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HOW CORRUPTION AFFECTS THE DEVELOPMENT OF A NATION: CASE STUDY MEXICO

CÓMO AFECTA LA CORRUPCIÓN AL DESARROLLO DE UNA NACIÓN: CASO DE ESTUDIO MÉXICO

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How corruption affects the development of a nation: case study Mexico.

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ABSTRACT

In this work we analyze the correlations between indexes that quantify corruption and indexes used to estimate the measure of wealth and well-being of a nation. Following the identification of the corruption-affected indexes, some strategies for lowering these indexes are put forth, and time estimates (six years in the future) are used to forecast the advantages of these strategies' execution on indexes that measure a country's wealth and well-being. Our statistical study demonstrates the detrimental effects that corruption has on peace, climate change performance and social progress of the Mexican nation. In this sense, the adverse impacts of corruption on a country's growth might be mitigated by policies that lower its rates; seeking to reduce its negative impacts on indexes related to the development of a nation. Machine learning projections show us scenarios where measures are implemented to reduce corruption and the benefits on the development indexes of a nation are visualized.

***Keywords*:** corruption, correlation, social progress, peace, climate change performance

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Cómo afecta la corrupción al desarrollo de una nación: caso de estudio México

RESUMEN

En este trabajo analizamos las correlaciones entre los índices que cuantifican la corrupción y los utilizados para estimar la riqueza y el bienestar de una nación. Tras identificar los índices afectados por la corrupción, se proponen estrategias para reducirlos, y se utilizan estimaciones temporales (a seis años vista) para pronosticar las ventajas de la ejecución de estas estrategias en los índices que miden la riqueza y el bienestar de un país. Nuestro estudio estadístico demuestra los efectos perjudiciales de la corrupción sobre la paz, el desempeño frente al cambio climático y el progreso social de México. En este sentido, los impactos adversos de la corrupción en el crecimiento de un país podrían mitigarse mediante políticas que reduzcan sus tasas, buscando reducir sus impactos negativos en los índices relacionados con el desarrollo nacional. Las proyecciones de aprendizaje máquina muestran escenarios donde se implementan medidas para reducir la corrupción y se visualizan los beneficios en los índices de desarrollo de una nación.

Palabras clave: corrupción, correlación, progreso social, paz, desempeño en materia de cambio climático

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INTRODUCTION

The misuse of authority for personal benefit is what we refer to as corruption. Over $1 trillion is thought to be spent in bribes annually worldwide, benefiting the unscrupulous and depriving future generations of opportunity.

Corruption is a worldwide occurrence that hinders progress, discourages investment, and results in poverty. Additionally, it weakens the political and legal structures, which ought to serve the general welfare. It is not unexpected that public confidence in public servants and national institutions declines when the rule of law is undermined and the voice of the people is not heard. Corruption worsens social division, poverty, inequality, and the environmental catastrophe while undermining democracy and economic growth. It is only possible to expose corruption and hold those responsible for it accountable if we comprehend the mechanisms that allow it to occur (Transparency 2024).

Many people believe that within the past 20 years, corruption in Latin America has increased. While bribery is not new in the area, incidents in Argentina, Brazil, Mexico, Venezuela, and other places seem to indicate that large-scale graft has increased. What are the primary causes of this growth, assuming that the public's improved awareness and better reporting aren't the only factors contributing to the perception of rising corruption? Explanations that are now in place typically emphasize more chances than incentives to extract bribes. Regarding the former, several academics have highlighted the rise in state interventionism, which grants politicians and bureaucrats wide latitude over resources that seem enticingly abundant. On the other hand, several academics have brought out the recent wave of neoliberal reforms, in which politicians and bureaucrats sold off large amounts of public property, frequently with little to no transparency. Even while these circumstances occasionally played a role, they are insufficient to explain the current increase in corruption.

The global bank (world bank 2024) claims that because corruption raises prices and restricts access to essential services like health, education, social programs, and even justice, it mostly affects the weak and impoverished. It hurts markets, jobs, and economies by increasing inequality and decreasing private sector investment. Moreover, corruption can impede a nation's ability to respond to crises, causing needless suffering and, in the worst case scenario, fatalities. Corruption has the potential to erode public confidence in institutions and leaders over time, causing rifts in society and, in some situations, raising

the possibility of violence, conflict, and instability.

According to Deloitte (2021), the average cost of a corruption act in Mexico is MXN $2,799 for an adult victim and MXN $12,243 for a corporation victim. The influence of corruption on commerce among the three North American nations is represented in the recent Treaty between Mexico, the United States, and Canada (T-MEC), which includes a chapter on the subject (Deloitte, 2021).

A nation's level of corruption may be estimated using a variety of indexes. Three of these primary corruption indexes are covered in this work: Political corruption index, corruption perception index and control of corruption.

The Political Corruption Index (PCI) is obtained as the best estimate of the extent to which a country is affected by political corruption. It was retrieved from the website Our World in Data, Source V-Dem (2024) and processed by Our World in Data (2024). The directionality of the V-Dem corruption index runs from less corrupt to more corrupt. The corruption index includes measures of six distinct types of corruption that cover both different areas and levels of the polity realm, distinguishing between executive, legislative and judicial corruption.

The Corruption Perceptions Index (CPI) is an index that scores and ranks countries by their perceived levels of corruption at public sectors, as assessed by experts and business executives. The CPI generally defines corruption as an "abuse of entrusted power for private gain". The index is published annually by the non-governmental organization Transparency International since 1995 (Corruption Perception Index, 2023). Ratings range from 0 to 100, with 100 signifying behavior that is impressively free from corruption and 0 signifying severely corrupt behavior.

Perceptions of the degree to which public authority is used for personal benefit, including both small-scale and large-scale corruption, as well as the "capture" of the state by elites and corporate interests, are captured by the **control corruption indicator.** This is one of the Worldwide Governance Indicators provided by the world bank group (world bank group, 2024). It ranges from 0 to 100 (percentile rank): the higher its value, the better in its fight against corruption (Hamilton and Hammer, 2018).

Scoring 180 countries around the world, the Corruption Perceptions Index is the leading global indicator of public sector corruption. Mexico got a CPI score of 31 on 2023 year, with a change of 0 since preview year, meaning it ranks 126 out of 180 countries. With respect to the other two indexes, in 2023 Mexico

obtained a score of 46 for the political corruption index while a score of 17.45 for control of corruption in 2022.

Below we introduce some indexes related to the development of a country. The Mexican Institute for Competitiveness A.C. (IMCO for its acronym in Spanish), created in 2003, is a non-profit, non-partisan research center whose actions to solve Mexico's most critical challenges are based on evidence. Its mission is to "develop public policy proposals that improve the competitiveness of the country's companies". IMCO introduced the **Urban Competence Index** (UCI) (Urban Competence Index by IMCO, 2024), this index is based on 10 subindexes o dimensions: I.-Reliable and objective law system, II.- Sustainable management of the environment, III.- Inclusive, educated and healthy society, IV.- Stable and functional political system, V.- Efficient and effective governments, VI.-Efficient Factor market, VII.- Stable economy, VIII.- World-class precursor sectors, IX.- Taking advantage of international relations. X.- Innovation and sophistication in the economical sectors. Another two indexes related to the competitiveness are the **World Competitiveness index** (WCI) and the Global Competitiveness Index. The World Competitiveness Yearbook is an annual report published by the Swiss-based International Institute for Management Development (IMD) on the competitiveness of nations. The yearbook benchmarks the performance of 63 countries based on 340 criteria measuring different facets of competitiveness. It uses two types of data: 2/3 hard statistical data provided by international/national sources and 1/3 survey data based on executive opinion survey (World Competitiveness index by IMD, 2024). Since 2005, the World Economic Forum has based its competitiveness analysis on the **Global Competitiveness Index** (GCI), a comprehensive framework that measures the microeconomic and macroeconomic foundations of national competitiveness, grouped into 12 categories (Global Competitiveness Index, 2024). **Global Peace Index** (GPI), which ranks 163 independent states and territories according to their level of peacefulness. Produced by the Institute for Economics and Peace (IEP) since 2007, the GPI is the world's leading measure of global peacefulness (Global Peace Index, 2024), another peace related index is given by the **Fragile States Index** (FSI). FSI is an annual report mainly published and supported by the United States think tank the Fund for Peace. It aims to assess states' vulnerability to conflict or collapse, ranking all sovereign states with membership in the United Nations where there is enough data available for analysis (Fragile States Index, 2024).

Two environmental aspect-related indices are taken into consideration: the Environmental Progress Index and the Climate Change Performance. The **Environmental Performance Index** (EPI) provides a data-driven summary of the state of sustainability around the world. Using 58 performance indicators across 11 issue

categories, the EPI ranks 180 countries on climate change performance, environmental health, and ecosystem vitality (Environmental Performance Index, 2024). One tool to promote openness in climate politics at the national and international levels is the **Climate Change Performance Index** (CCPI). The CCPI compares the climate performance of the EU and 63 nations, which together are responsible for more than 90% of the world's greenhouse gas emissions, using a standardized framework. Four criteria are used to evaluate the effectiveness of climate mitigation: greenhouse gas emissions, renewable energy, energy use, and climate policy (Climate Change Performance Index, 2024). Since the Sustainable Development Goals were adopted by the 193 UN Member States in 2015, annual progress on them is reviewed in the Sustainable Development Report (SDR). The Sustainable Development Report 2024, which was released on the eve of the UN Summit of the Future, makes several important reform recommendations to the UN system in order to address the problems of the twenty-first century and also reports the **Sustainable Development Goals Index** (SDGI) (Sustainable Development Goals, 2024). **The Global innovation Index** (GII) measures innovation in the context of an unpredictable geopolitical and economic landscape. By rating the innovation performance of over 132 economies and stressing the advantages and disadvantages of innovation, it identifies the most innovative economies in the world (Global Innovation Index, 2024). One of the most accurate sets of social and environmental data in the world is the **Social Progress Index**. It focuses only on the non-economic facets of global social performance, offering clear, useful information as well as in-depth understanding of the actual condition of our society (Social Progress Index,2024). A long and healthy life, knowledge, and a reasonable level of living are three important aspects of human development that the **Human Development Index** (HDI) measures in summary form. The normalized indices for each of the three dimensions' geometric means make up the HDI (Human Development Index, 2024). Designed by the world bank Development Research Group, the **GINI** index measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal

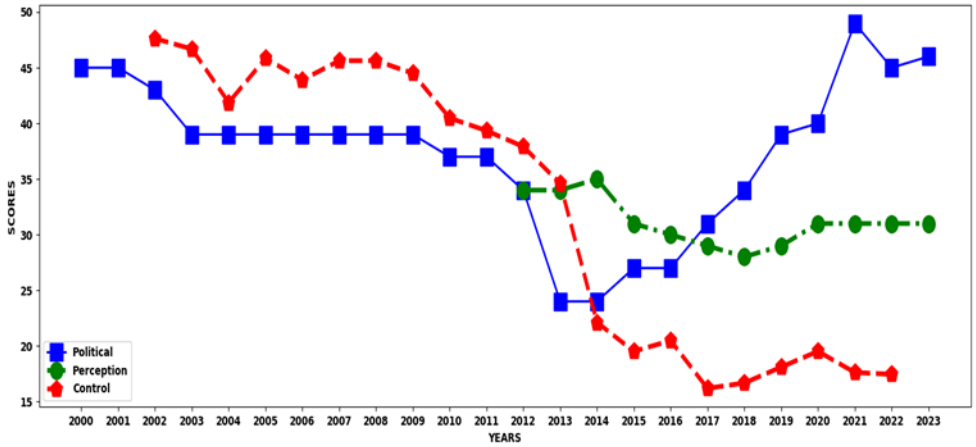
distribution (GINI, 2024). **The percentage at risk of poverty**, estimated as the share of population living on less than $6.85 a day, 2000 to 2022 was retrieved from the website (our world in data, 2024). Based on respondents' assessments of their own lives, the World Happiness Report is a publication that includes articles and rankings of country happiness. The report also compares these rankings with a variety of aspects related to the quality of life. The Gallup World Poll is the main source of data used in this study. Data is collected from people in over 150 countries. Each variable measured reveals a populated-weighted average score on a scale running from 0 to 10, thus the **Global Happiness Index (GHI)** is calculated (Global Happiness Index, 2024).

MATERIAL AND METHODS

Yearly data for the Mexican nation corresponding to the three above introduced corruption related indexes were collected: Corruption Perception Index ranges from 2012 to 2023, Political Corruption Index ranges from 2000 to 2023, while control Corruption ranges from 2002 to 2022.

As a first step, the correlation coefficients between the three indexes related to corruption are calculated. The results obtained show us that there is no correlation (statistically significant) between the Political Corruption Index and the Corruption Perception Index or between the Political Corruption Index and Control of Corruption. However, Control of Corruption and Corruption Perception Index show a correlation. Figure 1 shows these three corruption related indexes. Here PCI was reshaped (100-value) to bigger is better in order to the make the comparison with the other two indexes.

Figure 1. Three corruption related indexes.



Source: Figure drawn based on retrieved data.

Table 1. Statistical description of the three corruption related indexes

Index	Mean	Standard Deviation	Min.	Max.	Correlation with Political.	Correlation with Perception.	Correlation with Control
Political Corruption	62.5	6.7	51	76	1	None	None
Corruption Perception	31.16	2.07	28	35	None	1	0.735856
Control of Corruption	32.46	12.38	16.19	47.62	None	0.735856	1

Table 1 summarizes basic statistics of the three corruption related indexes, here the label None indicates that no correlation either Pearson or Spearman have been found (statistically significant). Let us point out that high values of the perception and control corruption indexes represent positive efforts, while high values of the political corruption index correspond to a more corrupt country (lower values are preferable). The value of 0.735856 obtained for the Pearson correlation coefficient between the control of corruption and corruption perception index indicates that: the more controls are implemented to reduce corruption, the perception of the fight against corruption improves, and when the perception of the fight against corruption decreases, it is indicative that the controls used to combat corruption are decreasing.

RESULTS

In what follows we investigate the impact that these three indexes related to corruption have on other indexes related to the development of a country, such as competitiveness, innovation, environmental progress, progress in climate change, GINI, poverty, happiness, human and social development among others. Thus, we compute the correlation coefficients between the three corruption related indexes and the fourteen development related indexes: UCI, WCI, GCI , GPI* (rescaled to range 0 to 100, high values more peaceful), FSI, EPI,CCP SDGI,GII, SPI, HDI, GINI, Poverty Risk, and GHI. Table II summarizes the correlation coefficients obtained between the three political related indexes and other indexes related to the development of a country (only indexes correlated with at least one corruption

related index are reported).

Table 2. Statistical description of the indexes correlated with the pci, cc and cpi

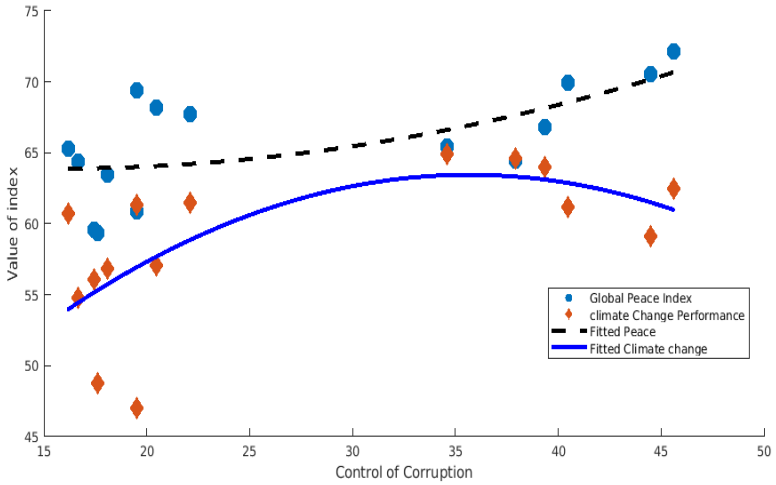
Index World	Mean	Standard Deviation	Min.	Max.	Correlation with Political Corruption	Correlation with Control of Corruption	Correlation with corruption Perception
Competitiveness Global	57.18	7.13	43.11	67.3	0.77167678	none	none
Innovation Global	33.32	3.38	24.67	38.03	0.62374322	-0.60540549	none
Peace*	64.89	4.48	55.5	72.12	0.53734113	0.63377071	
Urban Competitiveness Climate Change	45.89	0.99	43.19	47.09	0.51832251	none	none
Performance	58.11	5.17	47.01	64.91	0.61581826	0.590177522	none
GINI	47.63	2.33	43.5	51.66	None	0.820172083	0.63861352
Global Competitiveness Modified	61.81	1.71	59.84	64.95	None	-0.75958078	none
Fragile State	40.07	1.92	36.58	44	None	-0.64374888	None
Sustainable Development Goals	66.96	1.66	64.09	69.28	None	-0.932725	-0.58167244
Human Development	75.2	2.24	70.9	78.1	None	-0.93015821	-0.84972258
Social Progress	67.23	1.33	64.77	69.15	-0.6525253	-0.80222858	None
Poverty	43.83	2.51	36.3	46.2	None	0.60610654	None
Happiness	66.16	2.85	63.12	71.87	0.86972178	None	None

Namely three entries of *table II* support the *sand the wheels hypothesis* (corruption has negative effects on the development of a nation). Global Peace and Climate Change performance indexes are improved when control of corruption increases, while the social progress index increases when then political corruption index decreases. At first glance, shaded correlation coefficients in *table 2* seem to suggest contradictory relationships between the three indexes related to corruption and the indexes: WCI, GII, GPI, UCI, CCP, GINI, GCI, MFSI, SDGI, HDI, SPI, Poverty and happiness. That is, by increasing controls of corruption, poverty percentage and wage inequality (measured by GINI) increase; while Global Innovation, Global Competitiveness, Modified Fragile State (100-FSI), Sustainable Development Goals, Human Development and Social Progress indexes are reduced. Political Corruption increases seem to improve World Competitiveness, Global Innovation, Global Peace, Urban Competitiveness, Climate Change Performance and happiness indexes. Finally corruption perception increases seem to improve the salary inequality (GINI) while reducing the Sustainable Development Goals and the Human Development indexes. This peculiar occurrence has already been noted and explained by the hypothesis that corruption greases the wheels of financial sector development. It argues that corruption and bribery promote the avoidance of inefficient policies, leading to investment, trade, and economic growth in countries with weak institutions (Cooray & Schneider, 2018). In the case of corruption affecting the GINI, as stated by Andres and Ramlogan. From an empirical perspective, corruption reduces inequality in Latin America by virtue of its redistributive effect in the informal sector (Andres and Ramlogan-Dobson, 2011). Therefore, whereas institutional measures aimed at reducing corruption would likely to raise income disparity, corruption itself encourages wealth redistribution among the poor within the informal sector, resulting in a fall in inequities. Regarding the negative correlation between control of corruption and the global innovation index (also the positive correlation between political corruption and global innovation); in his master thesis, Bernier asserts that: In Latin America, corruption has a special effect on business activity and ensuing economic progress. His research (Bernier, 2020) provides an explanation that establishes a direct link between increasing corporate innovation and the existence of bribery. His research specifically suggests that there are three primary methods via which this happens: the habit of exporting, the general absence of business rivalry, and the development of tight ties with government officials. In fact, by using principal component analysis methodologies and structural equation

modeling, Alarcon (Alarcon, 2024) concluded that corruption facilitates innovative activity and economic growth in Mexico.

Next, we investigate, within the sand the wheels theory, how changes in the Control of Corruption and Political Corruption indexes affect peace, climate change, and social progress. *Figure 2* shows second order polynomial fitted curves to approximate relations of control of corruption with peace and climate change indexes, while *Figure 3* displays the second order polynomial curve fitted for the social progress index as a function of political corruption index. *Table 3* summarizes the fitting information of these polynomial approximation models.

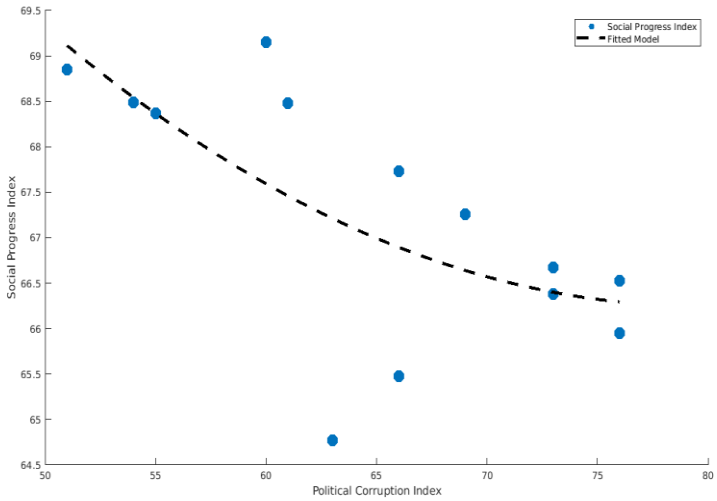
Figure 2.



No linear relation between control of corruption and peace and climate change performance indexes.

Source: Figure drawn based on retrieved data.

Figure 3. No linear relation between political corruption and social progress index.



Source*:* Figure drawn based on retrieved data.

Table 3. Goodness of the fitted p_1 x²+p_2 x+p_3 models

Dependent variable	Independent variable	p_1	Confidence interval	p_2	Confidence interval	p_3	Confidence interval	SSE	R²	Adjusted R²	RMSE
GPI	CC	0.0075	[-0.0235 ,0.0384]	-0.2305	[-2.0996, 1.6385]	65.6616	[41.1509 , 90.1723]	126.7571	0.4151	0.3177	3.2501
CCP	CC	-0.0250	[-0.0668 , 0.0169]	1.7801	[-0.7460 4.3062]	31.7032	[-1.4245 64.8308]	231.5473	0.4288	0.3336	4.3927
SPI	PCI	0.0035	[-0.0086 , 0.0156]	-0.5579	[-2.1079, 0.9921]	88.4501	[39.2532 , 137.647]	12.8344	0.4489	0.3387	1.1329

Figure 4 shows time machine learning projections of political corruption and control of corruption indexes (solid lines); the projections indicate growth for both indexes (good news for the control of corruption but not for the political corruption), constrained PCI and CC are also plotted. These constrained data are obtained by assuming that some preventive measures have been implemented in order to increase in 10 percent each year the control of corruption index while decreasing in the same rate the political corruption index. Here we notice that if nothong is done: political corruption index will increase, on the other hand control of corruption index is projected to decrease to vey low values and start an increase after 2025, in both cases the constrained ten percent per year offers a better strategy that doing nothing. *Figure 5* presents time domain machine learning projections of the Global Peace and the climate change performance indexes (solid lines); labeled as simulated GPI and CCP are the simulated values for these indexes when the control of corruption is constrained by a ten percent increase (the effects of the control of corruption over the global peace and climate change performance were obtained by the second order fitted polynomial models). Remarkable improvements of the Global Peace and Climate change performance indexes are obtained by imposing constrains over the control of corruption. In a similar way figure 6 shows time domain projections of the social progress index (solid line), also the improvement obtained over the social progress index by imposing a ten percent reduction on the political corruption index (social progress index was fitted as a second order function of the political corruption index) is plotted.

Figure 4. Time domain projections of political corruption and control of corruption indexes.

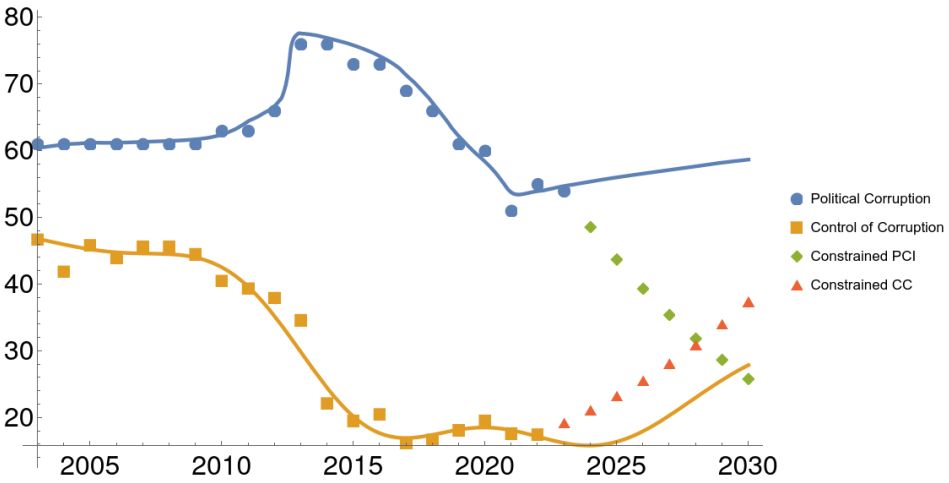


Figure 5. Time domain projections of global peace and climate change performance indexes compared with simulated obtained when control of corruption is constrained

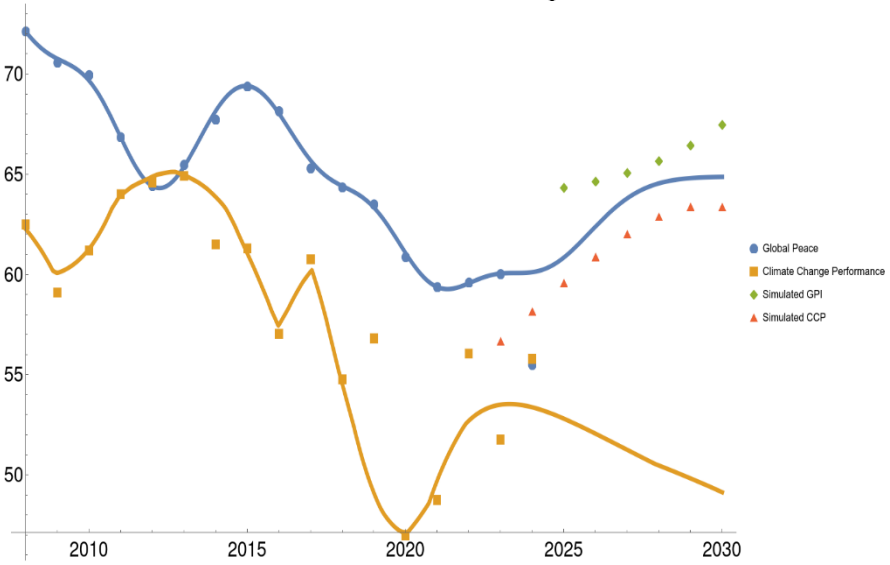


Figure 6. Time domain projections of social progress index compared with the simulated SPI obtained by constraint political corruption.

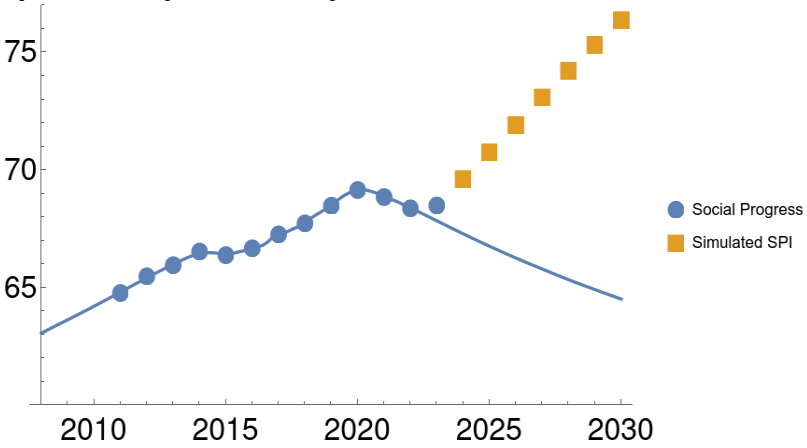


Table4 reports the goodness of the fitted machine learning methods for the time domain projections of the indexes: CC, PCI, GPI, CCP and SPI. Seven machine learning methods methods were tested: DecisionTree, Gradient Boosted Trees, Linear Regression, Nearest Neighbors, Neural Network, Random Forest, and Gaussian Process, here only the best fitted for each index were reported.

Table 4. Goodness of the fitted machine learning models for time domain projections

Index	Method	Mean Squared	R^2
Political Corruption	neural network	1.64875	0.963361
Control of Corruption	Gaussian process	3.39234	0.977874
Global Peace	Gaussian process	1.29359	0.935736
Climate Change	neural network	5.18387	0.806706
Social Progress	neural network	0.0337255	0.981174

DISCUSSION

Three corruption related indexes have been analyzed in order to investigate how corruption affects indexes related to the development of a country. The linear and nonlinear correlation coefficients obtained support both effects of corruption theories: grease the wheels and sand the wheels. We have decided to simulate scenarios assuming that corruption decreases to see its effects within the sand the wheel theory, since we consider it not appropriate (ethically) for the case of Mexico, which already has high rates of corruption, to assume that corruption continues to increase and estimate its benefits within sticking to the theory grease the wheels. As stated by Lucarelli et al., in the short term, corruption may be seen as a factor that promotes economic growth by expediting bureaucratic procedures; however, over time, corruption carries significant social costs that make it difficult to bear the political, economic, and social burdens. Consequently, corruption levels rise, which has a negative impact on economic growth.

CONCLUSIONS

Seeking to improve the indexes of global peace, climate change performance and social progress, we have assumed scenarios where restrictions are imposed to reduce corruption (sand the wheels theory). The hypothetical measures are implemented as an increase in control of corruption index by 10 percent as well as reduction of the political corruption index by the same percentage, the simulations allow us

to estimate the growth in the Global Peace, Climate Change Performance and Social Progress indexes. As a result of imposing these restrictions on the control of corruption and on the political corruption index, by 2030 we would obtain increases of 3%, 28.9% and 18% for each of the Global Peace, Climate Change Performance and Social Progress indexes respectively with respect to the values obtained without imposing restrictive measures. We have determined which corruption-related indexes are connected with a country's development indicators by computing the Pearson and Spearman coefficients. Next we have been able to quantify the association between the PCI and SPI as well as the relationship between the CC and the GPI and CCP indexes by fitting curves. Machine learning methods have been useful to estimate time domain projections of the indexes. Although we have presented results for the Mexican nation; all calculations can be carried out for another country if the information on its indexes is available. Thus each country can identify the main indexes affected by corruption and design its own strategy to reduce its effects.

As future work, clusters of countries can be defined, thus similar calculations can be carried out to estimate the effects of corruption on the indexes related to the development of the whole region/cluster. Some scenarios could be simulated where restrictions (collaborative efforts, bilateral and multilateral treaties) on corruption are imposed on some or all countries of the region and the benefits on the development indexes of the region can be estimated

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