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Abstract

In this paper, we develop a new index labelled the African Women Vulnerability index (AWVI) with a focus on rural women using the Round 7 Afrobarometer Survey. The AWVI comprises 59 indicators in six dimensions namely: safety, empowerment, health, education, economic prosperity and digitalisation. Our findings show that: (i) Botswana performs best while women in Guinea and Sudan are the most vulnerable. Indeed, Mauritius appears as a good example in some dimensions such as health and digitalisation. (ii) Except for the dimension digitalisation, rural women's vulnerabilities in other dimensions are very close to those at the national level. (iii) National vulnerability trends strongly explain rural women's vulnerability especially for the economic, empowerment and health dimensions.

Keywords: Index creation, gender, rural analysis, Africa

JEL Codes: C43, O18, O55.

1. Introduction

The question of gender has been extensively investigated in the existing literature. The main orientation in Africa is gender inequality. While women and men are born with the same rights to safety as well as access to social, health and education services, the reality shows that inequalities in access to the underlying services are still very apparent (ILO, 2011; African Union Commission, 2015). This reality is widely apparent in the context of Africa. The debate relative to gender has resurfaced for many reasons.

First, Goal 5 of the United Nations 2030 project for sustainable development is oriented towards the achievement of the objective of gender equality and empowerment: *“Target 5.5: Ensure women’s full and effective participation and equal opportunities for leadership at all levels of decision making in political, economic and public life”* (SDSN, 2021). Moreover, Agenda 2063 of the African Union (AU) allocates an important weight to equality between women and men in order to attain sustainable development (*“Africa of 2063 will have full gender parity, with women occupying at least 50% of elected public offices at all levels and half of managerial positions in the public and the private sectors. The economic and political glass ceiling that restricted women’s progress will have been shattered”* (African Union Commission, 2015, p. 9).

Secondly, the literature on gender has shown that promoting gender equality and women economic empowerment will positively affect global economic activity (Abney & Laya, 2018; Asongu & Odhiambo, 2020a). Hence, according to ILO (2011), reducing the gender gap in employment would generate an additional US\$1.6 trillion in output. Regarding sub-Saharan Africa, the gender gap reduction leads to a 0.2% increase in gross domestic product (GDP) growth. Reducing the gap in labour force participation rates between women and men by 25% by the year 2025 could raise GDP by 3.9% or US\$5.8 trillion. ActionAid International (2015) estimates that if gender gaps in employment and wages were closed, African women could gain an additional US\$0.7 trillion.

To date and to the best of our knowledge, the literature on women’s vulnerability and especially in African countries is very sparse. The existing studies are globally oriented towards gender inequality (Gender Inequality Index(GII) of the UNDP, the World Economic Forum’s Global Gender Gap Index, among others). Currently an African Gender Index (AGI) is jointly developed by African Development Bank Group and the United Nation Economic Commission for Africa (Africa Gender, 2020). The objective of this index is to calculate the

inequality between women and men. The AGI is composed of three dimensions (economic, social and empowerment). The index we develop in this paper differs from the existing indexes in different ways. Firstly, it is constructed by proportion from individual level data of the Afrobarometer survey in 34 African countries. Secondly, the index evaluates vulnerability contrarily to other indexes of inequality. This approach allows us to assess the exposure of women as opposed to inequality. Finally, to extend the existing literature, we are interested specifically in the vulnerability of rural women. This strategy is justified by the fact that women's vulnerability depends on place and context. Also, rural women play an important role in productivity and food security. For instance, according to FAO (2011), if female farmers were given the same access to resources as men, their agricultural production could rise by 20% to 30%, the national agriculture yields could increase by 2.5% to 4% while the number of hungry people could be reduced by 12% to 17%. However, rural women have less access to land control than rural men (Doss et al., 2013; Aguilar et al., 2014; Hallward et al., 2013).

The objectives of the paper are threshold. First, we construct an index to rank African countries in terms of women's vulnerability with respect to different dimensions such as safety, empowerment, health, education, economic prosperity and digitalisation. Second, specific emphasis is placed on the vulnerability of rural women. Finally, we examine whether, the national vulnerability of women reflects the vulnerability of rural women. In other words, the third objective allows us to evaluate whether compared to urban women, more efforts should be placed in promoting rural women in order to improve their socio-economic conditions.

The positioning of the above study departs from contemporary African-centric gender inclusive literature that has largely focused on, *inter alia*, nexuses between access to finance, mobile money, gender inclusion and social networks (Kairiza et al., 2017; Mannah-Blankson, 2018; Asongu & Odhiambo, 2018; Efobi et al., 2018; Bayraktar & Fofack, 2018; Bongomin et al., 2018); the importance of gender inclusion in rural zones, especially by leveraging on technology-driven agricultural programmes to bridge the rural-urban gap (Uduji & Okolo-Obasi, 2010; Uduji et al., 2020, 2021); the need to involve more women in science education (Elu, 2018); gender inclusion in promoting agricultural development that is sustainable (Theriault et al., 2017; Ofori et al. 2021); the political implication of women in industrialisation (Nchofoung et al., 2021) and inequality thresholds that should not be

exceeded in order for female economic participation to be positively impacted by good governance (Asongu & Odhiambo, 2020b).

The remainder of the paper is structured as follows. Section 2 provides the methodology for the construction of the index. Section 3 discusses the results while Section 4 checks the robustness of the results. Section 5 concludes.

2. The African Women Vulnerability Index (AWVI) construction

The different steps for constructing the AWVI are presented in this section. We first provide a theoretical framework which allows us to justify the selection variables and constitution of the dataset. Secondly, we present the method of normalization and finally the technique for weighting and aggregation.

2.1. Theoretical framework and data presentation

According to a handbook on constructing composite indicators, justification of the theoretical framework, definition of dimensions and selection of variables are the most important and problematic steps (OECD & Joint Research Centre, 2008). For Park and Claveria (2018), the theoretical framework represents the starting point of the composite indicator we need. In this study, the underpinnings of gender inequality and vulnerability discussed in the introduction constitute the theoretical foundation. We identify different vulnerabilities that African women face every day. Hence, we attempt to describe the vulnerabilities across different dimensions. To this end, we employ the dataset of the Afrobarometer. More precisely, we employ Round 7 surveys of the dataset which includes 45823 interviews completed in 34 countries between September 2016 and September 2018. It is worthwhile to note that the survey is handled in a comparative series of public attitude. It evaluates the attitude of citizens towards aspects such as democracy and governance, civil society and markets, *inter alia*. The Afrobarometer is a joined enterprise of the Institute for Justice and Reconciliation in South Africa (IJR), the Institute for Development Studies (IDS) at the University of Nairobi (Kenya), the Centre for Democratic Development (CDD-Ghana), and the Institute for Empirical Research and Political Economy (IREEP) in Benin. Additional technical support is provided to the program by the University of Cape Town and the Michigan State University.

We can justify the choice of the Round 7 dataset survey on many fronts. Firstly, a special module on gender equality is carried out in the dataset, thus allowing us to directly detect

responses about vulnerabilities. Secondly, the vulnerability of women could be appreciated as a personal status, and such information cannot easily be captured by secondary or macro level data. Fortunately, the Afrobarometer conducts face-to-face interviews in the language proposed by the respondent. Finally, it is a comprehensive survey covering most of African countries and freely available. Table 1 presents the sample characteristics. It appears there is equilibrium between males and females while the sample is dominated slightly by the rural population.

In Table 2, we describe the chosen indicators and their labels in order to understand the reference responses. The African Women Vulnerability Index (AWVI) has six dimensions (safety, empowerment, health, education, economic prosperity and digitalisation). The safety dimension assesses how women are vulnerable about their treatment both physically and psychologically. Seventeen indicators are included in this dimension. The empowerment dimension measures how African women are independent in their actions and whether they participate in society's decision-making process. Eleven indicators are in this dimension. For the health dimension, we have ten variables corresponding to the evaluation of women's social and health status. The education dimension assesses how women face problems of school services access and inequality in accessing educational opportunities. Six variables are included in this dimension. Regarding the economic dimension, seven indicators are selected. Within this dimension, we attempt to evaluate African women's vulnerabilities in the labour market, income and economic well-being. Finally, the digitalisation dimension (consisting of eight indicators) measures the level access to new technologies such as internet and bank services.

To construct our AWVI, we are only interested in women's responses to the interviews. The data are constituted by the proportion of women who favourably respond to the different questions. As is apparent in Table 2 on data description, we take the favourable response as the reference. So, all the data have a negative impact on vulnerability exposure. For example, regarding the question "Q89e. Own bank account", a value of 0.3 indicates that 30% of women have their own bank accounts. Hence, the higher the value of the indicator, the better the country's performance.

2.2. Data normalisation

There is a vast literature on data normalization methods among which we can mention Min-Max, ranking, Z-score, SoftMax, distance to a reference, *inter alia* (OECD & Joint Research Centre, 2008; Ebert & Welsch, 2004). Each of these methods has its advantages and disadvantages but the results obtained are usually close, *ceteris paribus*. In this study, we use the well-known min-max method which is one of the most famous ways to normalize data (Diop & Asongu, 2020). It provides value scaled into the range [0,1] where the minimum index and the maximum index are 0 to 1, respectively. One of the drawbacks of the method is that the presence of outliers could bias the results. Since we use proportions and therefore the same data measurement units, the probability that this event occurs is weak. The min-max transformation is given as follows:

$$I_{qc} = \frac{x_{qc} - \min_c(x_q)}{\max_c(x_q) - \min_c(x_q)}$$

Where x_{qc} is the value of indicator q for country c . The minimum and the maximum values for each indicator are calculated across different countries. 34 of the 54 African countries are sampled for the period 2016 to 2018 because of data availability constraints at the time of the study. The data are from the latest round of the Afrobarometer Survey named Round 7-2016/2018. Accordingly, the focus is exclusively on 34 African countries because the Afrobarometer Round 7 survey from which indicators are borrowed, are individual interviews in 34 countries. Data are collected for both opinions and perceptions of individuals around land-related issues including women's land rights. The sampled countries are disclosed in Table 6 of the Appendix.

2.3. Weighting and aggregating

In the existing literature on gender inequality and vulnerability, most of the studies previously discussed have used classical methods such as arithmetic or geometric means (Africa Gender, 2020). These methods of weighting and aggregating are criticized in statistical tools for index creation. Accordingly, they are sensitive to extreme values and mainly are robust only if all values are equally important. In our paper, we use a multivariate data analysis technique for data aggregation. More specifically, we employ the principal component analysis (PCA) which best works mostly when the variables are not equally important (Tchamyou, 2017, 2020). It is used with the objective to reduce the number of variables by elucidating the observed variance of data via the linear relation of the original data. Loadings obtained from

the PCA are used to compute the different weights instead of giving the same weight to all variables as it is with the arithmetic or geometric methods (Tchamyou et al., 2019). In the first step, we run the PCA on the variables in each of the six dimensions as presented in the tables in order to derive alternative weights. Once the weights are obtained, we again employ the PCA to the six sub-indexes that are weighted to compile the AWVI.

3. Results and discussion

Before interpreting the vulnerability scores, we first evaluate the results of the PCA for the selection of the number of component factors in order to determine the different weights. We use the Kaiser criterion which drops all factors with eigenvalues below 1 (Asongu & Tchamyou, 2019; Diop et al., 2021; Diop & Asongu, 2020). The results of the PCA, loadings and weights are presented in Table 3 and Table 4 for vulnerability at the national level and the rural population, respectively. For national and rural women vulnerabilities, we note different weights for all indicators mostly for the empowerment dimension and the composite index. This result confirms that classical methods of weighting and aggregating (arithmetic, geometric and harmonic means) are not robust in the construction of indexes in this field.

Table 5 presents the descriptive statistics of the indexes and their sub-dimensions. For vulnerability at the national level, the composite index ranges from 0.273 to 0.848 with a mean of 0.503. On average, the best score is obtained from the empowerment dimension (0.508) while the poorest performance is noted on health dimension. The most volatile dimension is digitalisation where the value ranges from 0.069 to 0.986. Regarding the rural RWVI, the composite index is apparent in the scale of 0.146 to 0.787, with a mean of 0.455 indicating that the performance decreases by 4.8 points in the rural population compared to the National Women Vulnerability Index(NWVI). We also note the poorest performance of the digitalisation vulnerability (0.355) which is characterised by a high spread (0.220 to 0.998). On average, with the exception of digitalisation for which vulnerability decreases by 10 points compared to the NWVI, there is no significant difference between the two composite indexes.

3.1. National Women Vulnerability Index (NWVI)

Now we are interested in the vulnerability at the national level and its ranking for all countries. The results are presented in Table 6. The index scores are scaled from 0 to 1 and the closer the value is to 0, the poorer is the performance and vice versa. Since we have 34

countries, the ranking is from 1 (best country's performance) to 34 (worst country's performance). The NWVI reveals Botswana as the country where women are least vulnerable. Botswana earns a score of 0.848 and also ranks 1st in terms of safety (0.650) and education (0.688), 2nd (0.668) and 3rd in health and empowerment, respectively. It is worthwhile to note that in the economic dimension, this country takes the modest 11th place with a score of 0.485. Botswana is followed by Namibia (2nd), Gambia (3rd), Ghana (4th) and Mauritius (5th). Another key fact is that Mauritius ranks first in two dimensions (health (0.703) and digitalisation (0.986)). Sudanese women are the most vulnerable (0.273) even if the country performs well in digitalisation (8th).

3.2. Rural Women Vulnerability Index (RWVI)

Table 7 presents the index scores only for the population of rural women. Once more, Botswana has the best score for the composite index (0.787). Namibia always keeps the 2nd place with a score of 0.730. Mauritius takes the 3rd place from Gambia which is now ranked 10th. Ghana continues to maintain the same rank (4th) as for the NWVI. Rural women in Guinea are the most vulnerable in Africa behind Morocco and Sudan, respectively. For the economic dimension, Ghana performs best (0.736) while Mauritius ranks best for health (0.717) and digitalisation (0.998). For education, Sao Tome and Principe is the top performer with a score of 0.613.

3.3. Comparative analysis between NWVI and RWVI

After having evaluated the NWVI and the RWVI, we can now focus our analysis on the comparison between the two indexes already created. It is apparent from the descriptive statistics that on average, when the two composite indexes are considered, at the national level, the score is 0.503 while it corresponds to 0.455 in the rural context, corresponding to a decrease of 4.8 points. However, the digitalisation dimension decreases substantially. In effect, digitalisation vulnerabilities decrease by 10 points (0.455 in the national index and 0.355 regarding the rural index). For a better view of the relationship between the indexes, a graph is used for illustration. Graph 1 confirms the strong relationships between the two indexes and their sub-dimensions. It appears that the national trend of women's vulnerabilities strongly explains rural women's vulnerabilities especially for the economic, empowerment and health dimensions.

4. Robustness checks

For robustness checks and sensitivity analysis, we make two changes. We first consider an alternative method for normalization. In place of Min-Max approach, a SoftMax method is employed. Secondly, we replace the PCA for weighting and aggregating by a geometric mean of aggregation. This method is used for the African Gender index (Africa Gender, 2020). The results are presented in Table 8. The findings show that the indexes have not changed much on average, indicating that the results are robust to the use of alternative methods of normalization, weighting and aggregating.

5. Conclusion and future research directions

In this paper, we have created women's vulnerability index in African countries. Departing from the existing indexes (AGI, GII, *inter alia*), we have used data from the Afrobarometer Round 7 surveys where indicators are individual interviews in 34 countries. This option has the advantage to take into account personal status on women's vulnerabilities. In a second step, we have focused our interest on rural women by creating a rural women vulnerability index (RWVI).

The results can be summarized as follows. Firstly, both for national and rural indexes, Botswana is the best ranked. It is followed by countries such as Namibia, Mauritius and Ghana. Indeed, Mauritius ranks first in the health and digitalisation dimensions. Secondly, on average, with the exception of the digitalisation dimension where there is a significant difference in the scores between national and rural vulnerability indexes, rural women's vulnerabilities in other dimensions are very close to those at the national level. Finally, the findings show that the national trend of women's vulnerabilities strongly explains rural women's vulnerability especially for the economic, empowerment and health dimensions.

The established findings in this study obviously leave room for future research especially as it pertains to employing the indexes to assess how they influence other macroeconomic factors or are influenced by other macroeconomic factors. In these suggested directions, it is worthwhile to focus on issues surrounding sustainable development goals (SDGs).

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Appendices

Table 1: Sample characteristics

		Weighted	Unweighted
Gender	Male	49.90%	49.90%
	Female	50.00%	50.10%
	Missing	0.00%	0.00%
Location	Urban	42.80%	43.30%
	Rural	55.50%	55.20%
	Semi-urban	1.60%	1.40%
	Peri-urban	0.10%	0.10%

Source: Authors’ calculation on data from Round 7 Afrobarometer Survey

Table 2: Dimensions and indicators presentation

	Indicators	Labels
Safety	Q86a. Experienced discrimination based on gender	0=Never
	Q78b. Justified for men to beat their wives	1=Never justified
	Q66. Difficulty to move across borders	4=Very easy
	Q60d. Feared violence by extremists	0=No, never,
	Q60a. Feared violence in neighbourhood	0=No, never
	Q57g. Better or worse: equal opportunities and treatment for women	4=Better
	Q57b. Better or worse: personal safety	4=Better
	Q56q. Handling promoting equal rights/opportunities for women	4=Very well
	Q51. Treatment by public officials compared to others	3=Better
	Q50. Respected by public officials	3=A lot
	Q49p. Difficulty to obtain police assistance	1=Very easy
	Q43g. Trust police	3=A lot
	Q40. How much fear political intimidation or violence	3=Not at all
	Q14. Freedom to say what you think	4=Completely free
	Q11b. Have been physically attacked	0=No
	Q11a. Had something stolen from your house	0=No
	Q10a. How often felt unsafe walking in neighbourhood	0=Never
Empowerment	Q77d. Women and men have equal chance to own/inherit land	1=Strongly
	Q95c. Who decides how money is used	1=You make the decisions yourself
	Q38f. Better if woman takes care of household	5=Strongly agree
	Q38e. Women have equal right to land	5=Strongly agree
	Q38d. Men have more right to job	1=Strongly disagree
	Q20b. Member of voluntary association or community group	2=Active member
	Q19b. Better or worse: freedom to join political organizations	5=Much more freedom
	Q19a. Better or worse: freedom to say what you think	5=Much more freedom
	Q18b. Access to information: land ownership	3=Very likely
	Q16. Men only as leaders vs. women leaders	4=Agree very strongly with Statement 2*
Health	Q9. How dependent on receiving remittances	0=Not at all
	Q92b. Location of toilet or latrine	1=Inside the house
	Q57a. Better or worse: access to medical care	4=Better
	Q56j. Handling ensuring enough to eat	4=Very well
	Q56i. Handling providing water and sanitation services	4=Very well
	Q56g. Handling improving basic health services	4=Very well
	Q49g. Pay bribe for medical care	0=Never
	Q49e. Difficulty to obtain medical treatment	1=Easy
	Q8c. How often gone without medical care	0=Never

	Q8b. How often gone without water	0=Never
	Q8a. How often gone without food	0=Never
	Q97. Education of respondent	5=Secondary school / high school completed
Education	Q77a. Girls and boys have equal chance at education	4=Agree, 5=Strongly agree
	Q57c. Better or worse: government effectiveness on education	4=Better
	Q56h. Handling addressing educational needs	4=Very well
	Q49c. Pay bribe for public school services	0=Never
	Q49b. Difficulty to obtain public school services	1=Very easy
	Q94. Employment status	3=Yes, full time
Economic	Q77c. Women and men have equal chance of paying job	4=Agree, 5=Strongly agree
	Q77b. Women and men have equal chance to earn income	4=Agree, 5=Strongly agree
	Q8d. How often gone without cooking fuel	0=Never
	Q5. Your living conditions vs. others	4=Better
	Q4B. Your present living conditions	5=Very good
	Q4A. Country's present economic condition	5=Very good
Digitalisation	Q93. Electric connection from mains	5=All of the time
	Q91b. How often use the internet	4=Every day
	Q91a. How often use a mobile phone	4=Every day
	Q90. Mobile phone access to internet	1=Yes, has Internet access
	Q89f. Own mobile phone	2=Yes, personally owns
	Q89e. Own bank account	2=Yes, personally owns
	Q89d. Own computer	2=Yes, personally owns
	Q89b. Own television	2=Yes, personally owns

Source: Authors' calculation on data from Round 7 Afrobarometer Survey. Note:* Statement 2: Women should have the same chance of being elected to political office as men.

Table 3: PCA and weights (National Level)

Principle Component Analysis				Squared loadings						
Comp	Egen. Val.	Proportion	Cumulative	Variable	F1	F2	F3	F4	F5	Weights
Dimension: safety										
1	4.225	0.248	0.248	Q86a	0.124	0.051	0.010	0.007	0.038	0.063
2	2.986	0.176	0.424	Q78b	0.000	0.006	0.273	0.070	0.043	0.062
3	2.099	0.123	0.548	Q66	0.071	0.045	0.001	0.000	0.031	0.040
4	1.367	0.080	0.628	Q60d	0.006	0.001	0.147	0.132	0.111	0.055
5	1.261	0.074	0.702	Q60a	0.113	0.020	0.000	0.022	0.017	0.050
6	0.927	0.055	0.757	Q57g	0.099	0.104	0.003	0.013	0.041	0.068
7	0.851	0.050	0.807	Q57b	0.012	0.214	0.057	0.027	0.006	0.072
8	0.694	0.041	0.848	Q56q	0.123	0.060	0.016	0.004	0.001	0.062
9	0.546	0.032	0.880	Q51	0.000	0.075	0.219	0.007	0.000	0.058
10	0.464	0.027	0.907	Q50	0.058	0.097	0.002	0.017	0.041	0.052
11	0.445	0.026	0.933	Q49p	0.031	0.068	0.117	0.016	0.116	0.062
12	0.314	0.018	0.952	Q43g	0.007	0.115	0.039	0.102	0.003	0.050
13	0.299	0.018	0.969	Q40	0.081	0.019	0.007	0.204	0.005	0.059
14	0.190	0.0112	0.981	Q14	0.006	0.081	0.100	0.001	0.274	0.069
15	0.160	0.009	0.990	Q11b	0.090	0.017	0.000	0.170	0.007	0.057
16	0.100	0.006	0.996	Q11a	0.120	0.006	0.007	0.009	0.083	0.055
17	0.068	0.004	1.000	Q10a	0.028	0.017	0.000	0.209	0.178	0.057
Dimension: empowerment										
1	4.139	0.376	0.376	Q95c	0.081	0.001	0.047			0.054
2	1.980	0.180	0.556	Q38f	0.023	0.162	0.028			0.061
3	1.277	0.116	0.672	Q38e	0.162	0.116	0.006			0.122

4	0.983	0.089	0.762	Q38d	0.147	0.002	0.000	0.083
5	0.818	0.074	0.836	Q20b	0.071	0.168	0.085	0.099
6	0.683	0.062	0.898	Q19b	0.118	0.098	0.155	0.119
7	0.491	0.045	0.943	Q19a	0.088	0.149	0.158	0.116
8	0.295	0.027	0.970	Q18b	0.066	0.007	0.100	0.056
9	0.179	0.016	0.986	Q16	0.142	0.024	0.047	0.094
10	0.093	0.008	0.994	Q9	0.002	0.158	0.363	0.107
11	0.061	0.005	1.000	Q77d	0.100	0.113	0.007	0.088
Dimension: Health								
1	2.883	0.288	0.288	Q92b	0.024	0.249	0.003	0.097
2	2.730	0.273	0.561	Q57a	0.153	0.003	0.099	0.085
3	2.193	0.220	0.781	Q56j	0.033	0.000	0.300	0.097
4	0.661	0.066	0.847	Q56i	0.088	0.003	0.295	0.116
5	0.520	0.052	0.899	Q56g	0.151	0.056	0.114	0.107
6	0.916	0.039	0.938	Q49g	0.194	0.003	0.079	0.095
7	0.241	0.024	0.962	Q49e	0.213	0.002	0.102	0.108
8	0.183	0.018	0.980	Q8c	0.074	0.226	0.000	0.107
9	0.122	0.012	0.992	Q8b	0.065	0.141	0.004	0.075
10	0.074	0.007	1.000	Q8a	0.003	0.315	0.001	0.111
Dimension: Education								
1	2.275	0.379	0.379	Q97	0.007	0.157	0.476	0.161
2	1.475	0.246	0.625	Q77a	0.104	0.066	0.325	0.143
3	1.129	0.188	0.813	Q57c	0.106	0.259	0.178	0.169
4	0.650	0.108	0.922	Q56h	0.004	0.511	0.012	0.159
5	0.384	0.064	0.986	Q49c	0.372	0.002	0.005	0.175
6	0.085	0.014	1.000	Q49b	0.407	0.005	0.008	0.193
Dimension: Economic								

1	2.401	0.343	0.343	Q94	0.116	0.057	0.246	0.131
2	1.731	0.247	0.590	Q77c	0.292	0.064	0.120	0.177
3	1.420	0.203	0.793	Q77b	0.284	0.068	0.132	0.178
4	0.654	0.093	0.887	Q8d	0.029	0.036	0.434	0.135
5	0.471	0.067	0.954	Q5	0.007	0.318	0.022	0.108
6	0.312	0.044	0.998	Q4B	0.110	0.294	0.027	0.146
7	0.010	0.001	1.000	Q4A	0.162	0.163	0.0193	0.126
Dimension: Digitalisation								
1	5.439	0.777	0.777	Q93	0.124			0.124
2	0.704	0.101	0.878	Q91b	0.163			0.163
3	0.419	0.060	0.938	Q91a	0.122			0.122
4	0.253	0.036	0.974	Q90	0.166			0.166
5	0.078	0.011	0.985	Q89f	0.143			0.143
6	0.074	0.011	0.996	Q89e	0.120			0.120
7	0.031	0.004	1.000	Q89d	0.162			0.162
National Vulnerability Index								
1	2.598	0.433	0.433	Safety	0.170	0.048		0.128
2	1.358	0.226	0.659	Empowerment	0.181	0.226		0.196
3	0.863	0.144	0.803	Health	0.212	0.204		0.210
4	0.580	0.097	0.900	Education	0.218	0.002		0.144
5	0.384	0.064	0.964	Economic	0.208	0.102		0.172
6	0.217	0.036	1.000	Digitalisation	0.011	0.416		0.150

Source: Authors' calculation on data from Round 7 Afrobarometer Survey.

Table 4: PCA and weights

Principle Component Analysis				Squared loadings						Weights		
Comp	Egen Val.	Proportional	Cumulative	Variable	F1	F2	F3	F4	F5	F6		
Dimension: Safety												
1	3.724	0.219	0.219	Q86a	0.011	0.005	0.217	0.000	0.067	0.01	0.050	
2	2.681	0.158	0.377	Q78b	0.004	0.079	0.100	0.066	0.083	0.117	0.062	
3	2.147	0.126	0.503	Q66	0.061	0.040	0.000	0.124	0.210	0.030	0.065	
4	1.530	0.090	0.593	Q60d	0.036	0.029	0.089	0.012	0.170	0.013	0.051	
5	1.143	0.067	0.660	Q60a	0.177	0.002	0.014	0.010	0.004	0.044	0.062	
6	1.035	0.061	0.721	Q57g	0.006	0.079	0.104	0.110	0.000	0.740	0.121	
7	0.825	0.048	0.770	Q57b	0.001	0.124	0.128	0.120	0.023	0.003	0.067	
8	0.778	0.046	0.815	Q56q	0.076	0.104	0.016	0.006	0.002	0.008	0.050	
9	0.667	0.039	0.854	Q51	0.019	0.038	0.122	0.077	0.096	0.002	0.054	
10	0.564	0.033	0.888	Q50	0.060	0.050	0.003	0.127	0.054	0.048	0.055	
11	0.493	0.029	0.917	Q49p	0.004	0.159	0.017	0.106	0.040	0.065	0.061	
12	0.412	0.024	0.941	Q43g	0.016	0.042	0.135	0.036	0.002	0.009	0.043	
13	0.307	0.018	0.959	Q40	0.147	0.003	0.038	0.031	0.003	0.085	0.063	
14	0.259	0.015	0.974	Q14	0.001	0.222	0.016	0.006	0.051	0.102	0.066	
15	0.180	0.010	0.985	Q11b	0.164	0.003	0.000	0.006	0.000	0.058	0.056	
16	0.142	0.008	0.993	Q11a	0.143	0.009	0.000	0.029	0.158	0.004	0.064	
17	0.142	0.006	1.000	Q10a	0.070	0.010	0.000	0.072	0.039	0.319	0.063	
Dimension: Empowerment												
1	4.213	0.383	0.383	Q95c	0.079	0.008	0.004				0.047	
2	2.162	0.197	0.580	Q38f	0.026	0.167	0.042				0.068	
3	1.283	0.117	0.696	Q38e	0.169	0.083	0.003				0.117	

4	0.942	0.086	0.782	Q38d	0.160	0.007	0.002	0.090
5	0.830	0.075	0.857	Q20b	0.068	0.165	0.040	0.090
6	0.616	0.056	0.913	Q19b	0.068	0.138	0.116	0.096
7	0.409	0.037	0.950	Q19a	0.102	0.191	0.082	0.124
8	0.242	0.022	0.973	Q18b	0.078	0.005	0.186	0.075
9	0.160	0.015	0.987	Q16	0.051	0.023	0.030	0.040
10	0.091	0.008	0.995	Q9	0.154	0.112	0.476	0.196
11	0.049	0.004	1.000	Q77d	0.109	0.099	0.011	0.090
Dimension: Health								
1	3.131	0.313	0.313	Q92b	0.000	0.184	0.033	0.074
2	2.785	0.279	0.592	Q57a	0.140	0.004	0.112	0.084
3	1.789	0.179	0.770	Q56j	0.012	0.087	0.248	0.094
4	0.715	0.072	0.842	Q56i	0.044	0.122	0.230	0.115
5	0.520	0.062	0.904	Q56g	0.110	0.154	0.032	0.107
6	0.3459	0.035	0.939	Q49g	0.160	0.001	0.110	0.091
7	0.244	0.024	0.963	Q49e	0.217	0.006	0.085	0.110
8	0.200	0.020	0.983	Q8c	0.188	0.092	0.021	0.115
9	0.114	0.011	0.994	Q8b	0.107	0.098	0.054	0.092
10	0.055	0.005	1.000	Q8a	0.017	0.250	0.030	0.104
Dimension: Education								
1	1.696	0.282	0.283	Q97	0.016	0.180	0.469	0.195
2	1.422	0.237	0.520	Q77a	0.004	0.174	0.425	0.176
3	1.184	0.197	0.717	Q57c	0.266	0.125	0.042	0.158
4	0.792	0.132	0.849	Q56h	0.088	0.246	0.001	0.116
5	0.697	0.116	0.965	Q49c	0.288	0.251	0.037	0.207
6	0.208	0.035	1.000	Q49b	0.337	0.023	0.026	0.148
Dimension: Economic								
1	2.578	0.368	0.368	Q94	0.079	0.098	0.282	0.135

2	1.731	0.247	0.616	Q77c	0.267	0.084	0.095	0.169
3	1.412	0.202	0.817	Q77b	0.250	0.100	0.107	0.169
4	0.496	0.071	0.888	Q8d	0.022	0.022	0.500	0.140
5	0.413	0.059	0.947	Q5	0.029	0.389	0.000	0.131
6	0.357	0.051	0.998	Q4B	0.147	0.221	0.014	0.136
7	0.012	0.002	1.000	Q4A	0.206	0.085	0.002	0.119
Dimension: Digitalisation								
1	5.255	0.751	0.750	Q93	0.120			0.120
2	0.720	0.103	0.853	Q91b	0.161			0.161
3	0.437	0.062	0.916	Q91a	0.131			0.131
4	0.260	0.037	0.953	Q90	0.146			0.146
5	0.202	0.029	0.982	Q89f	0.143			0.143
6	0.072	0.010	0.992	Q89e	0.131			0.131
7	0.054	0.008	1.000	Q89d	0.166			0.166
Rural Vulnerability Index								
1	2.613	0.435	0.435	Safety	0.150	0.022		0.105
2	1.382	0.230	0.666	Empowerment	0.218	0.182		0.206
3	0.828	0.138	0.804	Health	0.161	0.230		0.185
4	0.525	0.088	0.891	Education	0.228	0.012		0.153
5	0.463	0.077	0.970	Economic	0.193	0.018		0.132
6	0.190	0.031	1.000	Digitalisation	0.009	0.536		0.191

Source: Authors' calculation on data from Round 7 Afrobarometer Survey.

Table 5: Descriptive statistics on indexes

	Obs.	Mean	Std. Dev	Min	Max
National Vulnerability Index					
Safety	34	0.449	0.100	0.207	0.649
Empowerment	34	0.508	0.145	0.184	0.721
Health	34	0.420	0.125	0.119	0.702
Education	34	0.425	0.124	0.208	0.688
Economic	34	0.442	0.122	0.212	0.716
Digitalisation	34	0.455	0.246	0.069	0.986
CompositeNational Index	34	0.503	0.157	0.273	0.848
Rural Vulnerability Index					
Safety	34	0.522	0.105	0.341	0.807
Empowerment	34	0.529	0.146	0.180	0.766
Health	34	0.411	0.121	0.091	0.717
Education	34	0.416	0.114	0.230	0.613
Economic	34	0.448	0.121	0.207	0.736
Digitalisation	34	0.355	0.220	0.040	0.998
CompositeRural Index	34	0.455	0.146	0.232	0.787

Source: Authors' calculation on data from Round 7 Afrobarometer Survey.

Table 6: NWVI and Rankings

Country	Safety	Rank	Empow	Rank	Health	Rank	Educ	Rank	Econ	Rank	Digit	Rank	Global	Rank
Benin	0.411	24	0.550	14	0.337	26	0.359	23	0.484	12	0.201	30	0.430	22
Botswana	0.650	1	0.715	3	0.668	2	0.688	1	0.485	11	0.631	9	0.848	1
Burkina Faso	0.463	14	0.349	31	0.490	9	0.385	22	0.450	16	0.220	28	0.427	23
Cabo Verde	0.515	8	0.480	20	0.466	13	0.345	25	0.249	33	0.876	2	0.508	16
Cameroon	0.298	33	0.444	24	0.384	22	0.469	12	0.397	21	0.535	12	0.434	21
Cote d'Ivoire	0.432	21	0.260	32	0.308	30	0.279	30	0.372	26	0.397	19	0.291	33
Eswatini	0.422	23	0.398	26	0.527	5	0.469	11	0.373	25	0.612	10	0.509	15
Gabon	0.207	34	0.469	22	0.119	34	0.289	28	0.380	23	0.803	4	0.306	30
Gambia	0.458	15	0.719	2	0.539	4	0.483	9	0.675	2	0.564	11	0.740	3
Ghana	0.531	6	0.697	5	0.433	18	0.533	6	0.716	1	0.466	17	0.729	4
Guinea	0.381	27	0.483	19	0.244	31	0.282	29	0.292	30	0.315	23	0.294	32
Kenya	0.387	26	0.491	18	0.504	7	0.682	2	0.443	17	0.504	13	0.595	9
Lesotho	0.596	4	0.721	1	0.462	14	0.401	20	0.572	5	0.447	18	0.674	6
Liberia	0.315	32	0.601	11	0.412	21	0.398	21	0.613	4	0.267	26	0.515	13
Madagascar	0.437	19	0.366	28	0.203	33	0.456	14	0.404	20	0.069	34	0.303	31
Malawi	0.434	20	0.648	7	0.312	28	0.208	34	0.321	29	0.098	32	0.346	28
Mali	0.428	22	0.567	13	0.499	8	0.338	26	0.435	19	0.159	31	0.470	18
Mauritius	0.494	10	0.400	25	0.703	1	0.434	16	0.537	7	0.986	1	0.700	5
Morocco	0.455	17	0.184	34	0.431	20	0.248	33	0.283	31	0.763	6	0.334	29
Mozambique	0.325	30	0.358	29	0.476	11	0.413	19	0.389	22	0.316	22	0.388	26
Namibia	0.620	3	0.638	8	0.592	3	0.624	3	0.669	3	0.706	7	0.840	2
Niger	0.629	2	0.358	30	0.475	12	0.325	27	0.345	28	0.087	33	0.397	25
Nigeria	0.319	31	0.453	23	0.360	24	0.426	17	0.547	6	0.473	16	0.463	20
Sao Tome P	0.512	9	0.538	15	0.452	15	0.608	4	0.371	27	0.475	14	0.578	10
Senegal	0.475	12	0.624	9	0.432	19	0.425	18	0.470	15	0.474	15	0.570	11
Sierra Leone	0.381	28	0.525	17	0.343	25	0.504	8	0.479	13	0.270	25	0.468	19
South Africa	0.438	18	0.597	12	0.510	6	0.468	13	0.496	10	0.835	3	0.658	8

Sudan	0.392	25	0.244	33	0.335	27	0.271	31	0.212	34	0.689	8	0.273	34
Tanzania	0.580	5	0.703	4	0.439	17	0.594	5	0.528	8	0.250	27	0.665	7
Togo	0.326	29	0.611	10	0.211	32	0.348	24	0.437	18	0.325	21	0.384	27
Tunisia	0.523	7	0.471	21	0.450	16	0.250	32	0.472	14	0.777	5	0.532	12
Uganda	0.457	16	0.674	6	0.310	29	0.437	15	0.505	9	0.205	29	0.511	14
Zambia	0.488	11	0.530	16	0.478	10	0.471	10	0.374	24	0.290	24	0.507	17
Zimbabwe	0.473	13	0.396	27	0.377	23	0.532	7	0.264	32	0.392	20	0.415	24

Source: Authors' calculation on data from Round 7 Afrobarometer Survey.

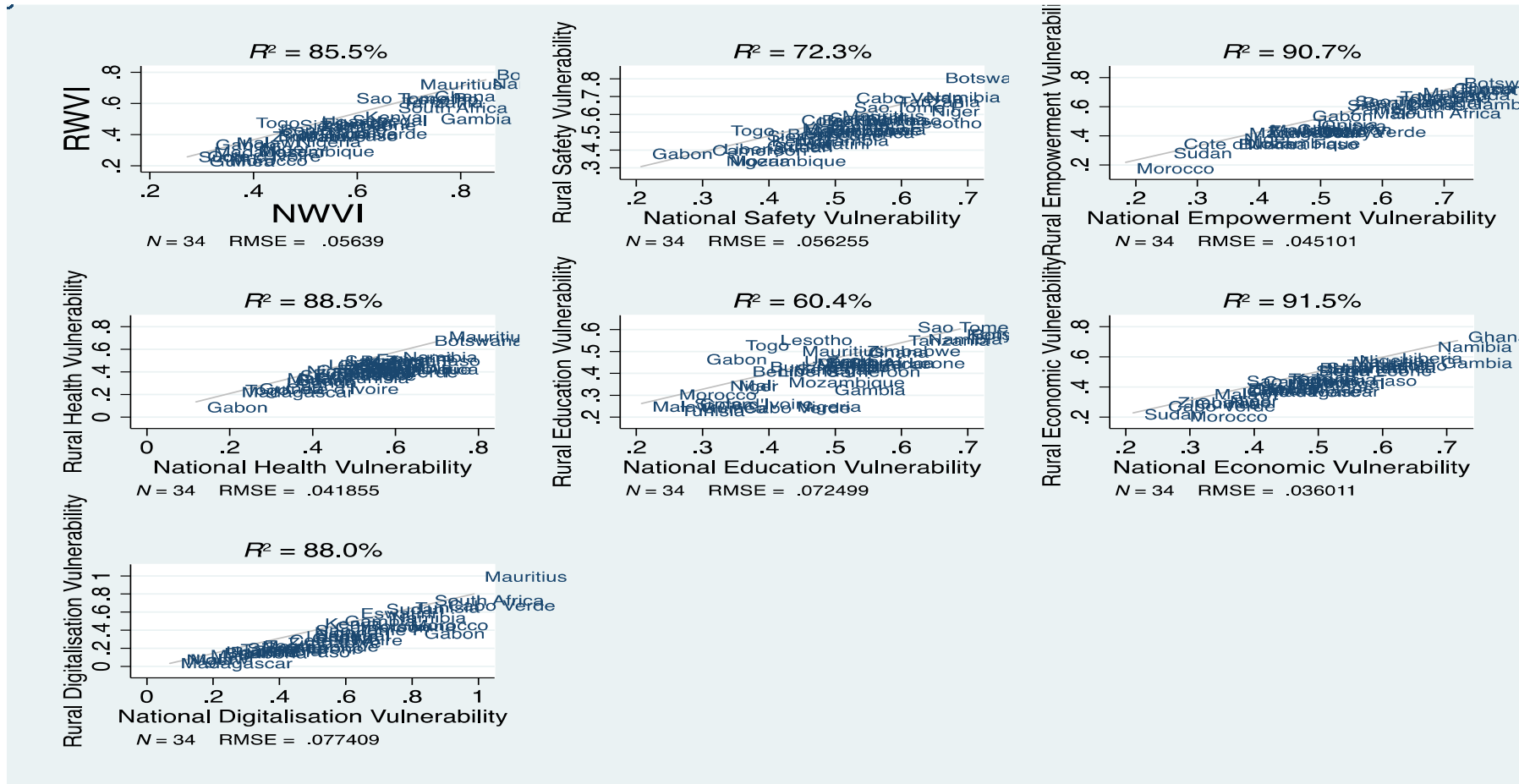
Table 7: RWVI and Rankings

Country	Safety	Rank	Empow	Rank	Health	Rank	Educ	Rank	Econ	Rank	Digit	Rank	Rural	Rank
Benin	0.493	22	0.633	10	0.330	27	0.411	21	0.511	12	0.153	29	0.435	18
Botswana	0.807	1	0.766	1	0.680	2	0.580	3	0.528	10	0.451	11	0.787	1
Burkina Faso	0.570	10	0.345	32	0.504	6	0.432	18	0.445	17	0.163	28	0.396	22
Cabo Verde	0.695	3	0.430	25	0.402	20	0.244	32	0.275	32	0.679	3	0.410	20
Cameroon	0.401	31	0.447	21	0.419	17	0.410	22	0.438	19	0.439	12	0.413	19
Cote d'Ivoire	0.570	11	0.348	31	0.255	31	0.263	28	0.373	27	0.295	19	0.264	31
Eswatini	0.437	27	0.439	24	0.517	4	0.434	17	0.393	23	0.591	6	0.476	14
Gabon	0.381	32	0.540	18	0.091	34	0.466	11	0.383	25	0.368	15	0.339	27
Gambia	0.456	24	0.619	12	0.442	13	0.326	26	0.562	6	0.507	8	0.504	10
Ghana	0.574	9	0.730	2	0.461	12	0.498	10	0.736	1	0.317	18	0.649	4
Guinea	0.426	28	0.471	20	0.257	30	0.244	33	0.294	31	0.212	23	0.232	34
Kenya	0.451	26	0.426	27	0.485	9	0.580	2	0.457	15	0.478	9	0.517	9
Lesotho	0.555	13	0.718	4	0.496	7	0.555	5	0.547	8	0.337	17	0.631	6
Liberia	0.410	30	0.616	13	0.467	10	0.411	20	0.595	3	0.151	30	0.471	15
Madagascar	0.513	18	0.424	28	0.226	33	0.447	16	0.374	26	0.040	34	0.292	30
Malawi	0.525	15	0.697	5	0.348	26	0.250	31	0.355	28	0.082	32	0.352	26
Mali	0.452	25	0.555	17	0.495	8	0.347	24	0.422	21	0.129	31	0.394	23

Mauritius	0.595	7	0.444	22	0.717	1	0.504	9	0.571	5	0.998	1	0.726	3
Morocco	0.506	20	0.180	34	0.381	23	0.305	27	0.208	34	0.462	10	0.237	33
Mozambique	0.341	33	0.352	30	0.428	16	0.361	23	0.396	22	0.226	22	0.296	29
Namibia	0.700	2	0.666	8	0.536	3	0.558	4	0.670	2	0.544	7	0.730	2
Niger	0.621	6	0.385	29	0.436	14	0.344	25	0.310	29	0.080	33	0.316	28
Nigeria	0.341	34	0.443	23	0.412	19	0.250	30	0.581	4	0.383	14	0.357	25
Sao Tome P	0.642	5	0.641	9	0.504	5	0.613	1	0.444	18	0.405	13	0.636	5
Senegal	0.582	8	0.632	11	0.395	21	0.420	19	0.428	20	0.347	16	0.495	11
Sierra Leone	0.483	23	0.612	14	0.373	24	0.449	15	0.510	13	0.205	24	0.463	16
South Africa	0.499	21	0.558	16	0.428	15	0.450	14	0.530	9	0.736	2	0.575	8
Sudan	0.419	29	0.284	33	0.328	28	0.262	29	0.222	33	0.640	5	0.261	32
Tanzania	0.674	4	0.725	3	0.419	18	0.552	6	0.551	7	0.196	25	0.609	7
Togo	0.512	19	0.674	7	0.245	32	0.531	7	0.458	14	0.235	21	0.479	13
Tunisia	0.518	16	0.481	19	0.350	25	0.230	34	0.453	16	0.657	4	0.406	21
Uganda	0.560	12	0.684	6	0.308	29	0.459	12	0.527	11	0.168	27	0.487	12
Zambia	0.533	14	0.586	15	0.463	11	0.457	13	0.384	24	0.177	26	0.458	17
Zimbabwe	0.514	17	0.429	26	0.382	22	0.505	8	0.302	30	0.266	20	0.391	24

Source: Authors' calculation on data from Round 7 Afrobarometer Survey.

Figure 1: Relationships between NWVI and RWVI



Source: Authors' calculation on data from Round 7 Afrobarometer Survey.

Table 8: Results for Robustness Checks

	Obs.	Mean	Std. Dev	Min	Max
National Vulnerability Index					
Safety	34	0.454	0.080	0.266	0.613
Empowerment	34	0.470	0.121	0.205	0.663
Health	34	0.461	0.107	0.211	0.682
Education	34	0.454	0.110	0.253	0.713
Economic	34	0.461	0.110	0.265	0.698
Digitalisation	34	0.483	0.190	0.169	0.847
CompositeNational Index	34	0.468	0.150	0.243	0.798
Rural Vulnerability Index					
Safety	34	0.454	0.080	0.312	0.678
Empowerment	34	0.470	0.124	0.187	0.682
Health	34	0.459	0.107	0.192	0.688
Education	34	0.456	0.105	0.268	0.640
Economic	34	0.460	0.107	0.255	0.702
Digitalisation	34	0.477	0.178	0.200	0.905
CompositeRural Index	34	0.264	0.155	0.068	0.629

Source: Authors' calculation on data from Round 7 Afrobarometer Survey.