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MACROECONOMIC POLICY RESPONSES IN AFRICA
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COVID-19 and Socioeconomic Vulnerability

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About CoMPRA

The COVID-19 Macroeconomic Policy Response in Africa (CoMPRA) project was developed following a call for rapid response policy research into the COVID-19 pandemic by the IDRC. The project's overall goal is to inform macroeconomic policy development in response to the COVID-19 pandemic by low and middle-income countries (LMICs) and development partners that results in more inclusive, climate-resilient, effective and gender-responsive measures through evidence-based research. This will help to mitigate COVID-19's social and economic impact, promote recovery from the pandemic in the short term and position LMICs in the longer term for a more climate-resilient, sustainable and stable future. The CoMPRA project will focus broadly on African countries and specifically on six countries (Benin, Senegal, Tanzania, Uganda, Nigeria and South Africa). SAIIA and CSEA, as the lead implementing partners for this project, also work with think tank partners in these countries.

Our Donor

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Abstract

In this study, a new index measuring countries' socioeconomic vulnerability to COVID-19 across countries was created. The index incorporates multiple dimensions of vulnerability, namely macroeconomic exposure, access to healthcare, financial inclusion, social protection and gender inclusivity. The purpose of the index is to identify the main factors driving such vulnerability in order to explain the observed income losses and financial hardships experienced by people in different countries during the pandemic. The results of the study support the notion that African countries are among the most socioeconomically vulnerable to COVID-19, with poor

gender inclusivity playing a major role in this regard. The results also show that socioeconomic vulnerability and the stringency of COVID-19 containment measures were key contributors to the income losses and financial hardships experienced on the continent during the pandemic. Thus, the study underscores the importance of incorporating socioeconomic vulnerability into pandemic response strategies and of gathering comprehensive and reliable data to inform such strategies.

Introduction

The COVID-19 pandemic resulted in substantial economic losses around the world. The amount of damage surpassed that of several major crises before it, including the global financial crisis (GFC) of 2008. The pandemic caused a global recession, with the global economy contracting by 3.1% in 2020.[1] Like all other regions, Africa was not spared. The sub-Saharan economy shrank by 1.7%, according to International Monetary Fund (IMF) estimates – the first recession in the region since 1993 and the worst since 1983. The lost output translated into increased hardship for many vulnerable populations across the continent who lost some, and in other cases all, of their livelihood incomes. Estimates from the World Bank show that for the first time in 20 years, extreme poverty increased across the world in the wake of the pandemic, with 70 million more people falling into poverty. Africa saw extreme poverty levels rise, with the number of extremely poor people reaching the half-billion mark in 2020.[2] A significant consequence of this development was increased food insecurity which saw the number of undernourished people in Africa reach 250 million.[3]

The social and economic hardships faced by people all over the world were influenced by many factors, ranging from the inability of national health systems to respond effectively to the severity of the impacts in individual countries to the stringency of the COVID-19 containment measures adopted. A survey by the World Bank revealed that these hardships were also a function of income levels and gender, with the poor and women experiencing more severe pandemic-related hardships than the non-poor and men.[4] This indicates that gender played a crucial role in determining the level of social and economic vulnerability to the impacts of

1 IMF, 'World Economic Outlook: Recovery During a Pandemic—Health Concerns, Supply Disruptions, Price Pressures' (Washington, DC, October 2021), https://www.imf.org/en/Publications/WEO/Issues/2021/10/12/world-economic-outlook-october-2021.

2 Baldwin Tong, 'COVID-19 has pushed extreme poverty numbers in Africa to over half a billion' (OECD Development Matters, October 2020), https://oecd-development-matters.org/2020/10/12/.

3 FAO, IFAD, UNICEF, WFP and WHO, 'The State of Food Security and Nutrition in the World 2020. Transforming food systems for affordable healthy diets' (FAO, Rome, 2020), https://doi.org/10.4060/ca9692en.

4 Asli Demirgüç-Kunt, Leora Klapper, Dorothe Singer and Saniya Ansar, 'The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19' (World Bank, Washington, DC, 2022), doi:10.1596/978-1-4648-1897-4.

the pandemic. Therefore, it is important to ensure that the gender dimension is included when assessing vulnerability in the context of the COVID-19 pandemic as well as similar shocks in the future.

The aim of this study was to assess the varying degrees of socioeconomic vulnerability to COVID-19, particularly in Africa, and the sources of these vulnerabilities. To this end, we created an index that reflects the social and economic dimensions of vulnerability across different African countries prior to the pandemic in 2019. These dimensions are: macroeconomic exposure; the strength and coverage of national health systems; social protection levels; financial inclusion and resilience; and gender inclusivity. In addition, we examined the relationship between the ex-ante vulnerability levels and the economic welfare outcomes during the pandemic, with a focus on the gendered impacts of the pandemic. The discussion of the findings centred on the six countries included in the COVID-19 and Macroeconomic Policy Responses in Africa (CoMPRA) project, namely South Africa, Tanzania, Uganda, Nigeria, Senegal and Benin.[5]

Measuring socioeconomic vulnerability

Theoretical framework

Vulnerability encompasses various concepts related to susceptibility to social, economic or financial risks. As such, many indices have been developed to capture the different facets of vulnerability (Table 1). For example, the Economic and Environmental Vulnerability Index (EVI), which is the official vulnerability index of the UN, is used to assess economic vulnerability of low-income countries by taking into consideration exogenous risks to trade and environmental shocks. Along with gross national income (GNI) per capita and the Human Assets Index (HAI), the EVI is used to assess whether or not countries should be regarded as least-developed countries (LDCs).[6] The United Nations Development Programme (UNDP) Multidimensional Vulnerability Index (MVI) expands on the EVI to cover four dimensions of vulnerability, namely economic, environmental, financial and geographic.[7] This index is designed to account for both long-term structural vulnerabilities as well as those specific to the pandemic. Using a mix of 11 indicators covering the four dimensions, the index captures multiple facets of vulnerability which simple income measures do not.

5 CoMPRA is a project funded by the International Development Research Centre (IDRC) whose goal is to inform macroeconomic policy development in response to the COVID-19 pandemic by low- and middle-income countries and development partners.

6 UN Department of Economic and Social Affairs, 'LDC Identification Criteria & Indicators,' https://www.un.org/development/desa/dpad/least-developed-country-category/ldc-criteria.html.

7 Jacob Assa and Riad Meddeb, 'Towards a Multidimensional Vulnerability Index' (UNDP Discussion Paper, February 2021).

In the context of the COVID-19 pandemic, economic vulnerability mostly refers to poor and adverse macroeconomic outcomes following the outbreak. However, other indices with a broader scope were also developed to measure economic vulnerability to the pandemic. One example is the COVID-19 Vulnerability Index which measures the direct and indirect economic impact channels of the pandemic.[8] Here the vulnerability of a country is measured through the assessment of the country's economic characteristics, including its trade openness, natural resource dependency, and dependency on foreign investment and tourism. Similarly, the Vulnerability to Pandemics Dashboard published by the UNDP analyses macroeconomic indicators of resilience but goes further by incorporating social protection in the index.[9] The dashboard further analyses inequality, healthcare and digital inclusion indicators to assess the preparedness of countries to respond to the pandemic. In another example, the European Investment Bank (EIB) COVID-19 Economic Vulnerability Index includes healthcare indicators covering three dimensions, namely quality of healthcare and age of the population, structure of the economy, and exposure and ability to respond to shocks.[10]

Table 1 Select vulnerability indices developed over the years

Author(s)	Index name	Dimensions and indicators
Jacob Assa and Riad Meddeb (UNDP)	Multidimensional Vulnerability Index (2021)	(1) Export concentration (2) share of agriculture in GDP (3) instability of exports (4) tourism receipts (5) personal remittances (6) FDI (7) share of population living in drylands (8) remoteness (9) share of population living in low-lying coastal zones (10) victims of disasters (11) instability of agricultural production.
Samba Diop, Simplice Asongu & Joseph Nnanna	COVID-19 Economic Vulnerability Index (2021)	(1) FDI (2) personal remittances (3) official development assistance (4) oil rents (5) total natural resource rents (6) tourism receipts (7) imports of goods and services.
Emmanouil Davradakis, Sanne Zwart, Barbara Marchitto and Ricardo Santos (EIB)	EIB COVID-19 Economic Vulnerability Index (2020)	**Quality of healthcare and age of the population**: (1) Physicians per 1000 people (2) beds per 1000 people (3) people aged 65 and over (% of total population). **Structure of the economy**: (4) Global value chain participation (% of GDP) (5) international tourism receipts (% of GDP) (6) personal remittances received (% of GDP) (7) exports of fuels, metals and ores (% of GDP). **Exposure and ability to respond to shocks**: (8) Basic balance – current account balance plus net FDI – (% of GDP) (9) debt (% of GDP) and debt distress risk (10) banking industry risk (BIR).

8 Samba Diop, Simplice Asongu and Joseph Nnanna, 'COVID-19 Economic Vulnerability and Resilience Indexes: Global Evidence,' *International Social Science Journal* 71, S1 (2020): 37–50.

9 UN Development Programme, 'COVID-19 and Human Development: Exploring global preparedness and vulnerability' (New York, April 29, 2020).

10 Emmanouil Davradakis, Ricardo Santos, Sanne Zwart and Barbara Marchitto, 'The EIB COVID-19 Economic Vulnerability Index – An analysis of countries outside the European Union' (European Investment Bank, 2020), https://library.oapen.org/handle/20.500.12657/43437.

Milorad Kovacevic and Admir Jahic (UNDP)	Vulnerability to Pandemics Dashboard (2020)[a]	**Population living below income poverty line**: (1) Population in multidimensional poverty (%) (2) population vulnerable to multidimensional poverty (%) (3) population living below income poverty line (PPP $1.90 a day, %) (4) population living below income poverty line (national poverty line, %) (5) working poor at PPP $3.20 a day (% of total employment) (6) social protection and labour programmes (% of population without any). **Immediate economic vulnerability**: (7) Remittances, inflows (% of GDP) (8) net official development assistance received (% of GNI) (9) inbound tourism expenditure (% of GDP).
Joel Cariolle (FERDI)	Economic Vulnerability Index (2011)[b]	**Exposure index**: (1) Population size (2) remoteness from world markets (3) export concentration (4) agriculture, forestry and fisheries (% of GDP). **Size and likelihood of shocks**: (5) Share of homeless people due to natural disasters (6) instability in agricultural production (7) instability in exports of goods and services.
UN Committee for Development Policy	Economic and Environmental Vulnerability index (2008)	**Economic vulnerability**: (1) Share of agriculture, forestry, and fisheries (% of GDP) (2) remoteness and landlockedness (3) merchandise export concentration (4) instability of exports of goods and services. **Environmental vulnerability**: (5) Share of population living in low-lying coastal zones (6) share of population living in drylands (7) instability of agricultural production (8) victim of disasters.
Luky Adrianto and Yoshiaki Matsuda	Economic Composite Index (2004)[c]	(1) Economic exposure (2) economic remoteness (3) economic impact of environmental and natural disasters.

Notes: FDI = Foreign direct investment, PPP = purchasing power parity, GDP = gross domestic product, GNI = gross national income

a Milorad Kovacevic and Admir Jahic, 'COVID-19 and human development: Exploring global preparedness and vulnerability' (April 29, 2020), https://hdr.undp.org/system/files/documents/covid-19andhumandevelopmentpdf.pdf.

b Joël Cariolle, 'The Economic Vulnerability Index - 2010 Update' (Working Paper 109, FERDI, March 1, 2011), https://ferdi.fr/en/publications/the-economic-vulnerability-index-2010-update.

c Luky Adrianto, L. and Yoshiaki Matsuda, 'Study on Assessing Economic Vulnerability of Small Island Regions,' *Environment, Development and Sustainability* 6 (2004): 317–36, https://doi.org/10.1023/B:ENVI.0000029902.39214.d0.

Source: Author's compilation

Most vulnerability indices induce macroeconomic disruptions, such as reduced trade and tapered economic growth. However, it is imperative to be cognisant of the fact that macroeconomic sources of fragility are only one dimension affecting the vulnerability of people in a given country. Beyond that, exclusion based on gender, low health coverage, lack of social protection of the poor and inadequate financial inclusion of the marginalised are also important dimensions, which should all be properly considered when measuring vulnerability. In this study, vulnerability was analysed through the lens of how different countries' socioeconomic attributes and policies exposed people to hardships during the pandemic. Hence, the index used for the purpose of the study not only drew on indices such as the Vulnerability to Pandemics Dashboard by Kovacevic

and Jahic and the COVID-19 Economic Vulnerability Index by Diop, Asongu and Nnanna; it also extended the scope of these indices by including five dimensions of vulnerability. A breakdown of how these dimensions and indicators used are arranged is provided in Table 2 and explained more fully below.

Macroeconomic dimension: COVID-19 affected people's socioeconomic welfare by impacting the overall macroeconomic performance of countries during the pandemic. The disruptions to trade, capital flows and commodity prices affected many aspects of the economy and had highly detrimental welfare effects on ordinary people. Hence, measuring socioeconomic vulnerability must take into consideration the channels through which such disruptions take place. Like most of the indices mentioned above, indicators of macroeconomic exposure form part of our index used in this study, including personal remittances and tourism receipts, which are susceptible to disruptions during pandemics like COVID-19 (and which signal a country's dependence on international financial flows), oil and natural resource rents (which signal a country's dependence on volatile commodities like oil and other natural resources), and imports as a share of GDP (which signal a country's dependence on imports of goods and services). In this regard, the pandemic affected the availability and cost of vital imports such as food, giving rise to food insecurity and other welfare challenges.

Healthcare coverage dimension: COVID-19 increased the need (as any pandemic would) for healthcare services and resources. In countries without adequate healthcare coverage, people may be required to incur out-of-pocket health expenditure to access the healthcare that they need, which further stretches their resources. The World Bank found that in developing countries, as many as 36% of people regard medical expenses as their biggest financial worry.[11] Good healthcare coverage also prevents loss of productivity due to sickness or extra (preventable) deaths. In our index, the healthcare coverage dimension is captured in five indicators: public health expenditure per capita, universal healthcare coverage (UHC), out-of-pocket expenditure as a share of health expenditure, percentage of debt incurred for health or medical purposes, and the youthfulness of the population (the latter reflecting the reduced health-related vulnerability in younger people).

Financial inclusion dimension: Economic vulnerability to any shock can be minimised through access to finance for consumption smoothing, business activities and other necessary expenses. The lockdowns imposed in many countries during the pandemic caused liquidity problems for many households and businesses. The World Bank found that in developing countries, work and social networks are the most common sources of emergency money, but they are not as reliable

11 Demirgüç-Kunt et al., 'The Global Findex Database 2021.'

as savings which is the main source of emergency funds in developed countries.[12] Furthermore, up to 14% of people in low-income countries are at risk of experiencing persistent hardship by resorting to selling assets to cover emergencies. This is much higher than the 2% of people in high-income countries who depend on asset sales. These facts highlight the importance of financial inclusion for minimising welfare vulnerabilities and increasing resilience to the pandemic. To capture the financial inclusion dimension in our index, four indicators are used: the percentage of the population with an account at a financial institution or a mobile-money service provider, the percentage of the poor who can save money, the share of people who can borrow from a formal financial institution, and the percentage of people who use digital payments.

Social protection dimension: People's ability to withstand the detrimental welfare effects of COVID-19 or any economic shock also depends on the country's ability to offer protection to its most vulnerable residents. Social protection programmes act as safety nets during times of crisis; indeed, many countries included such programmes in their COVID-19 recovery strategies. Social protection programmes help reduce socioeconomic vulnerabilities by providing income support, access to healthcare, food security and targeted assistance to vulnerable populations. These programmes play a vital role in ensuring that individuals and communities that lose their livelihoods can cope with the immediate challenges and recover more effectively in the long run. Four indicators are used in our index to capture the social protection dimension: the coverage provided by social protection programmes, government transfers to the poor, public-sector pension payments, and the rate of unemployment as an indicator of how much social protection may be needed in an economy.

Gender inclusivity dimension: The COVID-19 pandemic had gendered effects on economic vulnerability, with women disproportionately impacted in several ways. Women were heavily affected by job losses and income reductions during the pandemic as industries that predominantly employ women, such as retail, hospitality and personal services, experienced significant disruptions. The pandemic also reduced economic opportunities in the informal sector where women are mostly found, resulting in their further marginalisation and increased vulnerability to poverty. Another impact channel was the increased burden of unpaid care work (childcare, homeschooling and eldercare) which falls disproportionately on women. Given these challenges, it is not surprising that the World Bank found that women lagged behind their male counterparts in terms of resilience against the effects of the pandemic.[13]

With women constituting about half the world's population, the gendered impact channels contributing to socioeconomic vulnerability must be given proper consideration. For this

12 Demirgüç-Kunt et al., 'The Global Findex Database 2021.'

13 Demirgüç-Kunt et al., 'The Global Findex Database 2021.'

reason, our index deviates from other vulnerability indices by including a gender dimension and indicators capturing the vulnerabilities faced by women. These indicators are: female-vulnerable employment as a share of total female employment, the proportion of employed women engaged in informal employment, the female unemployment rate and the fertility rate. Fertility rate is included because of its negative association with women's wage employment,[14] which in turn increases the economic vulnerability of women.

Table 2 Index dimensions and indicators

Dimension	Indicator		Impact on socioeconomic vulnerability
Macro-economic dimension	ME1	Personal remittances received (% of GDP) – WDI	**Indicates increased socioeconomic vulnerability** due to over-dependence on remittances which decline during pandemics, thus reducing people's incomes.
	ME2	International tourism receipts (% of total exports) – WDI	**Indicates increased socioeconomic vulnerability** due to over-dependence on tourism, a sector that is highly exposed to the impact of lockdowns.
	ME3	Imports of goods and services (% of GDP) – WDI	**Indicates increased socioeconomic vulnerability** due to high dependency on imports of essential goods, whose access is constrained during pandemics.
	ME4	Oil rents (% of GDP) – WDI	**Indicates increased socioeconomic vulnerability**. Sharp drops in oil prices due to reduced demand compound economic challenges faced by oil-dependent countries.
	ME5	Total natural resource rents (% of GDP) – WDI	**Indicates increased socioeconomic vulnerability** due to high dependence on natural resource rents, such as oil, gas and coal, whose markets are volatile.
Healthcare coverage dimension	HC1	UHC service coverage index – WDI	**Indicates reduced socioeconomic vulnerability**. Faced with health-related shocks, good health coverage improves people's health and economic outcomes.
	HC2	Domestic general government health expenditure per capita (current $) – WDI	**Indicates reduced socioeconomic vulnerability** as the access to and quality of health services depend on public resources that are made available.
	HC3	Out-of-pocket expenditure (% of total health expenditure) – WDI	**Indicates reduced socioeconomic vulnerability** due to the negative financial effects on people paying for health services out of their pockets.
	HC4	Financing health/medical bills with debt (% of population aged 25+) – FINDEX	**Indicates reduced socioeconomic vulnerability** due to falling into debt to pay health or medical bills. It also shows low health coverage.
	HC5	Population aged 0–14 (% of total population) – WDI	**Indicates reduced socioeconomic vulnerability**. Pandemics like COVID-19 affect vulnerable groups such as the elderly, while the youth have higher immunity.

14 Julia Behrman and Pilar Gonalons-Pons, 'Women's employment and fertility in a global perspective (1960–2015),' *Demographic Research* 43 (September 3, 2020): 707–44, doi: 10.4054/demres.2020.43.25.

Financial inclusion dimension	FI1	Bank account ownership or mobile-money service (% of population aged 15+) – WDI	**Indicates reduced socioeconomic vulnerability** and higher resilience to economic shocks, as financially included people can better smooth their consumption patterns and save for 'rainy days'.
	FI2	Made/received digital payments (% of population aged 15+) – FINDEX	**Indicates reduced socioeconomic vulnerability** due to the ability to complete economic transactions even when faced with constrained movements.
	FI3	Saving rate (any money, income) among the poorest 40% (% aged 15+) – FINDEX	**Indicates reduced socioeconomic vulnerability**. A country with higher savings among the poor is less vulnerable than one with a low-savings poor population.
	FI4	Borrowed from a formal financial institution (% aged 15+) – FINDEX	**Indicates reduced socioeconomic vulnerability**. Like FI1, this is an indication of financial inclusion which can help with consumption smoothing.
Social protection dimension	SP1	Covered by at least one non-health social protection benefit (% of population) – ILOSTAT	**Indicates reduced socioeconomic vulnerability**, since vulnerable people can benefit from government social protection programmes.
	SP2	Receipt of government transfer (income) among the poorest 40% (% aged 15+) – FINDEX	**Indicates reduced socioeconomic vulnerability**, since people who are vulnerable due to poverty can benefit from government transfers.
	SP3	Receipt of a public-sector pension (% of population aged 15+) – FINDEX	**Indicates reduced socioeconomic vulnerability**, since elderly people (pensioners) can benefit from pension schemes.
	SP4	Unemployment rate (% of total labour force) (modelled ILO estimate) – ILOSTAT	**Indicates reduced socioeconomic vulnerability**. A high unemployment rate in a country means that there are more people in need of employment benefits.
Gender inclusivity dimension	GI1	Women in vulnerable employment (% of total female employment) – WDI	**Indicates reduced socioeconomic vulnerability**. Women working in small family businesses are more likely to fall into poverty during a shock like COVID-19.
	GI2	Women in informal employment (% of total female employment) – ILOSTAT	**Indicates reduced socioeconomic vulnerability**. As with vulnerable employment, women engaged in informal work are also likely to fall into poverty during shocks.
	GI3	Unemployment rate among women (% of total female labour force) – WDI	**Indicates reduced socioeconomic vulnerability** since high female unemployment rate shows a lack of female inclusion in economic activities.
	GI4	Fertility rate (births per woman – total female population) – WDI	**Indicates reduced socioeconomic vulnerability**. A high fertility rate is associated with lower-wage employment and therefore higher vulnerability of women.

Notes: WDI = World Development Indicators database, FINDEX = Global Findex database, ILOSTAT = Labour statistics database of the International Labour Organization (ILO)

Source: Author's compilation

Data normalisation and aggregation strategy

In the first step, the indicators are standardised to a scale of 0–1, using the min–max standardisation technique which is a popular technique for data normalisation.[15] Normalisation ensures that the impact of any variable on the final index is not affected by the scale with which the variable has been measured at the source.[16] Normalisation is also performed so that all indicators affect the composite index in the same direction, ie, higher values translate into higher vulnerability. To do this, the variables are divided into two categories. *Category 1* consists of variables that are positively related to vulnerability (those that translate into higher vulnerability). These include all indicators under the macroeconomic and gender inclusivity dimensions, the out-of-pocket and debt financing indicators under the healthcare coverage dimension, and the unemployment indicator under the social protection dimension. These variables are normalised using the formula:

$$x_{ik} = \frac{X_{ik} - min\,(X_i)}{max\,(X_i) - min\,(X_i)}$$

where x_{ik} is the standardised variable corresponding to X_{ik}, the i^{th} original variable for country k, and X_i is the set containing indicator i for all countries. $min(X_i)$ denotes the lowest value of X_i among the countries and $max(X_i)$ denotes the highest value of X_i. *Category 2* consists of variables that are associated with lowered vulnerability (ie, those not in *Category 1*). These are standardised as:

$$x_{ik} = \frac{max\,(X_i - X_{ik})}{max\,(X_i) - min\,(X_i)}$$

After data normalisation, the second stage concerns the derivation of weights for the composite index. Many popular indices such as the Economic and Environmental Vulnerability Index (EVI) and the Human Development Index (HDI) assign equal weights to the indicators.[17] The EIB COVID-19 Economic Vulnerability Index does the same for its dimensions. While this method is desirable for its simplicity, it becomes problematic if some of the indicators are correlated since those are 'double counted' and have an undue influence on the final index. Equal weighting also requires that all dimensions that are being measured by the index have an equal number of indicators. If some dimensions have more indicators, these will also have undue influence on the final index. For the index that we created, the Principal Component Analysis (PCA) method is used in lieu of the equal weighting approach.

The PCA is a statistical technique that identifies patterns in data and can be used to reduce the dimensionality of a dataset by transforming it into a new set of variables, called principal components (PCs). The PCs are linear combinations of the original data and capture the most

15 See Diop et al., 'COVID-19 Economic Vulnerability,' 40.

16 Jiawei Han, Micheline Kamber and Jian Pei, *Data Mining: Concepts and Techniques*, 3rd ed. (Waltham, Mass.: Morgan Kaufmann Publishers, 2012).

17 HDI is calculated as the equally weighted geometric mean of life expectancy, education and GNI per capita.

important information in that data while filtering out the inherent noise. With the PCA method, the contribution of each PC to the variability (variance) in the data can be discerned. This makes it possible to objectively assign weights to the variables in the original data, thus making the PCA an attractive tool for the construction of an index. The weights derived based on the PCA are not subject to the equal weighting problems stated above since, by making use of the correlation structure of data, the PCA corrects for overlapping information among correlated indicators and assigns each indicator or dimension its weight, taking into consideration its relationship with the other variables.

In this study, the procedure for deriving the weights followed the approach proposed by Huh and Park, which is summarised in Box 1 below.[18] In this procedure, the PCA was done on the normalised set of data serving as indicators in the sub-indices (the dimensions). The resultant PCs, Z_j, have their respective variances given by the corresponding eigenvalues, Z_j. The first PC, Z_1, explains the largest possible variation in the data, with the subsequent PCs explaining progressively lower variations in the data. Assuming J PCs are retained, the eigenvalues λ_j corresponding to the PCs are used to derive the proportions of the variance explained by each of the PCs. These proportions are constructed as $\theta_j = \lambda_j / \sum_{j=1}^{J} \lambda_j$. The final weights w_i for each indicator x_i are derived as:

$$w_i = \sum_{j=1}^{J} \theta_j \times p_{ij}^2$$

where p_{ij} are the correlation coefficients between the original variables, x_i and the PCs, Z_i, and are referred to as *loadings*. The weights for the overall index are also derived using the same PCA procedure using the sub-indices as the data.

BOX 1 TECHNIQUE FOR DERIVING WEIGHTS

Steps in deriving weights for the indicators

Step 1: Conduct PCA and get the PCs, eigenvalues and loadings.
Step 2: Select the PCs to be used using available criteria (the Kaiser criteria in this case).
Step 3: Square the loadings to get the proportion of variance in the variable explained by each PC.
Step 4: Generate a new parameter, θ, by dividing each eigenvalue by the sum of all eigenvalues of the selected PCs to get the proportions of the variance explained by each of the PCs.
Step 5: Calculate the weights as the sum of the products of θ and the squared loadings.

18 Hyeon-Seung Huh and Cyn-Young Park, 'Asia-Pacific Regional Integration Index: Construction, Interpretation, and Comparison' (Working Paper Series No. 511, ADB Economics, 2017), http://dx.doi.org/10.22617/WPS178772-2.

Results and analysis

The PCA yielded the results in Table 3 below. The decision on which PCs to retain was made based on the Kaiser criterion. The Kaiser criterion recommends that only those PCs with eigenvalues greater than 1 should be retained for use.[19] This is because if the eigenvalue is less than 1, the corresponding PC explains less variation in the data than the original variables, while those PCs with eigenvalues greater than 1 explain the variation better than the original variables. Using the procedure outlined in Box 1, the final weights for the dimensions and indicators were derived and are presented in Table 3. Here gender inclusivity was assigned the highest weight at 25.71%. This was closely followed by financial inclusion at 25.2% and social protection at 24.26%. The macroeconomic dimension was assigned the least weight at 10.48%, while healthcare coverage was assigned 14.36%.

Table 3 Dimension and indicator weights derived for the index

Dimensions and indicators		Weights
ME	**Macroeconomic dimension**	**0.1048**
ME1	Personal remittances received (% of GDP)	0.2016
ME2	International tourism receipts (% of total exports)	0.2141
ME3	Imports of goods and services (% of GDP)	0.0421
ME4	Oil rents (% of GDP)	0.2687
ME5	Total natural resource rents (% of GDP)	0.2735
HC	**Healthcare coverage dimension**	**0.1436**
HC1	UHC service coverage	0.3177
HC2	Domestic general government health expenditure per capita	0.0483
HC3	Out-of-pocket expenditure (% of total health expenditure)	0.0761
HC4	Financing health/medical bills with debt (% of population aged 25+)	0.2442
HC5	Population aged 0–14 (% of total population)	0.3137
FI	**Financial Inclusion dimension**	**0.2520**
FI1	Bank account or mobile-money service (% of population aged 15+)	0.3012
FI2	Made/received digital payments (% of population aged 15+)	0.1095
FI3	Saving rate among the poorest 40% (% aged 15+)	0.2497
FI4	Borrowed from a formal financial institution (% aged 15+)	0.3396
SP	**Social protection dimension**	**0.2426**
SP1	Covered by at least one social protection benefit (% of population)	0.2630
SP2	Receipt of government transfer among the poorest 40% (% aged 15+)	0.2154
SP3	Receipt of a public-sector pension (% of population aged 15+)	0.2321

19 Henry F Kaiser, 'The Application of Electronic Computers to Factor Analysis,' *Educational and Psychological Measurement* 20, no. 1 (1960): 141–51, https://doi.org/10.1177/001316446002000116.

SP4	Unemployment rate (% of total labour force)	0.2895
GI	**Gender inclusivity dimension**	**0.2571**
GI1	Women in vulnerable employment (% of total female employment)	0.1538
GI2	Women in informal employment (% of total female employment)	0.2756
G13	Unemployment rate among women (% of total female labour force)	0.3224
GI4	Fertility rate (births per woman – total female population)	0.2483

Source: Author's calculations

The pervasive gender inequality found in Africa and many other regions across the globe underpins the importance that the index attaches to gender-based vulnerability. In Africa, there is a significant bias against women in terms of economic and social empowerment as well as political representation in decision-making processes. The African Gender Index report of 2019 estimated that, overall, women in Africa are only 51.4% as equal as men, with significant gaps found in economic empowerment (only 38.3% as equal as men) and in decision-making representation (78.7% as equal as men).[20] In a region that experiences high vulnerability from other factors, such as low levels of social protection and financial inclusion, minimising gender-based vulnerability can improve the welfare of many women and their families. While the efforts made in the social sectors – health and education – have reduced the gender gap in these sectors, there are still significant gaps in the inclusion of women in economic activities and decision-making processes.

Ranking the vulnerability of countries

The derived index scores and vulnerability rankings for all 83 sampled countries are presented in Table 4 and visualised in Figure 1. The scores ranged from 0.1 for the least vulnerable country in the sample (Norway) to 0.688 for the most vulnerable country (Iraq). The average and median scores were 0.421 and 0.461, respectively. As expected, low-income countries exhibited higher levels of vulnerability compared to higher-income countries. This is evident in Figure 1 where vulnerability is concentrated in Africa and the less-developed regions. This phenomenon is further depicted in Figure 2 which shows a negative relationship between the vulnerability scores and per capita income in those countries. One notable outlier is Iraq which has the highest vulnerability of all the sampled countries, despite having a relatively higher income. This is because of its high macroeconomic vulnerability and very low levels of financial, health and gender inclusion. Norway, in contrast, leads in four of the five dimensions (health, financial inclusion, social protection and gender inclusion); hence, its very low ranking in terms of overall vulnerability.

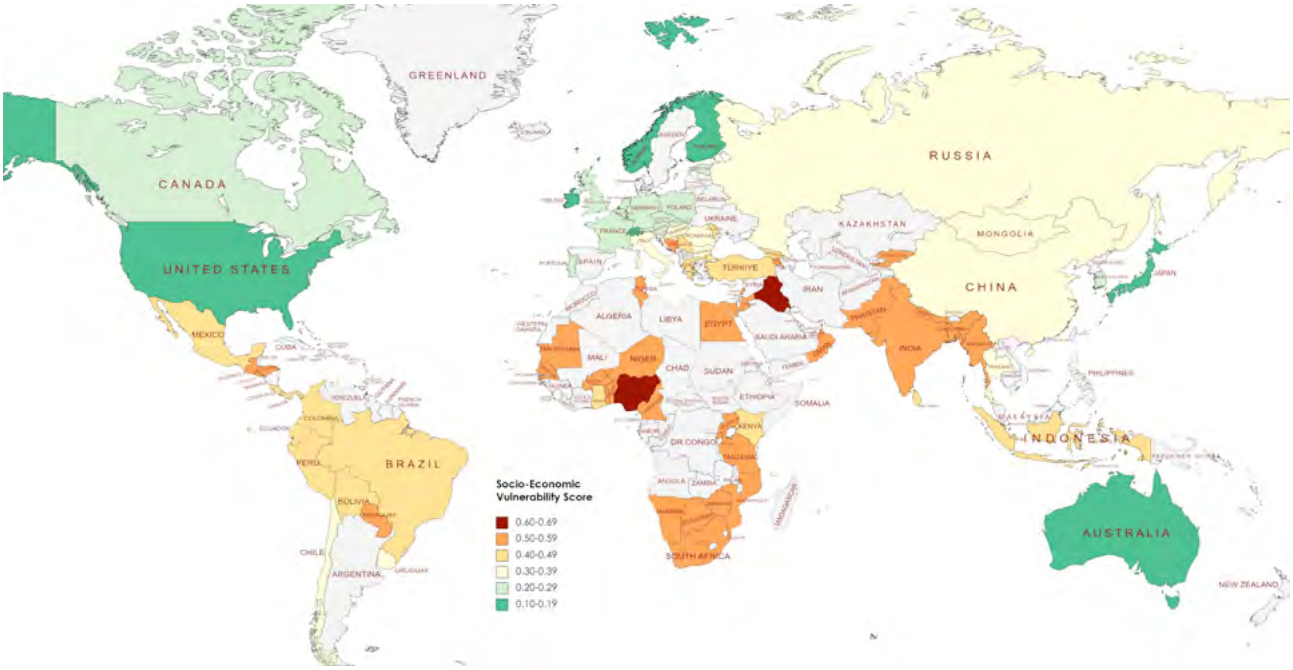
20 AfDB and UNECA, 'Africa Gender Index Report 2019' (African Development Bank, March 2020).

Table 4 Socioeconomic vulnerability rankings (most vulnerable to least vulnerable)

Country	Score	Rank	Country	Score	Rank	Country	Score	Rank	Country	Score	Rank
Iraq	0.688	1	Armenia	0.542	22	Mexico	0.461	43	Poland	0.285	64
Nigeria	0.610	2	Myanmar	0.539	23	Sri Lanka	0.452	44	Slovakia	0.277	65
Niger	0.592	3	Senegal	0.536	24	Greece	0.444	45	France	0.277	66
Pakistan	0.591	4	Zimbabwe	0.534	25	Panama	0.443	46	Czechia	0.260	67
Mauritania	0.590	5	Bosnia	0.532	26	Turkey	0.432	47	UK	0.249	68
Egypt	0.587	6	India	0.529	27	Brazil	0.431	48	Netherlands	0.226	69
Jordan	0.581	7	Paraguay	0.527	28	Georgia	0.426	49	Germany	0.225	70
Togo	0.581	8	Guatemala	0.525	29	Costa Rica	0.420	50	Estonia	0.221	71
Botswana	0.580	9	El Salvador	0.524	30	China	0.393	51	South Korea	0.214	72
Cameroon	0.577	10	Namibia	0.522	31	Romania	0.377	52	Belgium	0.212	73
Mozambique	0.576	11	Rwanda	0.517	32	Bulgaria	0.365	53	Austria	0.210	74
Bangladesh	0.574	12	South Africa	0.509	33	Russia	0.364	54	Canada	0.209	75
Nepal	0.572	13	Colombia	0.498	34	Mongolia	0.363	55	USA	0.199	76
Tanzania	0.570	14	Ecuador	0.492	35	Croatia	0.345	56	Switzerland	0.196	77
Tunisia	0.557	15	Peru	0.486	36	Chile	0.345	57	Ireland	0.185	78
Burkina Faso	0.556	16	Ghana	0.484	37	Uruguay	0.327	58	Luxembourg	0.175	79
Lebanon	0.552	17	Indonesia	0.474	38	Thailand	0.326	59	Japan	0.173	80
Honduras	0.552	18	Serbia	0.474	39	Cyprus	0.323	60	Finland	0.155	81
Uganda	0.549	19	Kenya	0.471	40	Hungary	0.318	61	Australia	0.151	82
Benin	0.547	20	Bolivia	0.465	41	Italy	0.301	62	Norway	0.100	83
Kyrgyz R.	0.543	21	Moldova	0.463	42	Portugal	0.292	63			

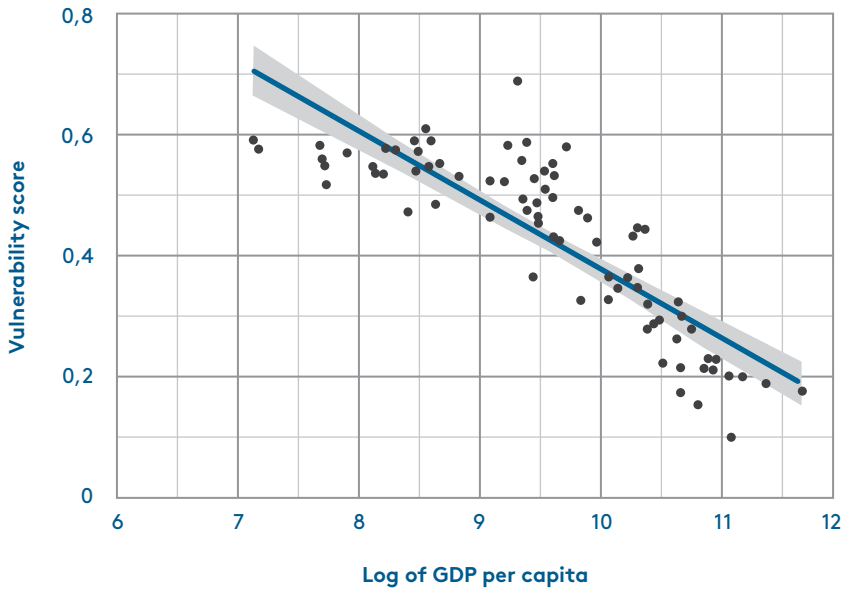
Source: Author's compilation

Figure 1 Vulnerability map



Source: Author's compilation

Figure 2 Relationship between vulnerability and income

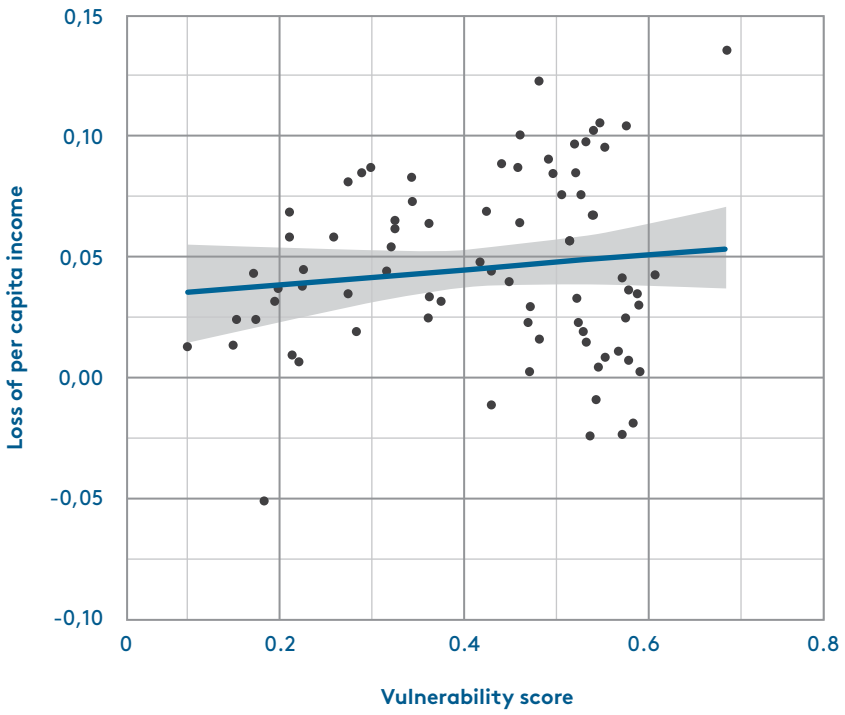


Sources: Author's compilation

Testing the index: vulnerability and welfare outcomes during the pandemic

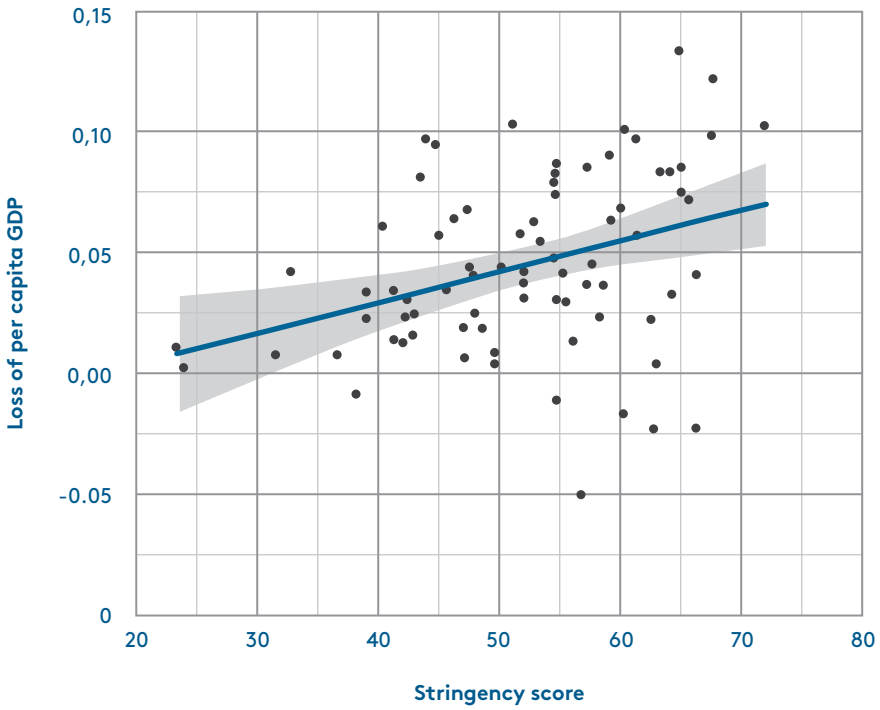
One way of testing the usefulness of the index is to analyse its ability to predict the welfare outcomes of the pandemic, which we did in this study. Specifically, we examined the relationship between the vulnerability index scores and changes in per capita incomes during the pandemic to see if the income losses could be predicted by the index. The analysis took into consideration the containment measures implemented by the various countries and the differences in their income levels. The expectation was that countries that have high vulnerability scores should experience higher losses of per capita income. Therefore, considering that most countries (74 of the 80 sampled countries) experienced losses in average incomes (ie, negative growth rates), these should be positively correlated to vulnerability, as shown in Figure 3. The same applied to countries that implemented more stringent containment measures, such as longer and stricter lockdowns (Figure 4).

Figure 3 Socioeconomic vulnerability and per capita income losses



Sources: Author's compilation

Figure 4 Stringency of COVID-19 containment measures and per capita incomes losses



Sources: Author's compilation

To establish the magnitude of the impact of vulnerability on income losses, a regression analysis was conducted in which the following model was estimated:

$$ypcg20_i = \beta_0 + \beta_1 sevi_i + \beta_2 string_i + \beta_3 ypc_{0i} + \mu_i$$

where $ypcg20_i$ was the percentage change in per capita income for country i in 2020 and was sourced from the WDI; $sevi_i$ was the socioeconomic vulnerability index score for country i, $string_i$ was the stringency of COVID-19 containment measures implemented in country i in 2020 and was sourced as the 2020 annual average of the COVID-19 Stringency Index compiled by Our World in Data;[21] and ypc_{0i} was the initial average income level represented by the 2017 PPP-adjusted per capita GDP figures from the World Bank. For the reasons explained above, both β_1 and β_2 were expected to be negative. Similarly, β_3 was expected to be negative since the income losses in percentage terms were expected to be higher in poorer countries, although the absolute losses should be higher in richer countries.

21 Mathieu et al., 'Coronavirus Pandemic (COVID-19)' (OurWorldInData.org), https://ourworldindata.org/coronavirus.

The results of the regression analysis are shown in Table 5 where a negative and statistically significant relationship between *sevi* and *ypcg*20 was established. This implies that high vulnerability scores were associated with more drastic income losses at the peak of the pandemic in 2020. This provides support to our index as a measure of the economic vulnerability experienced by the average person in a country. The results also showed a negative relationship between $string_i$ and $ypcg20_i$ which implies that the more stringent a country's COVID-19 containment measures, the more drastic was the drop in per capita income. This was also to be expected. Lastly, the negative relationship expected between ypc_0 and *ypcg*20 was also confirmed, thus showing that people in poorer countries experienced a higher percentage decline in per capita incomes – thereby exacerbating inequality.

Table 5 Income and welfare effects of vulnerability

Dependent var: $ypcg_{20}$ (mean = -4.9%)			
	Estimate	Std. error	Pr(>|t|)
vulnerability	- 18.28 ***	6.34	0.005
stringency	- 4.65**	2.21	0.039
log(gdppc$_{17}$)	- 2.4***	0.84	0.005
intercept	44.29***	10.74	0.000

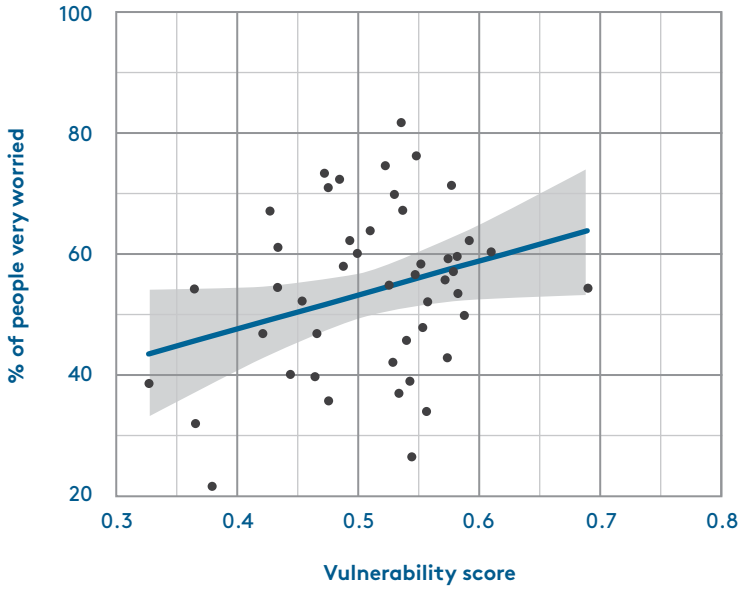
Significance codes: '***' at 1%; '**' at 5%; '*' at 10%

Source: Author's compilation

Beyond the changes in per capita GDP, the index was also able to capture the expected association between vulnerability and financial hardship experienced during the pandemic. The 2021 World Bank FINDEX database contained survey data on how worried people in different countries were about the financial hardship they experienced during the pandemic.[22] This data was plotted against the vulnerability scores and a positive association was established between vulnerability and the worry induced by the financial hardship caused by the pandemic (Figure 5). Furthermore, a negative association was also established between vulnerability and the proportion of people not worried about financial hardship caused by the pandemic (Figure 6).

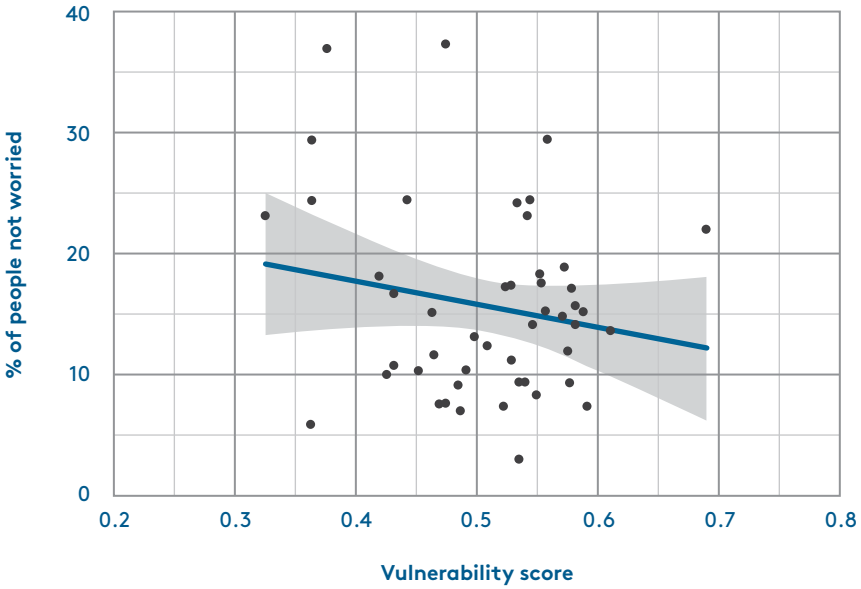
22 Demirgüç-Kunt et al., 'The Global Findex Database 2021.'

Figure 5 Vulnerability and financial hardship due to COVID-19 (% of people worried)



Sources: Author's compilation

Figure 6 Vulnerability and financial hardship due to COVID-19 (% of people not worried)

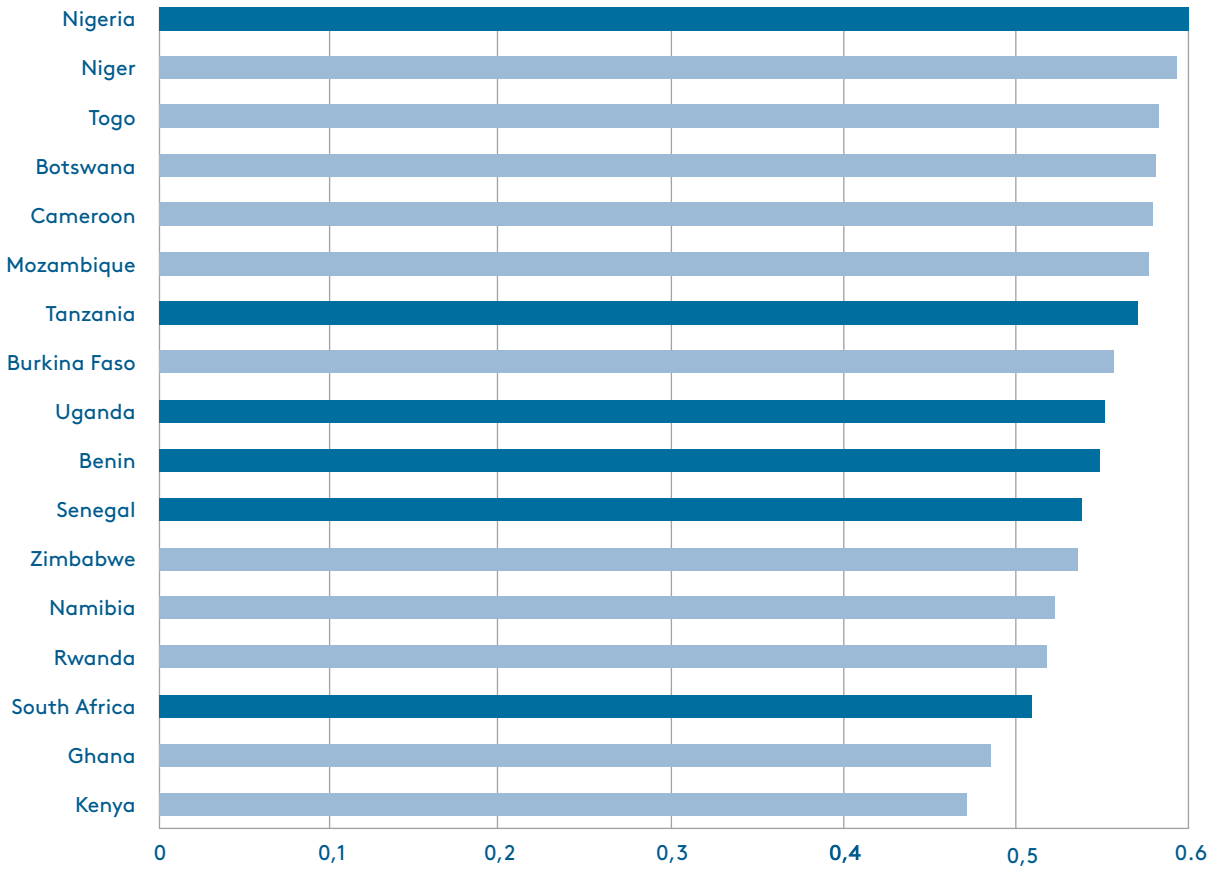


Sources: Author's compilation

Six case studies: vulnerability and the role of gender equality

The correlation between per capita income and vulnerability suggests that most countries in Africa are highly exposed to the adverse socioeconomic effects of the pandemic. Countries in sub-Saharan Africa scored an average of 0.548 on the index compared to 0.394 for the rest of the countries. Understanding the socioeconomic factors responsible for the region's high level of vulnerability is crucial for enhancing countries' preparedness for and resilience to future shocks. The vulnerability scores for the 17 sub-Saharan African countries making up the sample are shown in Figure 7. None of these countries scored below the 'world average' of 0.426. The least vulnerable country was Kenya with a score of 0.471.

Figure 7 Vulnerability of African countries



Sources: Author's compilation

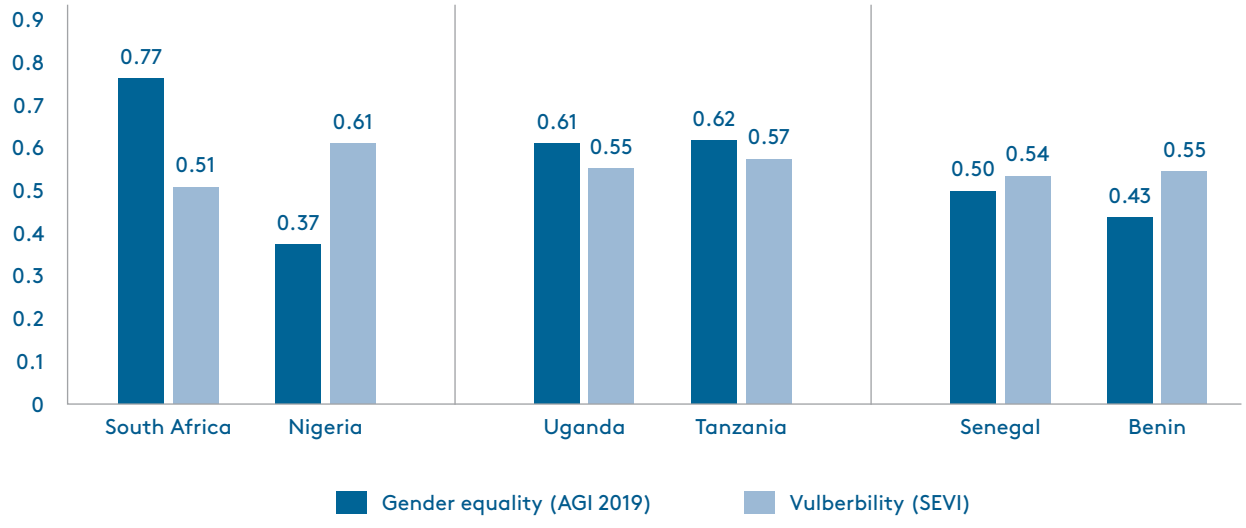
To further appreciate Africa's socioeconomic vulnerability to the pandemic, we delved more deeply into the factors driving vulnerability in selected economies on the continent, with a specific focus on gender as a major driver of vulnerability. The six countries in question were South Africa, Nigeria, Tanzania, Uganda, Senegal and Benin (highlighted in Figure 7) which were divided into pairs based on the relative sizes of these individual economies and average incomes (see Table 6) for better comparisons of the link between income and vulnerability. Thus, South Africa was compared to Nigeria, Senegal to Benin, and Tanzania to its neighbour, Uganda.

Table 6 Income statuses of the six countries

	GDP (constant 2015 billion $)	GDP per capita (constant 2015 $)
South Africa	360.5	6 019
Nigeria	535.3	2 450
Senegal	25.4	1 465
Benin	16.8	1 256
Tanzania	67.1	1 057
Uganda	44.2	935

Source: Author's compilation

Figure 8 Gender and vulnerability in selected countries



Source: Author's compilation

Figure 8 plots vulnerability scores developed in this study for the three country pairs against the gender equality scores, as reflected in the 2019 African Gender Index. South Africa and Nigeria are the least and most vulnerable countries of the six. Nigeria has higher socioeconomic vulnerability, despite having a significantly higher average income than Senegal, Benin, Tanzania and Uganda. Interestingly, South Africa scores highest on gender equality, while Nigeria scores lowest. The same dynamics are observed between Senegal and Benin, with the former exhibiting slightly lower vulnerability and higher gender equality than the latter. Tanzania and Uganda – two countries that are virtually tied in terms of gender equality – are also similar in their vulnerability scores, although the former has a higher score despite being slightly less gender-equal.

Conclusion

The index developed in this study can be used to assess the socioeconomic vulnerability of countries to future COVID-19 outbreaks or other pandemics that may cause similar social and economic fallouts. It will then become an additional tool to similar ones discussed in the literature which are used to detect the likely socioeconomic impact of pandemics in different countries. By including multiple dimensions of socioeconomic vulnerability, our index captures a wider range of factors determining people's socioeconomic welfare during pandemics. It also directs policymakers to areas that ought to be addressed to ensure that vulnerable populations and individuals become more resilient.

One of the main policy implications of the study is the need to view gender inclusion as a major area for policy intervention to minimise socioeconomic vulnerability to pandemics. This is highlighted by the weight given to the gender inclusivity dimension in the index. Policymakers in countries like Nigeria must facilitate greater inclusion of women in economic activities while pursuing overall gender equality. Another policy implication is the need for sustainable approaches to expanding social protection programmes and financial inclusion of the poor with a view to minimising the adverse socioeconomic welfare effects of pandemics.

The study also points to the need for policymakers to consider socioeconomic vulnerability when designing containment measures for pandemics. The 'one-size-fits-all' approach that was adopted at the peak of COVID-19, when countries at different levels of socioeconomic development adopted similar containment measures, may have exacerbated the socioeconomic circumstances of vulnerable countries. Therefore, policymakers should design pandemic responses that fit their domestic situations and make sure that socioeconomic vulnerability is taken into account.

Finally, there is a need for more stringent and comprehensive data gathering, especially for African countries, to enable the proper assessment of socioeconomic vulnerability.

Author

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Cover image: Roadside vendor selling peanuts (poco_bw/via GettyImages)

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