International Journal of Social and Educational Innovation (IJSEIro)
Volume 10/ Issue 20/ 2023

ACCESSING SUSTAINABLE LINK AMID ACCESS TO ELECTRICITY CONSUMPTION AND LABOR FORCE PARTICIPATION RATE IN SOUTH AFRICA

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Abstract
Labor force participation rate is a strong issue that affect the performance of any economy including South Africa. Sequel to this, this paper accesses the link amid access to electricity consumption and labor force participation rate of male (LFPRM) in South Africa. Using yearly data from 1991- 2020. The study employed ARDL technique to evaluate the data. The findings of the study shows that access to electricity consumption (AEC) positively stimulate labor force participation rate of male in the long run while gross domestic product per capita growth impacted negatively on LFPRM in the short-run. The paper recommends that government should ensure that access to electricity consumption is improved and efficient in South Africa in order to boost LFPRM.

Keywords: ***Energy consumption; Unemployment; South Africa; ARDL.***
JEL Clasification: E00, Q43, J21, J64

1. Introduction

One important macroeconomic problem that many emerging economies face is the low labor force participation rate (LFPR) issue. This study examines the relationship between labor force participation rate of male (LFPRM) and access to sustainable access to electricity consumption (AEC), controlling for employment/unemployment heterogeneity. The global economic goal seeks to promote an ongoing, all-encompassing, and sustainable growth rate, reasonable and innovative employment, and decent employment for the majority of people. However, in emerging economies like South Africa (SA), the problem of a low labor force participation rate male is alarming (unemployment), defenseless engagement, labor under-utilization, persistent gender wage gaps, and conducive work environment deficits continue to be major obstacles to achieving the sustainable access to electricity consumption. In general, African nations have performed worse in terms of sustained inclusive growth and decent jobs (ILO, 2019). In 2019, Africa had the highest low LFPR rate in the world (27.9%), and the continent also has five of the ten worst LFPRs (unemployment) in the world (UN, 2019). According to the AfDB (2020), African youth are three times more susceptible to LFPR (unemployment) than adults.

Due to a divergence amid experiences and jobs (Adeleye & Esposito, 2018; Agradi et al., 2022; Borhan et al., 2023), LFPR in Africa among those with intermediate or advanced levels of ability

and knowledge is the highest globally (AfDB, 2020). Additionally, since 2008, Africa has seen an increase in the underutilization of labour (Gomis, Kapsos & Kuhn, 2020). To maintain the present LFPR, Africa must add 11.8 million new jobs year (AfDB, 2020). By 2030, the number of people living in cities is predicted to climb from 3.48 billion to 4.9 billion, with the fastest expansion occurring in developing economies (Songsore, 2020). Due to the widespread rural-to-urban migration to cities in search of better economic possibilities, this is expected to make Africa's cities' LFPR (unemployment) situation worse. This could, over time, have an impact on the sustainable development of African cities and society, especially in SA. This is so because poor LFPR has a detrimental influence on people's quality of life and the environment, which in turn hinders cities' ability to grow sustainably (Cobbinah, Erdiaw-Kwasie & Amoateng, 2015).

Scholars have noted that youths in SA and other rising countries have difficulty finding jobs that are in line with their qualifications, despite the fact that the problem of LFPR (unemployment) is clearly low among this population (Abd Rahman et al. 2020). Reduced purchasing power, a halt in economic growth, and social and economic instability are only a few of the far-reaching effects of LFPR. Due to how it affects people's monthly income, it also has a negative impact on their level of living (Voumik et al., 2023).

The International Labor Organization (ILO) notes that in order to address the LFPR challenges and subsequently improve sustainability, the Southern African region needs creative processes of economic and social transformation that lead to sustained, socially inclusive growth and environmental sustainability. This calls for locating and improving advantageous synergies or trade-offs among sustainability metrics where they exist. Improvements to access to electricity consumption (AEC) can aid in the integration of the sustainability metrics and LFPR, as stated by Kruse, Dellink, Chateau, and Agrawala (2017). Additionally, AEC advancements lessen the strain on the economy's infrastructure, including the energy sector, and thus supports the sustainable development of cities and society. Sustainable urban and social development would be valued economically and lead to lower unemployment. In this study, we investigate if enhanced AEC results in a decline in South Africa's unemployment rate.

A detailed look at the early unemployment energy-efficiency studies, even in industrialized nations where there have been notable increases in AEC investments, the AEC nexus is still unclear (see Costantini et al., 2018; Kemna et al., 2016; Stavropoulos & Burger, 2020). There are just a few studies in the setting of Africa, however they are mostly based on energy efficiency (Borel-Saladin et al., 2013; Ruzive et al., 2019). Three significant gaps in the literature are identified by the current investigation. First, there is a dearth of a sound theoretical foundation in the available literature, which renders empirical models rarely valid and calls into questioning the foundations for the explanation of pragmatic outcomes. Second, the argument for the link between unemployment and energy efficiency in the previous literature ignores AEC. As a result, the majority of these research focus on E-E scenarios with energy generation techniques, which are unable to handle identification problems brought on by endogeneity. Thirdly, even if E-E advancements have the potential to generate jobs, the demand for these positions would be influenced by factors like the economy's human capital base such as education and professional skills a. The impact of E-E advancements on unemployment is anticipated to be variable because skills and qualifications levels are likely to be dramatically different among economies. One of the reasons for the

ambiguity in the relationship between LFPR and AEC improvements observed in the literature may be the failure to take into consideration potential conditioning factors, which may be causes of heterogeneities. Basically, the purpose of this study is to investigate the short- and long-term relationships between a few macroeconomic variables and unemployment in South Africa. Policymakers can create long-lasting measures to remedy the issue and preserve steady economic growth by determining the root reasons of poor LFPR.

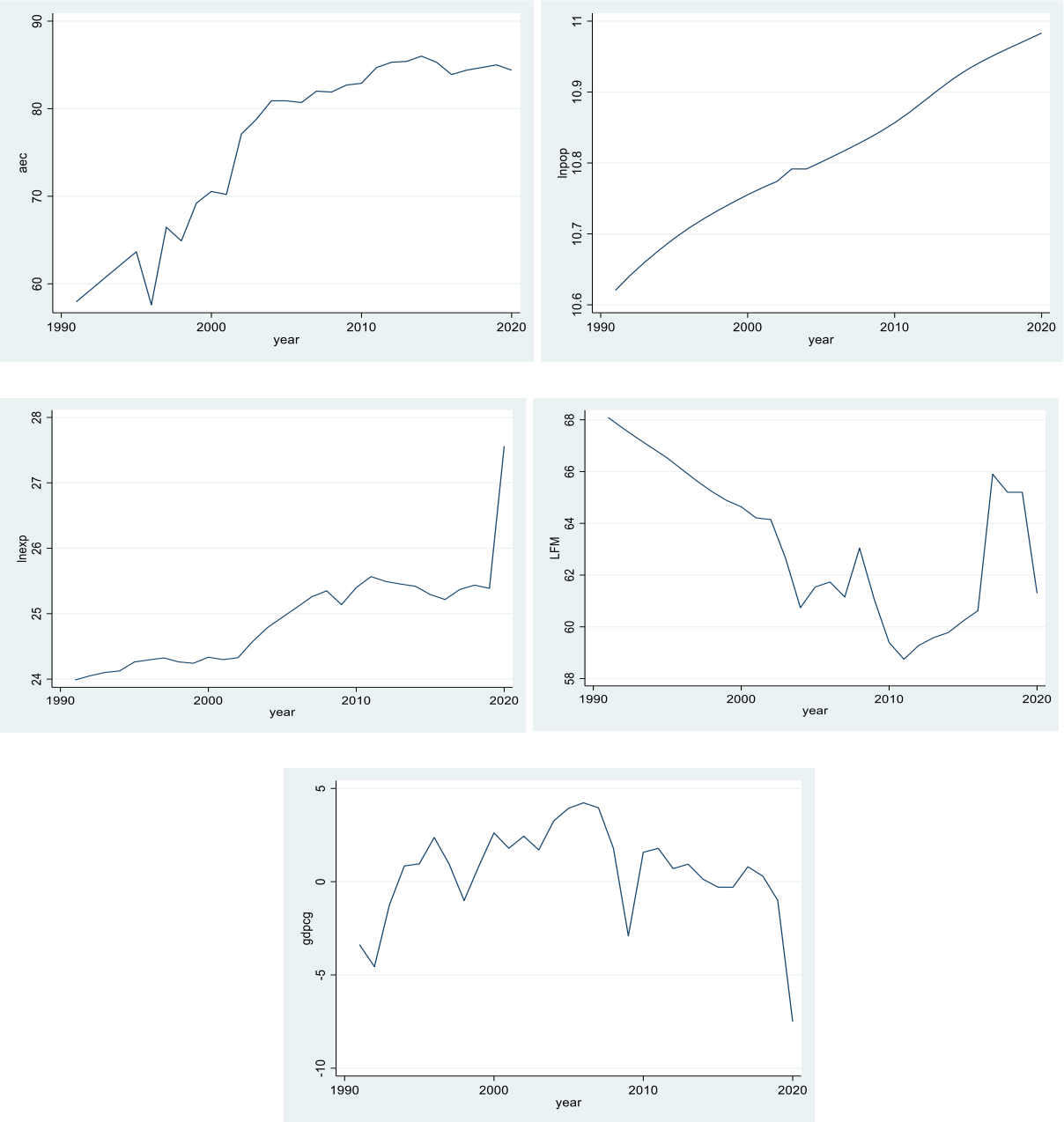

Figure 1 : Time series plots of variable used.
Source: Authors (@World Bank data)

2. Literature review

The earliest empirical work on the LFPR (unemployment) effects of AEC is still not definitive. The results appear to indicate that EnEf creates more jobs in developed economies (Stavropoulos & Burger, 2020). By 2020, it was predicted by Kemna, Wierda and Aarts (2016) that the EU's Eco-design Directives on EE measures will generate an additional 0.79 million direct jobs and 3.1–5.1 times as many indirect jobs. According to the US-DOE (2017), EnEf is said to have created about 2.2 million jobs in the US economy in 2017, representing an increase in EnEf employment of 7% over 2015 levels. Furthermore, Wei, Patadia and Kammen (2010) demonstrated that EnEf, along with other non-fossil fuel technologies, creates more jobs for the US economy per unit of energy produced than fossil fuel technologies do. In the UK, EnEf has been found to have favorable effects on employment by Rosenow, Platt and Demurtas (2014). In the long run, EnEf improvements improved employment by 0.21%, according to Allan, Hanley, McGregor, Swales, and Turner (2006), whereas Barker et al. (2007) found that the UK's 2000–2007 EnEf program resulted in 0.27 million more jobs in 2010. Using a neo-Keynesian CGEM Three-ME model, Khodeir (2016) found an inverse relationship between the production of renewable electricity and Egypt's unemployment rate between 1989 and 2013. The study's goal was to identify effects both in the short- and long-term over the study period, but it was discovered that the hypothesis was only true in the long-term. Bekmez and Apak (2016) looked into the connection between employment and non-hydro renewable energy for a panel of 80 nations. They came to the conclusion that there is a unidirectional causal relationship between employment and non-hydro renewable energy consumption for low to middle income nations, but not for high income nations. As a result, the findings do not support the idea that renewable energy reduces unemployment.

Apergis and Salim (2015) examined 80 nations over the years 1990–2013. Regarding the effect of using renewable energy on unemployment, they found a range of results. However, overall findings, which included data from several regions, including Asia and Latin America, revealed that using renewable energy has a beneficial effect on unemployment.

According to Adom (2020a), the consuming agent's level of knowledge affects whether or not to invest in EnEf and energy conservation. (Adom, 2020a; Littledyke, 2008) Environmental awareness and consciousness can be fostered through education, which supports sustainability by encouraging people to adopt energy-saving measures and safeguard the environment.

Additionally, education produces a revenue upshot that can promote modernization and investment in renewable energy devices and appliances, as the theory of human capital advocates (Acemoglu, 2002). Naturally, EnEf progress could also result in a rebound effect, where customers spend the money, they save on energy bills to buy more energy-intensive products, potentially reducing the employment-induced benefits of EnEf. The type of the impacts might have been affected by this. Additionally, the type of analysis—input-output, computational general equilibrium (i.e. impact analysis), or econometric—could be significant, particularly for research on the influence of EnEf on (un)employment (see Stavropoulos and Burger, 2020). In contrast to other research, the current work employs ARDL techniques as a component to address possible endogeneity in defining the impact of AEC on LFPRM in SA.

3. Methodology

In this research section, the study econometric model is specified. The study stated LFPR as proxy for Labor force participation rate of male (LFPRM). Essentially, the model for this study is specified as follow

LFPRM = *f*(AEC, GDPCG, POP, EXP)

Where

LFPRM = labor force participation rate of male

GDPCG = gross domestic product per capita growth

POP = population

EXP = export

The specified variables in functional form above can be changed into log-form (ln) which is specified below.

$$LFPRM = \beta_0 + \beta_1 AEC + \beta_2 LnPOP + \beta_3 GDPCG + \beta_4 LnEXP + \mu$$

The model 2 above can be specified in ARDL model

$$\mathrm{LFPRM_t} = \beta_0 + \varphi_i \mathrm{LFPRM_{t-}}_i + \beta_1 AEC_{\mathrm{t}} + \beta_2 LnPOP_{\mathrm{t}} + \beta_3 EXP_{\mathrm{t}} + \beta_3 GDPCG + \sum_{j}^{h} \tilde{\beta}_{j,i} \Delta AEC_{\mathrm{t}-i}$$

$$+\sum_{j}^{m}\tilde{\beta}_{j,i}\,\Delta\mathrm{POP}_{\mathrm{t}-i}\;+\sum_{j}^{m}\tilde{\beta}_{j,i}\,\Delta\mathrm{EXP}_{\mathrm{t}-i}+\sum_{j}^{m}\tilde{\beta}_{j,i}\,\Delta\mathrm{GDPCG}_{\mathrm{t}-i}\;+\sum_{j}^{m}\tilde{\beta}_{j,i}+\varepsilon_t$$

$$\mathrm{LFPRM}_{\mathrm{t}}=\;\beta_0\;+\varphi_i\mathrm{LFPRM}_{\mathrm{t}-i}+\;\beta_1 AEC_{\mathrm{t}}+\;\beta_2 LnPOP_{\mathrm{t}}\;+\beta_3 EXP_{\mathrm{t}}+\;\beta_3 GDPCG\;+\sum_{j}^{h}\tilde{\beta}_{j,i}\,\Delta AEC_{\mathrm{t}-i}$$

$$+\sum_{j}^{m}\tilde{\beta}_{j,i}\,\Delta\mathrm{POP}_{\mathrm{t}-i}\;+\sum_{j}^{m}\tilde{\beta}_{j,i}\,\Delta\mathrm{EXP}_{\mathrm{t}-i}+\sum_{j}^{m}\tilde{\beta}_{j,i}\,\Delta\mathrm{GDPCG}_{\mathrm{t}-i}\;+\boldsymbol{\pi ECT_{t-1}}\;+\boldsymbol{\varepsilon_t}$$

The model should be stable, the residuals for the ECM should be serially unbiased and uncorrelated, and Δ is the first difference operator. A series of stability tests are possible to use to address this validation of the model. Each independent variable's expected direction of influence on the dependent variable is bi-directional. According to the model, historical values can have an impact on and provide an explanation for labor force participation rates of men (LFPRM). As a result, it involves additional disruptions or shocks.

4. Empirical Results and Discussion

4.1. Unit Root Analysis

We perform the unit root test to establish order of integration of the variables. As confirmed by both ADF, PP, ERS Point Optimal and DF test. Table 1 presents the unit root testing, it is seen that the variables are I(0) and I(1) order;

Table 1: Unit root test

	ADF		PP		Statistics			
Variables $[z_t]$	Level	Diff. (1st)	Level	Diff. (1st)	μ	σ	z_{skew}	z_{kurt}
Panel A: Unit root test (Intercept)								
$LFPRM_t$	2.96	2.97*	2.96	2.97*	200.44	14.67	-1.05	4.08
AEC_t	2.99*	0.00	2.97*	2.98*	2.92	5.35	-1.93	8.89
$LnPOP_t$	2.96	2.97*	2.80	3.00*	2.62	1.77	-0.28	2.70
$GDPPCG_t$	2.96	2.97*	2.96	2.97*	16.06	0.407	-0.02	1.48
$LnEXP_t$	2.96	2.97*	2.96	3.00*	93.27	14.47	0.26	2.09
Panel B: Unit root test (Intercept and Trend)								
$LFPRM_t$	3.57	3.58*	3.57	3.58*				
AEC_t	3.61	3.63*	3.57	3.58*				
$LnPOP_t$	3.57	3.58*	3.57	3.58*				
$GDPPCG_t$	3.57	3.58*	3.57	3.58*				
$LnEXP_t$	3.57	3.58*	3.57*	3.58`*				

Note: ADF = Augmented Dickey-Fuller; PP = Phillips-Perron. * (**) = Significant @level 5% (1%). : $\mu \equiv$ *M*ean, $\sigma \equiv$ Standard deviation. Diff: Difference of variable each z_t, $z_{skew} =$ *s*kewness and z_{kurt}=kurtosis

Source: Authors| computation, 2023

Table 2: ARDL cointegration test

Variable $[z_t]$	Test F-stat.	CV Bounds	Significance 10%	5%	1%
$LFPRM_t$		I(0) Bound	2.45	2.86	3.74
	6.99	I(1) Bound	3.52	4.01	5.06

Note: Null Hypothesis is no long-run relationships exist
Source: Authors| computation, 2023

Table 3: ARDL long run coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LFPRM(-1))	24.92449	5.885464	4.234923	0.1476
D(LFPRM(-2))	31.1626	7.309714	4.263176	0.1467
D(LFPRM(-3))	-2.273745	1.88808	-1.204263	0.4412
D(AEC)	0.889191	0.29492	3.015027	0.0039
D(AEC(-1))	2.163605	0.546143	3.961612	0.0534
D(AEC(-2))	-1.01961	0.323131	-3.155404	0.1954
D(AEC(-3))	-0.602668	0.234159	-2.573752	0.2359
D(LNPOP)	-2967.611	824.0816	-3.601114	0.1724
D(LNPOP(-1))	-3983.96	950.8446	-4.189917	0.1492
D(LNPOP(-2))	-3881.725	943.8596	-4.112608	0.1519
D(LNPOP(-3))	2225.894	605.1682	3.678141	0.1169
D(LNEXP)	60.43659	15.15395	3.988175	0.0164
D(LNEXP(-1))	99.21568	28.01116	3.542005	0.0252
D(LNEXP(-2))	-15.26513	18.16775	-0.840232	0.5551
D(LNEXP(-3))	-139.0747	38.11172	-3.649133	0.1703
D(GDPCG)	12.17063	3.031785	4.014345	0.0454
D(GDPCG(-1))	15.51939	3.798317	4.08586	0.1528
D(GDPCG(-2))	3.688854	0.806313	4.574968	0.0537
D(GDPCG(-3))	10.32055	2.621852	3.936357	0.0154
C	12470	3074.016	4.056581	0.1539
AEC(-1)	-1.361284	0.412401	-3.300875	0.1873
LNPOP(-1)	-976.0802	255.0603	-3.826861	0.1627
LNEXP(-1)	15.10769	14.56115	1.037534	0.4883
GDPCG(-1)	-29.96118	7.259314	-4.127274	0.1513
LFM(-1)	-32.48525	7.525693	-4.31658	0.1449
R-squared	0.988461	Mean dependent var		-0.2155
Adjusted R-squared	0.711516	S.D. dependent var		1.571906
S.E. of regression	0.844282	Akaike info criterion		1.164321
Sum squared resid	0.712813	Schwarz criterion		2.374029
Log likelihood	9.863829	Hannan-Quinn criter.		1.512673
F-statistic	3.56916	Durbin-Watson stat		2.536242
Prob(F-statistic)	0.398553			

Source: Authors computation, 2023

The table above presents and discusses the effect of the estimated LFPRM, applying ARDL Model. The endogenous variable for the model, presented in Table 3, is the LFPRM (proxy for unemployment). Following the long-run output, a unit change in AEC at current lag and lag (-1) will lead to 0.88 unit increase in LFPRM significantly (i.e reduction in unemployment). When AEC is high, economic activities are higher, higher profit for the business, and thus, higher job creation occurs. Thus, there is an increase in LFPRM, this finding corroborates the study of Agradi et al., 2022, Platt et al., 2014 and Wierda et al., 2016. Essentially, a unit increase in export (EXP) would cause LFPRM to rise by 60.43 and 99.21 units significantly, this is feasible because a rise in exportation for a country simply signifies improvement in economic and production methods which required more labor force participation in a country. Furthermore, gross domestic product per capita growth (GDPCG) is significant related with LFPRM with a unit rise lead to 12.17, 3.68 and 10.32 respectively. Notably, LFPRM show a non-significant connection with a unit change in population. Essentially, any change in population lead to reduction in LFPRM, this could due to the ageing population in the system or youth cannot get a job that meet their educational standard thereby resigning from such a job.

Table 4 Short run Coefficient

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LFPRM(-1))	24.924407	5.885455	4.234916	0.1476
D(LFPRM(-2))	31.16249	7.309701	4.263169	0.1467
D(LFPRM(-3))	-2.273728	1.888079	-1.204255	0.4412
D(AEC)	0.889187	0.294919	3.015019	0.0203
D(AEC(-1))	3.183204	0.770939	4.128997	0.1513
D(AEC(-2))	-0.416941	0.193275	-2.157245	0.2763
D(AEC(-3))	-0.602665	0.234159	-2.573743	0.0359
D(LNPOP)	2967.599606	824.08017	-3.601105	0.1724
D(LNPOP(-1))	-102.234322	302.498475	-0.337966	0.7925
D(LNPOP(-2))	-6107.59648	1499.41415	-4.073322	0.1533
D(LNPOP(-3))	2225.88539	605.167197	3.678133	0.169
D(LNEXP)	60.43636	15.153918	3.988167	0.0534
D(LNEXP(-1))	114.480426	26.7398	4.281275	0.1461
D(LNEXP(-2))	123.80914	32.604207	3.797336	0.1639
D(LNEXP(-3))	-139.074155	38.111648	-3.649125	0.1703
D(GDPCG)	-12.170586	3.031779	-4.014338	0.1554
D(GDPCG(-1))	11.830493	3.05829	3.868336	0.161

D(GDPCG(-2))	-6.631664	1.904648	-3.481831	0.018
D(GDPCG(-3))	10.320507	2.621848	3.936349	0.1584
CointEq(-1)	-0.815145	0.525681	-1.550645	0.0149

Source: Authors| computation, 2023

Table 4 shows the short-run connection of LFPRM, AEC, GDPCG, POP, and EXP. At the 1% level of significance, the cointegration coefficient is statistically significant, confirming the variables' established long-run equilibrium. With the contribution of all the explanatory variables, our fitted model is strong, with an error correction term (ECM) that accounts for almost 81% of the speed of adjustment to its cointegration route. It is interesting that our empirical discovery supports Borhan et al., 2023. In other words, a unit change in AEC at lag 3 results in reduction of LFPRM by 0.60. Although, it is expected an access to electricity consumption suppose reduces unemployment but reverse is the case. This could due to underemployment and unavailability of suitable jobs that match the candidate educational profiling. Essentially, in the short GDPCG is negatively related to LFPRM in South Africa economy. Any 1unit changes in GDPCG leads to 6.6units reduction in LFPRM in the short run. This validates Adekunle et al. (2022) findings which argued that a fundamental transformation in the economic system, by boosting energy-intensive production dynamics like coal and fossil fuel energy technologies, which dominate South Africa's energy production system, energy intensity is increased but energy efficiency is decreased which translate to reduction in GDPCG of the country. Thus, low AEC means lower productivity in industries, thus decreasing productivity. As a result, companies cannot gain more income and limit their capabilities to hire new workers, thereby, causing reduction in LFPRM. Furthermore, the study found out that an increase in export at current level will help increase LFPRM in the short run. The magnitude of the impact seems to be greater in the short run compared to the long run. Specifically, a 1% increase in EXP increase the LFPRM by 60.43units.

4.4. Stability of the Model

The schematics below are plotted to rationalize the presence of long run connection among specified variables. This is displayed in Figure 1, 2 and 3, hence, the study came to the conclusion that our model is robust and reliable.

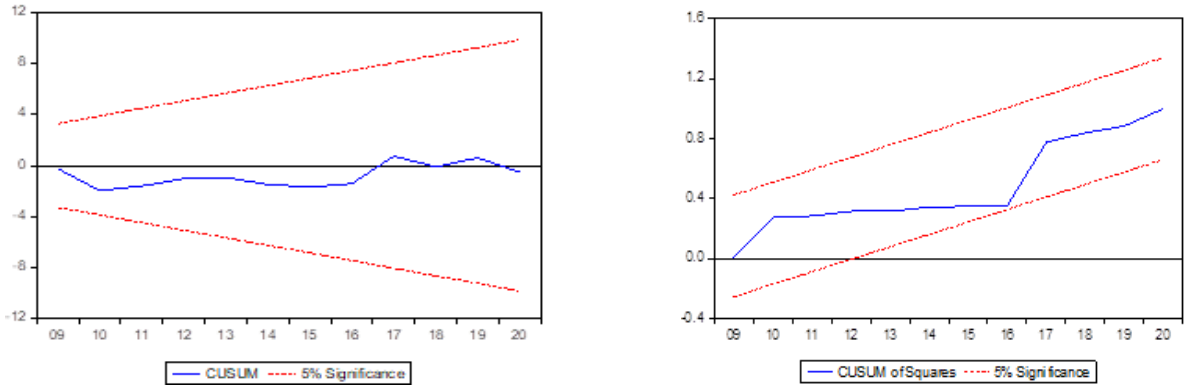

Figure 2: Plot of CUSUM and CUSUM Sum of Square CUSUM
Source: Authors (Eviews Output)

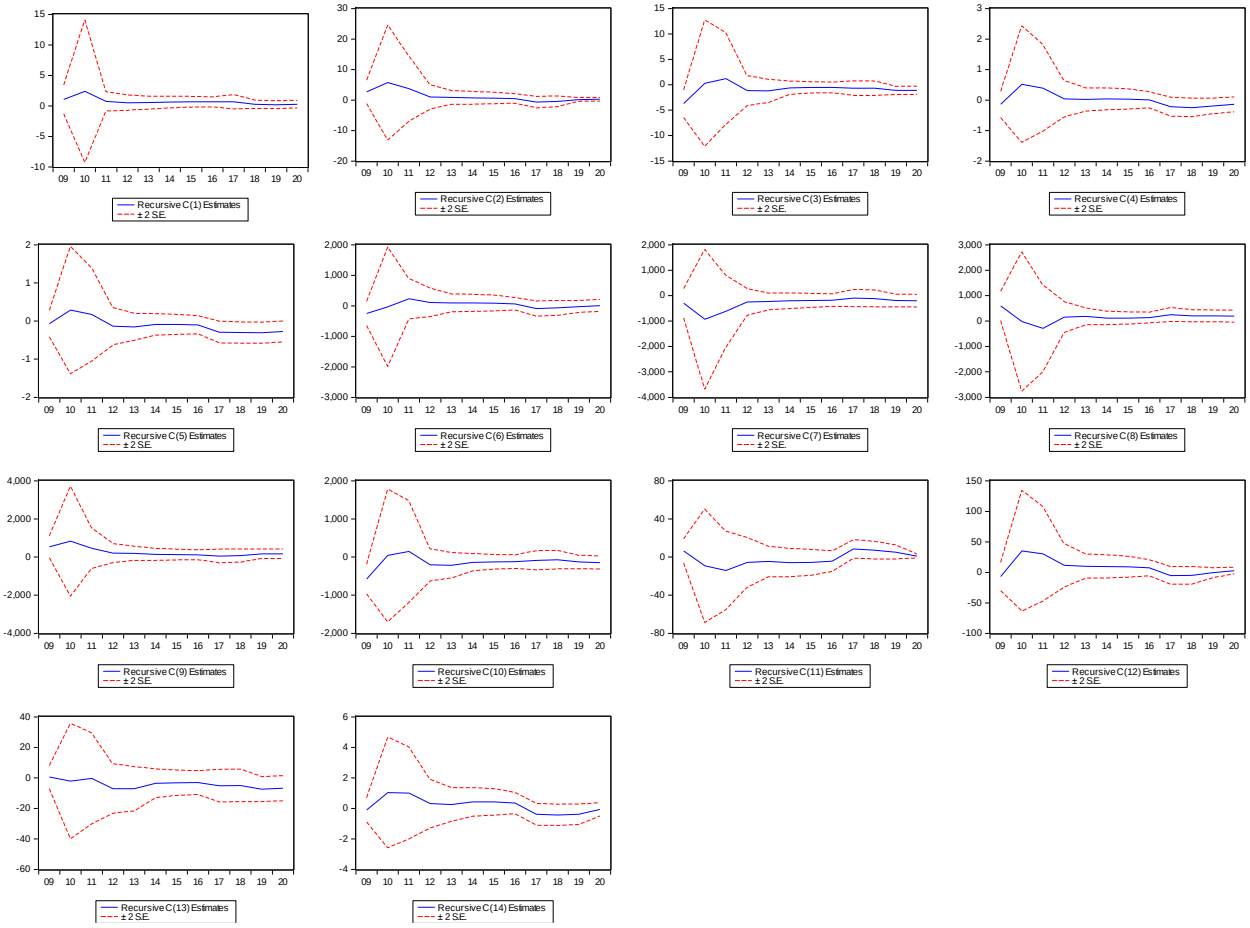

Figure 3: Plots of Recursive Estimates
Source: Authors (Eviews Output)

5. Conclusions

The aim of the paper is to evaluate the connection between access to electricity consumption and labor force participation rate in South Africa. The study uses ADF and PP methods to test for level of stationarity, the result indicate I(0) and I(1) which give justification for employing ARDL model to analyze the connection. The paper analyzes further the long-run connection between the examined variables through a bound testing, which confirms the existence of such relationships. The cumulative sum chart is also used to monitor the trend throughout the process.

Based on the results of the study, it can be concluded that most variables significantly affect the level of LFPRM in the short run and long run, with different lag values and expected signs. Essentially, it is found that access to electricity consumption (AEC), gross domestic product per capita growth (GDPCG) and export (EXP) have a positive impact on LFPRM. While in the short run access to electricity consumption (AEC) at lag 3, and gross domestic product per capita growth have negative connection with LFPRM while export shows positive impact on LFPRM in the short run. The study offers several policy recommendations. Firstly, the government should ensure that access to electricity consumption is improve and efficient. This will help boost LFPRM in the country thereby creating growth in the economic activities in economy. Secondly, the government should monitor the country's population growth to prevent it from rising too much, which could negatively affect the citizen's LFPRM. Finally, policymakers should not overlook the relevance of export in stimulating employment (LFPRM), government should formulate policies that encourage exportation such as creation of duty drawback schemes, increasing the availability of credit and simplifying regulation, thereby complementing LFPRM in the economy.

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