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# Clustering the Impact: How Economic Realities and Political Institutions shaped COVID-19 Fiscal Responses in Africa

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# Clustering the Impact: How Economic Realities and Political Institutions shaped COVID-19 Fiscal Responses in Africa

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**Abstract:**

The COVID-19 pandemic brought about unparalleled global challenges. While these challenges were similar across countries, they triggered diverse fiscal responses from governments worldwide. The objective of this study is to analyze the fiscal response of African countries to the COVID-19 crisis with an emphasis on how their responses varied based on their economic situations and political institutions before the start of the pandemic.

This research leverages a dataset of political and economic indicators before the pandemic (2019) and the total amount of fiscal response during the pandemic (2020-2021) for all countries in Africa. As a preliminary step, OLS regressions were conducted to determine the most influential political and economic factors affecting fiscal response during the pandemic. These factors were then used in a K-means clustering approach to categorize African countries based on similar economic and political profiles. Upon the completion of the clustering, subsequent Kruskal Wallis and Dunn's tests were conducted to evaluate the significance of the clusters on their diverse fiscal response.

Country clusters were determined using estimates of current account balance, government effectiveness, and political stability, controlled for the total number of reported COVID-19 cases. Results indicate that countries within the same cluster exhibit commonalities in their fiscal response and their economic and political profiles. Moreover, subsequent test results highlight the significance of these clusters, showing that economic context and political institutions influenced a country's approach to COVID-19.

This study's outcome offers valuable insights for policymakers and other stakeholders about the implications of economic contexts and political institutions on the fiscal response to an external shock such as COVID-19. Moreover, the segmentation of the countries in Africa provides a nuanced understanding of the diverse needs within the continent and the need for targeted policy interventions when dealing with external shocks.

Keywords: COVID-19 crisis, fiscal response, Africa, multivariate regression, cluster analysis,

JEL codes: C21, C38, E62

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## 1 Introduction

The emergence of a novel coronavirus and the subsequent declaration of the COVID-19 pandemic in 2020 (CNN Editorial Research, 2023) marked the beginning of a big change. It was a change that significantly altered how people all around the world lived their lives for the next two to three years (Alzueta, et al., 2020; Budayová, Pavliková, Samed Al-Adwan, & Klasnja, 2022).

Firstly, the pandemic led to an unprecedented health crisis (WHO, 2022). At the onset, the virus was novel with no vaccine or known treatment protocol. It spread quickly around the world and affected millions of people and strained global healthcare systems. Secondly, due to the highly contagious nature of the virus, stringency measures such as strict lockdowns and stay-at-home orders were implemented (Philpps, Zhang, & Petherick, 2021). These measures implemented to contain the spread of the virus led to a global recession (The World Bank, 2020).

Notwithstanding, while the above-mentioned were global challenges, countries faced different variations and degrees of these problems. These varying problems merited varying solutions. Countries responded differently not only because the pandemic affected each country differently but also because of the existing situations within each country that affected their ability to respond (Bavel, et al., 2020; Milani, 2020; Nair & Selvaraj, 2021). As such, an understanding of the factors that shape the response of countries, specifically enacted fiscal policy, provides insights into strategies and policy responses for the future against similar shock events.

This study looks into the relationship between a country's economic situation and political institutions before the pandemic and its enacted fiscal policy in response to COVID-19, with a specific focus on countries in the African continent. To investigate, a machine learning methodology called K-means clustering is used to categorize countries into cluster groups based on economic and political indicators prior to the pandemic. Parametric tests are then used to get insights into the differences and similarities in the cluster group's COVID-19-related fiscal policy. Moreover, further observations are also made about the various country cluster groups created.

This study contributes to the evolving discussion on pandemic response and preparedness. Moreover, it furthers research into clustering and its various applications. Complementarily, it also underscores that countries in similar situations could respond similarly to external shocks. As such, this study provides insight into the possibility of regional cooperation and targeted resource allocation and capacity building among countries within the same cluster groups.

## 2 Literature Review

### 2.1 Theory

This literature review begins with a discussion of theories in fiscal policy. Firstly, as per the Keynesian school, in times of recession, it would be desirable for governments to spend more, accrue deficits, and lower taxes to boost aggregate demand. This strategy is called

countercyclical fiscal policy (Alesina & Passalacqua, 2016). This policy assists governments in stimulating income and consumption, offsetting negative changes in private behaviour as a result of economic downturns (Eisner, 1989; Fatás, Ghosh, Panizza, & Presbitero, 2019). It is worth noting here that because of the economic effects of the COVID-19 pandemic, many governments around the world adopted Keynesian discretionary policies to support their respective economies (Wood, Ausserladscheider, & Sparkes, 2022; Beland, Cantillon, Hick, & Moreira, 2021).

Contrary to these actions, governments may also use fiscal deficits during periods of low growth to preserve constancy in tax rates (Barro, 1979). Building on the Ricardian equivalence, Barro suggests that increased spending financed through taxes does not impact aggregate demand due to the equivalent offset in private savings (Seater, 1993).

Similarly, the neoclassical school tends to be more sceptical of the use of budget deficits because it can have adverse economic effects like the crowding out of private investment (Mankiw & Elmendorf, 1999; Blanchard, 2019). More emphasis is given to long-term growth as opposed to combatting times of recessions, specifically in decreasing the natural rate of unemployment (OpenStax Economics, 2016). In terms of fiscal policy, this belief would translate to lower tax rates and limited government spending, thereby focusing more on market-driven resource allocations (Bernheim, 1989; Mankiw & Elmendorf, 1999).

Lastly, the role of politics in fiscal policy cannot be denied. Political economy theories suggest that politics and the quality of institutions influence fiscal programs (Eslava, 2010; Alesina & Perotti, 1995; Yared, 2019). Studies on political budget cycles have found that politicians tend to decrease taxes and increase deficits for a better chance of re-election (Alesina & Passalacqua, 2016). Relatedly, governments may also use spending as a form of strategic manipulation against political rivals. Alesina & Tabellini (1999) found that governments who knew they would stay in power would be less likely to increase deficits whereas governments who knew they wouldn't be re-elected would likely increase deficits so they won't internalise the cost of borrowing. Other studies have also found that conflicts (Pancrazi & Prosperi, 2020) and resource finds (Ruzzante & Sobrinho, 2022) could increase deficit spending.

## 2.2 Empirical Studies

*Fiscal policy in response to COVID-19.*

This next section in the literature review focuses on empirical literature on fiscal policy responses to the COVID-19 pandemic. At the onset, fiscal response to COVID-19 is determined by the incidence of the pandemic. More COVID-19 infections generally resulted in a larger negative economic effect requiring more fiscal spending (Alberola et al., 2021).

Yet, political factors can also affect fiscal outcomes. Using data from 98 countries covering the first six months of the pandemic, Aizenman, Jinjarak, Nguyen, & Noy (2021) recognized that political influences were pivotal in deciding the size and composition of fiscal policy. Their research showed that more united governments were able to deploy more and announce more substantial fiscal programs. Likewise, fiscal spending tends to be higher in more democratic countries. Highly democratic countries on average spent 7% of GDP on

COVID-19 fiscal spending versus 4.5% in less democratic countries (Chen, Shi, Zhang, & Ding, 2021).

In terms of economic performance, Yeyati & Filippini (2021) observed that on average, countries that have lower per capita income and face higher borrowing costs disbursed relatively smaller fiscal programs. These countries also tended to implement more stringent containment and mobility restrictions.

Relatedly, according to Benmelech & Tzur-Ilan (2020), a country's credit rating is a very important determinant of fiscal spending during the pandemic as this affects access to credit markets. Among the 85 countries in their sample, countries with poor credit history tended to be lower-income countries and were not as able to implement fiscal programs as successfully. Research by Apeti, Combes, Debrun, & Minea (2021) also revealed that countries with higher sovereign ratings and lower debt-to-tax ratios were able to implement larger fiscal programs. They concluded that having a larger fiscal space was able to support national fiscal programs.

On the other hand, monetary policy can complement fiscal policy in combating the economic effects of any external shock. Alberola et al. (2021) found that at the start of 2020, policy rates of emerging economies were higher compared to those of advanced economies, on average 4.9% compared to 0.4%. Because of this, emerging economies had a lot more room to cut policy rates in response to the pandemic. Additionally, the result of their research also showed that among advanced economies, those that had stronger safety nets tended to disburse fewer discretionary fiscal measures.

*Fiscal situation and challenges in Africa prior to the COVID-19 pandemic.*

It should be noted that while the COVID-19 pandemic did lead to challenges, countries in Africa were already experiencing problems, specifically with debt, even before the pandemic hit. In 2019, the IMF categorized 18 countries in Africa as either being in debt distress or at a high risk of it. Moreover, it's been estimated that countries in sub-Saharan Africa allocated more money to external debt servicing compared to healthcare (The Economist, 2020). Many countries that were at risk of defaulting before the pandemic, eventually defaulted when the pandemic hit, i.e., Ethiopia, Zambia, and Ghana (Reuters, 2023). Additionally, after the Heavily Indebted Poor Countries Initiative in 2012 which greatly reduced debt for African countries, China has now become the bilateral creditor to the continent which deals with forgiveness on a case-to-case basis (The Economist, 2020).

Debt management is important as it can affect a country's ability to respond to a crisis. Because of the ongoing debt distress prior to the pandemic, many poorer countries in Africa were limited to higher borrowing costs. Most of the funds spent in response to COVID-19 came from international support (World Bank Blogs, 2023). It should also be noted that automatic stabilizers in the form of tax policy are less effective in African countries owing to tax evasion and the tendency for movement from the formal sector to the informal sector (Bondzie & Armah, 2022). Tax buoyancy has also been found to have a larger effect during economic contractions as opposed to expansions as inflation and volatility reduce tax collections (Jalles, 2017).

Moreover, it's been observed that many countries in Africa conducted monetary policy response because of high debt constraints prior to the pandemic (Adam, Alberola, & Pierres, 2022). Complementary to this, data from 2019-2020 show that tax collections decreased in Africa (OECD/AUC/ATAF, 2023). This situation further impaired existing problems with debt burden as this limits the ability of countries to disburse funds in response to the COVID-19 pandemic. The pandemic exacerbated an already dismal trend in fiscal fundamentals in many African countries. Recovery post-pandemic would likely be dependent on fiscal discipline and efficient management of expenditures (Adam, Alberola, & Pierres, 2022).

*Fiscal policy in African and developing countries.*

Various literature on the determinants of fiscal behaviour, in general, is also reviewed. These give insight into variables to be used for the forthcoming analysis. Special attention is given to studies with a geographic focus on African countries, but studies on other developing countries are also reviewed.

Looking into the determinants and cyclicality of fiscal policy in the East African Community (EAC) countries, Mawejje & Odhiambo (2022) confirmed that fiscal deficits are positively affected by current account balance, real per capita GDP and interest rates; and negatively affected by the GDP deflator, grants, and debt service. They also found that government spending is procyclical, however, tax efforts are countercyclical. Related to this, budget deficits and interest rates have been found to be cointegrated in South Africa. Further, Granger causality exists between the two using quarterly data, but not annual data (Uwilingiye & Gupta, 2009).

Accordingly, Cevik & Teksoz (2014) observed from a sample of advanced and developing countries that discretionary fiscal policy is heavily affected by policy rigidity, public debt level, and output gap between advanced and emerging market economies. Various macro-financial variables, e.g., asset prices and real exchange rates, and institutional variables, e.g., institutional quality, also affect fiscal policy behaviour. Moreover, their research also showed that the direction of the effect of these variables differs between advanced and emerging market economies.

In a study by Lledo & Poplawski-Ribeiro (2011) that takes a deep dive into institutional limitations on fiscal programs in Sub-Saharan Africa, it was found that fiscal expansions are less likely to be implemented when institutions are weaker, when the rule of law is more fragile, and when the planned expansion is large. Shifting to fiscal policy determinants in West Africa, Umoh, Onye, & Atan (2018) ascertained that fiscal programs are more determined by political and institutional factors such as corruption, government effectiveness, and rule of law as opposed to economic considerations.

Consequently, Agnello & Sousa (2009) determined using a panel of advanced and developing countries that volatility in public deficits is associated with higher levels of political instability and less democracy.

In summary, empirical studies reviewed herein provide insight into the factors affecting the fiscal policy undertaken because of COVID-19. Moreover, information on specific country situations in African countries before the pandemic gives a better understanding of the limitations that some countries faced that affected their COVID-19 spending. Specific variables affecting fiscal behaviour, in general, were also reviewed. Overall, the variables and the corresponding direction of their effect on COVID-19 spending as well as general fiscal behaviour form the basis of variables to be tested in the forthcoming analysis.

## 3 Data

This section discusses the variables and corresponding data used in the study. Data was collected for 54 African countries[2].

### 3.1 Economic Indicators

Data for the year 2019 was compiled for economic indicators outlined in Table 1. Data for 2019 was used to baseline pre-pandemic levels. These variables were chosen based on the literature review above.

**Table 1**
Economic Indicators

| Indicator | | Source |
|---|---|---|
| GDP Per Capital USD Current | GDPpc | The World Bank (2023) |
| GDP Deflator (computed using based 2015) | GDPdef | The World Bank (2023) |
| Debt Service | debtservice | The World Bank (2023) |
| Current Account Balance | cab | The World Bank (2023) |
| Interest Rate | ir | The World Bank (2023) |
| Grants | grants | The World Bank (2023) |
| Debt-to-GDP Ratio | debt_GDP | The World Bank (2023) |
| Credit Ratings | cratings | Trading Economics (2023) |

Source: Author compiled, see appendices for full list and definitions

### 3.2 Political and Institutional Indicators

Data for the year 2019 was compiled for political and institutional indicators outlined in Table 2. Data for 2019 was used to baseline pre-pandemic levels. These variables were chosen based on the literature review above.

[2] See Appendices for the list of countries considered.

**Table 2**
Political and Institutional Indicators

| Indicator | | Source |
|---|---|---|
| Control of Corruption | corruption | The World Bank (2023) |
| Government Effectiveness | governeffect | The World Bank (2023) |
| Political Stability and Absence of Violence | policstab | The World Bank (2023) |
| Regulatory Quality | regu | The World Bank (2023) |
| Rule of Law | ruleoflaw | The World Bank (2023) |
| Voice and Accountability | accoun | The World Bank (2023) |

Source: Author compiled, see appendices for full list and definitions

3.3 COVID-19 Indicators

This study aims to ascertain the relationship between the economic situation and political institutions before the pandemic on COVID-19 fiscal policy response. For this study, COVID-19 fiscal policy response is primarily measured through the above the line COVID-19 spending dataset of the International Monetary Fund (hereinafter referred to as "COVID-19 spending"). These figures represent increases in expenditure and decreases in taxes in response to the COVID-19 pandemic in USD billion (Potter & Diamond, 1999; Tran, 2020). Further, other fiscal and monetary data and the extent of the pandemic severity measured through 2020 data on COVID-19 cases were also compiled. These are summarized in Table 3.

**Table 3**
COVID-19 Indicators

| Indicator | Definition | Source |
|---|---|---|
| Above the line COVID-19 spending (absolute) | atl_ab | IMF Fiscal Affairs Department (2021) |
| Total fiscal spending | total_fiscal | Porcher (2023) |
| Policy rate | policyrate | Porcher (2023) |
| COVID-19 Cases | c19_cases | Mathieu, et al. (2023) |

Source: Author compiled, see appendices for full list and definitions

## 4 Method

### 4.1 Clustering Variable Selection

Based on the above review of empirical studies on the determinants of fiscal policy and fiscal behaviour during the COVID-19 pandemic as discussed in 2.2, a shortlist of economic and political indicators was compiled. The purpose of the shortlist is to maximize the country sample size. Any variable for which data is not available for 20% or more of the countries was dropped from the analysis.

Simple multivariate regression analyses were then conducted to estimate the effect of the predicted variables on the COVID-19 spending. The variables that were deemed to significantly affect the COVID-19 spending were the ones eventually used to determine the country clusters (final variables used for clustering are shown in Table 4 below).

Multivariate regression is used to measure how linearly related various independent variables are to a chosen dependent variable. It is an extension of the ordinary least squares (OLS) regression in that it uses more than one independent variable.

*Regression model for economic indicators.*

To test for economic indicators, this study primarily adapted results from (Mawejje & Odhiambo, 2022). The formula used is as follows:

$$Y = \beta_0 + \beta_1 \omega + \varepsilon$$

Where:
*Y* is the response variable of above the line COVID-19 spending;
$\beta_0$ is the y intercept;
$\beta_1$ is the coefficient for each explanatory variable;
$\omega$ is a vector of the following explanatory variables: GDP per capita, GDP deflator, debt service, and current account balance;
$\varepsilon$ is the error term.

For this study, keeping as large as possible a sample was important to maintain representation. As such, any variable for which data is not available for 20% or more of the countries was dropped from the analysis. For the economic indicators, the following variables were dropped from the analysis: interest rate, grants, debt-to-GDP, and credit ratings.

*Regression model for political and institutional indicators.*

To test for political and institutional indicators, this study primarily adapted results from (Umoh, Onye, & Atan, 2018). The formula used is as follows:

$$Y = \beta_0 + \beta_1 \omega + \varepsilon$$

Where:
*Y* is the response variable of above the line COVID-19 spending;
$\beta_0$ is the y intercept;
$\beta_1$ is the coefficient for each explanatory variable;
$\omega$ is a vector of the following explanatory variables: estimates of control of corruption, government effectiveness, political stability and absence of violence, regulatory quality, rule of law, and voice and accountability;
$\varepsilon$ is the error term.

For this study, keeping as large as possible a sample was important to maintain representation. As such, any variable for which data is not available for 20% or more of the countries was dropped from the analysis. All political and institutional indicators mentioned above were retained.

The methodology and discussion on regression analysis used for this study are adapted from Wooldridge (2010). Regression analysis for this study was conducted using R.

4.2 K-means Clustering

After the variables for clustering were selected, K-means clustering was conducted to partition the African countries into groups with similar economic situations and political institutions.

*K-means Algorithm.*

K-means is a non-hierarchical unsupervised data mining technique that divides data into one or more clusters or groups. The aim is to create groups wherein the data points within the same cluster have a high degree of similarity and those data points in different clusters have a low degree of similarity. K-means clustering provides the advantages of effectiveness and ease of implementation, allowing it to be used for a variety of fields.

The steps of the approach are as follows:

1) Determine the number of cluster groups (Elbow method is used for this study to determine the number of clusters and is discussed below);
2) Randomly choose the initial centroid points;
3) Allocate the data points to the nearest centroid point using the Euclidean formula, i.e., a data point will be a member of Cluster A if the Euclidean distance between the data point and the centroid of Cluster A is the smallest compared to the centroids from all other Clusters;

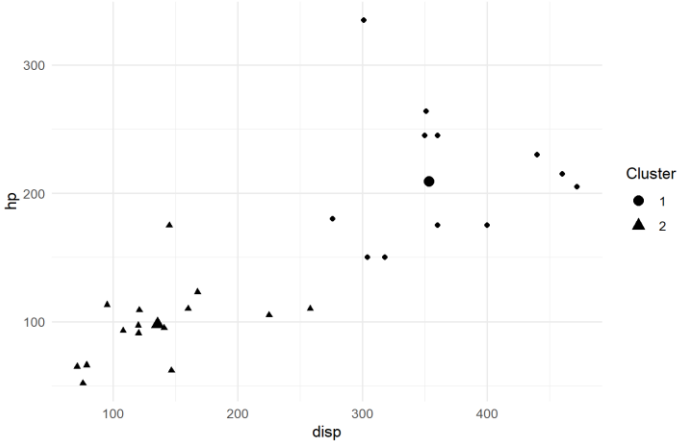
4) Recalculate the mean of the cluster to determine the new centroid points;
5) Repeating steps 3-4 until a point is reached where no data changes groups and the centroid values remain the same or until convergence.

For a dataset with *n* number of variables to be used for clustering, the Euclidean distance is computed as follows:

$$\boldsymbol{d(i,j) = \sqrt{(i_1 - j_1)^2 + (i_2 - j_2)^2 + \cdots + (i_n - j_n)^2}}$$

This is essentially computing for the distance between *i* ($i_1, i_2,\ldots, i_n$) and *j* ($j_1, j_2,\ldots, j_n$) in an *n*-dimensional Cartesian space. Figure 1 below shows a sample visualization for a dataset grouped into two clusters.

**Figure 1: Cluster Visualization (Two Clusters)**




Source: Author generated using preloaded mtcars dataset in R. Variables used were horsepower ("hp) and displacement ("disp"). The bigger circle or triangle for each cluster shows the respective centroids.

For this study, the cluster groups are determined using the chosen economic and political indicators identified using the methodology discussed in 4.1. Number of COVID-19 infections was also used to determine the clusters as a control variable.

*K-value Selection using Elbow Method.*

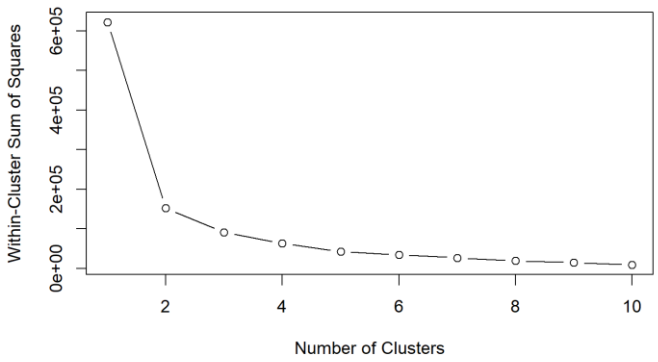
The number of clusters in a K-means algorithm is dependent on the K-value setting. This study uses the Elbow method to determine the K-value. The elbow method employs the square of the distance between the sample points in each cluster and the centroid of the cluster to determine the K-value. The sum of squared errors (SSE) is calculated for each possible K-value and is computed as follows:

$$\boldsymbol{SSE = \sum_{i=1}^{n} d^2}$$

Where:
d is the distance between the data point and the centroid. This study uses multiple variables to determine the number of clusters. As such, the d in this formula also represents the Euclidean distance for multidimensional space as discussed above.

In general, as the number of clusters increases, the SSE would decrease indicating that the groups are more localized. This is shown graphically in Figure 2 below. The number of clusters to be used is determined by the inflection point in the graph or the elbow bend. This is the point where increasing the number of clusters does not provide further benefit in terms of decreasing the squared distance between the sample points and the centroid. Put differently, as the K-value approaches the optimal number of clusters, the SSE decreases rapidly. After that point, the decrease in SSE happens more slowly.

**Figure 2: The Elbow Method Showing Optimal K**




Source: Author generated using preloaded mtcars dataset in R. Optimal K is two clusters.

It should be noted that there are other possible approaches to determine the optimal K. These include the gap statistics algorithm and silhouette analysis. For this study, the elbow method was used to determine the appropriate number of clusters due to its simplicity and ease of interpretation.

The methodology and discussion on K-means clustering and elbow method used for this study are adapted from Selvida, Zarlis, & Situmorang (2020); Nainggolan, Perangin-angin, Simarmata, & Tarigan (2019); Yuan & Yang (2019); Zhang, Liu, Chen, & Luo (2019). Clustering analysis for this study was conducted using R.

4.3 Kruskal-Wallis Test and Further Analysis

Once the cluster groups had been created, a Kruskal-Wallis Test[3] was conducted. It is a non-parametric test to compare three or more groups in terms of a quantitative variable. In this case, it's used to compare the cluster groups in terms of their COVID-19 spending.

The null and alternative hypotheses of the test are as follows:
$H_0$: All groups disbursed equal COVID-19 spending
$H_1$: At least one group is different from the other two groups in terms of COVID-19 spending

[3] As a caveat, ANOVA was originally intended to be used, however, an ANOVA test assumes normally distributed residuals within each cluster group. After clustering, some groups ended up with too country members that the normality assumption did not hold. Further, it should be noted that a Mann-Whitney, as opposed to Kruskal-Wallis, test would've been used had there only been two cluster groups.

Compared to an analysis of variance (ANOVA) test, the alternative hypothesis for a Kruskal-Wallis test is not that all groups are different in COVID-19 spending. The test would only tell us that at least one group is different from the others. As such, a post-hoc Dunn's Test using the Holm method is also conducted to determine which cluster group is different from another in terms of their COVID-19 spending. A Dunn's Test conducts several pairwise comparisons among all the cluster groups and determines which pairs are statistically different from each other.

Lastly, due to the limitations imposed by the small sample size, for further insights, additional descriptive comparisons were done among groups.

The methodology and discussion on tests used for this study are adapted from Ostertagová, Ostertag, & Kováč (2014); Hecke (2012); and Dinno (2015). Various tests for this study were conducted using R.

## 5 Results and Discussion

### 5.1 Model Results

*Regression and Clustering Results*

Regression models for both economic and political indicators were run and the final list of indicators used for the clustering algorithm are shown in Table 4. The regressions were run using the complete sample and results can be found in the appendices. For the clustering, the countries for which the indicators shown in Table 4 were not available were dropped, leaving a final sample of 37 countries for clustering.

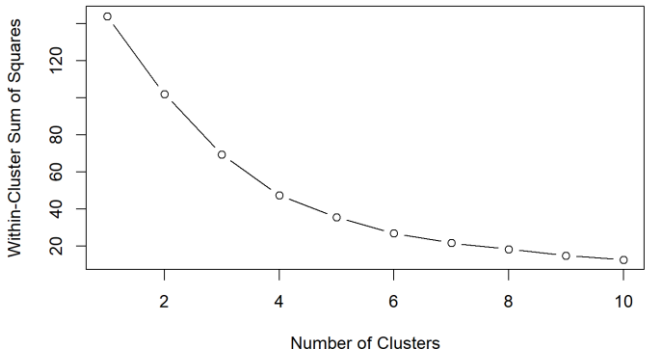
**Table 4**
Indicator list used for clustering

| Indicator | |
|---|---|
| Current Account Balance | cab |
| Government Effectiveness | governeffect |
| Political Stability and Absence of Violence | policstab |
| COVID-19 Cases | c19_cases |

Source: Author compiled

For comparability and to avoid any one variable being considered relatively more important by the model, the values for the above indicators were scaled to have a mean of 0 and a standard deviation of 1. The elbow method was carried out and results are shown in Figure 3. The results show that the appropriate number of clusters for the abovementioned variables is 4.

**Figure 3: Results of Elbow Method Showing Optimal K**




Source: Author generated results

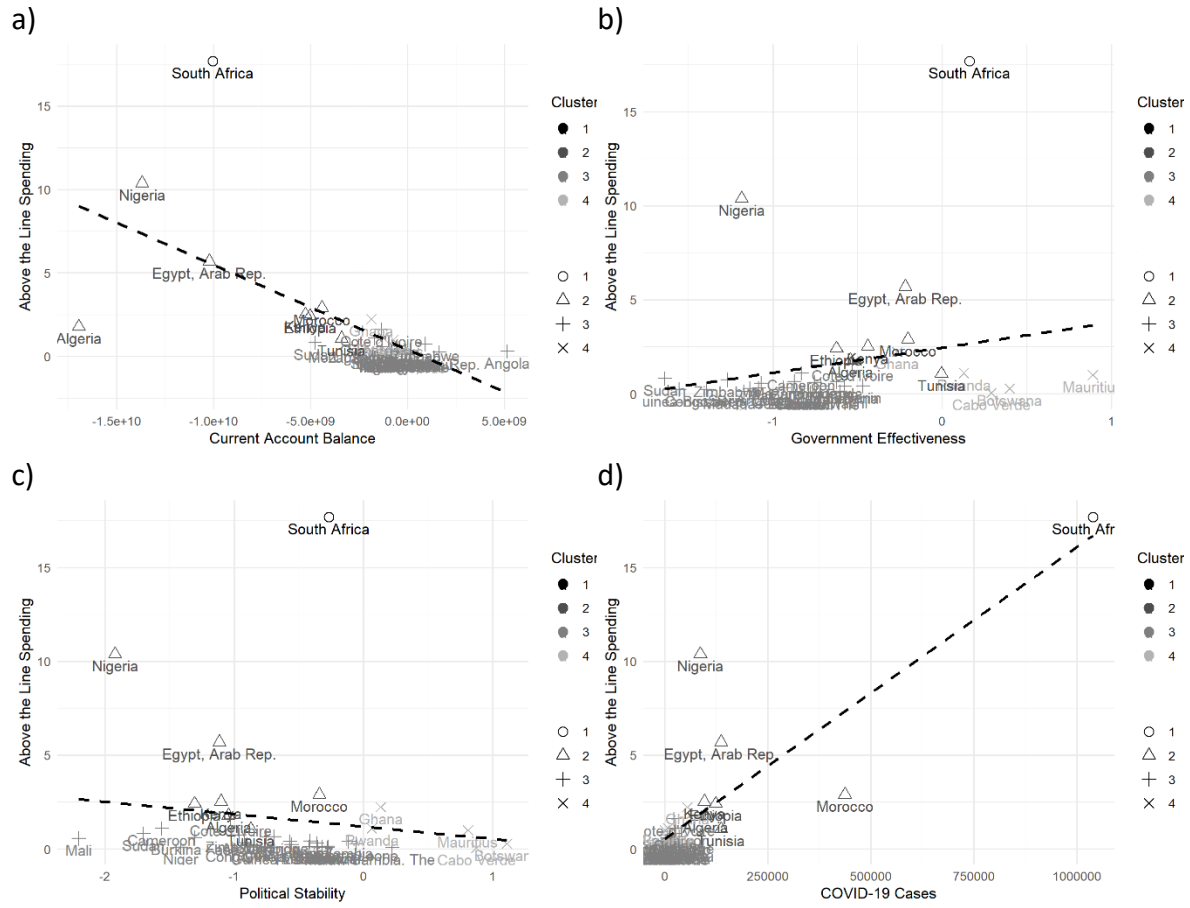
The K-means clustering methodology was implemented and the resulting country groups are shown in Table 5. Figure 4 shows four panels illustrating the cluster groups along with the relationship between the variables used in clustering and above the line COVID-19 spending.

**Table 5**
Country Cluster Results

| Cluster | Countries |
|---|---|
| 1 | South Africa |
| 2 | Algeria, Egypt, Arab Rep., Ethiopia, Kenya, Morocco, Nigeria, Tunisia |
| 3 | Angola, Benin, Burkina Faso, Cameroon, Congo, Rep., Cote d'Ivoire, Djibouti, Eswatini, Gambia, The, Guinea, Guinea-Bissau, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Sierra Leone, Sudan, Togo, Uganda, Zambia, Zimbabwe |
| 4 | Botswana, Cabo Verde, Ghana, Mauritius, Rwanda |

Source: Author generated results

**Figure 4: Regression analysis and cluster groups: Relationship between cluster variables and the above the line COVID-19 spending**




Source: Author generated results

The results show that:

a. There exists a strong positive relationship between COVID-19 cases and COVID-19 spending (panel d). This is in line with the literature that says that a greater pandemic incidence would lead to a greater negative economic effect and hence require a greater fiscal response (Alberola et al., 2021).

b. There also exists a positive albeit weaker relationship between government effectiveness and COVID-19 spending (panel b). This is in line with the results observed in literature where government effectiveness has been seen to negatively affect fiscal persistence or dependence of current fiscal behaviour on past behaviour. Fiscal authorities have been found to be less responsive to recessions or booms if fiscal policy is more persistent (Umoh, Onye, & Atan, 2018). As such, if government effectiveness affects fiscal persistence negatively, it implies increasing government effectiveness leads to more discretion in fiscal policy. This and the result presented above indicate that as a country's government effectiveness increases, i.e., better quality of public and civil services, and more independence from political pressures, among others (The World Bank, 2023), a country's fiscal authorities are more likely to implement discretionary counter-cyclical fiscal policy, such as in response to an external shock like the COVID-19 pandemic.

c. There also exists a negative relationship between COVID-19 spending and current account balance and, to a lesser extent, political stability (panel a and c). For current account balance, literature suggests that it should have a positive relationship with fiscal deficit (Mawejje & Odhiambo, 2022; the twin deficit hypothesis). As noted above, fiscal policy in African countries in response to COVID-19 mainly came from international support due to the countries' inability to borrow. As such, for the countries that could borrow, notably those in Cluster 1 and 2, there is negative current account balance associated with higher fiscal response to COVID-19. For the rest of the countries, there was lower COVID-19 spending and a more positive current account balance. The results pertaining to political stability are somewhat contrary to literature where it has been seen to negatively affect fiscal persistence (Umoh, Onye, & Atan, 2018). Similar to the discussion above on government effectiveness, if political stability affects fiscal persistence negatively, it implies increasing political stability leads to more discretion in fiscal policy. In general, the countries in the sample tended to have lower political stability scores versus government effectiveness scores. This implies that countries with lower political stability, or countries with the presence of political violence or terrorism, can still be able to disburse funds if necessary and may still have a somewhat "effective" government. This is something that can be further explored in the future, especially for the sample of African countries.

For the cluster groups, it is noteworthy that South Africa is the only country that is part of Cluster 1. As seen in panel d, South Africa has the largest reported number of COVID-19 cases. Further, South Africa is one of the largest economies in Africa by nominal GDP (Galal, 2023) and its government also implemented several strict lockdown measures that limited the movement of what they considered non-essential workers (IMF, 2022). This shows that South Africa is one of the countries that did have the capacity to allocate more on COVID-19 spending and this response was also necessitated due to the overwhelming number of COVID-19 cases and equivalent stringency measures. Fiscal policy in South Africa in response to COVID-19 primarily went to unemployment insurance, tax credits for health workers, food for parcels for distribution, assistance to tourism and hospitality SMEs, and loans for eligible businesses (IMF, 2022).

Except for Ethiopia, Nigeria, and Kenya, Cluster 2 is mostly composed of northern African countries. Moreover, again with the exception of Ethiopia, Cluster 2 is also mainly composed of lower middle-income countries (UN/DESA, 2016). Countries in Cluster 2 also notably maintain a negative current account balance like Nigeria, Egypt, and Algeria. These countries are some of the bigger economies in Africa by nominal GDP (Galal, 2023) and have a greater ability to borrow. Concerning this, Cluster 2 also prominently has countries that were in debt distress or have already defaulted, namely Egypt, Kenya, Tunisia, and Ethiopia (Reuters, 2023). Political stability and government effectiveness also tended to be weak for countries in Cluster 2 with values generally in the negative range.

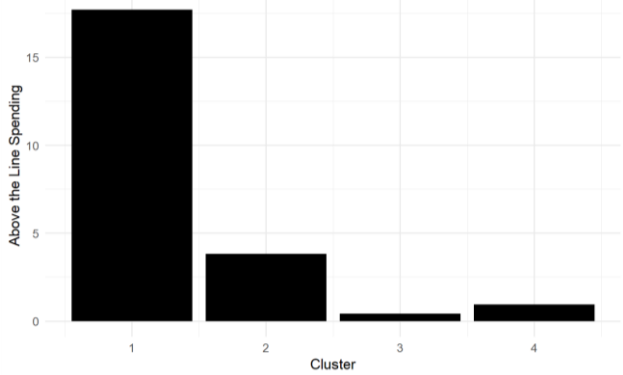
Clusters 3 and 4 are composed mostly of sub-Saharan countries and, with the exception of Mauritius, a mix of lower-middle-income to low-income countries (UN/DESA, 2016).

Countries in Cluster 3 generally maintained a positive current account balance which is complemented by the fact that they generally have limited ability to borrow with half of them not even rated by S&P and those rated have a score of BBB- and below (S&P, 2019). Countries in Cluster 3 also tended to have weak political stability and government effectiveness.

Countries in Cluster 4 generally have positive scores for government effectiveness and political stability. Moreover, countries in this group are mixed in terms of income and credit ratings (UN/DESA, 2016; S&P, 2019).

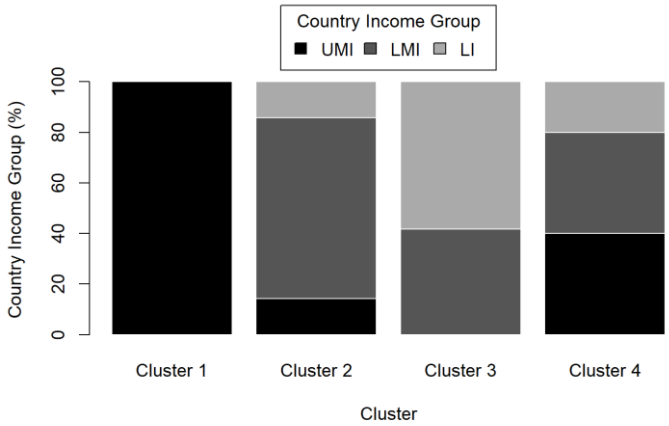
In terms of the size of COVID-19 spending, Figure 5 shows the average above the line COVID-19 spending among the cluster groups. This is followed by Figure 6 which shows the country income group distribution by cluster. Cluster 1 (South Africa) spent the most in response to COVID-19 followed by Cluster 2, then 4 and 3. In conjecture with what is shown in Figure 6, Clusters 3 and 4 are composed mostly of lower-middle-income to low-income countries highlighting that countries with larger income capacity tend to allocate more to government services.

**Figure 5: Average above the line COVID-19 spending per cluster**




Source: Author generated results

**Figure 6: Country income group per cluster**




Source: UN/DESA, 2016; UMI = upper middle-income, LMI = lower middle-income, LI=lower income

*Parametric Test Results*

The Kruskal-Wallis test was implemented and results are seen in Table 6. The p-value of the results indicates that there is a significant difference between at least two of the clusters in terms of their above the line COVID-19 spending.

**Table 6**

| **Kruskal-Wallis Test** |
|---|
| *Kruskal-Wallis rank sum test* |
| |
| *data: atl_ab by Cluster* |
| *Kruskal-Wallis chi-squared = 17.948, df = 3, p-value = 0.0004509* |

Source: Author generated results

To complement this, Table 7 shows the result of the Dunn's Test. The results indicate that there is a highly significant difference between Cluster 2 and Cluster 3 in terms of their above the line COVID-19 spending. This is shown by the Z-score and the p-value. Further, the Holm-adjusted p-value shows that the difference between the two groups remains significant after adjusting for multiple comparisons.

**Table 7**

| **Dunn's Test** | | | |
|---|---|---|---|
| *Comparison* | *Z* | *P.unadj* | *P.adj* |
| *Cluster 1 - Cluster 2* | *0.4073971* | *0.6837163870* | *0.6837163870* |
| *Cluster 1 - Cluster 3* | *2.0592780* | *0.0394676146* | *0.1973380729* |
| *Cluster 2 - Cluster 3* | *3.8788689* | *0.0001049433* | *0.0006296597* |
| *Cluster 1 - Cluster 4* | *1.4674273* | *0.1422598585* | *0.4267795755* |
| *Cluster 2 - Cluster 4* | *2.0015032* | *0.0453381899* | *0.1813527594* |
| *Cluster 3 - Cluster 4* | *-1.0054104* | *0.3146992791* | *0.6293985582* |

Source: Author generated results

5.2 Further Observations and Discussions

*Note on country outliers*

Several countries are noticeably outliers in terms of their COVID-19 spending as tested using the 1.5 times interquartile range rule[4]. As such, for purposes of additional comparison, the same clustering methodology was implemented without the outliers from the sample. The results in Table 8 show that the cluster groups remained fairly the same even in the absence of the outliers (country outliers are stricken out in the table).

[4] Values which are equal to 1.5 times the interquartile range above the third quartile or below the first quartile are considered outliers.

**Table 8**

Country Cluster Results with and without outliers

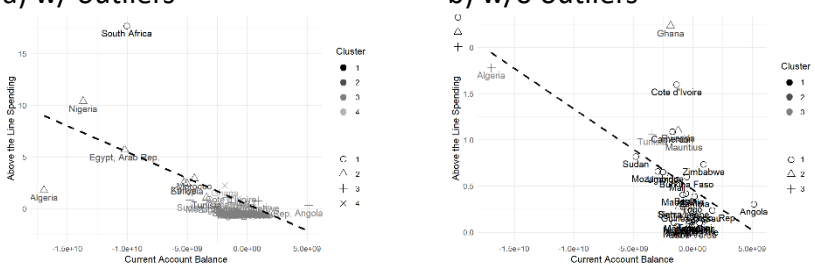
| | Country Clusters (w/ outliers) | Country Clusters (w/o outliers) | |
|---|---|---|---|
| 1 | South Africa | ~~South Africa~~ | N/A |
| 2 | Algeria, Egypt, Arab Rep., Ethiopia, Kenya, Morocco, Nigeria, Tunisia | Algeria, ~~Egypt, Arab Rep., Ethiopia, Kenya, Morocco, Nigeria,~~ Tunisia | 3 |
| 3 | Angola, Benin, Burkina Faso, Cameroon, Congo, Rep., Cote d'Ivoire, Djibouti, Eswatini, Gambia, The, Guinea, Guinea-Bissau, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Sierra Leone, Sudan, Togo, Uganda, Zambia, Zimbabwe | Angola, Benin, Burkina Faso, Cameroon, Congo, Rep., Cote d'Ivoire, Djibouti, Eswatini, Gambia, The, Guinea, Guinea-Bissau, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Sierra Leone, Sudan, Togo, Uganda, Zambia, Zimbabwe | 1 |
| 4 | Botswana, Cabo Verde, Ghana, Mauritius, Rwanda | Botswana, Cabo Verde, Ghana, Mauritius, Rwanda | 2 |

Source: Author generated results

Moreover, Figure 7 shows the clusters with and without the outliers along the relationship between current account balance and COVID-19 spending. While the sign of the relationship did not change from the original clustering, there was some variation in the strength of the relationship among the variables in the absence of outliers. The same can be observed for the other variables (i.e., government effectiveness, political stability, and COVID-19 cases). As a distance-based algorithm, K-means clustering can be significantly impacted by outliers. This is one of the reasons why the dataset was scaled prior to clustering. However, in the case of our sample, it appears that the outliers didn't inappropriately "pull" any of the other data points as the groupings remained largely the same.

**Figure 7: Regression with cluster groups with and without outliers**

a) w/ outliers b) w/o outliers



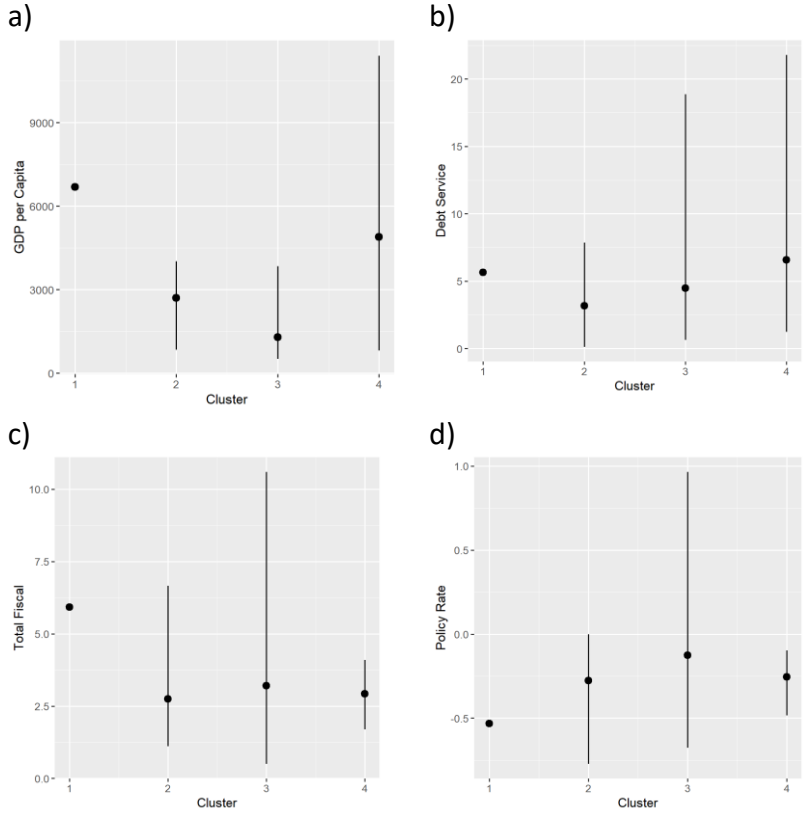

Source: Author generated results

*Further cluster comparisons*

Figure 8 shows the maximum, minimum, and mean values for several indicators among the clusters, namely, 2019 GDP per capita and debt service, and pandemic response measured in total fiscal disbursement and mean change in policy rate during the pandemic.

There is no clear observable pattern among the clusters in terms of these other variables. Further, Kruskal-Wallis tests were also conducted and results showed that the clusters were not able to significantly explain differences in the same variables. As the original clustering was based on indicators that were seen to affect above the line COVID-19 spending, no clear pattern can be observed when other variables are compared among clusters. Further analysis can be undertaken in this regard using the cluster methodology to determine determinants of fiscal policy in general or fiscal policy specifically in times of recession or external shock.

**Figure 8: Further Cluster Comparisons**




Source: Author generated results

## 6 Conclusions and Policy Recommendations

This study delved into the relationship between African countries' economic situation and political institutions before the pandemic and the subsequent size of fiscal policy implemented in response to COVID-19. I employed K-means clustering to categorize the countries into cluster groups using data on current account balance, estimates on political stability and government effectiveness, and COVID-19 cases. This resulted in four cluster groups with varying fiscal response to the COVID-19 crisis.

Kruskal-Wallis and subsequent Dunn's tests showed that the differences among the groups in terms of their COVID-19 spending could be explained by the clusters. This demonstrates that economic and political variables do influence the fiscal strategies of the governments in the sample.

The analysis revealed that COVID-19 spending was positively affected by the number of COVID-19 cases and the degree of government effectiveness. Moreover, spending was negatively affected by the level of current account balance and the degree of political stability. Moreover, the discussion revealed various similarities among the cluster groups that give insight into the size of funding disbursed to counter the effects of the pandemic.

The clustering exercise undertaken highlights two contrasting points. Firstly, there is significant variation in the size of fiscal policy disbursed by countries in response to COVID-19 which is affected by the degree they were affected by the pandemic and by their respective situations before the pandemic. But secondly, while there is variation, the cluster groups also show that there are similarities in the ways countries responded and in the economic and political characteristics of those countries before the pandemic. The variation and similarities in the response of the countries to the pandemic pinpoint that there is no one answer to dealing with a crisis such as COVID-19. Each cluster represents countries with a unique combination of political and economic factors that affect how they will respond. These nuanced differences and similarities between countries must be considered when designing plans for future external shocks.

To check for the possible impact of outliers, the same K-means clustering methodology was also conducted while removing the outliers from the sample. The countries within the specific clusters remained the same. The sign of the relationship between notable variables and COVID-19 spending also remained the same.

Based on the findings, several policy recommendations can be made. Firstly, countries should build and maintain strong economic and political foundations. A more resilient economy coupled with a society that cultivates public trust can better respond to shocks. Secondly, regional cooperation and capacity building could be conducted among countries within the same cluster. Countries that have had better success can share their best practices with other countries within the same cluster and government-to-government collaboration should be promoted especially since the since the countries within the same cluster act similarly or had similar prior economic and political characteristics. Further, policy response varies and there is no "one-size-fits-all" solution. The response should be tailored to the specific needs of the countries concerned. An understanding of similar situations could allow for targeted resource allocation and health measures among those groups with similar needs.

Overall, this study contributes to the evolving discussion on the pandemic and the equivalent appropriate response should similar shocks occur. Additionally, it demonstrates the importance of economic and political variables in shaping fiscal policy response to COVID-19. Insights from this study can be useful for policy formulations that can help governments better prepare for future crises and ensure the well-being of their people and the stability of their economies.

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**Appendices**

*Appendix 1: Africa Country List*

1. Algeria
2. Angola
3. Benin
4. Botswana
5. Burkina Faso
6. Burundi
7. Cabo Verde
8. Cameroon
9. Central African Republic
10. Chad
11. Comoros
12. Congo, Dem. Rep.
13. Congo, Rep.
14. Cote d'Ivoire
15. Djibouti
16. Egypt, Arab Rep.
17. Equatorial Guinea
18. Eritrea
19. Eswatini
20. Estonia
21. Gabon
22. Gambia, The
23. Ghana
24. Guinea-Bissau
25. Guinea
26. Kenya
27. Lesotho
28. Libera
29. Libya
30. Madagascar
31. Malawi
32. Mali
33. Mauritania
34. Mauritius
35. Morocco
36. Mozambique
37. Namibia
38. Niger
39. Nigeria
40. Rwanda
41. Sao Tome and Pricipe
42. Senegal
43. Seychelles
44. Sierra Leone
45. Somalia
46. South Africa
47. South Sudan
48. Sudan
49. Tanzania
50. Togo
51. Tunisia
52. Uganda
53. Zambia
54. Zimbabwe

This study adapts country naming convention of The World Bank.

*Appendix 2: Data List and Definitions*

| Indicator | | Definition | Source |
|---|---|---|---|
| GDP Per Capital USD Current | GDPpc | GDP per capita (current US$) – "GDP per capita is gross domestic product divided by mid-year population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in current U.S. dollars." | The World Bank (2023) |
| GDP Deflator (computed using based 2015) | GDPdef | Author computed using the following formula: $\frac{GDP\ per\ capita\ (current\ US\$)}{GDP\ per\ capita\ (constant\ 2015\ US\$)}\ x\ 100$ | The World Bank (2023) |
| Debt Service | debtservice | Total debt service (% of GNI) – "Total debt service is the sum of principal repayments and interest actually paid in currency, goods, or services on long-term debt, interest paid on short-term debt, and repayments (repurchases and charges) to the IMF." | The World Bank (2023) |
| Current Account Balance | cab | Current account balance (% of GDP) – "Current account balance is the sum of net exports of goods and services, net primary income, and net secondary income." | The World Bank (2023) |
| Interest Rate | ir | Deposit interest rate (%) – "Deposit interest rate is the rate paid by commercial or similar banks for demand, time, or savings deposits. The terms and conditions attached to these rates differ by country, however, limiting their comparability."<br>Real interest rate (%) – "Real interest rate is the lending interest rate adjusted for inflation as measured by the GDP deflator. The terms and conditions attached to lending rates differ by country, however, limiting their comparability." | The World Bank (2023) |
| Grants | grants | Grants, excluding technical cooperation (BoP, current US$) – "Grants are defined as legally binding commitments that obligate a specific | The World Bank (2023) |

| | | | |
|---|---|---|---|
| | | value of funds available for disbursement for which there is no repayment requirement. Data are in current U.S. dollars." | |
| Debt-to-GDP Ratio | debt_GDP | Central government debt, total (% of GDP) – "Debt is the entire stock of direct government fixed-term contractual obligations to others outstanding on a particular date. It includes domestic and foreign liabilities such as currency and money deposits, securities other than shares, and loans. It is the gross amount of government liabilities reduced by the amount of equity and financial derivatives held by the government. Because debt is a stock rather than a flow, it is measured as of a given date, usually the last day of the fiscal year." | The World Bank (2023) |
| Credit Ratings | cratings | "Credit ratings that are forward-looking opinions on the relative ability of an entity or obligation to meet financial commitments" (Fitch Ratings, 2023). | Trading Economics (2023) |
| Government Effectiveness | governeffect | Government Effectiveness: "Estimate - Government Effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5." | The World Bank (2023) |
| Political Stability and Absence of Violence | policstab | Political Stability and Absence of Violence/Terrorism: Estimate – "Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5. | The World Bank (2023) |
| Regulatory Quality | regu | Regulatory Quality: Estimate - Regulatory Quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development. Estimate gives the country's score on the aggregate indicator, in units of a standard normal | The World Bank (2023) |

| | | | |
|---|---|---|---|
| | | distribution, i.e. ranging from approximately -2.5 to 2.5." | |
| Rule of Law | ruleoflaw | Rule of Law: Estimate – "Rule of Law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5." | The World Bank (2023) |
| Voice and Accountability | accoun | Voice and Accountability: Estimate – "Voice and Accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media. Estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5." | The World Bank (2023) |
| Above the line COVID-19 spending (absolute) | atl_ab | Above the line measures, subtotal health and non-health sector - These figures represent increases in expenditure and decrease in taxes in response to the COVID-19 pandemic in USD billion (Potter & Diamond, 1999; Tran, 2020). | IMF Fiscal Affairs Department (2021) |
| Total fiscal spending | total_fiscal | Fiscal – "This is the global amount spent on a given date, which is then divided between various categories. Fiscal includes additional or foregone revenues that had been specifically targeted at dealing with COVID-19. It does not account for delayed revenues such as tax deferrals and off-budget measures that do not directly affect the annual fiscal deficit. The breakdown of fiscal includes wage support, cash transfers, in-kind transfers, sectoral support, tax cuts, and credit schemes ." | Porcher (2023) |
| Policy rate | mean_policyrate | Policy rate – "rate is meant to capture the evolution of policy rates set up by the Central Bank. The values taken by the variable translate the nominal evolution. For example, a decrease of 1% will be coded -100." | Porcher (2023) |

| | | | |
|---|---|---|---|
| COVID-19 Cases | c19_cases | Refers to confirmed COVID-19 cases as reported by the corresponding national governments. It should be noted that countries defer in criteria used to define and report cases. Moreover, some countries have changed their reporting methodologies over the court of the pandemic (Mathieu, et al., 2023). | Mathieu, et al. (2023) |

*Appendix 3: Variable Selection Regression Results*

Economic Indicators

**Regression Results**

*Coefficients:*

| | *Estimate Std.* | *Error* | *t value* | *Pr(>\|t\|)* |
|---|---|---|---|---|
| *(Intercept)* | *-2.855e-01* | *6.254e-01* | *-0.457* | *0.651* |
| *GDPpc* | *2.397e-04* | *2.136e-04* | *1.122* | *0.269* |
| *GDPdef* | *-1.092e-04* | *2.648e-04* | *-0.412* | *0.683* |
| *debtservice* | *5.607e-02* | *9.096e-02* | *0.616* | *0.541* |
| *cab* | *-5.021e-10* | *1.048e-10* | *-4.793* | *2.82e-05 **** |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Multiple R-squared: 0.4741, Adjusted R-squared: 0.4156

Political and Institutional Indicators

**Regression Results**

*Coefficients:*

| | *Estimate Std.* | *Error* | *t value* | *Pr(>\|t\|)* |
|---|---|---|---|---|
| *(Intercept)* | *1.9851* | *0.5938* | *3.343* | *0.00168 *** |
| *corruption* | *-1.7247* | *1.3275* | *-1.299* | *0.20050* |
| *governeffect* | *3.9677* | *1.7614* | *2.253* | *0.02921 ** |
| *policstab* | *-1.6337* | *0.6597* | *-2.476* | *0.01709 ** |
| *regu* | *-1.6181* | *1.5975* | *-0.387* | *0.70063* |
| *ruleoflaw* | *-1.0467* | *2.0131* | *-0.520* | *0.60565* |
| *accoun* | *1.7418* | *0.8944* | *1.947* | *0.05773 .* |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Multiple R-squared: 0.2331, Adjusted R-squared: 0.1309

COVID-19 Cases

**Regression Results**

*Coefficients:*

| | *Estimate Std.* | *Error* | *t value* | *Pr(>\|t\|)* |
|---|---|---|---|---|
| *(Intercept)* | *4.322e-01* | *2.238e-01* | *1.931* | *0.0592 .* |
| *covidcases* | *1.567e-05* | *1.378e-06* | *11.370* | *1.79e-15 **** |

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Multiple R-squared: 0.7211, Adjusted R-squared: 0.7155