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Household Expenditure In Africa: Evidence Of Mean Reversion

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ABSTRACT

This present paper investigates the mean reversion in household consumption expenditure in 38 Africa countries, the expenditure series obtained as the percentage of nominal Gross Domestic Product (GDP), each spanning 1990 to 2018. Due to the small sample point of available time series of household expenditure, with possible structural breaks, the Fourier unit root test approach, allowing for modelling both smooth and instantaneous breaks in the expenditure series was utilised. The results showed non-mean reversion in the consumption expenditure pattern of Egypt, Madagascar, and Tunisia, while mean reversion was detected in the remaining 35 countries. Thus, the majority of African countries are on the verge of recession once shocks that affect the growth of GDP are triggered. Findings in this paper are of relevance to poverty alleviation programmes in those selected countries.

Keywords: Household expenditure; Poverty level; Mean reversion; Africa
JEL Classification: C22; D19; H31

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1.0 Introduction

One of the Sustainable Development Goals (SDGs) is to eliminate extreme poverty in any region of the globe by 2030, and as at the time of writing this paper, poverty is still prevalent in most parts of Africa. Many rich African countries, for instance, South Africa, Nigeria, and Senegal still have quite a high proportion of poor people. Household consumption expenditure amounts to about 60% of the Gross Domestic Product (GDP) as it includes government transfers, the total amount spent by household residents in catering for needs such as clothing, food, housing, transportation, etc., as well as other miscellaneous services that directly benefit households (OECD, 2020).

African Development Bank in 2012 reported that the four largest economies in Africa in order as South Africa, Egypt, Nigeria, and Algeria accounted for 55% of the overall African household final consumption expenditure for 2009, and of the four, Nigeria is referred to as only a middle-expenditure country. Also, household expenditure varies generally among African countries concerning basic needs such as transportation, food, etc, and their areas, be it urban or rural. For instance, urban households allocate a greater percentage of their expenditures to housing compared to rural areas, except in Uganda, Malawi, and Ethiopia (Lozano-Gracia and Young, 2014).

Based on the latest household consumption expenditure dataset (2018), Africa has the highest average (84.92) household consumption expenditure.[6] Africa also has the second-largest population in the world, after the Asia continent. All these reasons enliven our interest in studying the time-series dynamics of household consumption expenditure across African countries.

Mean reversion is used as a financial term for the assumption that asset price and historical returns tend to revert to the mean price over time (Mahdavi, 2013). Based on this extract, the strategies of mean reversion on household expenditures work on the assumption that there is an underlying fixed trend in the expenditures of households, and the expenditure of a particular household is assumed that it will revert to its previous state from the long-term norm. However, its return to a normal pattern is not guaranteed, as unexpected high or low income could indicate a shift in the household expenditure. Mean reversion of household expenditure can take place in two folds: firstly, the expected expenditure of household can go in a direction opposite to that of the expenditure; and secondly, the expected expenditure can revert toward a mean level. Reverting to mean level in the sense of a

[6] Europe: 58.35; North America: 67.88; Asia: 56.10; Africa: 84.92, South America: 68.23; and Australia: 54.65 (these were computed by the authors based on datasets available on databank.worldbank.org/world-development-indicators)

stationary series with supposed constant mean as in Box et al. (2015). Non-mean reversion in the case of nonstationary series, which deviates totally from the mean level of the series. As posited by Ben (2015), as households progress through life, they experience differing successes. Some households generate high incomes, however, others generate less. For many households, there is evidence of income fluctuation throughout life, which shows both upward and downward trends.

The fluctuation of household income, therefore, influences the welfare and the behavioral pattern of the households. Ben (2015) ascertained that mean reversion is a crucial measure of high-frequency household expenditure. The ability to understand the household spending patterns particularly among the poor would be useful to manage their expenditure as preparation for any change in the economic uncertainties that are expected in the future (Nik et al., 2014). Although, at the time of writing this paper, there is no much review on unit roots or mean reversion on household income and expenditure, thus bringing the dire need of embarking on the research for the growth of the African economy. However, a few pieces of literature are cited to have a broad overview of the nature of this research work.

Thankgod (2014) used private consumption expenditure and national income dataset to examine the consumption expenditure of private function in Nigeria with the use of Keynes' hypothesis of absolute income. The Augmented Dickey-Fuller (ADF) unit root test results utilised depicted the stationarity of the log of consumption expenditure and income after the first difference. This indicated that there is a possibility of extraneous regression if however the exact series of these variables were actualised in the modelling. There is evidence of a long-run association between the variables, and this gave room for estimating a parsimonious error correction model. This in turn indicated a positive relationship between the national income and private consumption expenditure.

Akhand (2011) examined the consumption behaviour of households in Indonesia with the use of Friedman's permanent income hypothesis under rational expectation. The unit root test results suggested that the real household consumption per-capita and the real disposable income per-capita in Indonesia follow a random walk process, and hence are eligible to form a cointegrating relationship.

Giray (2013) investigated the stochastic characteristics of the income-consumption ratios of eleven countries in Central and Eastern Europe (CEE). The countries are Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. Heterogeneous panel unit root tests and the Modified ADF unit root test for the period of March 1997 – September 2012 were used to account for cross-sectional dependence. The half-lives were also calculated for nine of eleven CEE economies to examine the strong mean-reversion in the consumption income ratio. The empirical findings in the research foresaw significant evidence of the existence of a hypothesis that indicated that the income-consumption ratio is mean-reverting.

Ben (2015) proved that long-lived income shocks convey far less than one-for-one through to consumption, and is particularly so for younger households. Ben (2015) used household consumption and wealth, as well as UK income panel data. The estimates of households' ability to smooth shocks to the estimates of transmission were compared, and the result included in the data on wealth. Conditionally, on the appropriateness of the consumption's model, the estimates provided evidence of the power of alternative Heterogeneous Income Process ('HIP') over the Restricted Income Process ('RIP'). Also, the findings explained why there was a slow growth of cross-sectional consumption inequality over the period considered even though the long-lived shocks have a high variation. Ben (2015) concluded that it is crucial and necessary to account for the mean reversion of shocks in the construction of life-cycle consumption models.

The present paper investigates the mean reversion in household consumption expenditure in 38 African countries, spanning across the four regions of the continent: the North, West, South, and East. The authors' approach of statistical analysis is a variant from those employed by a few works of literature on household expenditure. The analysis is based on the ADF test with Fourier nonlinearity with smooth and instantaneous breaks (FADF-SB) as proposed in Furuoka (2017). The approach works quite well, particularly due to the small sample size of expenditure series since unit root lag is fixed to unity. Three other tests: the ADF, FADF, and ADF-SB are restricted tests to the FADF-SB test. In selecting the best representative test regression model, Furuoka (2017) set out an F-test strategy that is adopted and applied in this paper.

The remaining part of this paper is structured as follows: Section 2 presents the data and unit root tests employed with the F-tests. Section 3 of the paper presents the empirical findings while Section 4 renders the concluding remark.

2.0 Data and Methods

The data used in this paper are the annual time series of average final consumption expenditure of households in Africa computed as a percentage of nominal GDP. These were obtained from the World Development

Indicators (WDI) of the World Bank at the website: https://data.worldbank.org/indicator/. Household expenditure series of thirty-eight (38) African countries were included, and each time series spanned between 1990 and 2018. Figure 1 shows the map of the African countries considered in this study. The figure shows the average consumption expenditure in each country. As displayed in the figure, Burundi had the highest (106.14) average consumption expenditure, while Gabon had the lowest (50.88) average consumption expenditure.

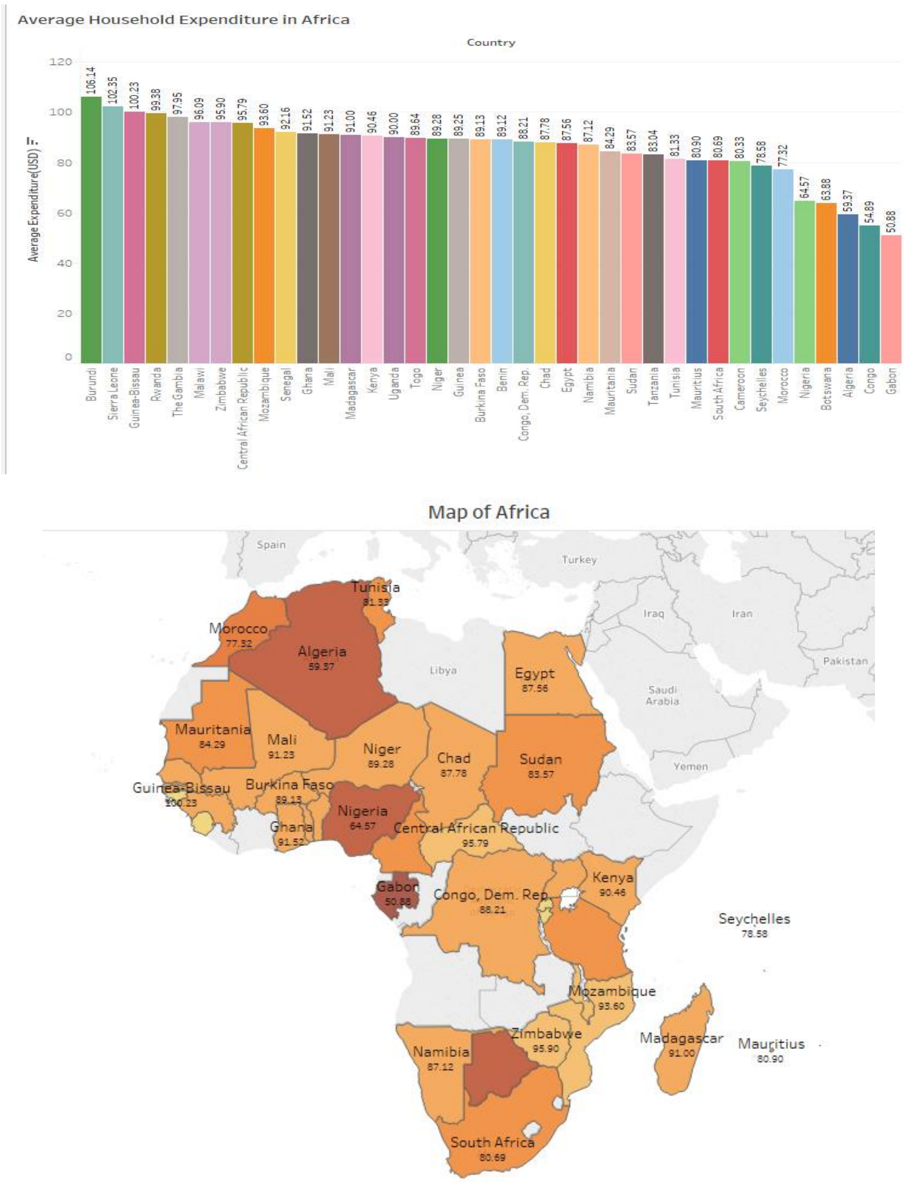

Figure 1: Map of the African countries considered in this study with their respective average consumption expenditure.

Table 1 presents the summary report of the dataset, showing the household expenditures across the countries in 1990 and 2018. The table includes the minimum and maximum expenditures in the periods sampled throughout the considered countries. The table also includes the rank of countries in ascending order concerning their household consumption expenditure changes between 1990 and 2018. The ranking was done based on the difference between the household expenditure of 1990 and 2018 for each country. The country with the highest positive difference was ranked as the 1st, while the country with the highest negative difference was ranked as the 38th. As displayed in Table 1, it was observed that Nigeria was ranked as 1st, having the highest positive change of about 46.39 increments. Chad was ranked as the 38th, having the highest negative change of about -26.77. As presented in the table, in 1990 Nigeria had the lowest household expenditure rate of 36% of GDP. Botswana, Gabon, Congo, Algeria, Cameroon, Guinea, Mauritius, Morocco, Namibia, Seychelles, South Africa, and Tunisia have expenditure rate ranges from about 51% to 80%. Burundi, Chad, Tanzania, and Uganda have a very high expenditure rate above 100% of their GDP. As of 2018, the expenditure rates of Congo, Gabon, Tanzania, and Uganda dropped within the ranges from about 2% to 18%. Central African Republic, Sierra Leone, and The Gambia improved with a rate that ranges from about

6% to 22%. The range between the minimum and maximum rates varied widely across all the countries been considered. This implies that there are fluctuations in household expenditure rates across the years sampled, and these imply high expenditure rates in Africa.

Table 1 Data Summary

Country	**Code**	**1990 Exp.**	**2018 Exp.**	**Min. Exp.**	**Max. Exp.**	**Rank**
Algeria	DZA	72.90	59.61	42.94	73.44	32nd
Benin	BEN	93.30	83.03	83.03	96.64	25th
Botswana	BWA	57.37	68.26	55.77	72.60	9th
Burkina Faso	BFA	94.58	81.72	79.19	100.09	31st
Burundi	BDI	105.37	104.12	97.84	113.78	20th
Cameroon	CMR	79.32	81.59	76.92	83.46	16th
Central African Republic	CAF	96.10	102.19	89.91	102.19	14th
Chad	TCD	107.67	80.90	69.19	140.81	38th
Congo	COG	51.36	38.98	35.07	91.45	30th
Congo, Dem. Rep.	COD	88.21	77.89	72.46	101.00	26th
Egypt	EGY	83.30	93.80	82.89	98.22	10th
Gabon	GAB	63.14	49.19	39.51	65.12	34th
Ghana	GHA	94.53	81.01	75.81	102.96	33rd
Guinea	GIN	77.84	96.06	77.61	105.29	3rd
Guinea-Bissau	GNB	97.17	96.23	92.99	110.06	19th
Kenya	KEN	81.03	94.68	77.57	95.69	6th
Madagascar	MDG	94.45	85.52	80.20	100.34	24th
Malawi	MWI	86.60	96.43	85.80	104.11	11th
Mali	MLI	95.58	90.17	82.93	100.04	22nd
Mauritania	MRT	95.12	83.43	58.16	100.23	28th
Mauritius	MUS	76.99	90.91	73.07	90.91	5th
Morocco	MAR	74.45	77.00	74.28	80.97	15th
Mozambique	MOZ	93.60	87.44	82.72	109.44	23rd
Namibia	NAM	76.86	93.62	76.86	97.25	4th
Niger	NER	95.75	80.43	80.29	99.95	35th
Nigeria	NGA	35.79	82.18	35.79	86.92	1st
Rwanda	RWA	93.80	92.40	90.70	148.51	21st
Senegal	SEN	97.64	85.52	85.52	99.09	29th
Seychelles	SYC	79.69	86.28	70.32	86.28	13th
Sierra Leone	SLE	86.30	108.21	86.30	120.16	2nd
South Africa	ZAF	79.91	81.21	78.67	82.62	17th
Sudan	SDN	90.30	78.73	74.40	95.72	27th
Tanzania	TZA	100.56	83.04	67.94	103.15	37th
The Gambia	GMB	89.34	102.69	87.14	105.45	7th
Togo	TGO	85.29	85.63	68.44	100.23	18th
Tunisia	TUN	79.98	92.72	76.49	93.05	8th
Uganda	UGA	100.48	84.30	81.94	100.77	36th
Zimbabwe	ZWE	82.55	90.03	78.19	121.46	12th

Rates are given in percentages of Nominal GDP. In red represents negative changes with highest negative having the lowest ranking (i.e. 38th)

The ADF unit root test involving three regression specifications namely: (i) no intercept and trend (ii) intercept only and (iii) intercept and trend, was carried out and the results of the test were contained in Table 2. Furthermore, the automatic selection of augmented lags was examined, thereafter used the minimum Schwarz information criteria in selecting the optimal lag, and is contained in squared brackets. Noting that these optimal lags may be large enough to bias the unit root decisions in some cases. In the case of no intercept, the null hypothesis of a unit root in household consumption expenditure series was not rejected in virtually all the countries except in Uganda. In this sense, rejection of unit root implies mean reversion evidence, while acceptance of null of unit root implies non-mean reversion in the time series. Due to the magnitude of the time series, the test regression model with no intercept would have under-represented the unit root decision. Meanwhile, by considering models with intercept only, and intercept with time trend, the authors found improved results. The two-unit root regression models jointly determined unit roots in household consumption expenditure series of Cameroun, Guinea-Bissau, Malawi, Rwanda, Seychelles, Sierra Leone, Gambia, and Togo (21%). Altogether, unit root regression with intercept and trend detected unit root in household expenditure series of

Benin, Cameroon, Chad, Egypt, Guinea-Bissau, Malawi, Niger, Nigeria, Rwanda, Senegal, Seychelles, Sierra Leone, Sudan, Gambia, Togo, and Uganda (42.1%). The test regression model with only the constant detected unit root in Burundi, Cameroon, Congo, Congo DR., Gabon, Guinea-Bissau, Malawi, Rwanda, Seychelles, Sierra Leone, Gambia, and Togo (approximately, 31.6%). These inconsistencies in the ADF decision occurred due to the small size of the series, particularly in this case of 29 sample size. Also, it is necessary to care for inherent structural breaks during the unit root test. We described below the unit root frameworks that cater to these shortcomings.

Table 2: Results of ADF Unit root tests

Country	Code	None	Intercept	Intercept and trend
Algeria	DZA	-0.7815 [0]	-1.7534 [0]	-1.4175 [0]
Benin	BEN	-0.9044 [0]	-1.7888 [0]	**-3.6599 [1]**
Botswana	BWA	0.3293 [0]	-2.4362 [0]	-2.6255 [0]
Burkina Faso	BFA	-0.7990 [0]	-1.5384 [0]	-2.0962 [0]
Burundi	BDI	-0.1629 [0]	**-3.6057 [0]**	-3.5479 [0]
Cameroon	CMR	0.4097 [1]	**-3.3211 [0]**	**-4.1486 [0]**
Central African Republic	CAF	0.2679 [0]	-2.7199 [0]	-3.3771 [0]
Chad	TCD	-0.7082 [1]	-2.9566 [0]	**-3.9549 [0]**
Congo	COG	-0.1139 [2]	**-3.4651 [1]**	-3.4094 [1]
Congo, Dem. Rep.	COD	-0.6807 [3]	**-4.6115 [0]**	-3.2890 [2]
Egypt	EGY	0.9748 [0]	-0.9641 [0]	**-3.6447 [5]**
Gabon	GAB	-0.9538 [2]	**-2.9961 [0]**	-3.1788 [0]
Ghana	GHA	-0.6397 [0]	-1.5135 [0]	-1.8238 [0]
Guinea	GIN	0.5797 [1]	-2.0094 [0]	-3.3989 [0]
Guinea-Bissau	GNB	-0.1155 [1]	**-4.0749 [0]**	**-3.9617 [0]**
Kenya	KEN	0.9416 [0]	-1.7497 [0]	-1.6344 [0]
Madagascar	MDG	-0.5678 [0]	-1.9170 [0]	-3.2636 [0]
Malawi	MWI	0.2770 [1]	**-4.0283 [0]**	**-4.0293 [0]**
Mali	MLI	-0.4038 [0]	-1.9220 [0]	-1.8934 [0]
Mauritania	MRT	-0.5427 [0]	-2.7786 [0]	-3.0788 [0]
Mauritius	MUS	1.3613 [0]	-0.0905 [0]	-2.3536 [0]
Morocco	MAR	0.2441 [0]	-2.5937 [0]	-2.6143 [0]
Mozambique	MOZ	-0.3823 [0]	-1.5728 [0]	-2.1244 [0]

Namibia	NAM	0.5374 [0]	-2.8040 [0]	-3.2824 [0]
Niger	NER	-1.6206 [1]	-0.8629 [1]	**-4.0671 [0]**
Nigeria	NGA	3.4296 [5]	-0.1365 [5]	**-4.8912 [0]**
Rwanda	RWA	-0.3431 [0]	**-3.6677 [0]**	**-4.8875 [0]**
Senegal	SEN	-1.8074 [0]	-1.1199 [0]	**-4.1930 [6]**
Seychelles	SYC	-0.0200 [2]	**-5.2911 [0]**	**-5.1670 [0]**
Sierra Leone	SLE	0.6118 [1]	**-3.3522 [0]**	**-3.6541 [0]**
South Africa	ZAF	0.2581 [0]	-2.3954 [1]	-2.7995 [1]
Sudan	SDN	-0.8751 [2]	-2.2498 [0]	**-3.6334 [0]**
Tanzania	TZA	-1.0607 [0]	-2.1177 [2]	0.2001 [2]
The Gambia	GMB	0.2901 [1]	**-4.8758 [0]**	**-4.7726 [0]**
Togo	TGO	-0.2193 [0]	**-4.3405 [0]**	**-4.6638 [0]**
Tunisia	TUN	1.7287 [0]	1.0535 [0]	-1.1212 [0]
Uganda	UGA	**-2.0633 [2]**	-2.3776 [2]	**-3.6275 [0]**
Zimbabwe	ZWE	0.2162 [1]	-1.8254 [0]	-0.7937 [1]

Bolded figures denote that the ADF test is significant at 5% level, and reported in square brackets is the optimal lag length of the augmentation.

The traditional ADF unit root test does not account for structural breaks, in the long run, household expenditure rate can however experience smooth or instantaneous breaks within the considered years (see Perron, 1989; Furuoka, 2017a). As in Enders and Lee (2012a,b), to account for the limitation of the traditional ADF test, they expanded the traditional ADF test to a nonlinear framework with the use of a Fourier function with different frequencies. The general equation of the Fourier form is given as:

$$G(t) = \alpha + \beta t + \sum_{j=1}^{m} \lambda_j \sin(\frac{2\pi jt}{N}) + \sum_{j=1}^{m} \gamma_j \cos\left(\frac{2\pi jt}{N}\right); m \leq \frac{N}{2}; t = 1, 2, \ldots \qquad (1)$$

where α and β represent the model intercept and coefficient of the trend, respectively; λ_j and γ_j are the measures of the amplitude and displacement of the sinusoidal component of the deterministic term, respectively; π is canonically taken to be 3.1416; m is the optimal number of frequencies, and it is to be obtained by the information criteria; j is a specific frequency, which is set to 1, 2, …, up to m initially; and N represents the total number of observations – the length of the household expenditure rate in this paper. λ_j and γ_j are the nonlinear parameters in the Fourier function that was set up and are assumed to be real values upon estimation. The entire function in (1) becomes a linear function if the values of $\lambda_j$and γ_j are 0, therefore, the significance of at least one of (λ_j, γ_j) indicates nonlinearity. The classical ADF test regression is given as:

$$\Delta Exp_t = \alpha + \beta t + (\rho - 1)Exp_{t-1} + \sum_{i=1}^{p} d_i \, \Delta Exp_{t-i} + \varepsilon_t \qquad (2)$$

where Exp_t is the household expenditure rate specific to a country at the time t; ε_t is the error term; ρ is the slope parameter specific to the first lagged dependent variable; Exp_{t-1} is 1, when the series contains unit root attributes; *d* and *p* represent the slope and the lag length for the augmentation in the augmented component, respectively. Putting equation (2) and (1) together resulted in the Fourier ADF (FADF) test regression as developed by Enders and Lee's:

$$\Delta Exp_t = \alpha + \beta t + (\rho - 1)Exp_{t-1} + \sum_{j=1}^{m} \lambda_j \sin\left(\frac{2\pi jt}{N}\right) + \sum_{k=1}^{n} \gamma_k \cos\left(\frac{2\pi kt}{N}\right)$$

$$+\sum_{i=1}^{p} d_i \, \Delta Exp_{t-i} + \varepsilon_t \quad (3)$$

While testing for a unit root in a given time series modelling, the FADF unit root test accounts for smooth breaks (Becker et al., 2006). Furuoka (2017a), extended the test with a structural break obtained simultaneously in the process. This process aligns with Perron's (2006) one structural break unit root test. Hence, in this study, both the ADF-SB as in Perron (2006) and the FADF-SB as in Furuoka (2017a), are utilised respectively and given as,

$$\Delta Exp_t = \alpha + \beta t + \delta DU_t + \theta D(N_B)_t + (\rho - 1)Exp_{t-1} + \sum_{i=1}^{p} c_i \, \Delta Exp_{t-i} + \varepsilon_t \quad (4)$$

$$\Delta Exp_t = \alpha + \beta t + \delta DU_t + \theta D(N_B)_t + (\rho - 1)Exp_{t-1} + \sum_{k=1}^{n} \lambda_k \sin\left(\frac{2\pi kt}{N}\right) +$$

$$\sum_{k=1}^{n} \gamma_k \cos\left(\frac{2\pi kt}{N}\right) + \sum_{i=1}^{p} c_i \, \Delta Exp_{t-i} + \varepsilon_t \quad (5)$$

where δ represents the coefficient of the structural break dummy variable DU_t, where $DU_t = 1$ if $t > N_B$, otherwise, $DU_t = 0$; N_B denotes the break date; θ represents the coefficient of the one-time break dummy, where $D(N_B) = 1$ if $t = N_B$, $D(N_B) = 0$ otherwise. As the same with the ADF test, the null hypothesis of unit root, $\rho - 1 = 0$ was tested using a t-test, in the above models represented as the equation (3), (4), and (5). These correspond, respectively to FADF, ADF-SB, and FADF-SB unit root tests. The optimal frequency $\hat{j}$ in equations (3) and (5) is obtained by reducing the residual sum of squares errors (SSR) to its minimum value through,

$$SSR_{FADF}(\hat{j}) = \inf_{j} SSR_{FADF}(j); \quad SSR_{FADF-SB}(\hat{j}) = \inf_{j} SSR_{FADF-SB}(j) \tag{6}$$

whereas considering ADF-SB and FADF-SB cases, as shown in Perron (2006) and Zivot and Andrews (1992), one structural break is determined endogenously, and not exogenously. The $(\widehat{N}_B)$, structural break date, is then obtained. The $\hat{\lambda}$, break fraction, is estimated as:

$$\hat{\lambda} = \frac{N_B}{N} \tag{7}$$

The optimal break date, $\widehat{N}_B$, as observed in Furuoka (2017a) shows that the FADF-SB regression model is responsive to both the break-position $(\widehat{N}_B)$ and the frequency $(\hat{j})$. Hence, the optimal location of the break date and frequency are jointly determined by:

$$\varphi_{FADF-SB}(\widehat{\omega}, \hat{j}) = \inf_{\omega, j} \omega_{FADF-SB}(\widehat{\omega}, \hat{j}) \tag{8}$$

which minimises the statistic value for FADF-SB in equation (5).

As it stands, aside from the power to additionally reject more unit-roots depending on the introduction of the Fourier forms with a structural break, the most appropriate test regression model needs to be ascertained. Furuoka (2014; 2017a) suggested the use of an F-statistic,

$$F = \frac{(SSR_0 - SSR_1)/k}{SSR_1/(N-r)} \tag{9}$$

where SSR_1 denotes the unrestricted model sum of squares residuals (SSR); SSR_0 denotes the restricted model of SSR; k represents the number of restrictions present in the restricted model, and r represents the number of regressors contained in the unrestricted model. For clarity's sake, the FADF model is an unrestricted model of the ADF regression model in a case when the nonlinear trigonometrical terms are zeros, that is, $\lambda_j = \gamma_j = 0$. Also, the ADF-SB model is an unrestricted model of the ADF model when there is no structural break observed. Moreover, the FADF-SB model is an unrestricted model of the ADF model in a case where structural break and nonlinearity forms are not included in the model. Furthermore, the FADF-SB regression is an unrestricted model to the FADF model when the structural break dummies in the model are not found. Finally, the FADF-SB model is an unrestricted model to ADF-SB regression in a case whereby nonlinearity form via trigonometry is not included. Hence, there are cases of five pairings considered, given as F_{FADF_ADF}, F_{ADF-SB_ADF}, $F_{FADF-SB\_ADF}$, $F_{FADF-SB\_FADF}$ and $F_{FADF-SB\_ADF-SB}$ tests. The critical values for each pairing can be found in Furuoka (2017a). Considering the pairing cases, in a case where there is no significant improvement of an unrestricted model against a restricted one, the model which contains the lowest value of Type I error was accepted to be a better model. The accepted model determined the acceptance of the hypothesis of the unit root of household expenditure rate.

3.0 Empirical Findings

Concerning the unit root approach described above, the ADF test, whereby the augmentation lag fixed to unity (i.e. $p = 1$) was conducted, and this same augmentation lag was fixed for the other tests, ADF-SB, FADF, and FADF-SB. The results of the unit root tests are presented in Table 3; and the result of the robustness test using the F test is in Table 4. Based on the ADF test result, there is evidence of mean reversion in household expenditure in the cases of Benin, Cameroon, Central African Republic, Democratic Republic of Congo, Malawi, Nigeria, Rwanda, Seychelles, The Gambia, Togo, and Uganda, accounting for approximately 28.95% of the 38 countries considered. Also, using the result from the Fourier form of the ADF framework (FADF), we found evidence of mean reversion in the household expenditure of Benin, Cameroon, Central African Republic, Congo, Democratic Republic of Congo, Malawi, Seychelles, Sierra Leone, Togo and Uganda (approximately 26.32% of total cases considered). It was observed that there was only a sparing distinction between the results of the ADF and that of the FADF. The unit root test results by the ADF and the FADF both display evidence of mean reversion in Benin, Cameroon, Central African Republic, Democratic Republic of Congo, Malawi, Seychelles, Togo, and Uganda (approximately 21.1%). Considering the ADF-SB test, it was discovered that there has been an increase in the number of rejections of the unit-roots. More importantly, the affected cases under the FADF test are almost exhaustively a subset of the rejection cases under the ADF-SB test, safe Sierra Leone. The number of cases that indicated mean reversion under the ADF-SB test is 24 (approximately 63.16% of the total cases). The evidence of an increase in the number of unit root rejection is because the ADF-SB test accounts for instantaneous breaks, while the FADF test does not. Furthermore, by using the FADF-SB test, the number of mean reversion cases increased to 33 (approximately 86.84% of the total cases), excluding just five countries – Egypt, Ghana, Madagascar, Nigeria, and Tunisia. The increment is also evident from the fact that the FADF-SB test allows for a smooth break. However, as a result of the consistency in the non-rejection of unit roots in the three countries, Egypt, Madagascar, and Tunisia, for the FADF, ADF-SB, and FADF-SB tests, there is, in turn, a nonrejection of the hypothesis of unit root for the household consumption expenditures in the three countries (Egypt, Madagascar, and Tunisia), and this indicates non-mean reversion.

Table 3: Result of ADF, FADF, ADF-SB, and FADF-SB unit root tests

Country	Code	ADF	FADF	K	ADF-SB	T_B	λ	FADF-SB	T_B	λ	*K*
Algeria	DZA	-1.407	-3.641	1	-3.165	1999	34	**-5.702**	**2008**	**66**	**1**
Benin	BEN	**-3.660**	**-4.859**	**1**	**-4.377**	**2004**	**52**	**-5.660**	**2015**	**90**	**1**
Botswana	BWA	-2.344	-3.313	1	-4.860	2008	66	**-5.133**	**2008**	**66**	**1**
Burkina Faso	BFA	-1.937	-3.129	1	-3.760	2009	69	**-4.659**	**1993**	**14**	**1**
Burundi	BDI	-3.243	-4.413	1	**-4.381**	**2014**	**86**	**-5.049**	**2012**	**79**	**1**
Cameroon	CMR	**-4.123**	**-5.374**	**1**	**-7.264**	**1995**	**21**	**-8.236**	**1995**	**21**	**2**
Central African Republic	CAF	**-3.851**	**-4.617**	**2**	**-4.186**	**2008**	**66**	**-5.958**	**2009**	**69**	**1**
Chad	TCD	-2.803	-3.840	2	**-9.969**	**2002**	**45**	**-8.974**	**2002**	**45**	**1**
Congo	COG	-3.409	**-4.636**	**1**	**-4.905**	**1998**	**31**	**-10.015**	**2014**	**86**	**2**
Congo, Dem. Rep.	COD	**-3.762**	**-6.406**	**1**	**-5.799**	**1996**	**24**	**-7.785**	**1995**	**21**	**1**
Egypt	EGY	-1.056	-0.311	2	-3.429	2011	76	-3.654	1998	31	2
Gabon	GAB	-2.588	-3.952	1	**-4.458**	**2014**	**86**	**-5.059**	**2008**	**66**	**2**
Ghana	GHA	-1.469	-2.841	1	**-4.565**	**2012**	**79**	-4.168	2012	79	2
Guinea	GIN	-2.407	-3.253	2	**-4.060**	**2005**	**55**	**-4.474**	**2006**	**59**	**2**
Guinea-Bissau	GNB	-2.221	-4.044	1	**-4.245**	**1997**	**28**	**-6.072**	**2001**	**41**	**1**
Kenya	KEN	-2.232	-3.386	1	**-4.835**	**1994**	**17**	**-5.749**	**1995**	**21**	**2**
Madagascar	MDG	-2.704	-2.973	1	-3.788	2011	76	-4.084	2006	59	1
Malawi	MWI	**-4.288**	**-4.592**	**2**	**-5.261**	**2006**	**59**	**-5.092**	**2012**	**79**	**2**
Mali	MLI	-1.793	-3.714	1	-3.599	2012	79	**-5.283**	**2012**	**79**	**1**
Mauritania	MRT	-2.347	-3.597	1	**-3.709**	**1994**	**17**	**-7.515**	**1993**	**14**	**1**
Mauritius	MUS	-2.249	-4.326	1	**-4.223**	**2007**	**62**	**-6.289**	**2000**	**38**	**1**
Morocco	MAR	-1.881	-2.330	1	-3.485	2010	72	**-4.737**	**2011**	**76**	**2**
Mozambique	MOZ	-2.116	-3.483	1	**-3.952**	**1994**	**17**	**-5.645**	**2001**	**41**	**1**
Namibia	NAM	-2.362	-2.588	2	-3.691	2003	48	**-5.829**	**2008**	**66**	**2**
Niger	NER	-2.735	-3.680	2	**-4.093**	**2011**	**76**	**-5.238**	**2011**	**76**	**2**
Nigeria	NGA	**-4.036**	-3.789	1	**-4.797**	**1998**	**31**	-4.623	1999	34	1
Rwanda	RWA	**-3.987**	-3.943	1	**-8.898**	**1994**	**17**	**-11.703**	**1994**	**17**	**2**
Senegal	SEN	-1.621	-4.206	1	-3.062	2005	55	**-4.798**	**2006**	**59**	**1**
Seychelles	SYC	**-3.957**	**-4.449**	**2**	**-5.132**	**2004**	**52**	**-5.749**	**2017**	**97**	**1**
Sierra Leone	SLE	-2.339	**-4.626**	**2**	-3.389	2003	48	**-6.627**	**2009**	**69**	**2**
South Africa	ZAF	-2.799	-3.935	1	**-4.259**	**2001**	**41**	**-5.116**	**2011**	**76**	**1**
Sudan	SDN	-2.885	-3.668	1	**-5.116**	**1999**	**34**	**-6.787**	**1999**	**34**	**1**
Tanzania	TZA	-0.363	-4.019	1	-2.110	1997	28	**-4.793**	**2014**	**86**	**1**
The Gambia	GMB	**-3.512**	-3.502	1	-3.826	1996	24	**-5.459**	**2011**	**76**	**1**

Togo	TGO	**-3.969**	**-4.571**	**2**	**-5.034**	**1999**	**34**	**-5.237**	**1999**	**34**	**2**
Tunisia	TUN	-0.968	-2.755	1	-3.490	2010	72	-4.078	2006	59	1
Uganda	UGA	**-3.733**	**-5.037**	**2**	**-4.344**	**1999**	**34**	**-5.395**	**1999**	**34**	**2**
Zimbabwe	ZWE	-0.794	-4.397	1	-2.496	2001	41	**-5.367**	**2009**	**69**	**1**

Bolded figures denote that the test is significant at 5% level

Afterwards, the F-test statistic is used to juxtapose the different pairs of unrestricted and restricted model constructs to determine which of the unit root tests considered in the analysis would yield the most viable and reliable mean reversion decision, and its consistency in doing so compared to other tests. This is to determine the test that would caption the sum of squares regression variation in the household consumption expenditure excellently. Based on the result presented in Table 4, it was discovered that the F-test (F_{FADF_ADF}) that investigates the improval of the FADF over the ADF test shows significant improval of FADF in just 3 of the 38 cases, which are Algeria, Sierra Leone and Zimbabwe. This apparently indicates a high power of the Classical ADF test over its Fourier form (FADF) test. Considering the F-test (F_{ADF-SB_ADF}), the test investigates the significant improval of the ADF-SB over the ADF. We discovered that there has been an appreciable improvement with respect to 18 cases over the ADF. Considering all the results, it is evident that FADF-SB test performed highly well over the other three tests, ADF, FADF, and ADF-SB, in all the African countries examined in the study, except for Benin, Burundi, Nigeria, Seychelles, South Africa, Tanzania and Togo (7). Hence, it is safe to say that the FADF-SB unit root test is more reliable and preferable compared to others as displayed in Table 4. Additionally, it is evidently shown, in the result, that the mean reversion hypothesis is significantly affected by the availability of structural breaks. This thereby improve the power of the Fourier function test when combined with structural breaks in unit root testing framework.

Table 4: F tests

Country	Code	F_{FADF_ADF}	F_{ADF-SB_ADF}	$F_{FADF-SB\_ADF}$	$F_{FADF-SB\_FADF}$	$F_{FADF-SB\_ADF-SB}$
Algeria	DZA	**12.278**	**7.117**	**13.745**	**7.873**	**27.359**
Benin	BEN	4.889	2.918	5.699	4.866	5.524
Botswana	BWA	4.102	**12.516**	**7.448**	**8.219**	**14.606**
Burkina Faso	BFA	4.114	5.281	5.363	**5.134**	**10.265**
Burundi	BDI	3.783	4.650	3.238	2.274	5.284
Cameroon	CMR	4.672	**14.623**	**10.268**	**11.570**	**20.464**
Central African Republic	CAF	2.970	1.952	5.428	**6.471**	**8.072**
Chad	TCD	3.669	**124.785**	**85.869**	**127.662**	**160.603**
Congo	COG	5.342	5.188	**17.505**	**20.575**	**21.745**
Congo, Dem. Rep.	COD	9.624	**10.251**	**9.084**	5.107	**15.383**
Egypt	EGY	5.401	**7.996**	**10.511**	**10.948**	**11.759**
Gabon	GAB	4.265	**6.014**	5.039	4.511	**9.563**
Ghana	GHA	4.087	**12.730**	**6.197**	6.392	**11.836**
Guinea	GIN	3.067	**9.599**	**8.129**	**10.625**	**9.893**
Guinea-Bissau	GNB	5.553	**7.701**	**8.345**	**7.836**	**15.669**
Kenya	KEN	3.870	**11.379**	**12.116**	**15.487**	**22.743**
Madagascar	MDG	1.048	3.352	4.878	**8.063**	**9.296**
Malawi	MWI	1.398	3.700	3.402	4.928	**6.371**
Mali	MLI	7.765	4.892	**9.924**	**7.616**	**18.965**
Mauritania	MRT	4.730	**20.134**	**13.989**	**16.764**	**26.844**

Mauritius	MUS	7.520	**7.592**	**10.179**	**8.158**	**20.335**
Morocco	MAR	4.238	4.346	**7.406**	**7.995**	**14.594**
Mozambique	MOZ	5.443	**7.579**	**10.276**	**10.577**	**19.916**
Namibia	NAM	2.178	4.684	**8.849**	**13.208**	**16.615**
Niger	NER	4.103	4.692	**5.746**	5.710	**11.234**
Nigeria	NGA	0.408	2.910	1.966	3.437	3.726
Rwanda	RWA	0.996	**180.571**	**161.930**	**297.207**	**320.899**
Senegal	SEN	9.857	3.724	**6.945**	2.634	**13.667**
Seychelles	SYC	2.233	4.596	4.032	5.045	5.952
Sierra Leone	SLE	**10.677**	3.193	**11.542**	**6.915**	**21.331**
South Africa	ZAF	4.526	4.888	4.887	4.048	7.238
Sudan	SDN	2.999	**9.412**	**9.951**	**13.614**	**19.163**
Tanzania	TZA	9.828	3.223	**7.342**	3.079	-1.169
The Gambia	GMB	0.692	2.047	5.058	**8.946**	**8.930**
Togo	TGO	2.488	3.964	2.725	2.613	5.417
Tunisia	TUN	4.212	**10.498**	4.912	4.375	**7.984**
Uganda	UGA	5.559	2.137	3.683	1.544	**7.157**
Zimbabwe	ZWE	**14.221**	**6.210**	**11.438**	4.423	**16.696**

Note: In bold indicates significance at 5% level. See Furuoka (2017a) for critical values.

4.0 Conclusion

The study examines the evidence of mean reversion or non-mean reversion in household expenditures in selected thirty-eight (38) countries across Africa between 1990 and 2018 using Fourier unit root test with breaks (FADF-SB). The test procedure works quite well in the presence of a small sample size, and it is capable of controlling for smooth breaks based on the Fourier function in the test regression. Other unit root tests, the ADF, FADF, and ADF-SB, considered are restricted versions to the FADF-SB, which further gives the general test appealing properties. An F test that determines the superiority of FADF-SB and ADF-SB is also presented. On applying the traditional ADF unit root test, the authors discovered that only 16 of the considered cases indicate significance. That is, about 42% signify evidence of mean reversion in the time series of household expenditures across African countries considered. The three tests, FADF, ADF-SB, and FADF-SB rejected unit root hypotheses in 26.31%, 63.16%, and 86.84% of the total cases, respectively. Based on these results, the household expenditure rate in most of the African countries is mean-reverting for the period considered in this study. The FADF-SB test outperformed others in the majority of the African countries considered. Based on the results of only the FADF-SB test, the non-mean reversion hypothesis holds in five (5) of the thirty-eight (38) African countries examined in this study.

Meanwhile, based on the decisions of nonrejection of unit root by the four tests considered, non-mean reversion exists in only three countries, that is, in Egypt, Madagascar, and Tunisia. In these cases of non-mean reversion, the household expenditure rates do not revert to their mean levels, which is the likelihood that these countries may experience the persistence of shocks for a longer period. The implication herewith requires strong public policy actions to address the household expenditure shock. Depending on the nature of the shock, a strong check and balance are needed to be put in place. In cases where the household expenditure rate is lower compared to the Gross Domestic Product (GDP) per capita, the shocks could mean evidence of economic development. However, in cases where the household expenditure rate is higher, then the shock could mean the evidence of GDP per capita debt. Considering the robustness investigation to ascertain the most powerful and preferable test, the result indicates the dominance of the FADF-SB over other tests.

The study was limited to the sampled 38 African countries due to the unavailability of data for the duration covered in this study for the remaining 16 African countries. The Fourier unit root test was adopted because of the small size of the data points and the likelihood of structural breaks in the series. By expanding the scope of the study (large sample size), Fractional Persistence could be examined in the household consumption expenditure in Africa.

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