let y denote the response, where the $x_i s$ have been centered and scaled to have unit standard deviation and mean

zero, and y has mean zero. Then for a given parameter t, the LASSO regression coefficients $\beta = (\beta_1, \beta_2, \beta_3, ..., \beta_m)$ the solution to the constrained optimization problem

$$\min \| y - X\beta \|^2 \quad subject\ to \quad \sum_{j=1}^{m} | \beta_j | \leq t$$

Provided that the LASSO parameter t is small enough, some of the regression coefficients will be exactly zero. Hence, the LASSO can be considered as selecting a subset of the regression coefficients for each LASSO parameter. By increasing the LASSO parameter in discrete steps one can obtain a sequence of regression coefficients where the nonzero coefficients at each step correspond to selected parameters. Early implementations (Tibshirani 1996) of LASSO selection used quadratic programming techniques to solve the constrained least-squares problem for each LASSO parameter of interest. Later, Efron et. al (2004) derived a variant of their algorithm for least angle regression that can be used to obtain a sequence of LASSO solutions from which all other LASSO solutions can be obtained by linear interpolation.

4.3. Post LASSO

One of the downsides of LASSO method is that it shrinks the coefficient estimates. Thus, the suggested solution in the literature is to run OLS with nonzero coefficients gathered from LASSO. This method is called Post LASSO.

4.4. IV Method with LASSO

Instead of using univariate correlation for choosing instrumental variables, in this method, LASSO is used as a model selection for correct instrumental variables. After the correct set of instrumental variables are determined, the regular 2SLS IV method is applied to account for the endogeneity problem.

LASSO Part: with *wgi*

$$wgi_i = \beta_1 * \left\{ \begin{matrix} All\ Legal\ and \\ Cultural\ Variables \end{matrix} \right\}_i + \nu_i$$

First Stage: with *wgi*

$$wgi_i = \beta_1 * \left\{ \begin{matrix} Selected\ Legal\ and \\ Cultural\ Variables \end{matrix} \right\}_i + \nu_i$$

Second Stage:

$$TFP_i = \beta_2 * \{Econ\ and\ Ag\ \text{Variables}\}_i + \beta_3 * \left\{\hat{wgi}_i\right\} + \beta_4 * \{Other\ \text{Variables}\}_i + \varepsilon_i$$

5. Data

The analysis of this paper is conducted with a data set combined from fifteen different data sources. Table 1 presents the data definitions and sources. Table 2 displays the descriptive statistics of all variables. As discussed in the previous section, Table 3 correlation of quality of institutions variables with candidate instrumental variables.

To have a preliminary understanding between the TFP and some of the independent variables, it would better have a visualization of the data. So, Figure 1-12 visualize the data set used in this paper on the world map.

Table 1. Data Definitions and Sources

Variable	*Definition*	*Source*	*N. of Obs.*
Dependent Variable			
TFP_AAG7110	Total Factor Productivity Growth Between 1971-2010	Fuglie. (2012)	173
Economic & Agricultural Variables			
AG_LAND	The agricultural land % of land area.	World Development Indicators (WID), 2012	206
AG_EMP	Employment in agriculture % of total employment.	World Development Indicators (WID), 2012	98
AG_MACH	Agricultural machinery (tractors per 100 sq. km arable land)	World Development Indicators (WID), 2012	124
DIESEL_USA	Pump price for diesel fuel in US dollars per liter.	World Development Indicators (WID), 2012	175
FER_KHAL	Fertilizer consumption in kilograms per hectare of arable land.	World Development Indicators (WID), 2012	129
Institutional Variables			
WGI	Worldwide Governance Indicators.	World Development Indicators (WID), 2012	212
ICRG_QOG	ICRG Quality of Government	http://www.prsgroup.com/ICRG.aspx	140

Legal & Cultural Variables			
LORGN	English, French, German, Scandinavian, and Socialist legal origins.	La Porta et al. (2008)	187
LEGOR_EN	English legal origin.		61
LEGOR_FR	French legal origin.		99
LEGOR_GE	German legal origin.		20
LEGOR_SC	Scandinavian legal origin.		5
LEGOR_SO	Socialist legal origin.		2
FRAC	Ethnic, linguistic and religion fractionalization indices measured for 2003, or the nearest year to 2003 available.	Alesina et al. (2003)	215
FRAC_ETH	Ethnic fractionalization index.		
FRAC_LAN	Linguistic fractionalization index.		
FRAC_REL	Religion fractionalization index.		
Other Variables			
POP_DEN	Population per square kilometers measured for 2012, or the available year.	World Development Indicators (WID), 2012.	213
AA_PRE	Average precipitation in depth (mm per year)	World Development Indicators (WID), 2012.	179
EPI	Environmental Performance Index measured for 2012.	Emerson et al. (2012)	132
LAT_ABST	The absolute value of the latitude of the capital city, divided by 90 (to take values between 0 and 1.	La Porta et al. (1999)	208
LPI	Logistic Performance Index : Quality of trade and transport-related infrastructure (1=low to 5=high)	World Development Indicators (WID), 2012.	162
PTY	Percentage rural population below national poverty line.	World Development Indicators (WID), 2012.	96
GLOB_OVE	Overall of KOF Index of Globalization	http://globalization.kof.ethz.ch/	187
HCI	Human Capital Index	World Economic Forum, The Humcan Capital Report	122

Table 2. Descriptive Statistics

Variable	*N*	*Min*	*Max*	*Median*	*Mean*	*Std*
TFP_AAG7110	173	-0.0117000	0.0550000	0.0111000	0.0119272	0.0112807
AG_LAND	206	1.0000000	86.0000000	39.5000000	38.3834951	22.4534971
AG_EMP	98	0	65.6000000	10.1500000	16.2081633	16.6269789
AG_MACH	124	0.1000000	5895.20	153.1000000	494.0185484	872.1375592
DIESEL_USA	175	0.0110000	2.3500000	1.2500000	1.2546971	0.5167489
FER_KHAL	159	0	6105.70	77.6000000	202.4742138	579.4381633
WGI	212	-2.2747828	1.8668361	-0.1179205	0.0048443	0.9201737
ICRG_QOG	140	0.1111111	1.0000000	0.4722222	0.5231647	0.2073764
LEGOR_EN	187	0	1.0000000	0	0.3262032	0.4700812
LEGOR_FR	187	0	1.0000000	1.0000000	0.5294118	0.5004742
LEGOR_GE	187	0	1.0000000	0	0.1069519	0.3098817
LEGOR_SC	187	0	1.0000000	0	0.0267380	0.1617497
LEGOR_SO	187	0	1.0000000	0	0.0106952	0.1031392
FRAC_ETH	191	0	0.9301750	0.4372560	0.4400409	0.2575690
FRAC_LAN	200	0.0021132	0.9226795	0.3546570	0.3878356	0.2782332
FRAC_REL	213	0.0022857	0.8602599	0.4628099	0.4384687	0.2256377
POP_DEN	213	0.1384822	19847.54	82.9140288	405.0561858	1932.35
AA_PRE	179	51.0000000	3200.00	1032.00	1159.63	781.7361536
EPI	131	25.3200000	76.6900000	53.5500000	53.0292366	9.8591331
LAT_ABST	208	0	0.8000000	0.2287222	0.2800518	0.1897892
LPI	162	1.6100000	4.1200000	2.8150000	2.8922222	0.5603426
PTY	96	2.5000000	88.0000000	44.7000000	44.2486443	20.7421594
GLOB_OVE	187	24.3514600	92.2958100	54.7165600	56.5997205	16.6421303
HCI	122	-1.3950000	1.4550000	-0.1095000	-0.0080492	0.6394431

Table 3. Correlation of Quality of Institutions Variables with Candidate IVs

Candidate IVs	*WGI*	*ICRG_QOG*
legor_uk	0.16346	0.09283
	(0.0254)	(0.2824)
legor_fr	-0.37529	-0.37497
	(<.0001)	(<.0001)
legor_ge	0.24432	0.24008
	(0.0008)	(0.0049)
legor_so	-0.16602	-0.12185
	(0.0232)	(0.1576)
legor_sc	0.32392	0.41785
	(<.0001)	(<.0001)
frac_eth	-0.42855	-0.44438
	(<.0001)	(<.0001)
frac_lang	-0.30107	-0.30238
	(<.0001)	(<.0001)
frac_rel	0.10276	-0.00569
	(0.1446)	(0.9472)

*Standard errors are in the parenthesis and ***, **, ** denotes significance at 1%, 5% and 10% level respectively.

6. Estimation Results

As mentioned before, this paper tests the effect of the quality of government on TFP by using several estimation methods: OLS, LASSO, Post LASSO, 2SLS IV, and a combination of IV and LASSO methods.

Throughout the four OLS estimations, the paper tries to test the effect of quality of institutions while controlling the suggested determinants of TFP by the literature. None of the OLS estimations yield a significant coefficient of quality of institutions. However, it seems that the coefficients of agricultural land, average annual precipitation, geographic location, and population density are significant and robust throughout our OLS estimations. One important point that the reader should notice is that using poverty variable in our estimation reduced the number of observations significantly and most probably hindering the real effects of some estimations. Thus, after the OLS 2 estimation the poverty variable is not used in the rest of the estimations.

The results of the LASSO method indicate that the ICRG quality of institutions variable has a nonzero coefficient and should be added into the selected model. In other means quality of institutions has a positive effect on TFP. However, regressing

Table 4. Estimation Results

Variables	*OLS 1*	*OLS 2*	*OLS 3*	*OLS 4*	*LASSO*	*Post LASSO*	*IV 1*	*IV 2*	*IV&LASSO 1*	*IV&LASSO 2*
Dependent Variable	tfp_aag7110	tfp_aag7110	tfp_aag7110	tfp_aag7110	tfp_aag7110	tfp_aag7110	tfp_aag7110	tfp_aag7110	tfp_aag7110	tfp_aag7110
ag_land	-0.00032064	-0.00030877**	-0.00009579	-0.00011693**	-0.000042323	-0.00009758	-0.00012*	-0.00193	-0.00011*	-0.00193
aa_pre	-0.00001036	-0.00001072**	-0.00000557*	-0.00000770***	-0.000003847	-0.00000752*	-6.25E-6*	-6.12E-6*	-6.16E-6*	-6.12E-6*
fer_khal	0.00000963	0.00001156	-0.00000135	-0.00000159	-0.000001471	-0.00000117	-1.24E-6	-1.2E-6	-9.56E-7	-1.2E-6
ag_emp	0.00003540	0.00007617	0.00005335	0.00008076	-0.000035002	0.00007623	0.000053	0.000036	0.000049	0.000036
ag_mach	-0.00002088	-0.00002153	-0.00000183	-0.00000115	-0.000001572	-0.00000118	-9.75E-7	-1.05E-6	-1.13E-6	-1.05E-6
lpi	-0.00307	-0.00468	0.00627	0.00734*	0.003696	0.00660*	0.004994	0.005136	0.003665	0.005136
lat_abst	-0.03634	-0.04196	-0.03277**	-0.03015**	-0.036526	-0.03093**	-0.03598**	-0.03499**	-0.03914**	-0.03499**
pop_dn	0.00002588	0.00002886	0.00001145*	0.00001154	0.000007877	0.00001049*	0.000011*	0.000011*	0.000011*	0.000011*
hci	0.01492	0.01446	0.00544	0.00390	0.007727	00553	0.005304	0.005469	0.005051	0.005469
glob_ove	0.00001952	0.00021461	0.00019518	0.00009403	0.000184	0.00017917	0.000184	0.000215	0.000199	0.000215
epi	0.00002229				-0.000189	0.00018066				
pty	-0.00022774	-0.00021742								
diesel_usa	0.00530	0.00546	-0.00018421				0.000907	0.003776	0.000496	0.003776
dfpli	-0.00222	-0.00230	0.00222				0.002347	0.003115	0.001645	0.003115
wgi	-0.00068155		0.00049471	0.00097224			Endogenous 0.003777		Endogenous 0.002841	
icrg_qog					0.007820	0.01343		Endogenous -0.00193		Endogenous -0.00193
legor_uk							Instrument	Instrument	Instrument	Instrument
legor_fr							Instrument	Instrument	Instrument	Instrument
legor_ge							Instrument	Instrument	Instrument	Instrument
legor_sc							Instrument	Instrument	Instrument	Instrument
legor_so							Instrument	Instrument	Instrument	Instrument
frac_eth							Instrument	Instrument	Instrument	Instrument
frac_lang							Instrument	Instrument	Instrument	Instrument
frac_rel									Instrument	

***, **, ** denotes significance at 1%, 5% and 10% level respectively.

the suggested nonzero variables on TFP using OLS—which is basically Post LASSO—suggests that the quality of institutions variable is actually statistically insignificant.

In the 2SLS IV method, the paper identifies two different endogenous variables—*wage* and *icrg_qog*—and uses the same set of instrumental variables suggested from the univariate correlation results shown in Table 3. Both of the 2SLS IV methods suggest that quality of institutions has no effect on TFP. However, agricultural land, average annual precipitation, geographic location, and population density have significant and robust effects on TFP as suggested by the previous literature.

In the combination of 2SLS IV and LASSO method, the paper identifies two different endogenous variables—*wgi* and *icrg_qog*—and uses set of instrumental variables suggested from the LASSO regression. On the contrary of the univariate correlation results for *wgi* with candidate instrumental variables, LASSO suggests that religious fractionalization should be used as an instrumental variable of *wgi*. Although, LASSO suggests one additional instrumental variable for *wgi*, there is no change in our conclusion: quality of institutions is statistically insignificant; agricultural land, average annual precipitation, geographic location, and population density have significant and robust effects on TFP. Instrumental variable suggestion for icrg_qog of LASSO coincides with the suggestions of univariate correlation results. Thus, IV 2 and IV & LASSO 2 yield basically same the results suggests that the quality of institutions is statistically insignificant in effecting the TFP.

7. Conclusion

Throughout the all methods used to test the effect of quality of institutions on TFP yield statistically insignificant coefficients. That means the quality of institutions is ineffective in determining TFP and our results are very robust.

Moreover, while investigating our main aim, we find that agricultural land, average annual precipitation, geographic location, and population density is significant and quite robust in our regressions.

One unexpected result is that human capital is not a significant determinant for TFP and our results are robust.

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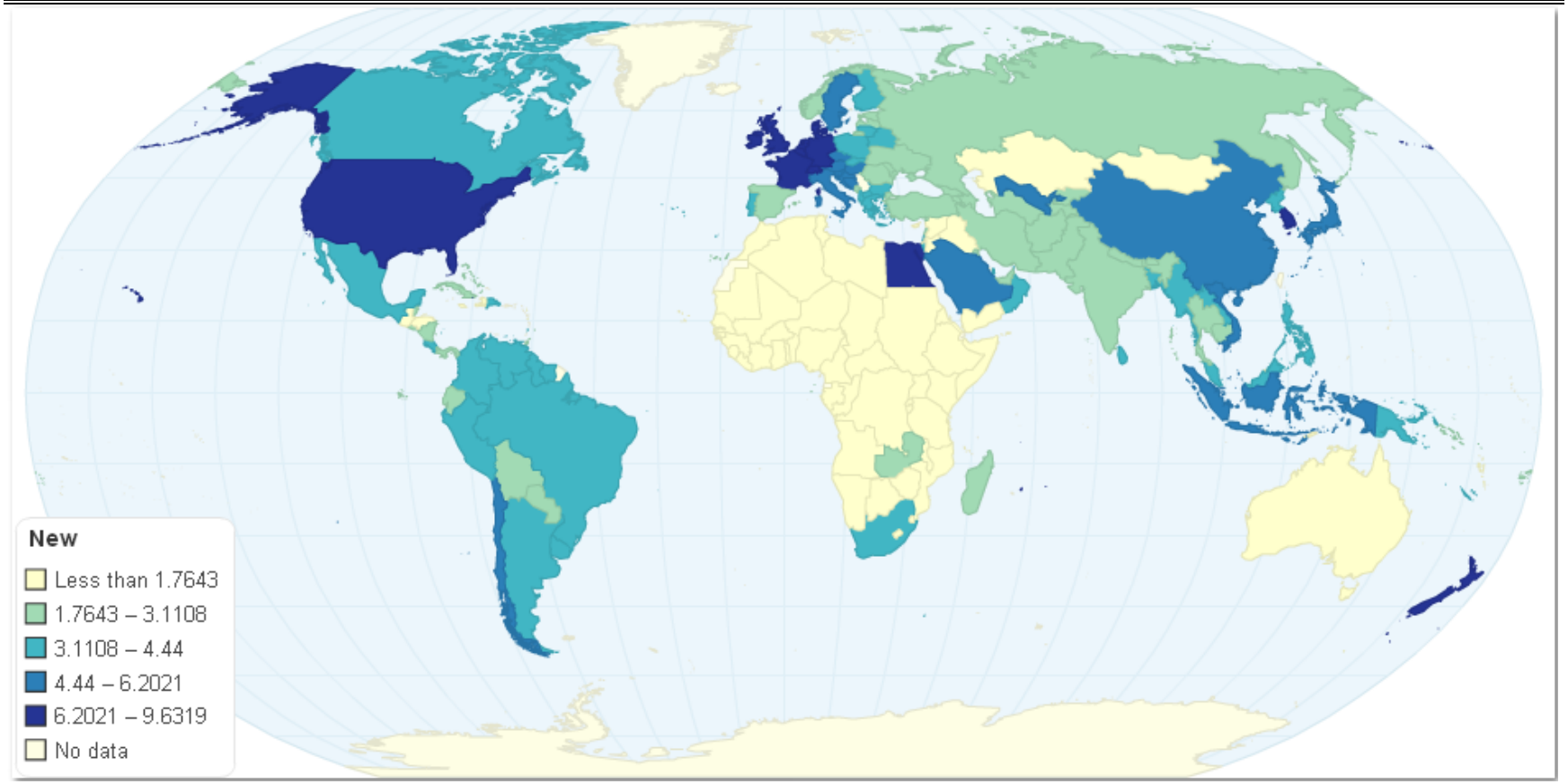
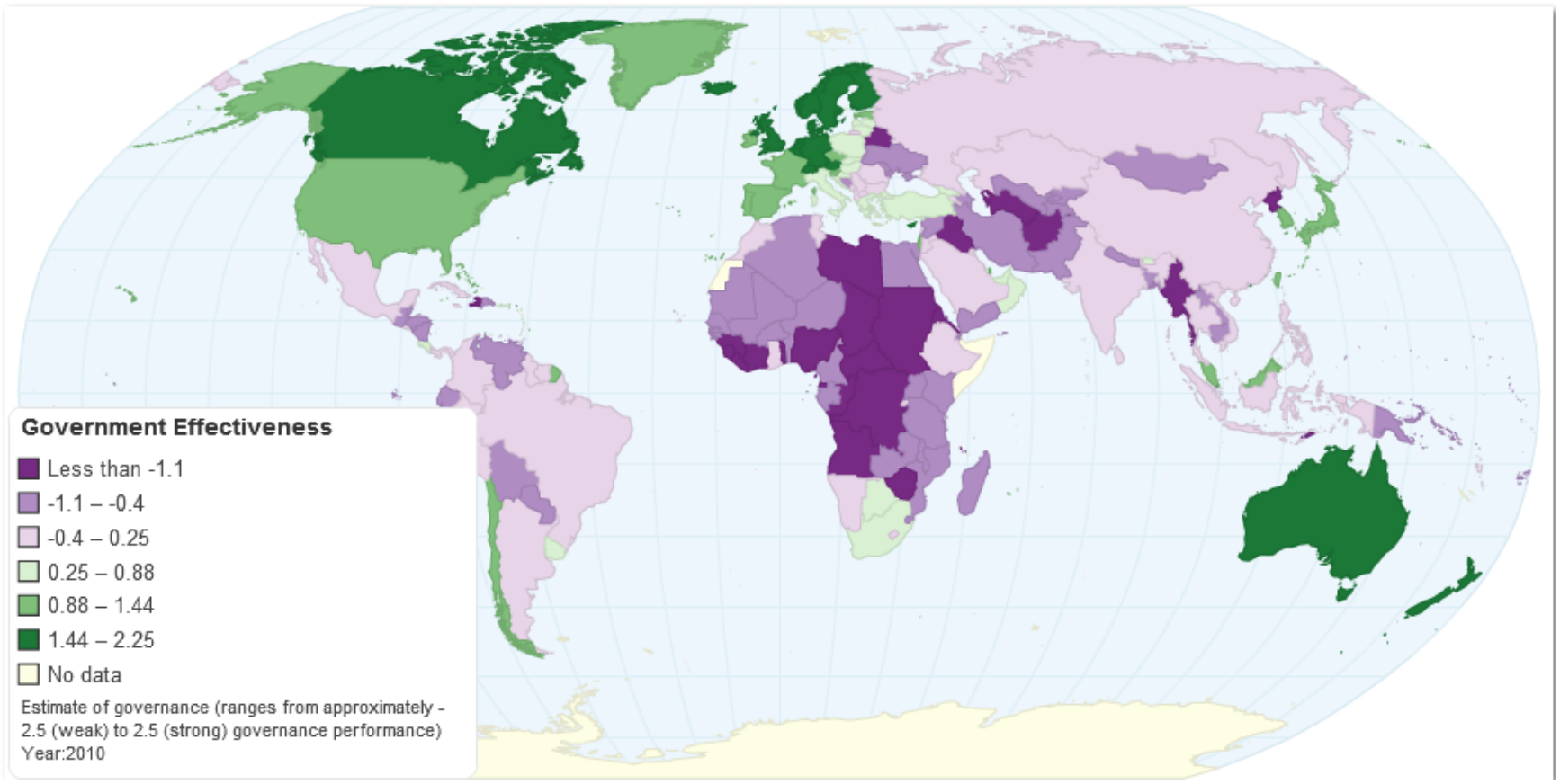
Appendix: Figures

Figure 1. World Agricultural Productivity per Hectare Harvested



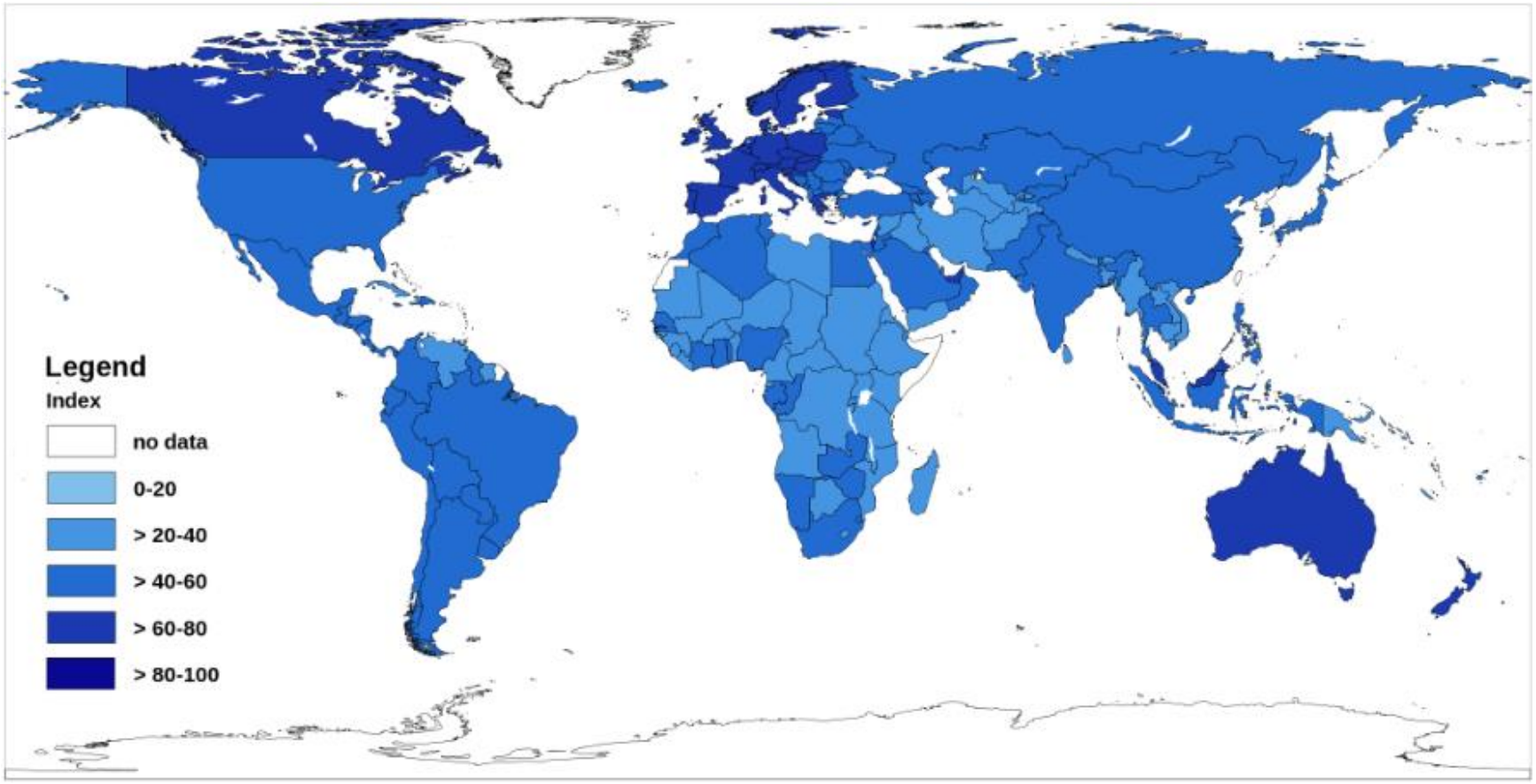
Source: World Agricultural Productivity per Hectare Harvested, ChartsBin.com, viewed 10th December, 2013, <http://chartsbin.com/view/1929>.

Figure 2. WGI – Government Effectiveness



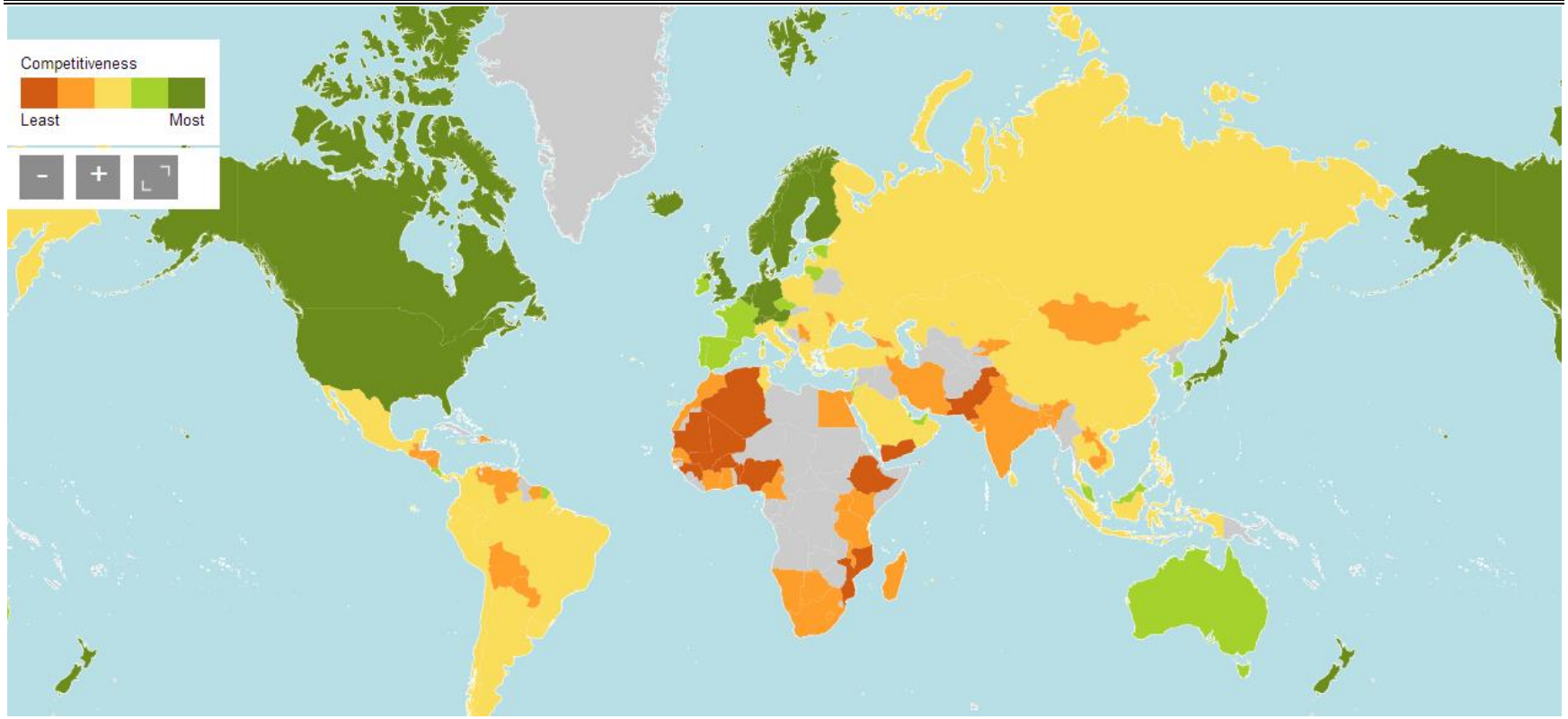
Source: ChartsBin statistics collector team 2011, *Government Effectiveness*, ChartsBin.com, viewed 12th December, 2013, <http://chartsbin.com/view/3412>.

Figure 3. KOF Index of Globalization



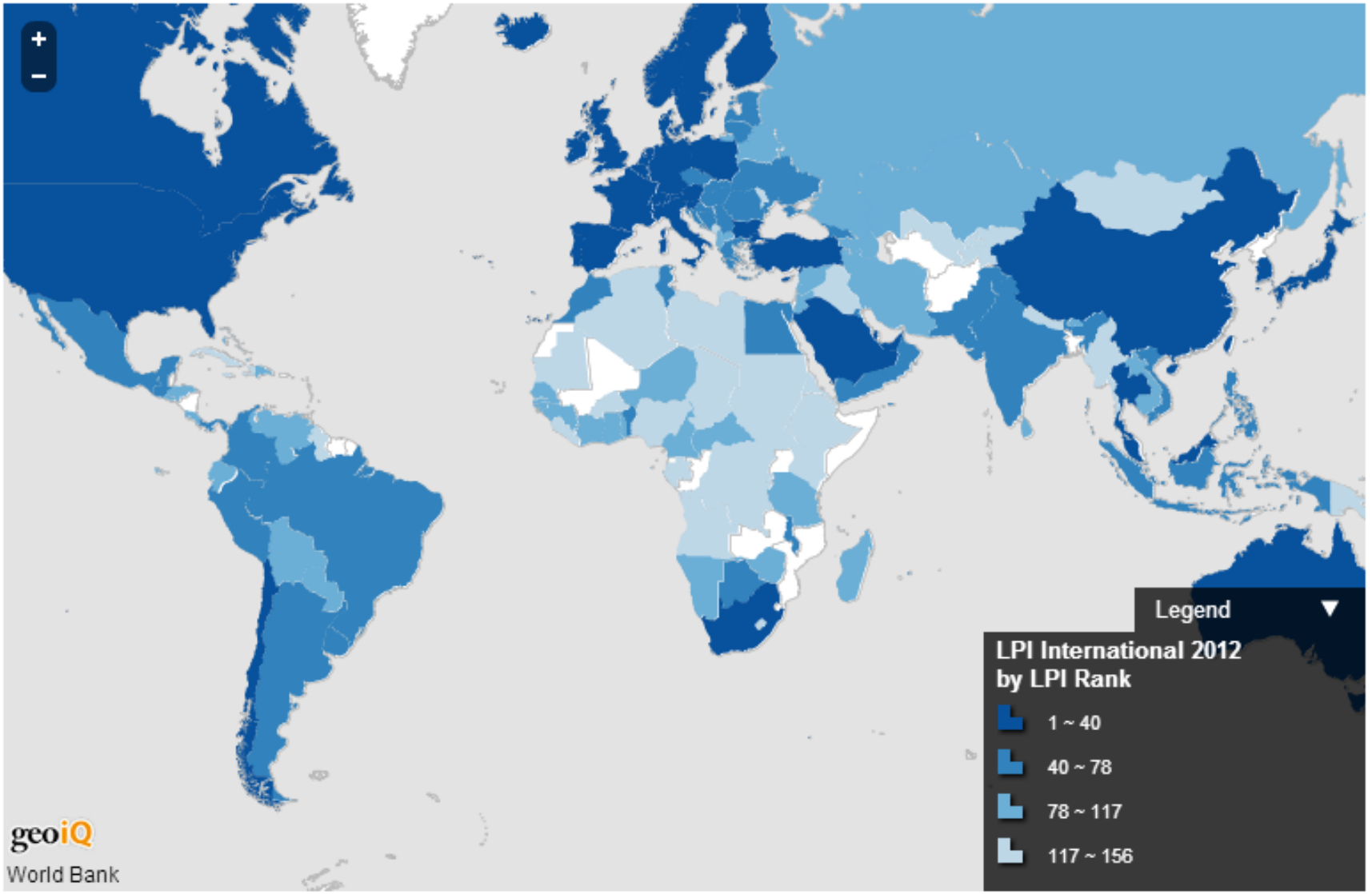
Source: KOF Index of Globalization, viewed 11th December, 2013, < http://globalization.kof.ethz.ch/maps/ >.

Figure 4. Human Capital Index



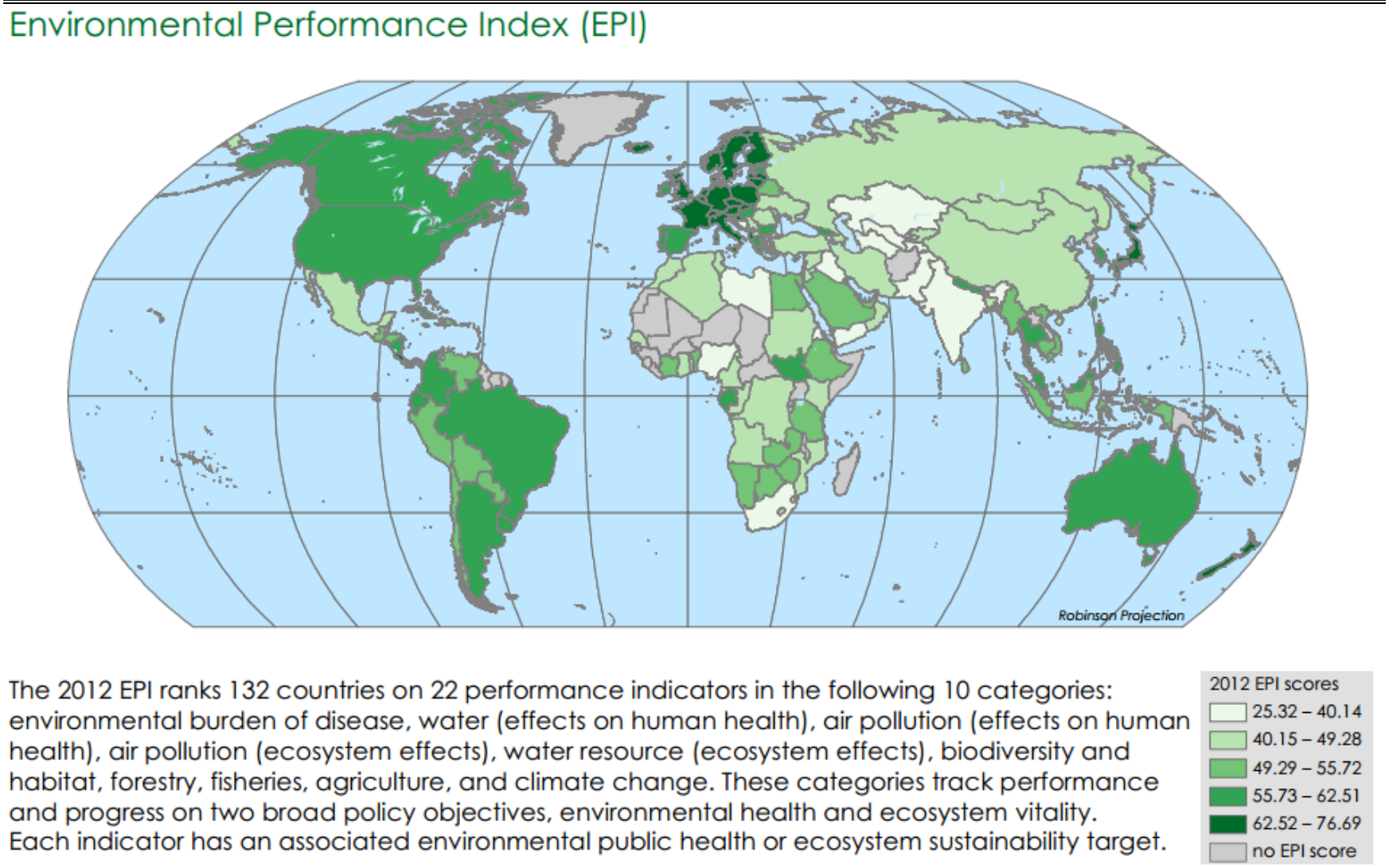
Source: Human Capital Index, viewed 11th December, 2013, < http://widgets.weforum.org/human-capital-index-2013/ >.

Figure 5. Logistic Performance Index



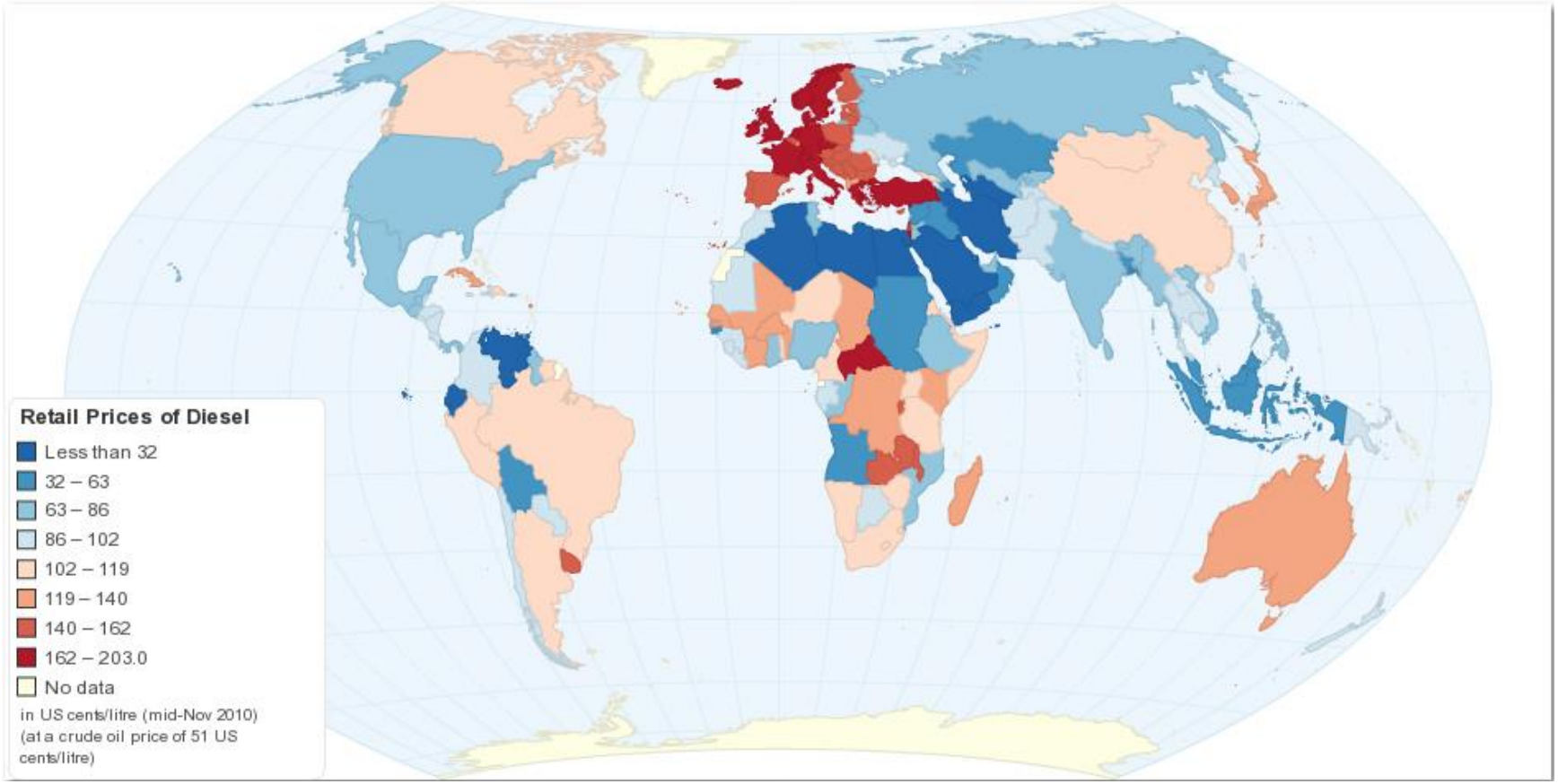
Source: Logistic Performance Index, viewed 11th December, 2013, < http://lpi.worldbank.org/ >.

Figure 6. Environmental Performance 2012 Index Map



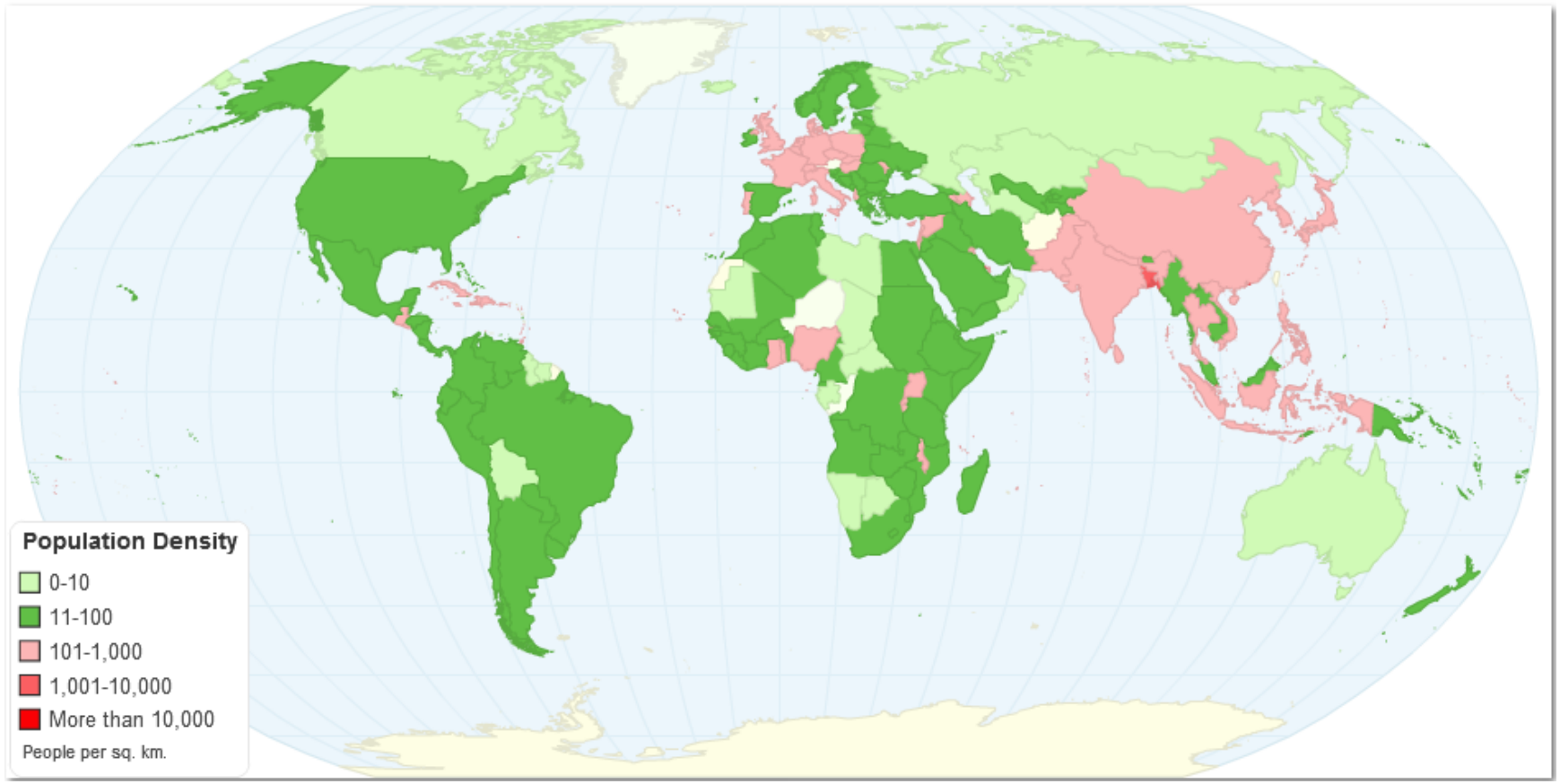
Source: Environmental Performance Index, viewed 11th December, 2013, < http://sedac.ciesin.columbia.edu/data/set/epi-environmental-performance-index-pilot-trend-2012/maps >.

Figure 7. Worldwide Retail Prices of Diesel (US cents per litre)



Source: Logistic Performance Index, viewed 11th December, 2013, < http://lpi.worldbank.org/ >.

Figure 8. Population Density



Source: Population Density, ChartsBin.com, viewed 12th December, 2013, <http://chartsbin.com/view/4881>.

Figure 9. Ethnic Fractionalization

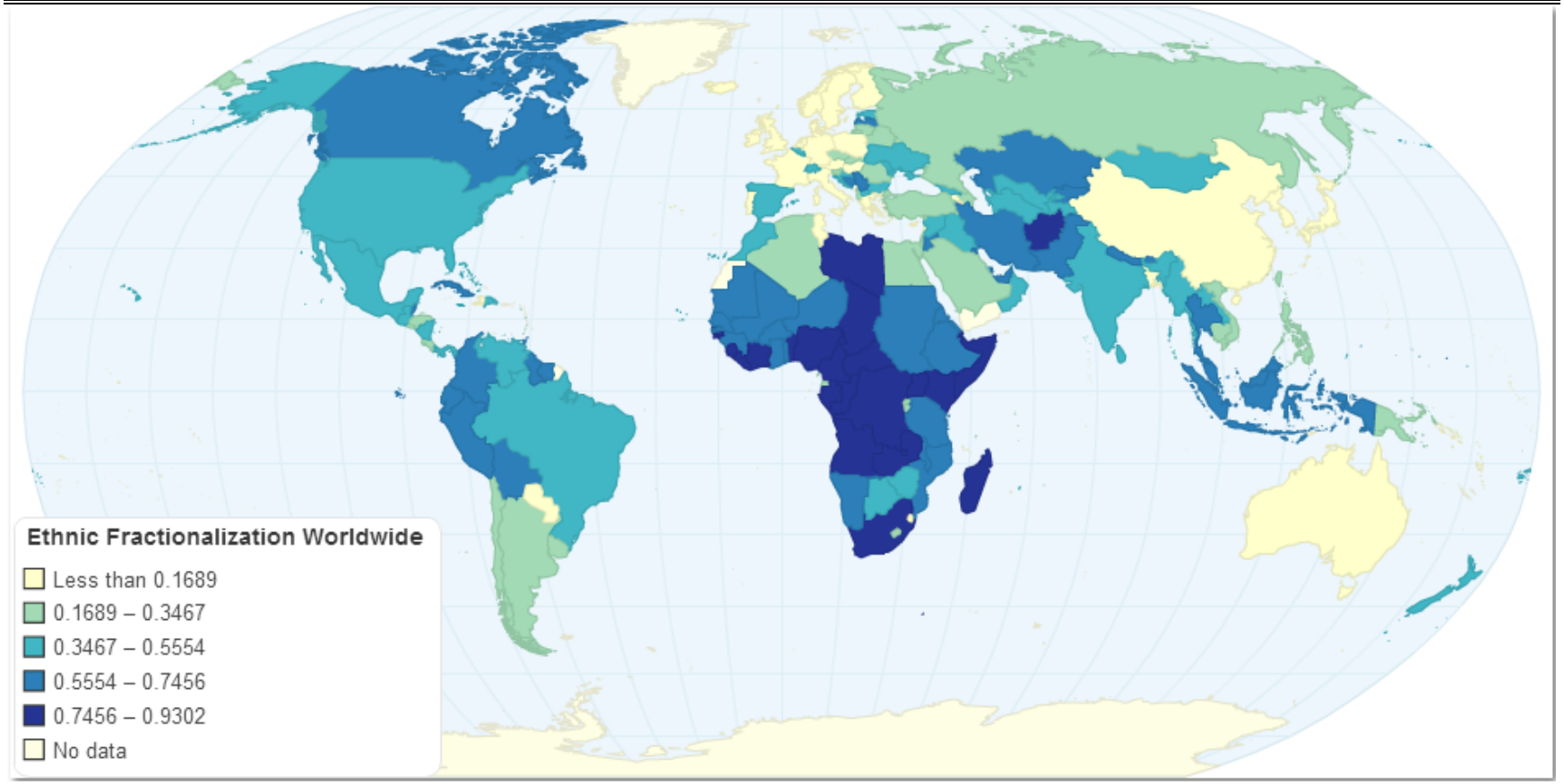


*Figure shows the ethnic fractionalization index map which is prepared by using Alesina et al. (2003) data set.

Source: Alesina et al. (2003) and World Ethnic Fractionalization, ChartsBin.com, viewed 11th December, 2013, <http://chartsbin.com/view/8922>.

Figure 10. Language Fractionalization

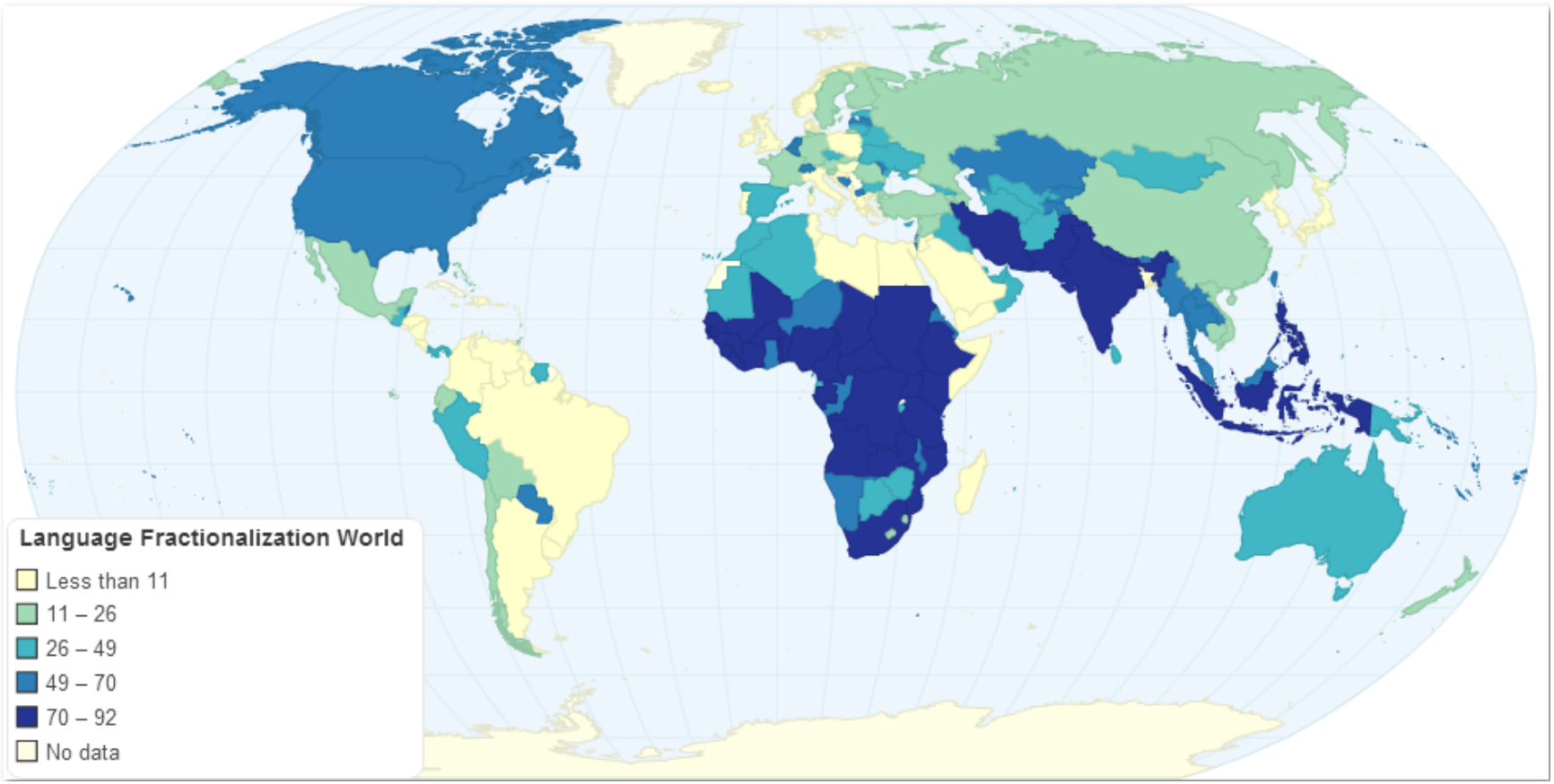
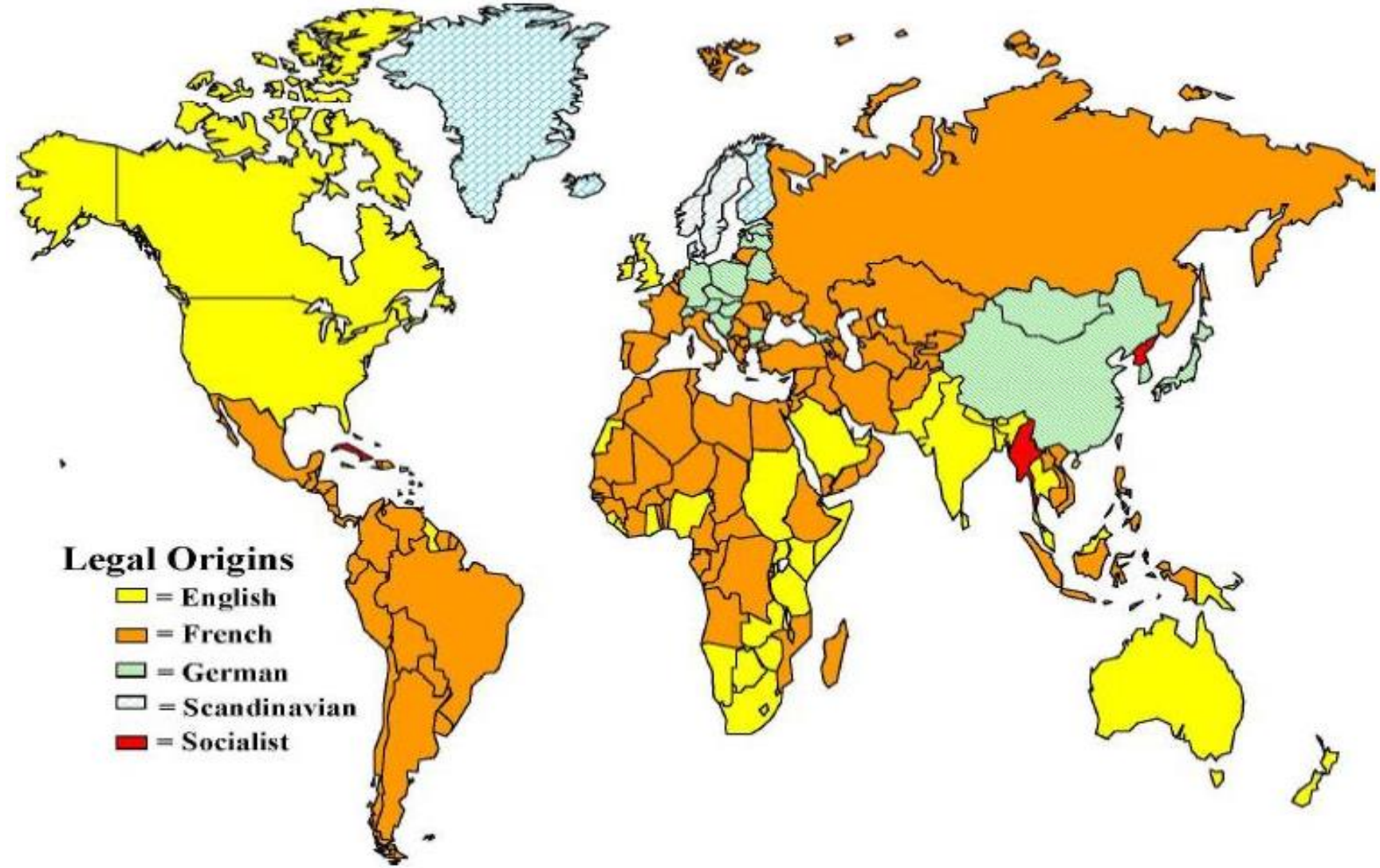


*Figure shows the ethnic fractionalization index map which is prepared by using Alesina et al. (2003) data set.

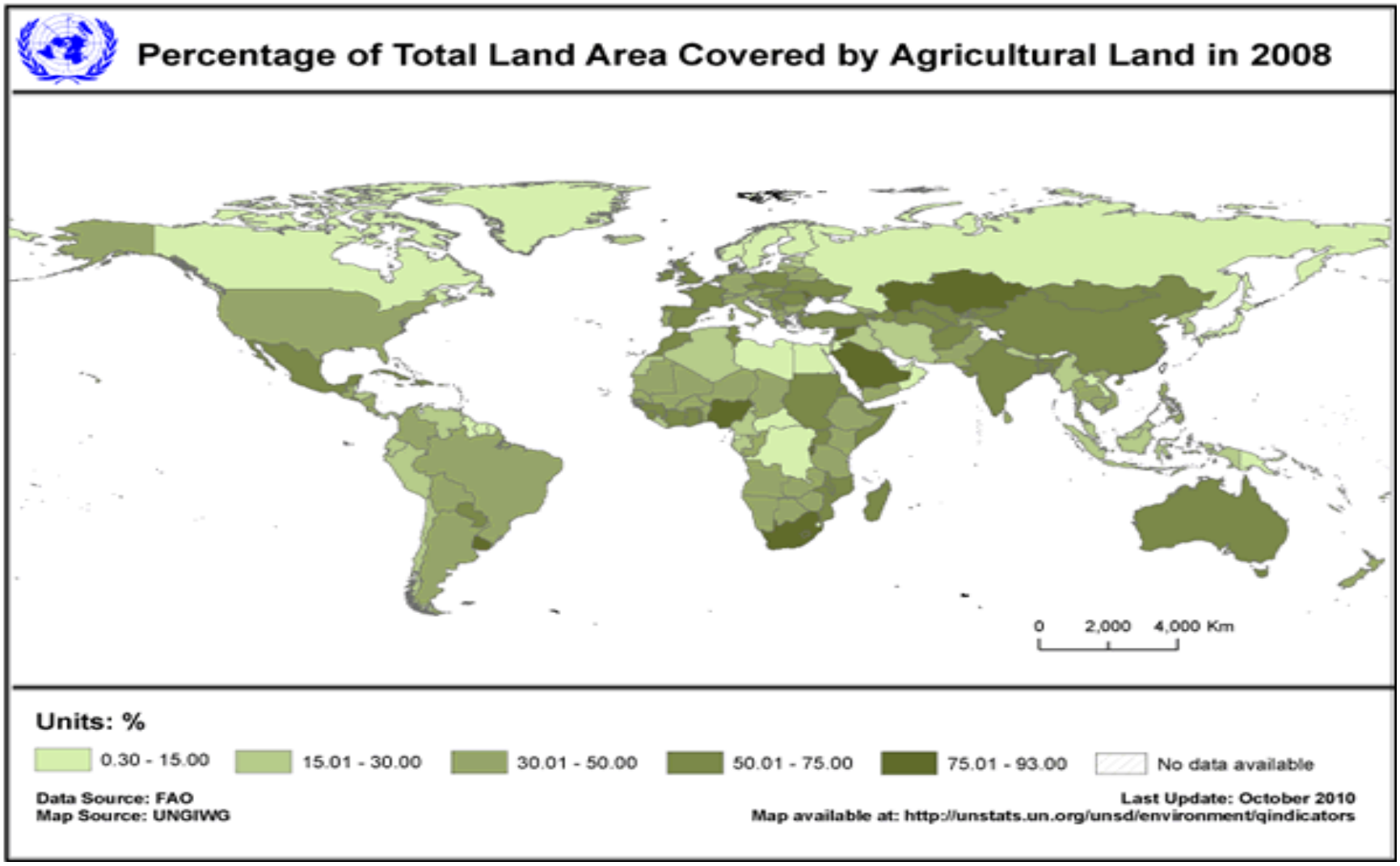
Source: Language Fractionalization World, ChartsBin.com, viewed 12th December, 2013, <http://chartsbin.com/view/9466>.

Figure 11. Legal Origins



Source: Legal Origins, viewed 12th December, 2013, <http://grundelanbankcentury.files.wordpress.com/2010/02/legal-origin.jpg>.

Figure 12. Percentage of Total Land Area Covered by Agricultural Land in 2008



Source: Agricultural Land, viewed 12th December, 2013, <http://unstats.un.org/unsd/environment/agriculturalland.htm>.