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ARE COUNTRIES CATCHING-UP WITH THE WORLD TECHNOLOGICAL FRONTIER?

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Title: *"Are Countries Catching-up with the World Technological Frontier?"*

Abstract:

This empirical analysis seeks to study the effect that institutional and geographical variables have on the economic growth of countries and in the catch-up process of the less developed with the technological frontier. Three institutional variables from Transparency International, The Heritage Foundation and Freedom House will be used. Adding two geographic variables: latitude and access to the coast.

The results of the regression (robust and significant) verify that higher quality institutions, a stronger defense of political rights and civil liberties, latitudes far from the equator and access to the coast have positive effects on economic gro. In addition, through the estimation of a stochastic production frontier function, the importance of certain institutional and geographical variables as determinants of efficiency is demonstrated. Finally, an efficiency ranking is drawn up and it is calculated whether there has been a catch-up effect of less developed countries.

Keywords: economic growth, catch-up, stochastic frontier, institutional quality, corruption, economic freedom, civil liberties, political rights.

Título: *"¿Están los Países aproximándose a la Frontera Tecnológica Mundial?"*

Resumen:

Este análisis empírico estudia el efecto que tienen variables de carácter institucional y geográfico sobre el crecimiento económico de los países y el proceso de "catch-up" de los menos desarrollados con la frontera tecnológica. Se utilizarán tres variables institucionales de Transparency International, The Heritage Foundation y Freedom House. Añadiendo dos variables de geográficas: la latitud y el acceso a la costa.

Los resultados de la regresión (robustos y significativos) verificar que instituciones de mayor calidad, una defensa más férrea de derechos políticos y libertades civiles, latitudes alejadas del ecuador y el acceso a la costa tienen efectos positivos en el crecimiento de los países. Además, a través de la estimación de una función frontera de producción estocástica se demuestra la importancia de determinadas variables institucionales y geográficas como determinantes de eficiencia. Finalmente, se elabora un ranking de eficiencia y se calcula si ha habido efecto "catch-up" de países menos desarrollados.

Palabras clave: crecimiento económico, "catch-up", frontera estocástica, calidad institucional, corrupción, libertad económica, libertades civiles, derechos de propiedad.

Síntesis de las conclusiones en español:

En este análisis empírico se ha demostrado que cuándo se habla de crecimiento económico, además de analizar las variables económicas tradicionales, es necesario tener en cuenta las instituciones y características geográficas de las distintas economías. Las regresiones econométricas reflejan que la existencia de un sector público libre de corrupción y de sociedades más libres, hace que las economías se organicen de forma más eficiente. De la misma forma, se encuentra un efecto significativo de las variables geográficas, y es que aquellos países que estén situado en latitudes más alejadas del ecuador y que tengan acceso al mar, presentarán tasas de crecimiento más altas.

DECLARACIÓN RELATIVA AL ARTÍCULO 8.3 DEL REGLAMENTO SOBRE LA ASIGNATURA TRABAJO FIN DE GRADO

(Acuerdo de 5 de marzo de 2020, del Consejo de Gobierno de la Universidad de Oviedo).

Yo Diego Pérez González, con DNI

DECLARO

que el TFG titulado "*Are Countries Catching-up with the World Technologica Frontier?*"es una obra original y que he citado debidamente todas las fuentes utilizadas.

27 de mayo de 2022

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1. INTRODUCTION

In modern growth theory, investments in knowledge-generating activities (for example human capital or R&D) are decisive when talking about economic growth and development. Romer (1989) defined this knowledge (germ of the economics of ideas) as non-rivalrous and partially excludable, meaning that state-of-the-art production processes or technological advancements should be available for everyone at any time. Thus, even less developed countries would be able to benefit from the increasing returns to scale linked to these innovations, either imitating or licensing them to leading countries.

However, reality does not match the theory, and most less developed countries are not catching-up with the world technological frontier, i.e., reducing the distance with the most advanced economies, by means of adopting more efficient production processes. This has been already claimed by previous research, like Prescott (1998) or Hall and Jones (1999), who argue cross-country income gaps are not caused by differences in physical or human capital yet by differences in productivity.

Empirical evidence, such as the one presented by Kneller and Stevens (2002), suggests that the factors affecting the absorptive innovation process of less developed economies, and ultimately their efficiency levels, are institutions and geography.

This empirical analysis tries to estimate the effect of those potential determinants of economic growth, employing a Cobb Douglass production function. The new variables included in the model will account for: corruption perception, protection of civil liberties and political rights, defence of economic freedom, latitude and coast access. All these variables appear to be statistically significant in previous scientific literature. Therefore, they do play a role when explaining economic growth and efficiency cross-country differences.

The analysis presents the following sections: a literature review (Section 2), where the empirical and theoretical backbone frameworks used to underpin this analysis are commented on.

Section 3, the data section, is where the variables used in this analysis are defined. In addition, a discussion on the source, elaboration and specifics of the institutional and geographic variables is provided.

In the fourth section the empirical model is presented, and the results of the econometric estimation of the model with two different data sets are commented in the fifth section (one from 1995 to 2019 with 82 countries, and another one from 2000 to 2019 with 99 countries). In the sixth section, an efficiency analysis is conducted utilizing a stochastic frontier model, to assess the "catch – up" process of less developed countries with those at the technological frontier. Finally, in Section 7 presents the concluding remarks and main insights from this empirical analysis.

2. ECONOMIC GROWTH ANALYSIS

How and why developed countries became rich? These are core questions in the field of economics. For centuries, many economists have tried to answer those questions giving different explanations on which factors cause economic growth and make countries develop.

In this empirical analysis, to answer those questions, the starting point will be the neoclassical model proposed by Robert Solow in *A Contribution to the Theory of Economic Growth (1956)*, further developed by the empirical research of Mankiw et al. (1992). In order to analyse why not all the countries have been growing at the same pace, some other explanatory variables will be added. More precisely variables accounting for institutional quality (corruption level, economic freedom, political right and civil liberties) and geographical characteristics (latitude and coast access) will be included.

2.1. ECONOMIC GROWTH AND INSTITUTIONS

The influence of institutions on the economy has been an object of investigation since the 1930s. However, the interest in institutions peaked during the 1980s, appearing a new school of thought, New Institutional Economics. Douglass North, a member of this school and Nobel prize winner in economics in 1993 (with Robert Fogel), defined institutions as "the rules of the game in a society or, more formally, are the humanly devised constraints that shape human interaction" (North, 1990). From there three essential characteristics of institutions can be derived. First, institutions are "humanly devised", implying that they are elements under human control; second, institutions are "the rules of the game" ruling over human behaviour; third, their primary impact will be through incentives (North, 1981; Acemoglu et al., 2010).

More recently, Acemoglu and Robinson (2010) gathered empirical evidence to show that an important source of differences in prosperity across countries is due to their institutions. In their conclusions, they emphasize the importance of understanding "what instruments can be used to push a society from a bad to a good political equilibrium". In addition, a quasi-causal relation is pointed out: "promoting democracy and accountability and checks and balances will almost certainly lead to better economic policies and institutions".

Assane and Grammy (2003) argued that "good institutions" improve countries' economic efficiency and boost their growth rates. Their policy recommendations include: "freedom to participate in social economic and political activities" without any type of intervention, and "institutional support to enforce the rule of law, procedures and organizations" so that they do not interfere with incentives "to trade, invest and innovate". Considering these results, and the wide range of scientific literature analysing the impact of institutional quality, four institutional dimensions will be considered in this empirical analysis: corruption and political instability, economic freedom, political rights and civil liberties.

Centring on institutional corruption, the first relevant study was carried out by Gunnar Myrdal. In his book *Asian Drama: An Inquiry into the Poverty of Nations* (Myrdal,1968) he suggests that corruption influences the development process of countries, by introducing elements of irrationality and inefficiency in the administration contracts. From another perspective, Bardhan (1997) argues that in over-regulated economies, where there is an abundance of complex rules and corrupt bureaucrats, there is a lack of incentives to invest in new physical capital and technology.

Nevertheless, there are some references arguing corruption has positive effects on economic growth (Leff, 1964; Lui 1985). An example is Méndez and Sepúlveda (2006), who conclude that in "free countries", there is a level of corruption (greater than 0) that maximizes the growth rate of its economy. Even so, most of the empirical evidence available supports the idea that corruption has a detrimental effect on per capita income growth (e.g., Mauro, 1995).

The positive effect of institutions on economic freedom is considered a relevant input affecting economic development. Adkins et al. (2002) tested the relation between institutional corruption and economic growth using a stochastic frontier model. The results from their analysis indicate that increases in economic freedom are related to enhanced economic performance, moving countries closer to the production frontier.

Political rights and civil liberties are the two factors for which there are less robust results. Keefer and Knack (1997) explain that indices used to account for institutional quality are somehow unclear. The main reason is that they are based on the combination of several evaluations of countries about different single scores. But there are no ideal measures for collecting this information. Still, investigations such as Rigobon and Rodrik (2005) show that both democracy and the enforcement of the rule of law have a positive impact on economic growth and incomes.

Regarding civil liberties, most of the literature suggests that there exists a positive relationship between economic growth and the protection of this type of liberties (Barro, 1996). Even so, these results are not always statistically significant or robust (Barro and Sala-i-Martin, 1995).

2.2. ECONOMIC GROWTH AND GEOGRAPHY

The evidence of geographic variables' impact on economic growth is large and robust. Most of the related scientific literature is relatively recent and based on analysing the effect of several geographical aspects (latitude, coastal surface, mean temperature, precipitation level, etc.) on the economic performance of countries.

According to Kneller and Stevens (2002), landlocked countries and those closer to the equator are less efficient. They conclude that these geographic factors are robust determinates of economic efficiency. Hence, in this empirical analysis, the attention will be centred on latitude and coast access.

Regarding latitude, both Hall and Jones (1999) and Bloom et al. (2002) show the importance of geography in determining the level of productivity. The first one shows that the latitude of a country helps to predict differences in the level of productivity. While the latter uses a more original approach, allowing for convergence through technical adoption instead of steady state capital accumulation. However, both get to the same conclusion: latitude does play a role in the economic development of countries. Hall and Jones (1996) go even further in their conclusions, suggesting that countries in the 45-to-70-degree latitude bands (above or below the equator) are the most benefitted by the climate conditions.

The World Economic Forum (Nagurney, 2021), states that nowadays 90% of the world's goods are transported by sea. Therefore, the economies of countries which are landlocked will be more isolated from international trade than those which are not. Indeed, the Office of the High Representative for the Least Developed Countries, Landlocked Developing Countries and Small Island Developing Countries, from the United Nations has indicated that because of being landlocked, a country will have higher transportation costs They

quantified this effect, stating that countries without coast end up bearing bigger costs, even 30% and 40% higher. (Report of the Secretary-General, 2021).

3. DATA

The dataset used in the empirical analysis contains panel data for 82 countries from 1995 to 2019. The main criteria used for selecting countries was data availability for the years considered. Additionally, countries with a population below one million in 1970 were excluded. Next, an explanation of the variables is given used in the empirical analysis.

3.1. ECONOMIC VARIABLES

All the economic variables i.e., national GDP, physical capital, labour and human capital are taken from the Penn World Table, version 10.0. This last version provides data for 183 countries between 1950 and 2019.

The Penn World tables were developed by Robert Summers and Alan Heston, to enable researchers with a consistent and comparable database with national accounts from countries all over the world. The main advantage of this database is that the expenditure side items are expressed as a set of weighted average international prices in a common currency; so that it is possible to compare them among countries and over time. Table 3.1.1. presents a summary of the relevant information about the four economic variables used:

Table 3.1.1. Description of the economic variables used in the empirical analysis

Variable	Description	Units	Expected Sign
National Income	Real GDP at current PPPs	Mill. 2017US$	Not applicable
Labour	Number of persons engaged	Mill. of persons	+
Physical Capital	Capital stock at current PPP	Mill. 2017US$	+
Human Capital	Human Capital Index	Average schooling years and return to education	+

Source: own elaboration

3.2. INSTITUTIONAL VARIABLES

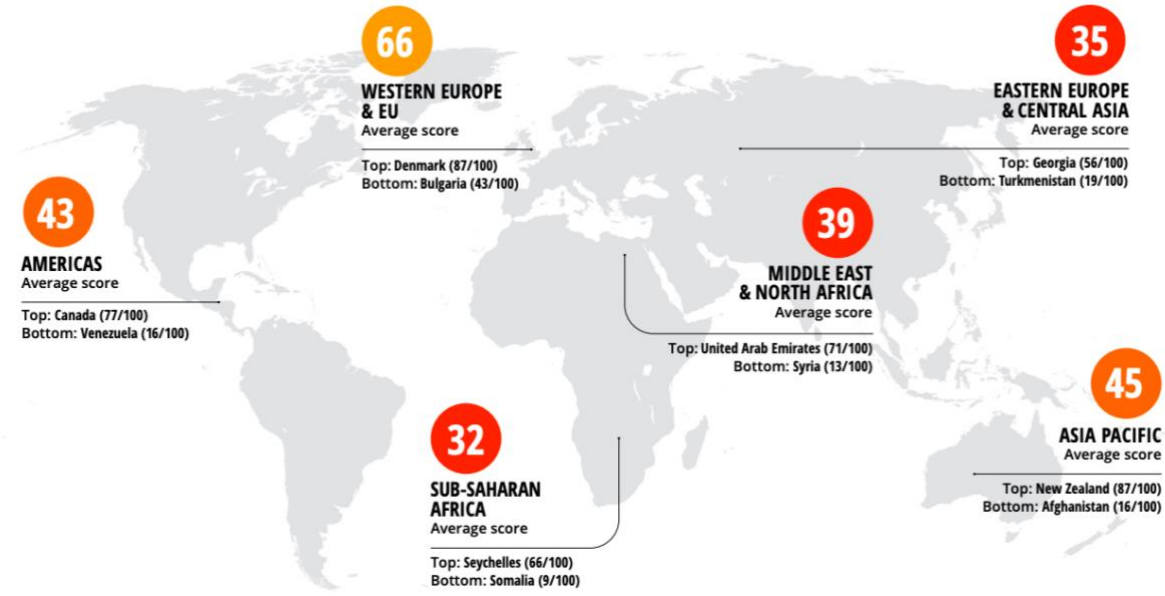
Among the many possible ways of accounting for institutional quality, 4 indices have been selected. They account for: corruption, degree of economic freedom, political rights and civil liberties.

The Corruption Perceptions Index (CPI) is elaborated by *Transparency International*, an NGO whose main purpose is to fight against global corruption and prevent criminal activities. This index is computed every year, since 1995, for around 180 countries and collects the perceptions from businesspeople and country experts about the level of corruption in the public sector. It uses 13 data sources from 12 different institutions which

are later standardized to create a scale from 0 to 100; where 0 means "totally corrupt" and 100 means "totally clean".

The results from the 2019 CPI Report show that the average score is 43 and more than two-thirds of the countries score below 50. Figure 3.2.1. depicts the remarkable differences across regions, more than doubling the score for the case of "Western Europe & EU" and "Sub-Saharan Africa". According to Transparency International, corruption prevails in those countries where electoral campaign funding is not controlled; or where governing authorities are highly influenced by national economic elites

Figure 3.2.1. CPI 2019 average regional scores (top and bottom performers)

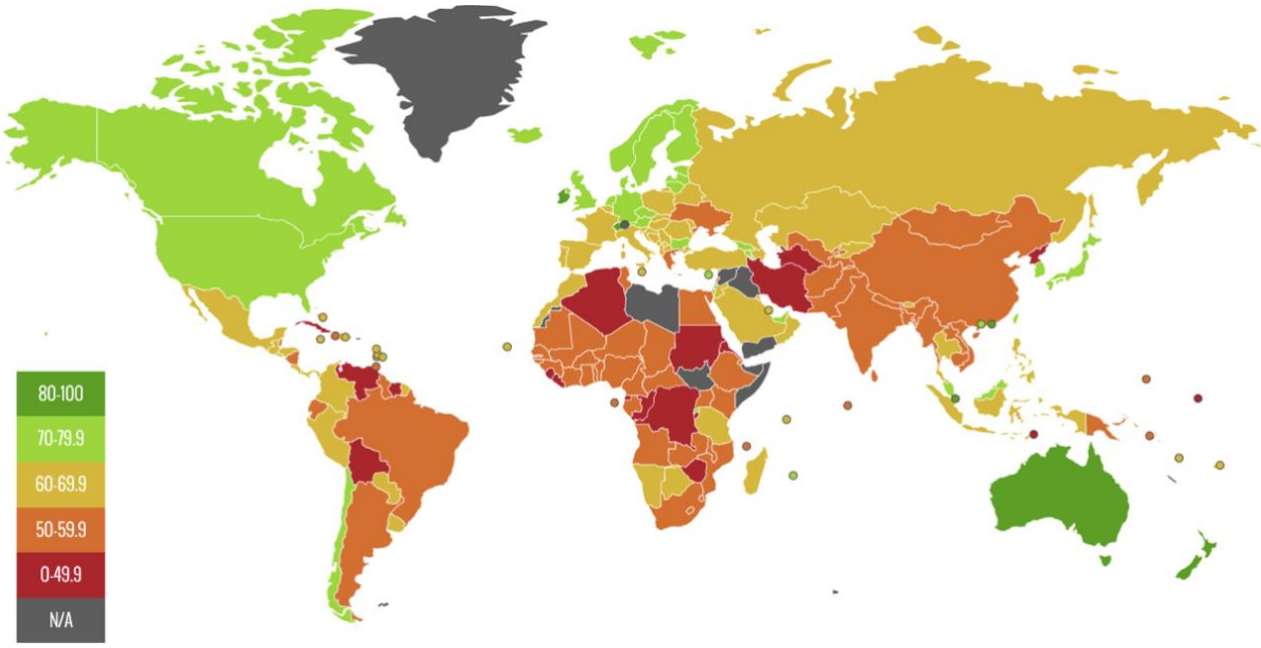


Source: Transparency International 2019 Report

The Index of Economic Freedom (IEF) is published by *The Heritage Foundation* on an annual basis since 1995, and it is based on 12 quantitative and qualitative factors and reported for 184 countries. These factors comprise a wide range of variables (trade, business, governance, policy…), elaborated by internationally recognized institutions, and are summarized in 4 main pillars: Rule of Law, government size, regulatory efficiency and open markets. In order to produce an economy's overall score, the 12 components are equally weighted and averaged. The result is a final economic freedom score ranging from 0 to 100; where 0 means repressive government interference and 100 no government interference.

In 2019, the average IEF rating among the 186 countries was 60.1, the third highest score in the history of the index. 86 economies have ranked below 60: 64 of them scored between 50-60 (mostly unfree), while the other 22 scored below 50 (repressed). Figure 3.2.2. shows the least free region in the world is Sub-Saharan Africa. Indeed, the 2019 Index of Economic Freedom Report states that it is the only region not having at least one country in the top 20 freest economies.

Figure 3.2.2. IEF 2019 score per country



Source: The Heritage Foundation 2019 Report

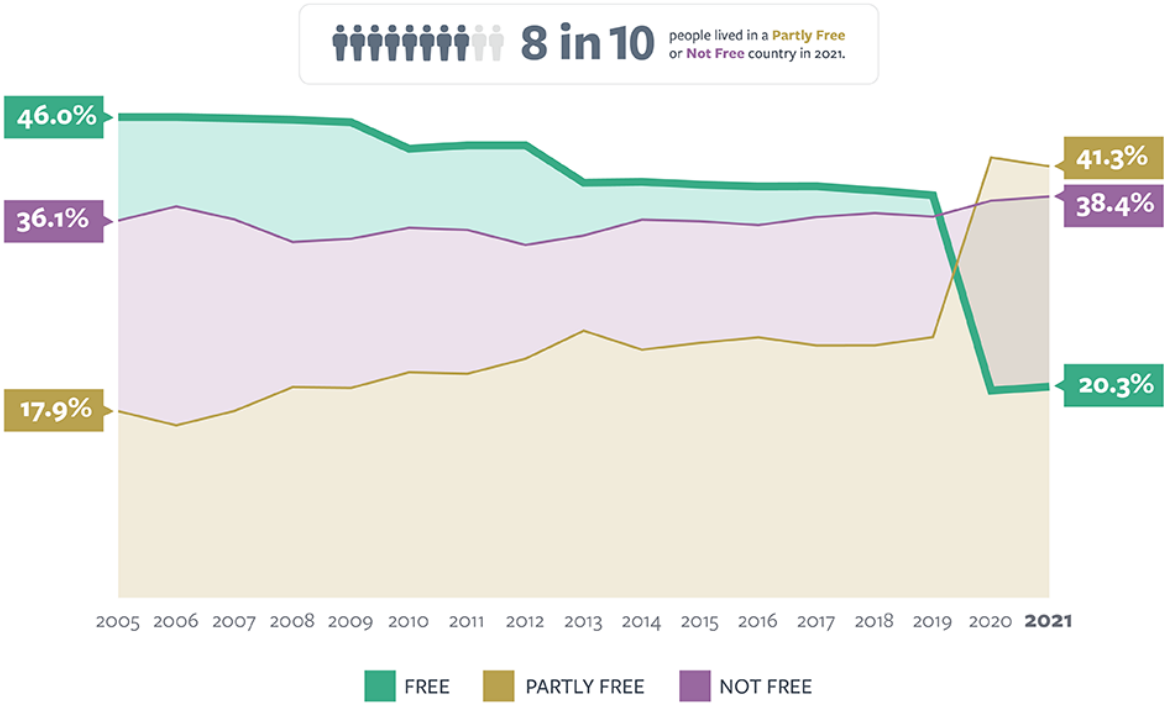
The last institutional variables come from the annual report "Freedom in the World" elaborated by *Freedom House*: political rights (PR) and civil liberties (CL). *Freedom House* is an organization founded in the United States whose main objective is the promotion and support of democratic values all over the world. It was founded in 1941, during World War II and the rise of authoritarian regimes in Europe.

Freedom House has been elaborating this report since 1978, evaluating different aspects regarding PR (electoral process, political pluralism and participation, and functioning of government) and CL (freedom of expression and belief, associational and organizational rights, rule of law, and personal autonomy and individual rights) for states all around the world, and its latest edition scores and provides a status to 195 countries.

This report's rating system assigns a score to each country regarding its political rights and civil liberties. A country or territory is given a maximum score of 40 for political rights and a maximum of 60 for civil liberties. Based on the scores of each sub-index countries are rated between 1 and 7 for each score, where 1 represents the lowest degree of freedom and 7 the highest.

Figure 3.2.3 shows the results from Freedom in the World 2022 that represent a consolidation of a democratic backsliding trend, which started 16 years ago. The report states that "global freedom faces a dire threat". The decline in global freedom is explained since autocrats have tailored an international environment to promote themselves as the best alternative to the existing status quo.

Figure 3.2.3. Share of world's population living in "free", "partly free" and "not free" countries



Source: Freedom in the World 2022

Table 3.2.4. presents a summary of the relevant information about the four institutional variables previously discussed:

Table 3.2.4. Description of the institutional variables used in the empirical analysis

Variable	Description	Source	Expected Sign
Corruption Perceptions Index (CPI)	Scale from 0 to 100 (lower values indicate more corrupt economies)	Transparency International	+
Index of Economic Freedom (IEF)	Scale from 0 to 100 (lower values indicate less economic freedom)	The Heritage Foundation	+
Civil Liberties (CL)	Scale from 1 to 7 (lower values indicate higher protection of CL)	Freedom House	+
Political Rights (PR)	Scale from 1 to 7 (lower values indicate a higher protection of PR)	Freedom House	+

Source: own elaboration

3.3. GEOGRAPHICAL VARIABLES

Previous research has found that some geographic characteristics of the countries play an important role in the explanation of economic growth. Considering he previous empirical evidence two geographic variables will be used: *Latitude*, measured as the absolute value of the distance from a country to the equator; and *Coast* which is a dummy variable indicating if a country has access to the seacoast.

Table 3.3.1 Description of the geographical variables used in the empirical analysis

Variable	Description	Source	Expected Sign
Latitude	Angle in degrees from each country to the Equator	Antipodas.net	+
Coast Access	Dummy variable, sets 1 for countries with coast access	Own elaboration	+

Source: own elaboration

Finally, Table 3.1. shows some descriptive statistics of the variables used in the empirical analysis:

Table 3.1. Descriptive statistics from the variables used in the empirical analysis

Variable	Mean	Std. Deviation	Minimum	Maximum
National income	945,275	2,388,552	6,012.630	20,862,890
Labour	30.99992	97.45928	0.56	799.31
Physical Capital	3,861,031	9,163,272	11,983.8	81,598,696
Human Capital Index	2.682790	0.632731	1.11	4.35
CPI	47.23898	22.74152	4.0	100.0
IEF	62.74766	9.880243	21.4	89.4
CL	2.814146	1.536316	1.0	7.0
PR	2.68	1.826554	1.0	7.0
Latitude	31.49232	16.16650	1.0	64.0
Coast Access	0.8414663	0.365333	0.0	1.0

Source: own elaboration

4. EMPIRICAL MODEL

The empirical model explains how the traditional inputs, together with the above described institutional and geographical variables affect the economic growth of a country. Assuming an aggregate production function describing the income level of country *i* in year *t*:

$$Y_{it} = F(K_{it}, L_{it}, H_{it}, Z_{it}, W_i, t\ ) \tag{1}$$

where K accounts for physical capital, L for labour, H is a proxy for human capital, Z represents the institutional variables (CPI, IEF, PR and CL); and the geographical variables latitude (LAT) and coast access (COAST) are collected in W. Finally, t is a time trend that is intended to capture technical change.

The econometric model to be estimated is the following Cobb-Douglas production function (Cobb and Douglas, 1928):

$$\begin{aligned} lnY_{it} = \alpha + \beta_1 lnL_{it} + \beta_2 lnK_{it} + \beta_3 lnH_{it} + \gamma_1 lnCPI_{it} + \gamma_2 lnIEF_{it} \\ + \gamma_3 lnPR_{it} + \gamma_4 lnCL_{it} + \delta_1 lnLAT_i + \delta_2 COAST_i \\ + \theta_1 trend_t + \theta_2 trend^2{}_t + \lambda_1 DCRISIS_t + \lambda_2 DOIL_i \\ + \lambda_3 DUSA + \lambda_4 DCOUNTRY\ GROUPS_i + \varepsilon_{it} \end{aligned} \tag{2}$$

where Y_{it} is the dependent variable, α is the intercept, β coefficients account for the elasticities of the economic variables, γ coefficients for the elasticities of the institutional variables and δ for the elasticities of the geographical variables. Additionally, to control for unobserved heterogeneity several control variables are included:

- A dummy variable to account for the last economic crisis, taking on value 1 from 2008 until 2017.
- A time trend and a quadratic time trend.
- A dummy variable for the oil-exporting countries (Mexico, India, Ecuador, Russia, Norway, Venezuela and Kazakhstan). A similar definition has been used previously by Rodrik et al. (2004) or Vijayaraghavan and Ward (2001).
- Dummies for country groups to group countries with similar technological levels:
    - *Leading Country:* United States.
    - *North Europe:* Austria, Belgium, Denmark, Finland, France, Germany, Ireland, the Netherlands, Norway, Sweden and United Kingdom.
    - *Central Europe:* Bulgaria, Croatia, Estonia, Hungary, Latvia, Lithuania Poland, Romania, Slovakia and Slovenia.
    - *South Europe:* Italy, Greece, Portugal, Spain and Turkey.
    - *Latin America:* Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Paraguay, Peru and Uruguay.
    - *East Asia:* Malaysia, Indonesia, Philippines, Singapore, Thailand, Taiwan and Vietnam.
    - *Central Asia:* Jordan, Kazakhstan, Kyrgyzstan and Mongolia.
    - *Industrialized Countries:* Australia, Canada, Israel, Japan and New Zealand.

Therefore, the omitted country group will be all the countries from the African continent.

5. ECONOMETRIC ESTIMATION AND RESULTS

The model in equation (2) has been estimated by ordinary least squares (OLS) using Limdep 10 (Greene, 2012). For the first regression (Table 5.1.), a restricted version of the original dataset has been used, including data of 82 countries from 1995 to 2019 (82 x 25 = 2050 observations; a list with the countries used in this regression can be found in appendix A).

Table 5.1. OLS regression for 82 countries from 1995 to 2019

Dependent variable: LGDP

Variable	*Coefficient*		*Standard Error*	*t statistic*	*p value*
Constant	-1.417	***	0.215	-6.59	0.000
L_LABOR	0.463	***	0.011	39.34	0.000
L_CAPITAL	0.553	***	0.011	50.04	0.000
L_HUMAN CAPITAL	0.431	***	0.046	9.37	0.000
L_CPI	0.358	***	0.027	13.24	0.000
L_IEF	0.703	***	0.056	12.4	0.000
L_POLITICAL RIGHTS	0.005		0.020	0.27	0.787
L_CIVIL LIBERTIES	0.153	***	0.025	5.97	0.000
L_LATITUDE	0.074	***	0.008	8.72	0.000
D_COAST	0.051	***	0.018	2.78	0.005
TREND	0.015	***	0.003	3.91	0.000
$TREND^2$	-0.001	***	0.000	-3.99	0.000
D_CRISIS	-0.02		0.015	-1.38	0.168
D_OIL	0.114	***	0.023	4.87	0.000
D_LEAD COUNTRY	0.268	***	0.059	4.49	0.000
D_NORTH EUROPE	0.145	***	0.026	5.51	0.000
D_CENTRAL EUROPE	0.294	***	0.026	11.05	0.000
D_SOUTH EUROPE	0.24	***	0.029	8.05	0.000
D_LATIN AMERICA	0.126	***	0.018	6.74	0.000
D_CENTRAL ASIA	-0.167	***	0.033	-5.05	0.000
D_EAST ASIA	0.109	***	0.025	4.33	0.000
D_IND	0.060	*	0.031	1.93	0.053

Note: ***, **, * denote significance level at 1%, 5% and 10%.

$R^2 = 0.976$

F statistic = F (21, 2028) = 3980.932 (p value < 0.000001)

Most of the coefficients present the expected sign and are statistically significant at 1% significance level, except from D_IND (significant at 10% significance level) and the political rights variable and D_CRISIS dummy variable (statistically insignificant). Additionally, the variables in the model are jointly statistically significant, as the null hypothesis of the F test is rejected. The coefficient of determination (R^2) shows that the model explains more than 97 % of the variations of the dependent variable.

Taking into consideration the previous results, some of the hypotheses stated previously can be discussed:

- For the economic variables, the results obtained are the expected ones. As the previous empirical evidence has shown; labour force, capital stock and human capital present a positive and statistically significant relationship with GDP. The three coefficients (L_LABOR, L_CAPITAL and L_HUMAN CAP) are statistically significant at a 1% significance level. The positive sign in these coefficients shows a direct relationship with economic growth. Hence, countries where there is a larger workforce, a greater capital stock and people spending more years in school, will present higher growth rates.

- The Corruption Perceptions Index (CPI) presents a direct relation with GDP. This was expected, as a less corrupt country is supposed to be governed more efficiently. Therefore, if a country is able to lower the degree of institutional corruption, its output is expected to increase. According to the model an increase of 1% in the CPI, ceteris paribus, will cause a 0.358% increase in the GDP.

- As expected, L_IEF has a positive effect on the National Income of a country. This is because the IEF presents higher values for countries which are more integrated into the global economy and stand for the protection of a market economy. For this reason, a country that enjoys stronger economic freedom will present higher growth rates.

- In the case of Political Rights (PR) and Civil Liberties (CL), the results are not the expected ones. As for L_CIVIL LIBER, it is reasonable that this coefficient has a positive effect on the economic growth rate of a country's economy. The bigger the CL index is, the more protected civil liberties are. Leading to higher social stability that, eventually, could boost the economic performance of an economy. The L_POL RIGHTS coefficient presents, as expected, a positive sign. However, this coefficient has to be ignored, as according to the t-test it is statistically insignificant.

- The geographic variables present similar results and conclusions. Both, latitude and access to the sea have a small positive impact but are statistically significant on the economic growth of a country. If there is an increase in the latitude of 1%, ceteris paribus, the GDP of a country will increase by 0.074%. Likewise, if a country is not landlocked, ceteris paribus, the GDP of a country will increase by 0.051%. Thus, countries further from the equator and with coast access will perform better than those landlocked countries which are closer to the equator.

- Regarding the dummy variables, the results are overall consistent. The D_OIL variable indicates that oil-exporting countries will tend to have larger growth rates than those without oil exports. It is worth emphasizing the fact that the effect of being an oil-exporting country is bigger than the effect of the geographic variables.

  As could be expected, the dummy variable collecting a set of industrialized and technologically advanced countries (D_IND) shows a positive. Therefore, being an advanced economy has a positive effect on the economic growth of those countries.

The positive sign of the country groups, except for D_CENTASI, indicates that Africa (omitted country group) presents certain characteristics not collected in the dataset that make it the poorest continent in the world.

After testing and empirically verifying some of the initial hypotheses, the number of countries in the sample will be expanded. To do so, and due to the lack of available data for some of them, it is necessary to restrict the period of time analysed; from 1995-2019 to 2000-2019. Before estimating the model using the expanded dataset, some dummy variables have to be redefined due to the inclusion of new countries:

- D_OIL will now account for the following countries Mexico, India, Ecuador, Russia, Norway, Venezuela, Kazakhstan and Saudi Arabia.
- D_EAST ASIA will now account for: Malaysia, Indonesia, Philippines, Singapore, Sri Lanka, Thailand, Taiwan and Vietnam.
- D_CENTRAL ASIA will now account for Iran, Jordan, Kazakhstan, Kyrgyzstan, Mongolia and Tajikistan.

For this second estimation (Table 5.2.), data from a sample of 99 countries from 2000 to 2019 (99 x 20 = 1980 observations) has been used.

Table 5.2. OLS regression for 99 countries from 2000 to 2019

Dependent variable: LGDP

Variable	*Coefficient*		*Standard Error*	*t statistic*	*p value*
Constant	-1.595	***	0.236	-6.73	0.000
L_LABOR	0.401	***	0.012	32.61	0.000
L_CAPITAL	0.613	***	0.011	54.58	0.000
L_HUMAN CAPITAL	0.353	***	0.041	8.46	0.000
L_CPI	0.434	***	0.032	13.35	0.000
L_IEF	0.564	***	0.062	8.97	0.000
L_POLITICAL RIGHTS	0.001		0.024	0.06	0.951
L_CIVIL LIBERTIES	0.154	***	0.03	5.06	0.000
L_LATITUDE	0.045	***	0.009	4.69	0.000
D_COAST	0.098	***	0.018	5.19	0.000
TREND	0.019	***	0.006	2.92	0.003
$TREND^2$	-0.001	***	0.000	-3.53	0.000
D_CRISIS	-0.051	***	0.019	-2.7	0.006
D_OIL	0.15	***	0.026	5.79	0.000
D_LEAD COUNTRY	0.172	**	0.071	2.39	0.016
D_NORTH EUROPE	0.015		0.031	0.48	0.628
D_CENTRAL EUROPE	0.244	***	0.031	7.7	0.000
D_SOUTH EUROPE	0.097	***	0.035	2.76	0.005
D_LATIN AMERICA	0.08	***	0.021	3.7	0.000
D_CENTRAL ASIA	-0.14	***	0.032	-4.38	0.000
D_EAST ASIA	0.037		0.029	1.28	0.201
D_IND	-0.052		0.037	-1.40	0.16

Note: ***, **, * denote significance level at 1%, 5% and 10%.

$R^2 = 0.972$

F statistic = F (21, 1958) = 3375.939 (p value < 0.000001)

In the estimation of Table 5.2, as for the previous one in Table 5.1., the set of variables is jointly significant as the p-value for the F statistic is approximately 0 (rejecting the null hypothesis). Despite the marginal decrease in the goodness of fit, the model is still explaining 97 % of the variations of the explained variable.

The coefficients which are relevant for the analysis are statistically significant, except for L_POL. This coefficient is, again, still statistically insignificant, however now it presents the expected positive sign (as in the previous estimation this coefficient was negative).

There are some marginal changes in the value of the estimated coefficients. However, the effect of economic variables is still the most important one, together with the effect of L_IEF. Regarding the geographic variables, despite the increase of the influence of D_COAST, in general, the geographic variables still play a secondary role when explaining the variation of GDP.

Regarding the dummy variables there are some minor changes with respect to the first estimations (Table 5.1.). When using the second data set, dummies accounting for North-European, East-Asian and Industrialized countries appear to be statistically insignificant. In exchange, the variable D_CRISIS turns out to be statistically different from 0 and has a negative effect on the GDP of countries (expected negative sign).

After analysing the estimations in Tables 5.1. and 5.2., it can be concluded that the first data set fits better the estimated model. Nonetheless, the hypotheses raised in this empirical analysis can be verified by both estimations; including institutional and geographic variables enrich economic growth models, as they increase its explanatory capacity.

6. EFFICIENCY ANALYSIS

In this section, an efficiency analysis will be developed to check which countries were able to catch-up with respect to the technological frontier. Additionally, it will be possible to determine the role human capital, institutional and geographical variables play when determining how efficient countries are (technical efficiency)

In in this empirical analysis, a stochastic frontier model will be used to study if less developed countries are able to close, or at least reduce, the gap with those countries in the technological frontier. The generic functional form that will be used is:

$$y_{it} = \beta' X_{it} + v_{it} - u_{it} \tag{3}$$

Where *y* is the explained variable, x are the explanatory variables, *v* is the random noise and *u* the non-negative stochastic term capturing inefficiency.

As the main objective is to identify which factors explain the catching-up process, the inefficiently term (u_{it}) is transformed into a function of several endogenous variables (z = HUMAN CAPITAL, CPI, IEF, CL, PR, latitude and coast access). The general form of the model is:

$$y_{it} = \beta' X_{it} + v_{it} - u_{it}(z_{it}) \tag{4}$$

There are multiple ways in which $u_{it}(z_{it})$, but the approach used in this analysis models the variance of the efficiency term, distributed as $N^{+}(0, \sigma^2_{it})$; Reifschneider et al., 1991). Additionally, u will present multiplicative heteroscedasticity and z is presented in an exponential function (Caudill et al., 1995):

$$u_{it} \sim N^{+}\left(\mu, \sigma^2_{u_{it}}\right) ;\ \sigma_{it} = g(z_{it}, \gamma) = \sigma_u \cdot \exp\left(\gamma z_{it}\right) \tag{5}$$

Where z is the vector gathering the exogenous variables, previously described, and γ is a vector of unknow parameters. Modelling the variance of the one-sided error term is crucial as if heteroscedasticity of u is ignored, estimates from both frontier production function and technical efficiency will be biased.

Table 6.1. presents the maximum-likelihood estimates of the stochastic frontier using the first dataset, 82 countries from 1995 to 2019, estimated by maximum likelihood using Limdep 10.0 (Greene, 2012). The parameter λ is the ratio of the standard deviation of the inefficiency component (σ_u) to the standard deviation of the random noise component σ_v), and it indicates if the stochastic production frontier approach fits the data. In this case, it is statistically different from 0, therefore the data is supporting the stochastic production frontier approach.

Table 6.1. Maximum-Likelihood Estimates of the Production Frontier and Determinants of Technical Inefficiency for 85 countries from 1995 to 2019 Dependent variable: LGDP

Variable	*Coefficient*		*Standard Error*	*t statistic*	*p value*
Production Frontier					
Constant	3.044	***	0.10	30.25	0.000
L_LABOR	0.379	***	0.008	44.13	0.000
L_CAPITAL	0.633	***	0.008	70.96	0.000
TREND	0.014	***	0.003	4.29	0.000
$TREND^2$	-0.0005	***	0.000	-4.37	0.000
D_CRISIS	-0.064	***	0.013	-4.92	0.000
D_OIL	0.078	***	0.028	2.8	0.005
D_LEAD COUNTRY	0.35	***	0.085	4.11	0.000
D_NORTH EUROPE	0.186	***	0.021	8.6	0.000
D_CENTRAL EUROPE	0.211	***	0.019	10.98	0.000
D_SOUTH EUROPE	0.046	**	0.023	2.01	0.044
D_LATIN AMERICA	-0.001		0.024	-0.08	0.935
D_CENTRAL ASIA	-0.036		0.028	-1.28	0.199
D_EAST ASIA	0.188	***	0.021	8.68	0.000
D_IND	0.172	***	0.026	6.42	0.000
Technical Inefficiency Effects					
Constant	17.42	***	1.996	8.73	0.000
L_HUMAN CAPITAL	-1.303	***	0.385	-3.38	0.000
L_CPI	-1.672	***	0.293	-5.70	0.000
L_IEF	-2.894	***	0.457	-6.33	0.000
L_POLITICAL RIGHTS	-0.084		0.177	-0.47	0.636
L_CIVIL LIBERTIES	0.274		0.272	1.01	0.314
L_LATITUDE	-0.143		0.1	-1.43	0.153
D_COAST	-0.44	***	0.133	-3.3	0.001

Note: ***, **, * denote significance level at 1%, 5% and 10%.

$$\lambda = \left({}^{\sigma_u}/_{\sigma_v}\right) = \left({}^{0.475}/_{0.153}\right) = 3.104$$

Since the coefficients of a Cobb-Douglas production function have a direct economic interpretation, they can be understood as elasticities. The results suggest the estimated coefficients of variables accounting for labour (L_LAB) and physical capital (L_CAP), which exhibit the expected sign and are statistically significant, are the main factors contributing to economic growth, as they present the highest coefficients. As they represent the input shares in national accounting; it can be concluded that physical capital plays a major role when explaining why some countries grow more than others.

Concerning the dummy variables, all of them are significant at 5% significance level, except for those accounting for Latin-American and Central-Asian countries. Regarding the coefficient of D_OIL, the fact of having a strong oil-exporting economy will enhance the economic growth of countries.

From the technical inefficiency determinants, several results can be derived. First, human capital presents a significant strong role to explain cross-country differences in efficiency, as Benhabib and Spiegel (1994), among others, have already claimed. Hence, increases

in the average schooling years will boost the catch-up process of less developed countries with the frontier.

When analysing the effect of the institutional and geographic variables included in the model, the results are miscellaneous. Corruption and economic freedom appear to be important, and statistically significant, factors when explaining differences in efficiency across countries. Therefore, decreases in institutional corruption and increases economic freedom of a country will lead to a reduction in their inefficiency. However, both civil liberties and political rights are not statistically significant.

Regarding the geographic variables, latitude, despite presenting the expected sign, does not appear to be statistically significant when explaining cross-country income differences. Nevertheless, the fact of a country having access to the sea/ocean helps economies to be more efficient and come closer to the production frontier.

Table 6.2. presents the results of the expanded dataset (99 countries from 2000 to 1999). The results shown in this table considerably mirror those from the previous estimation (Table 6.1.).

Table 6.2. Maximum-Likelihood Estimates of the Production Frontier and Determinants of Technical Inefficiency for 99 countries from 2000 to 2019
Dependent variable: LGDP

Variable	*Coefficient*		*Standard Error*	*t statistic*	*p value*
Production Frontier					
Constant	2.548	***	0.092	27.41	0.000
L_LABOR	0.318	***	0.008	37.76	0.000
L_CAPITAL	0.686	***	0.008	81.47	0.000
TREND	0.005		0.006	0.95	0.342
$TREND^2$	-0.0004	*	0.0002	-1.67	0.094
D_CRISIS	-0.058	***	0.016	-3.59	0.000
D_OIL	0.199	***	0.02	9.77	0.000
D_LEAD COUNTRY	0.314	***	0.104	3.02	0.002
D_NORTH EUROPE	0.098	***	0.024	4.04	0.000
D_CENTRAL EUROPE	0.177	***	0.023	7.58	0.000
D_SOUTH EUROPE	-0.035		0.024	-1.44	0.15
D_LATIN AMERICA	-0.016		0.026	-0.63	0.531
D_CENTRAL ASIA	-0.053	**	0.025	-2.08	0.037
D_EAST ASIA	0.119	***	0.025	4.73	0.000
D_IND	0.115	***	0.032	3.58	0.000
Technical Inefficiency Effects					
Constant	17.22	***	2.074	8.3	0.000
L_HUMAN CAPITAL	-0.768	***	0.277	-2.77	0.005
L_CPI	-2.353	***	0.335	-7.01	0.000
L_IEF	-2.423	***	0.492	-4.93	0.000
L_POLITICAL RIGHTS	-0.335	*	0.2	-1.67	0.094
L_CIVIL LIBERTIES	0.301		0.279	1.08	0.28
L_LATITUDE	-0.046		0.094	-0.49	0.621
D_COAST	-0.433	***	0.143	-3.02	0.002

Note: ***, **, * denote significance level at 1%, 5% and 10%.

$$\lambda = \left({}^{\sigma_u}/_{\sigma_v}\right) = \left({}^{0.47}/_{0.167}\right) = 2.814$$

Concerning the stochastic production frontier, seems to fit the model as accurately as the 1995-2019 dataset. Using the expanded dataset, the parameter λ is also statistically different from 0, therefore the data is supporting the stochastic production frontier approach.

Similarly, the estimated coefficients and significance levels from the efficiency determinants are essentially the same. The main difference is that the Political Rights coefficient becomes significant at 10% significance level. Thus, countries which advocate for stronger protection and guarantee of political rights will present more efficient economies. For the other institutional variables, CPI and IEF are still significant inefficiency determinants while CL remains statistically insignificant.

Now, to analyse which economies have been able to catch-up with the technological frontier a ranking will be elaborated using the efficiency levels from frontier estimations from Table 6.2. The main reason for this decision is the estimates of the production frontier and technical inefficiency determinants perform in a better fashion when using the 2000-2019 data set, plus it contains data for a larger sample of countries.

Table 6.3 presents the efficiency score for the first and last years of the sample, the difference between those two values and some ranks (one for each period and another one for the total variation).

Table 6.3. Estimated Efficiency and Catch-up Levels by Country

	2000	*Ranking*	*2019*	*Ranking*	*ΔEfficiency*	*Best Performers*
Albania	0,584	73	0,681	83	0,097	31
Argentina	0,850	40	0,912	31	0,063	39
Armenia	0,413	89	0,934	22	0,521	2
Australia	0,935	14	0,944	11	0,009	59
Austria	0,917	19	0,914	30	-0,003	75
Belgium	0,908	24	0,922	25	0,014	55
Benin	0,561	76	0,868	45	0,307	9
Burkina Faso	0,725	56	0,864	47	0,139	23
Bangladesh	0,572	75	0,620	86	0,048	42
Bulgaria	0,905	26	0,901	37	-0,004	76
Bolivia	0,749	54	0,897	38	0,148	22
Brazil	0,794	47	0,777	68	-0,017	84
Canada	0,950	5	0,941	15	-0,009	81
Switzerland	0,939	11	0,947	8	0,008	61
Chile	0,919	17	0,917	28	-0,002	73
China	0,599	70	0,778	67	0,179	17
Cameroon	0,682	64	0,699	81	0,017	53

Colombia	0,708	59	0,895	40	0,186	16
Germany	0,918	18	0,940	18	0,022	51
Denmark	0,949	7	0,949	5	0,000	71
Dominican Rep.	0,893	29	0,821	57	-0,072	94
Algeria	0,765	51	0,767	72	0,002	69
Ecuador	0,501	81	0,543	89	0,042	46
Egypt	0,946	8	0,954	4	0,008	62
Spain	0,921	16	0,910	34	-0,012	82
Estonia	0,861	36	0,942	14	0,081	37
Ethiopia	0,494	83	0,780	66	0,285	11
Finland	0,943	9	0,945	10	0,003	68
France	0,915	20	0,893	41	-0,022	86
United Kingdom	0,949	6	0,941	16	-0,008	79
Ghana	0,684	63	0,896	39	0,212	15
Greece	0,815	44	0,758	73	-0,057	92
Guatemala	0,815	45	0,812	61	-0,002	74
Honduras	0,691	62	0,616	87	-0,075	95
Croatia	0,779	49	0,854	51	0,075	38
Haiti	0,387	95	0,386	98	-0,001	72
Hungary	0,857	38	0,840	53	-0,017	83
Indonesia	0,561	77	0,512	92	-0,049	91
India	0,547	78	0,717	79	0,170	18
Ireland	0,953	3	0,963	1	0,010	57
Iran	0,712	58	0,713	80	0,001	70
Israel	0,915	21	0,938	20	0,023	50
Italy	0,902	27	0,863	48	-0,038	87
Jamaica	0,833	42	0,689	82	-0,144	98
Jordan	0,754	53	0,911	32	0,157	19
Japan	0,868	34	0,916	29	0,048	45
Kazakhstan	0,397	93	0,939	19	0,541	1
Kenya	0,578	74	0,734	76	0,156	20
Kyrgyzstan	0,464	87	0,806	63	0,341	6
Sri Lanka	0,896	28	0,851	52	-0,044	90

Lithuania	0,826	43	0,941	17	0,115	28
Latvia	0,703	60	0,816	59	0,113	29
Morocco	0,671	65	0,679	84	0,009	60
Madagascar	0,485	84	0,521	90	0,035	48
Mexico	0,786	48	0,722	78	-0,064	93
Mali	0,848	41	0,869	44	0,022	52
Mongolia	0,479	85	0,807	62	0,329	7
Mozambique	0,623	68	0,451	94	-0,173	99
Malawi	0,503	80	0,783	65	0,281	12
Malaysia	0,808	46	0,892	42	0,085	35
Niger	0,384	98	0,391	97	0,008	63
Nigeria	0,382	99	0,821	58	0,439	4
Nicaragua	0,590	72	0,638	85	0,048	43
Netherlands	0,952	4	0,943	13	-0,009	80
Norway	0,938	12	0,931	23	-0,007	77
Nepal	0,398	92	0,494	93	0,096	32
New Zealand	0,957	1	0,959	3	0,003	67
Pakistan	0,892	30	0,919	27	0,027	49
Panama	0,913	22	0,891	43	-0,022	85
Peru	0,699	61	0,829	56	0,130	25
Philippines	0,649	67	0,775	69	0,126	26
Poland	0,858	37	0,946	9	0,088	34
Portugal	0,879	32	0,838	55	-0,042	89
Paraguay	0,546	79	0,839	54	0,292	10
Romania	0,598	71	0,906	35	0,309	8
Russia	0,406	91	0,749	74	0,343	5
Saudi Arabia	0,874	33	0,911	33	0,037	47
Senegal	0,661	66	0,795	64	0,134	24
Singapore	0,955	2	0,960	2	0,005	66
Sierra Leone	0,420	88	0,926	24	0,506	3
El Salvador	0,886	31	0,769	71	-0,117	97
Slovakia	0,730	55	0,855	50	0,125	27
Slovenia	0,773	50	0,862	49	0,089	33

Sweden	0,940	10	0,947	7	0,008	64
Thailand	0,476	86	0,740	75	0,264	13
Tajikistan	0,384	97	0,393	96	0,009	58
Tunisia	0,854	39	0,937	21	0,083	36
Turkey	0,910	23	0,902	36	-0,008	78
Taiwan	0,937	13	0,944	12	0,006	65
Tanzania	0,393	94	0,607	88	0,214	14
Uganda	0,713	57	0,730	77	0,016	54
Ukraine	0,384	96	0,432	95	0,048	44
Uruguay	0,868	35	0,920	26	0,052	41
United States	0,934	15	0,948	6	0,014	56
Venezuela	0,497	82	0,381	99	-0,116	96
Vietnam	0,617	69	0,773	70	0,156	21
South Africa	0,908	25	0,867	46	-0,041	88
Zambia	0,407	90	0,514	91	0,106	30
Zimbabwe	0,755	52	0,815	60	0,060	40

The results from Table 6.3. seem to be sensible according to general knowledge. In both periods the top ten highest efficiency scores belong to occidental and technologically advanced economies (Canada, U.S.A., New Zealand, Australia, Denmark, Finland, Sweden, the Netherlands, Switzerland, Ireland…).

However, two economies are ranking in the top ten which are not occidental economies, Singapore and Egypt. Both economies have experienced meaningful liberalization processes and the establishment of solid institutions (in the case of Egypt through the Arab Spring protests), which might have influenced their efficiency results.

The top 10 countries which have been able to reduce the most their gap with the technological frontier are Kazakhstan, Sierra Leone, Armenia, Nigeria, Russia, Kyrgyzstan, Benin, Mongolia, Romania and Malawi. It is worth noting that most of the countries which present the strongest catch-up are former Soviet republics. Most probably, their increase in technical efficiency might have been markedly affected by the economic liberalization carried out by those post-soviet economies.

Nevertheless, most of the countries ranking low in 2000 (e.g., Nigeria, Nepal, Haiti or Zambia) are still ranking low in 2019. Thus, despite some low-income and middle-income countries have been able to catch-up, it is clear that the majority of them are still ranking at low-efficiency levels. Indeed, inefficiency was even exacerbated during this period (e.g., Venezuela).

7. CONCLUSION

In this empirical analysis, not only the effect of institutional and geographical variables on economic growth was studied, but also how they affect the catch-up process of less developed countries with the world technological frontier. The impact of these variables has been estimated for two datasets: one of 82 countries from 1995 to 2019, and another one of 99 countries from 2000 to 2019.

To conduct this empirical analysis, institutional and geographic variables have been added to the neoclassical economic growth scheme to test the hypotheses which were initially posed. Despite the results from this analysis should be interpreted with some caution, they offer interesting insights which should not be overlooked. Indeed, the results from this analysis endorse all the hypotheses stated at the beginning and allow to present a more complete explanation of countries' economic development and cross-country income differences.

This empirical analysis has demonstrated that not only institutions matter but also geography. The estimations reflect that institutional quality, the defence of political and civil rights and the geographical characteristics of a county influence their economic development.

Institutional corruption and protection of political rights and civil liberties should be among the top issues economies should tackle. If countries can achieve "cleaner" public institutions and freer societies, they will be able to organize their economies more efficiently; and not respond to political or personal criteria.

Regarding geographic variables, despite being factors which are fixed in time, or difficult to modify (countries' borders); this empirical analysis provides evidence to state that latitude and coast access are relevant. Those countries which are located further from the equator and have coast access will perform better, than those countries which are further from the equator and landlocked.

Considering the results from the efficiency analysis, institutional and geographical variables appear when explaining the factors which make some countries diverge from the world technological frontier. Results show that human capital, corruption, economic freedom, political rights and coast access help to explain why some countries catch-up, up and why others do not.

In conclusion, despite the limitations associated with the estimation presented in this empirical analysis which obliges us to be cautious with the results, the findings presented indicate that economic development is not only dependent on classical economic variables but also other factors like the quality of institutions. Hence, it is essential to protect and enforce liberal democracies around the world. Liberal democracy is the only kind of political regime in which economic freedom, civil liberties and political rights are strongly guaranteed and defended.

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APENDIX A
List of countries considered in the empirical analysis

- Model for period 1995 – 2019:

Albania
Argentina
Australia
Austria
Belgium
Bangladesh
Bulgaria
Bolivia
Brazil
Canada
Switzerland
Chile
China
Cameroon
Colombia
Germany
Denmark
Ecuador
Egypt
Spain
Estonia
Finland
France
United Kingdom
Ghana
Greece
Guatemala
Honduras
Croatia
Hungary
Indonesia
India
Ireland
Israel
Italy
Jamaica
Jordan
Japan
Kazakhstan
Kenya
Kyrgyzstan
Lithuania
Latvia
Morocco
Mexico
Mongolia
Mozambique
Malawi
Malaysia
Nigeria
Nicaragua
Netherlands
Norway
New Zealand
Pakistan
Peru
Philippines
Poland
Portugal
Paraguay
Romania
Russia
Senegal
Singapore
El Salvador
Slovakia
Slovenia
Sweden
Thailand
Tunisia
Turkey
Taiwan
Tanzania
Uganda
Ukraine
Uruguay
United states
Venezuela
Vietnam
South Africa
Zambia
Zimbabwe

- Model for period 2000 – 2019:

Albania
Argentina
Armenia
Australia
Austria
Belgium
Benin
Burkina Faso
Bangladesh
Bulgaria
Bolivia
Brazil
Canada
Switzerland
Chile
China
Cameroon
Colombia
Germany
Denmark
Dominican Republic
Algeria
Ecuador
Egypt
Spain
Estonia
Ethiopia
Finland
France
United Kingdom
Ghana
Greece
Guatemala
Honduras
Croatia
Haiti
Hungary
Indonesia
India
Ireland
Iran
Israel
Italy
Jamaica
Jordan
Japan
Kazakhstan
Kenya
Kyrgyzstan
Sri Lanka
Lithuania
Latvia
Morocco
Madagascar
Mexico
Mali
Mongolia
Mozambique
Malawi
Malaysia
Niger
Nigeria
Nicaragua
Netherlands
Norway
Nepal
New Zealand
Pakistan
Panamá
Peru
Philippines
Poland
Portugal
Paraguay
Romania
Russia
Saudi Arabia
Senegal
Singapore
Sierra Leone
El Salvador
Slovakia
Slovenia
Sweden
Thailand
Tajikistan
Tunisia
Turkey
Taiwan
Tanzania
Uganda
Ukraine
Uruguay
United states
Venezuela
Vietnam
South Africa
Zambia
Zimbabwe