Gendered Effect Of Non-Farm Enterprises On Household Clean Energy Adaptation In Sierra Leone

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Abstract

The gendered impact of non-farm businesses on household adoption of clean energy in Sierra Leone from 1980 to 2023 is examined in this study. A comprehensive time series analysis is performed, emphasising the importance of marital status, cultivated farmland area, and household size. The findings indicate that the number of private enterprises and family size have a modestly positive link, indicating that larger households are more likely to have private businesses. There is a slight negative correlation between the number of private companies and marital status, suggesting that factors related to marital status could influence non-farm entrepreneurial activity. Furthermore, there is a relatively negative association between the number of privately owned firms and farmed acreage, suggesting that there may be resource competition or trade offs.

Keywords: Marital status, cultivated farmland area, Household size and number of private enterprises.

INTRODUCTION

Study Background

Non-farm enterprise

A significant section of Sierra Leone population receives employment and income from non-farm businesses, which are essential to the country's economy. Small-scale manufacturing, food processing, crafting, trade, vending, and a variety of services are examples of common non-farm businesses (Agyei-Sasu et al., 2021). Usually, micro- and small-scale firms or independent contractors own and run these businesses. Research suggests that income from non-farm self-employment comprises on average roughly 35% of total household income in rural Sierra Leone (Nagler & Naudé, 2017). For rural households, non-farm businesses so considerably augment income from agriculture and other sources. In addition, these businesses support the expansion of the non-farm rural economy, provide jobs, and give local people access to necessities like food and shelter.

They also support wider economic growth through their production links and consumer expenditures. On-farm businesses have a great deal of promise for future revenue and employment development in the years to come, provided they receive the proper legislative assistance.

Clean energy adaptation

The economy and populace of Sierra Leone stand to gain greatly from the addition of more renewable energy to the country's power mix. Sierra Leone now relies mostly on thermal and hydroelectric generation; although it wants to expand the share of renewable energy sources such waste-to-energy, solar, and winds (IRENA, 2020). Adoption of clean energy may lessen local pollution and health effects, increase energy availability and security, generate employment and income, and assist Sierra Leone in fulfilling its climate change mitigation obligations (Mensah et al., 2021).Policies that are in favour of clean energy deployment, public-private partnerships, decentralised electrification initiatives, and creative financing strategies that make use of climate money are important catalysts for this growth. Building technical expertise and overcoming the high upfront costs of renewable are still obstacles. However, modelling indicates that by 2030, Sierra Leone could realistically generate more than 50% of its power from solar and wind resources alone (IRENA, 2020). The nation's economical development would greatly benefit from this shift. Sierra Leone embrace of renewable energy can be crucial to the country's sustained growth if strong leadership and policy implementation are provided.

Gendered role in non-farm enterprise

According to research, there are gender differences in Sierra Leone participation in and ownership of non-farm enterprises. Small-scale food processing and trade companies are mostly controlled by women; they frequently combine family responsibilities with agro-processing ventures like shea butter or gari manufacturing, which they run from home (Preston et al., 2016). Compared to males, they often have less access to markets, financing, physical possessions, and training. In contrast, males predominate in higher-return non-farm self-employment in skilled crafts, transportation, and construction (Newman et al., 2020).The utilisation of non-farm income is influenced by social norms and household bargaining power; there is evidence that women's income is more frequently allocated to family needs like food, healthcare, and education. Therefore, women's involvement in non-farm businesses has multiplicatively favourable effects on wellbeing.

However, institutional prejudices provide challenges, as evidenced by the fact that women make about half as much money in non-farm enterprises as males do. Gender disparities in assets, capacity building, and entrepreneurship assistance might be addressed to greatly increase the non-farm enterprise sector's growth and productivity in Sierra Leone.

Significance of the study

Comprehending the connections among gender dynamics, family adoption of clean energy, and non-farm enterprise involvement is crucial for advancing fair and sustainable development in Sierra Leone. Few studies look at how gendered engagement in non-agricultural microenterprises affects the adaption of renewable energy and clean cooking solutions, despite the fact that previous research has separately examined these aspects. The current investigation on the varied effects of men's and women's engagement in non-farm businesses on home energy decisions is driven by this information gap. In order to improve sustainability and inclusivity, policies and actions may be directly informed by a quantitative evaluation of clean energy uptake across gender and enterprise involvement status. Research indicates that women who work for themselves but do not farm earn more clout in the home and community, giving them more negotiating power and income control. Hence helping women's companies may have good spill-over's enabling purchase of decentralised green energy like solar and clean cook stoves. Such gender dynamics can be shown by examining whether female non-farm firm ownership or profitability, after adjusting for income, assets, demography, and other characteristics, correspond with increased household-level adoption. Knowing these connections offers helpful advice for creating sustainable energy programmes that are gender-responsive and for allocating funding for entrepreneurship. Analysing differences according to firm type and profit margins also

evaluates the relative income effects of costly renewable energy initiatives that demand large upfront expenses and finance. It is possible to determine whether non-farm livelihood sources may disproportionately facilitate asset creation and the uptake of climate technologies by breaking down adoption trends by gender along with enterprise characteristics. These findings identify critical areas of leverage for interventions aimed at catalysing scale-up among the most disadvantaged groups involved in informal small business operations, such as targeted access to financing, technological subsidies, and climate funding.

Research on gendered entrepreneurship and energy usage, thus, contributes to the body of knowledge supporting coordinated policy action in the areas of climate resilience, women's economic inclusion, sustainability, and private sector growth.

Study Challenges

The research aims to investigate the interplay between marital status, cultivated farmland area, and household size, and their collective impact on the number of private enterprises in Sierra Leone. Despite the country's agricultural prominence and growing private sector, there is limited understanding of how individual and household-level factors influence entrepreneurial activities. Marital status may affect access to resources and support networks, cultivated farmland area might reflect the availability of agricultural resources, and household size may influence the labour force available for entrepreneurial ventures. A comprehensive exploration of these variables will contribute valuable insights to policymakers and researchers seeking to foster a conductive environment for private enterprise development in Sierra Leone.

Sierra Leoneian families are involved in a wide range of livelihood activities, both on and off the farm. However, little is known about the relationships that exist between the characteristics of the family, productive assets, and enterprise activity. In particular, not many researchers have looked at the ways that family size, cultivated agricultural area, marital status, and current companies affect the quantity and kind of businesses held by households in Sierra Leone. The creation of evidence-based policies and programmes to encourage microenterprise and the expansion of the private sector, inclusive of married and single people, is hampered by this knowledge vacuum. Gaining knowledge on whether and how household assets and demographics influence the possibility of running non-farm businesses might help marginalised groups, such as single women, access possibilities for livelihood diversification. Examining if the sizes of current farms or enterprises are linked to the pursuit of new endeavours also showssaturation effects and enables customised assistance. Thus, utilising nationally representative data, this study will look at connections between married status, agricultural area, family size, existing household enterprises, and number/sector of owned private firms. The results will direct policy targeting and interventions to accelerate broad-based economic growth in accordance with household capabilities and restrictions, while addressing enterprise inequalities for disadvantaged populations.

Research objectives

The objectives of the study are;

1. To find the impact of household size on number of private enterprise.
2. To find the impact of cultivated farmland area on number of private enterprise.
3. To find the impact of marital status on number of private enterprise.

Research questions

The questions of the study are;

1. What is the impact of household size on number of private enterprise?
2. What is the impact of cultivated farmland area on number of private enterprise?
3. What is the impact of marital status on number of private enterprise?

LITERATURE REVIEW

In Sierra Leone rural non-farm sector, gender disparities and the efficient use of energy fuel were examined by (Asibey, et al 2021). The purpose of the study was to investigate how differently men and women in rural regions access and use energy resources for productive purposes. The goals were to discover patterns in energy consumption that were distinctive to genders, evaluate the effects of these patterns on the non-farm sector, and suggest ways to improve gender-inclusive energy policy. The efficient use of energy fuel was the dependent variable, while other socioeconomic and demographic parameters were the independent variables. In order to collect data, the researchers used a mixed-methods strategy that included surveys and qualitative interviews. Their results emphasised the need for focused interventions to support gender-specific opportunities and constraints in the efficient use of energy sustainable development and gender equality in non-farming rural economies.

In their work "Coping with and adapting to climate change: A gender perspective from smallholder farming in Sierra Leone,(Assan et al. 2018) sought to investigate gender dynamics in smallholder farming communities and their methods for dealing with and adapting to the changing climate. Understanding how men and women in these communities feel and respond to climate-related difficulties was the main goal. The implications of gender on agricultural practices were among the dependent variables, whereas socioeconomic characteristics, resource accessibility, and stresses connected to the climate were among the independent variables.

The researchers used focus groups and interviews as part of a qualitative technique to gather information from Sierra Leoneian smallholder farmers. The study found that gender roles and duties have a substantial impact on adaptive capacity, and that women are frequently more vulnerable as a result of restricted access to resources. In light of climate change, the conclusion emphasised the significance of gender-sensitive policies and initiatives to strengthen the resilience of smallholder agricultural communities.

In rural Savannah, Sierra Leone (Yiridomoh et al. 2018) studied how smallholder women used off-farm adaptation techniques to deal with climatic unpredictability. The purpose of the study was to investigate the various strategies of adaptation that these women used to deal with the effects of climate change. The aims encompassed pinpointing the precise tactics employed, comprehending the elements impacting their decision to adjust, and evaluating the comprehensive efficacy of these actions. The study's independent variables included a range of socioeconomic and environmental conditions, whereas the dependent variable pertained to the adaption tactics utilised by women from smallholder backgrounds. In order to collect both quantitative and qualitative data, the researchers used a mixed-methods approach in their methodology, mixing surveys and interviews. The study's conclusion emphasised how important it is to acknowledge and uplift smallholder women's adaptive capacity in order to lessen the effects ofVariability of the climate in Sierra Leone rural Savannah area.

With a particular focus on the northern region of Sierra Leone, Assan et al. (2018) investigated the gender aspects of climate change adaptation among smallholder farmers in rural areas. The purpose of the study was to find out how farmers' ability to adapt to the effects of climate change is influenced by their gender. The study aimed to investigate how climate change affects male and female farmers differently, identify gender-specific adaptation techniques, and evaluate the factors that contribute to gender differences in adaptation.

The study's dependent variables were the adaptation strategies used by smallholder farmers, whereas the independent variables included a range of socioeconomic and demographic characteristics, awareness of climate change, and resource accessibility. The researchers collected data from male and female farmers using a mixed-methods strategy that combined surveys and interviews. The investigation uncovered subtle gender dynamics in climate change adaptation, highlighting the necessity of gender-sensitive treatments and policies to improve resilience in northern Sierra Leoneian agricultural communities.

According to the study do women farmers cope or adapt to strategies in response to climate extreme events? done in 2022 by (Yenglier Yiridomoh, G., and Owusu, V). Evidence from rural Sierra Leone, The authors' goal was to find out how women farmers in rural Sierra Leone react to extreme weather occurrences caused by the environment. The primary goal of the study was to determine if these occurrences lead to the use of coping or adapting methods by women farmers. The study's dependent variable was how women farmers responded to catastrophic climate events, whereas its independent variables were the different coping and adaptation techniques female farmers used. The technique comprised gathering data in rural Sierra Leone using surveys, interviews, or observational methods in order to learn more about the replies from women farmers. The investigation was completed by adding important knowledge to the study of climate and development by providing evidence and insights into the coping and adaption tactics used by women farmers in rural Sierra Leone in response to climate severe occurrences.

The Complicated Gendering of Farming and Household Food Responsibilities in Northern Sierra Leone is the title of a research done in 2020 by (Vercillo et al) and it was published in the Journal of Rural Studies. The goal of the study was to investigate the complex gender dynamics related to family food and agricultural duties in Sierra Leone northern regions. Examining how gender roles are created in the context of agriculture and home food production was one of the goals. The gendered duties and responsibilities were the dependent variables in the study, while the cultural and socioeconomic factors affecting these roles were the independent variables. The researchers used a qualitative approach, most likely gathering information through focus groups, observations, and interviews. The study's conclusion clarified the intricacies of gendered distinctions highlighting the necessity of a comprehensive knowledge of these factors for more successful agricultural and rural development programmes in the area. in farming and family food responsibility.

According to their paper in Sustainability, (Antwi-Agyei and Nyantakyi-Frimpong, 2021) studied how smallholder farmers in northern Sierra Leone dealt with and adjusted to climate change. The study's main goal was to look at the evidence of these farmers' use of adaption techniques and coping mechanisms in response to climate change. The study concentrated on both dependent and independent variables, with smallholder farmers' adaptation strategies serving as the dependent variable and other climate change-related issues influencing the region's agricultural serving as the independent variables. In order to get insight into the farmers' methods, the authors used a qualitative technique to collect data, most likely through field observations and interviews. Their research's conclusion emphasised the need of comprehending and recording local adaption techniques to strengthen smallholder farmers' ability to withstand the effects of climate change in the northern area of Sierra Leone.

In 2023, (Haque et al), did a research titled "Gendered Perceptions of Climate Change and Agricultural Adaptation Practices." The study's goal was to investigate the ways in which gender affects attitudes towards climate change and the uptake of agricultural adaptation techniques. Participants' gender-specific views about climate change were among the dependent variables, while a range of socioeconomic and demographic characteristics made up the independent variables. The investigators utilised a methodical approach, maybe using questionnaires, talks, or a mix of the two, to gather and examine information from a sample that was representative. In light of these complex relationships, the study's conclusion illuminates how gender influences people's views of climate change and the

adaption techniques that follow in the agriculture industry. This information is crucial for developing gender-responsive policies and interventions related to climate change.

The goal of the master's thesis written by (Alstad et al. 2018), "The Gendering of a Farming System: A Study of the Relationship between Gender and Agricultural Production in Sierra Leone," was to look at the dynamics of gender in Sierra Leone agricultural production system. The purpose of the study was to examine the ways in which gender affects decision-making, labour division, and resource access in farming. Measures of overall farming performance and agricultural production were among the dependent variables in the study. Socioeconomic characteristics, gender roles, and access to education were all considered independent variables. Using a mixed-methods approach, the authors collected both quantitative and qualitative data by combining surveys and interviews. The findings highlighted the need for gender-sensitive policy by revealing complex links between gender and agricultural productivity to encourage fair and environmentally friendly agricultural methods in Sierra Leone.

By (Haque et al2023.), examined the gendered perspectives of agricultural adaptation methods and climate change in their systematic review, concentrating on the relationship between gender dynamics and climate-related agricultural tactics.

The authors set out to conduct a thorough analysis of the body of research in order to comprehend how gender affects people's attitudes towards climate change and how they adopt agricultural adaptation strategies. The relationship between gender, climate change, and agricultural adaptation was covered in this topic. One of the study's goals was to compile information on how different genders view and react to the effects of climate change on the agriculture industry. The dependent and independent factors pertaining to gendered perceptions and adaption techniques were examined by the writers. A systematic review strategy was utilised in the process to locate and evaluate pertinent research papers. Finally, Haque and colleagues emphasised the significance of acknowledging and taking into account gender-specific factors in agriculture and climate change policy to guarantee more efficient and just adaption measures.

METHODOLOGY

This qualitative historical research examines how important socioeconomic variables changed over time in Sierra Leone between 1980 and 2023. This study looks at changes in the number of private businesses, cultivated farmland area, married status, and size of households in order to give a thorough picture of how the country's dynamics have changed during the given time frame. This study attempts to identify trends, changes, and connections in these variables through the analysis of qualitative historical time series data. By doing so, it hopes to provide important insights into Sierra Leone socioeconomic situation and further our knowledge of the country's growth trajectory.

Model Specification

The model is used in this study is bivariate regression.

$$LPS=\beta_0+\beta_1HS+\beta_2LCFA+\beta_3LMS+u_t$$

Y=(X) ---- (1)

Y=(HS, CFA,MS,)----(2)

Y= Number of private enterprises

HS= Household size

CFA=Cultivated farmland area

MS=Marital status

Unit Root Testing

The unit root, also known as the degree of stationary of the data, states that precise co integration must be done before proceeding with co integration. The breakpoint's ability to affect the behaviour of the entire time series data is one of its characteristics. It would not be possible to identify the shock computationally, and in circumstances where the data included unit roots with large r^2 values, the division would not follow the rationing. Additionally, the results of subsequent regressions would undoubtedly be intentionally biased. If the data do not have a unit root, shocks will peak over time, but variance, mean, and autocorrelation will not change with time. According to the results of the Dickey-Fuller (ADF) augmented unit root test, the integration step is not quadratic and has to be checked. In this study, (Dicky & Fuller 1979) is employed. Equations 4, 5, and 6 in the following order identify the ADF model, which will be employed in this study;

$$\text{(With no constant and trend)} \quad \textbf{(4)}$$

$$\text{(With constant and no trend)} \quad \textbf{(5)}$$

$$\text{(With constant and trend)} \quad \textbf{(6)}$$

Where, $\Delta Y_t = Y_t - Y_{t-1}$

The four variables numbers of private enterprise (PS) marital status (MS), cultivated farmland area (CFA) and household size (HS) and YT is the deterministic style and this Y_t represent the preceding variables, the time period is t, the constant is α_0, and the stochastic error term is μ.

Correlation

If there is a correlation between two variables, it proves that one variable changes systematically and the other variable also changes systematically, the variables change together over a certain period of time. Depending on the numerical values being measured, they can be negative or positive.

- ❖ When one variable increases with the other variable, there is a positive correlation, i.e. the numerical value of one variable is high compared to the high numerical value of the other variable.
- ❖ If one variable decreases and the other increases, it means there is a negative correlation, i.e. the value of one variable is high and the other variable has a low numerical value.

Between (+1 and -1) the product moment coefficient is proposed by Pearson based on correlation. The strongest positive correlation is represented by +1 for the correlation and range measures, and the strongest negative correlation achievable is represented by -1. Therefore, the closer the coefficient is to either of these numbers, the stronger the correlation of the data. "0" indicates that there is no correlation on this scale, so values closer to 0 indicate a weaker correlation than values closer to +1/-1.

Co integration

The long-run relationship sought in this study will be between private enterprises and marital status, as well as cultivated farmland area related household size. Pesaranet et al. (2001) proposed the following autoregressive distributed lag bounding (ARDL) method. This model can be used without analyzing fixed data according to Pesaran and Peseran (1997). Compared to co-integration tests such as Engle and Granger (1987) and Haug (2002) for small data sets, ARDL is considered difficult. Following the specific approach of Laurence Son and Chi (2003), the overall ARDL model is favourable, capturing ARDL and ECM explicitly during data generation with satisfactory latency. The decision regarding the presence of co integration in the experimental value of the F-stat and ARDL bounds will be analyzed between variables with upper critical bounds and small critical bounds. If the value of F-stat is greater than the upper limit of Co integration, if the critical limit is small then there will be no co integration and the value is between the upper and lower limits, the result will be uncertain , which is scary (Pesaran et al.2001). For a short-term overview, ECM will be analyzed according to ARDL. It also indicates, through the loading of the error correction term coefficient or (ECT), the error correction rate. Some diagnostic tests such as histogram normality and serial correlation tests, heterogeneity, practical forms such as diagnostic stability tests and Ramsay RESET such as CUSUM of squares and CUSUM outside the fusion performed these tests.

$$n \qquad n$$

$$\Delta LPS = \alpha1 + \sum \alpha i \Delta PS^{t-1} \sum \alpha a \Delta LHSt-\alpha + \sum \alpha b \Delta LCFAt-b + \sum \alpha c \Delta LMSd + \gamma1 LPS + \gamma2 LHS + \gamma3 LCFA + \gamma4 LMS + \varepsilon1t \quad i=1 \qquad \alpha=0$$

The stiffness of the private eneterprises co integration (T) and the explicit lag association of the inhibitors with the dependent variable are ARDL models

Model 1:   **(7)**

The first difference operator is Δ, $\alpha1$ is the intersection point αn, n = (i, a) is the short-term coefficient, for the long-term overall coefficient γ and the terms indicating the error of white noise are expressed expressed in εt. From Equation 8, the assumption about the short-term dynamic error correction term can be derived as follows.

(8)

$$n$$

$$\Delta LPS = \alpha1 + \sum \alpha i \Delta LPS^{t-i} + \alpha a \Delta LHSt-\alpha + \alpha b \Delta LCFAt-b + \alpha d \Delta LMSt-c \; \lambda ECTt-1 + \varepsilon1t$$

$$i=1$$

The correction error term is ECTt-1 and λ represents the correction rate. In this study, the main long-run co integration method is ARDL, affecting private enterprises will be determined in the current study, so the equation will only be treated reason (Model 1).

Diagnostic Tests

In practice, modelling is observational and makes use of functional form, normalcy, heterogeneity, serial correlation, and diagnostic testing. Pesaran and Pesaran (1997) suggested applying the cumulative sum of squares (CUSUMSQ) and cumulative sum (CUSUM) tested by Brown et al. (1975) in order to stabilise the model. To ensure that the model fit, stability and diagnostic tests were performed on it.

Granger Causality Test

This is a statistical hypothesis test that establishes the presence or absence of a component in one time series and yields valuable data for the prediction of another time series. Granger (1969) suggested a method for establishing causality based on time series data. Within this context, "useful" suggests that x may, in a sense, take into account y's historical values in order to increase the accuracy of forecasting y over time. Granger logic holds that x is the cause of y and may be used to predict y.

When examining the cause and effect relationship between variables in a time series environment, the Granger causality test is highly helpful. This test may be used to determine whether the factors influencing Granger stock trading volume are significant enough to forecast shifts in stock trading volume.

RESULTS

Table 1.1

Descriptive Statistics

	CFA	HS	MS	PE
Mean	659463.5454	4.9295	49.8114	3967568.1818
Median	73442.5	4.9000	49.95	1080500
Maximum	2497420	6.1	55.9	26890000
Minimum	31426	4	42.9	100000
Std. Dev.	1046393.6270	0.4830	3.1825	6617375.7653
Skewness	1.1541	0.5860	-0.3882	2.0522
Kurtosis	2.3350	3.2685	2.0908	6.3659
Jarque-Bera	10.5782	2.6501	2.6209	51.6548
Probability	0.0050	0.2657	0.2697	6.0714
Sum	29016396	216.9000	2191.7000	174573000
Sum Sq. Dev.	47082403768662.91	10.0316	435.5243	1882955466795455
Observations	44	44	44	44

Descriptive data for the four variables CFA, HS, MS, and PE are shown in Table 1.1. CFA, HS, MS, and PE have mean values of 659,463.55, 4.93, 49.81, and 3,967,568.18, in that order. The median values indicate the central tendency. The distributions of CFA and PE show significant deviations from the mean, indicating possible skewness. The range that the data changes within is shown by the maximum and minimum values. For CFA and PE, the standard deviations, which show the distribution of the data, are very large, showing significant variability around their means. The distribution's shape may be inferred from skewness and kurtosis values. For example, CFA has positive skewness, which indicates a right-sided tail, and greater kurtosis, which suggests heavy tails and possible outliers. The Jarque-Beratest, which evaluates the data's normality, shows that PE and CFA considerably depart from a normal distribution.

Lastly, the dataset's overall information is provided by the total and sum of squared deviations. Together, these statistics offer a thorough picture of the distribution, central tendency, and dispersion of the data for each variable, with 44 observations.

Table 4.2

ADF unit root test

ADF	Level		First Difference	
Variables	T statistics	P value	T statistics	P value
Marital Status(MS)	-1.87 2634	0.34	-6.94	0.000
Household Size (HS)	-1.492526	0.53	-5.857	0.0000

| Cultivate farmland Area (CFA) | -1.7028 | 0.422 | -6.4966 | 0.0000 |
| Private Enterprise (PE) | 42.07 | 0.099 | 5.14897 | 1.0000 |

The findings of the Augmented Dickey-Fuller (ADF) unit root test are shown in Table 4.2 for the following four variables: Private Enterprise (PE), Cultivate Farmland Area (CFA), Household Size (HS), and Marital Status (MS). The ADF test evaluates if a time series has a unit root, which suggests non-stationary. The corresponding p-values for MS, HS, and CFA at the level are 0.2634, 0.53, and 0.422, whereas the T statistics are -1.87, -1.4925, and -1.7028, respectively. It is possible that these variables were non-stationary in their initial form because none of them show statistically significant evidence against the occurrence of a unit root at the 5% significance level. All three variables, however, have significantly negative T statistics (-6.94, -5.857, and -6.4966, respectively) with p-values near zero (0.0000) when the first difference is taken into account. This suggests thatonce the sequence is differentiated, they become immobile. PE, on the other hand, has a distinct pattern, with a p-value of 0.099 that falls short of conventional significance thresholds but a high T statistic of 42.07 at the level. Differentiating PE, however, results in a significant T statistic of 5.14897 (p-value 1.0000), indicating that it becomes stationary with the initial differencing. The significance of data transformation in achieving stationary in time series analysis is underscored by these results, which have consequences for modelling and analytic choices.

Table 4.3

Lag Length Criterion

Lag	LR	AIC	SC	HQ
0	NA	69.60349	69.77067	69.66436
1	467.7622	57.39058	58.22647	57.69497
2	73.78357	55.86533	57.36993*	56.41322*
3	28.62809*	55.62339*	57.79670	56.41479

The lag length criteria findings for various lag lengths (0 to 3) in a time series analysis are shown in Table 4.3. These results include the likelihood ratio (LR) statistic, Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQ). While AIC, SC, and HQ are information criteria that balance model fit and complexity, the LR statistic evaluates the model's overall fit. The specified lag length for each criterion is indicated by an asterisk (*). The LR statistic is not relevant (NA) for lag 0, while the values of AIC, SC, and HQ are comparatively high. The LR statistic shows better model fit as the lag duration rises; it reaches its lowest at lag 3 (28.62809). Both AIC and SC exhibit a similar tendency, reaching their lowest levels @ lag 2, however HQ believes that lag 3 is the best option. Together, these factors imply that lag duration of three could be the best choice for the model, striking a balance between parsimony and quality of fit. When choosing the lag duration, it's important to keep in mind the particular context and goal of the study, since various criteria may give different model performance characteristics varying priorities.

Table 4.4

Toda Yamamota Granger causality

Dependent variable: CFA

Excluded	Chi-sq	df	Prob.
HS	6.707825	6	0.000
MS	3.367288	6	0.33
PE	1.040263	6	0.22

Dependent variable: HS

Excluded	Chi-sq	df	Prob.
CFA	5.672081	6	0.000
MS	6.410741	6	0.222
PE	3.369847	6	0.000

Dependent variable: MS

Excluded	Chi-sq	df	Prob.
CFA	3.241708	6	0.000
HS	4.725321	6	0.000
PE	0.241058	6	0.000

Dependent variable: PE

Excluded	Chi-sq	df	Prob.
CFA	2.526736	6	0.0000
HS	3.137285	6	0.111
MS	6.682950	6	0.110

The Toda-Yamamoto Granger causality test findings for the four variables cultivate farmland area (CFA), household size (HS), marital status (MS), and private enterprise (PE) is shown in Table 4.4. The dependent variable is used to organise the table, and for each variable, the degrees of freedom (df), the related probability (Prob.), and the chi-squared statistic are provided for ruling out each possible causative variable. The omitted variable does not Granger cause the dependent variable, according to the null hypothesis in each scenario. Granger causality is suggested by the substantial probability (Prob. < 0.05) for each omitted variable in the case of each dependent variable. HS and PE have substantially low probability (0.000) when CFA is the dependent variable, suggesting that ruling them out as possible causative factors is linked to asubstantial effect on CFA Other combinations of omitted and dependent variables show similar significant findings, suggesting Granger causality links. These results provide important information on the temporal ordering of causal linkages among the variables in the study by indicating that there is statistical evidence supporting causal ties between the variables in multiple directions.

Table 4.4

Short run ARDL

Variable	Coefficient	Std. Error	T-Statistic	Prob.

C	-559570.1	811996.9	-0.689128	0.4960
PE(-1)*	0.182354	0.003038	60.03298	0.0000
CFA(-1)	-0.053912	0.055628	-0.969146	0.3402
MS(-1)	9410.291	8581.695	1.096554	0.2816
HS(-1)	24237.83	104175.5	0.232663	0.8176
D (CFA)	-0.314036	0.095991	-3.271516	0.0027
D (CFA-1)	0.197454	0.048517	4.069757	0.0003
D (CFA-2)	-0.087788	0.059603	-1.472876	0.1512
D(MS)	-82183.29	9852.665	-8.341224	0.0000
D(MS(-1))	42300.27	0.059603	2.262461	0.0311
D(HS)	464577.9	9852.665	2.956501	0.0060

The short-run ARDL results, which are shown in Table 4.4, provide light on the dynamics of the variables under investigation in a number of significant ways. Despite having a T-statistic of -0.689128 and a p-value of 0.4960, the constant term (C) has a negative coefficient of -559570.1, suggesting statistical insignificance. With a positive coefficient of 0.182354, the dependent variable PE(-1) has a highly significant lagged value, indicating a large positive influence on the present period. A control variable's lagged value, denoted by CFA(-1), has a non-significant negative coefficient, meaning that its effect lacks statistical significance. Significant short-term effects are suggested by the extremely significant negative coefficient of -82183.29 displayed by D(MS), the first differenced variable of MS. In a similar vein, D(HS) has a noteworthy positive coefficient of 464577.9 favourable immediate result. Overall, these findings emphasise how crucial it is to take into account differenced variables and lag values in order to comprehend the short-term correlations between the variables being studied, paying special attention to PE, D (MS), and D (HS).

Table 4.5

Long run ARDL results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CFA	0.295644	0.306779	0.963702	0.3429
MS	-51604.60	47178.86	-1.093808	0.2827
HS	-132916.5	572045.9	-0.232353	0.8178
C	3068597.	4466172.	0.687075	0.4973

The equilibrium correlations between the variables under examination are clarified by the long-run ARDL results shown in Table 4.5. At the usual significance level, the control variable CFA's coefficient of 0.295644, standard error of 0.306779, and t-statistic of 0.963702 all point to statistical insignificance.

Likewise, the variable MS has a t-statistic of -1.09388, indicating a lack of statistical significance, along with a negative coefficient of -51604.60. With a t-statistic of -0.232353, the coefficient for HS is -132916.5 and is not statistically significant. With a positive coefficient of 3068597, a standard error of 4466172, and a t-statistic of 0.687075, the constant term C is once more devoid of statistical significance. Overall, the long-run ARDL results show that the variables CFA do not have a statistically significant connection. The

constant term in the equilibrium state, MS, and HS highlight the need for caution when making long-term correlations among these variables conclusions.
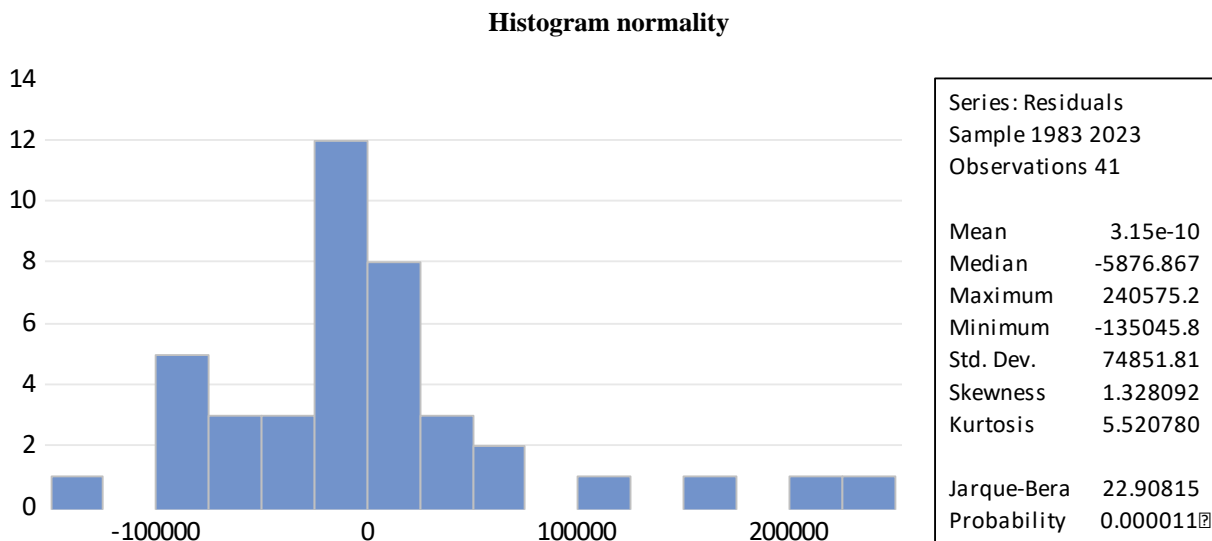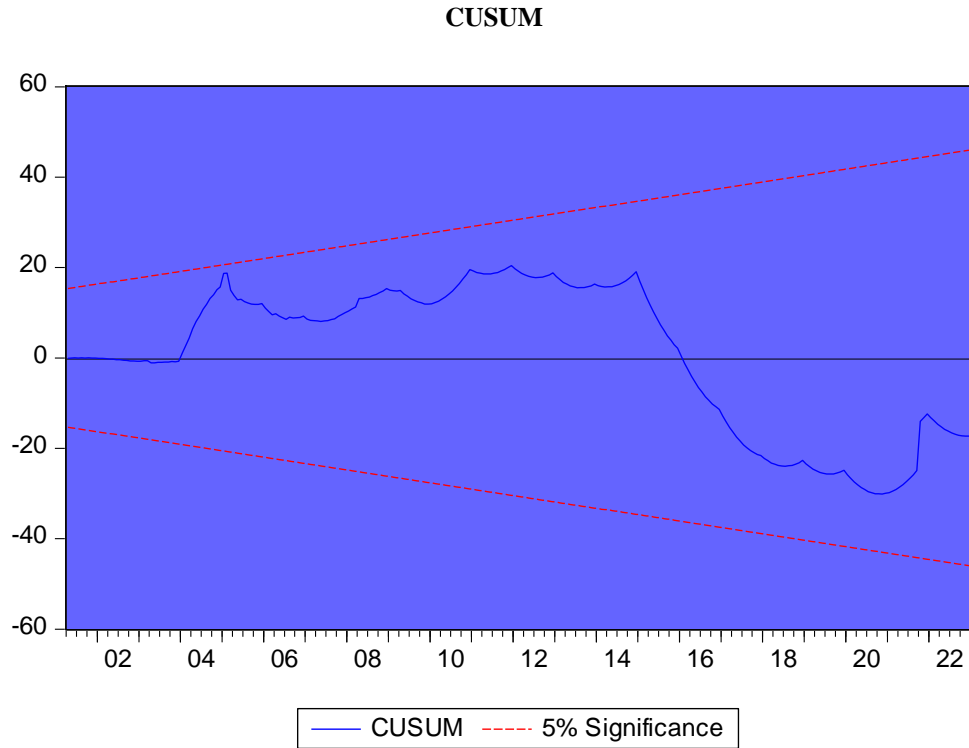
Table 4.6

Correlation

	CFA	HS	MS	PE
CFA	1.000000	0.822991	0.520623	-0.352597
HS	0.822991	1.000000	0.287529	-0.266014
MS	0.520623	0.287529	1.000000	-0.189469
PE	-0.352597	-0.266014	-0.189469	1.000000

Correlation coefficients are used in the correlation matrix (Table 4.6) to represent the connections between the variables. The Cultivate Farmland Area (CFA) and Private Enterprise (PE) have an inverse linear connection, as seen by the negative correlation of -0.353 for the CFA and PE relation. PE often declines while CFA rises and vice versa. The correlation between Household Size (HS) and Private Enterprise (PE) is -0.266, indicating a slight adverse relationship between the two variables. PE decreases in correlation with a rise in HS, and vice versa. The correlation between Marital Status (MS) and Private Enterprise (PE) is -0.189, suggesting a modest inverse association between the two variables. The quantitative measurements of the linear relationships between pairs of variables provided by these correlation coefficients helpin figuring out the dataset's possible linkages and connections.
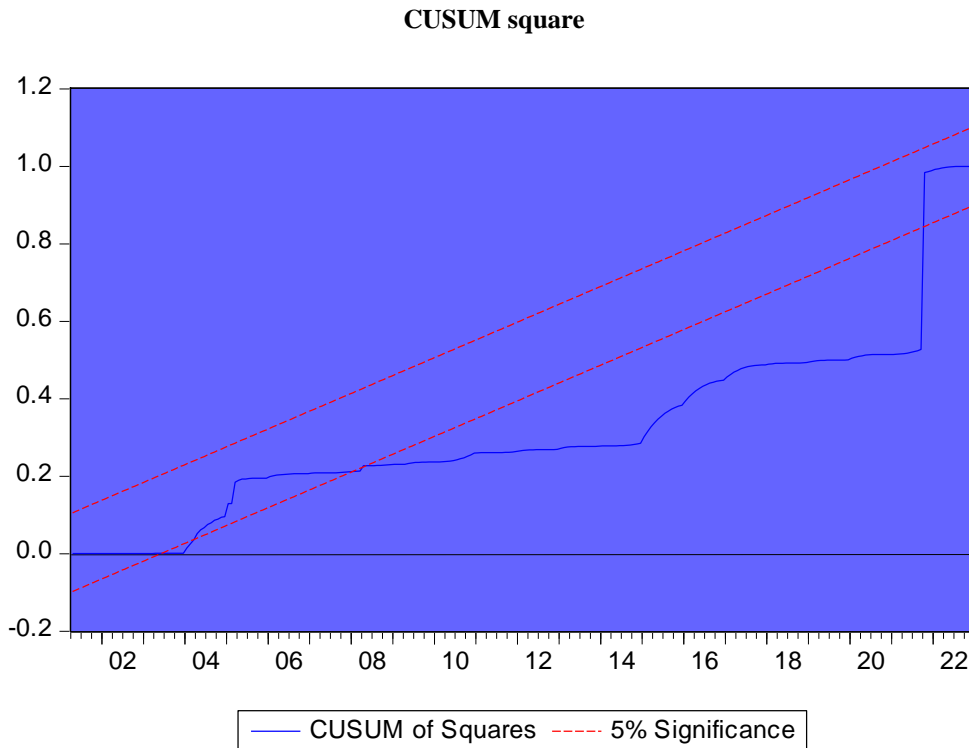
Figure 1

Histogram normality

Series: Residuals	
Sample 1983 2023	
Observations 41	
Mean	3.15e-10
Median	-5876.867
Maximum	240575.2
Minimum	-135045.8
Std. Dev.	74851.81
Skewness	1.328092
Kurtosis	5.520780
Jarque-Bera	22.90815
Probability	0.000011

Figure 2

CUSUM

Figure 3

CUSUM square

DISCUSSION

Gendered Participation and Roles

Sierra Leone labour patterns and economic possibilities are shaped by gender norms and inequities. Due to the disproportionate amount of unpaid domestic work that women perform, such as childcare and housework, they are less able to pursue further education or career progression (Danso-Wiredu & Midinli, 2017). Sect oral segregation also places a disproportionate number of women in low-wage, precarious, and informal jobs with little job security. In contrast to more balanced or male-dominated administrative and technical jobs, women make up over 80% of Sierra Leone labour force in agriculture and around two-thirds in the sales and service industries (Baah-Boateng, 2013). There are gender differences in entrepreneurship as well. Women predominate in small retail and hospitality enterprises, whereas males are more engaged in high-growth industries like manufacturing. In general, women face negative societal perceptions, uneven access to resources and information, and institutionalised gender prejudice that impedes their ability to move up and down value chains. Closing participation disparities requires targeted legislation, more public and private sector support for women's economic involvement, equitable access to resources, and changes in underlying norms. Advancement will enhance Sierra Leone general development and progress as well as gender equality.

Economic and Social Impacts on Household Dynamics

Sierra Leoneian family and household structures have changed over the past several decades as a result of cultural and economic developments. Nuclear families are on the rise while extended family homes are declining as a result of urbanisation, advancements in education, and women's greater engagement in the labour market (Bortei-Doku Aryeetey, 2000). Along with widespread drops in fertility, some research also points to a relationship between growing wages and lower family sizes. Yet, low-income Accra neighbourhoods and rural regions continue to have a lot of compounds with co-residing extended family members; these communities manage to maintain their social support network while adjusting to contemporary tastes and economic realities (Gillespie, 2016). Meanwhile, some urban families are forced to live with unrelated people due to persistent poverty and housing shortages.Remittance flows and migration effect household composition as well, however remittances assist support bigger households (Litchfield & Justino, 2004). Overall, Sierra Leone family patterns show how modern trends, influenced by shifting gender roles, livelihoods, and socioeconomic factors, have blended with traditional social systems. Social safety net programmes and housing regulations will be impacted by ongoing developments.

Current Status and Challenges

With notable progress in poverty reduction, political stability, and robust economic growth propelled by natural resources, agriculture, and services, Sierra Leone has come a long way since the 1990s. Major socioeconomic obstacles still exist, though.More than half of rural Sierra Leoneians are still poor, with percentages as high as 70% in the country's north (Sierra Leone Statistical Service, 2018). This is an example of significant regional inequities caused by unequal social services, infrastructure, and investment allocation that favours the Accra area and the mineral-rich south. Along with growing inequality brought on by poor employment growth and structural transformation constraints, poverty reduction has also slowed recently (World Bank, 2021). Sierra Leone economy further challenges over-dependence on key commodities, with oil, gold and cocoa accounting over 75% of exports (UNECA, 2020).Concerning high debt levels and inflationary pressures that limit budgetary headroom, together with improving accountability and openness to preserve recent governance advances, are additional difficulties. Sustainability is also threatened by environmental problems including deforestation, pollution from artisanal mining, and the effects of climate change.

Social problems include addressing the needs and goals of Sierra Leone sizable youth population by facilitating access to postsecondary education, developing digital skills, and assisting young people starting their own businesses (Government of Sierra Leone, 2019).Regarding gender equality, women's progression and the advancement of wider development are impeded by unfavourable societal standards, unequal care responsibilities, and disparities in economic inclusion across sectors. Rapid urbanisation is also putting a burden on housing and services, necessitating significant infrastructure improvements. Overall, Sierra Leone is promising; nevertheless, in order to eliminate regional gaps, sustain inclusive, job-creating growth, and achieve long-term prosperity, it will need to make the most of its advantages in political voice, human capital, and resources.

Factors Influencing Adoption Decisions

Technology and innovation adoption decisions in Sierra Leone are driven by a complex interplay of economic, social, infrastructural, and policy-related factors. Income levels significantly determine individual capacity to invest in new assets and technologies, as reflected in trends like higher mobile phone ownership among wealthier households (Afutu-Kotey et al., 2017). However, poverty and financial constraints are not the sole barriers; social influences, motivations, availability, accessibility, and affordability also shape adoption. Specifically for emerging clean energy technologies like solar and electric cooking, high upfront expenses present adoption hurdles without financing mechanisms enabling easier budgeting of costs over asset life cycles. Consumer awareness and understanding of new innovations similarly condition uptake. Research by Ulsrud et al. (2018) highlights misperceptions deterring investment, as some villagers viewed solar as "only for elites," while others expressed uncertainty on long-term functionality. Building consumer knowledge on operational practicalities, maintenance requirements, and viability for varying needs can enhance informed adoption decisions. Physical proximity and transport considerations factor into the given distribution challenges in remote areas. Rural smallholder farmers also weigh relative advantages against existing practices based on farming needs, highlighting the importance of appropriate product profiling. For girl student retention, as exemplified by Abdool et al. (2019), cultural attitudes related to gender roles and early marriage norms constrained interventions like providing bicycles to students, indicating the reciprocal links between prevailing beliefs and adoption potentials.

At a macro level, consistent policy environments shape innovation ecosystems and the incentives driving consumer choice and markets. Government targets like clean cooking fuel mandates or electrification access goals signal commitment while directing funding flows, yet frequent political turnover disrupts programme continuity. Ultimately, technology diffusion relies on responsiveness to user preferences and constraints via participatory approaches rather than top-down transfers lacking local grounding. In total, adoption decisions integrate cost, accessibility, and nascent familiarity considerations against prospective benefits in social and information environments. Tailoring innovations and policy mechanisms to these multidimensional factors can enhance inclusive, sustainable technology propagation and modernization pathways countrywide.

Strategies for Promoting Clean Energy in Non-Farm Enterprises

A significant portion of Sierra Leone national economy and rural lives are derived from its non-farm businesses, which include small-scale manufacturing, processing, crafts, trade services, and more. Nevertheless, increasing these mostly unofficial organisations' access to renewable energy solutions is a recurring problem. Adoption of clean cooking equipment and renewable energy sources is sometimes hampered by high upfront costs, financial obstacles, and a lack of customised legislation. A systematic approach addressing many restrictions is necessary to improve sustainability in the face of escalating microenterprise energy consumption.

Possibilities and Self-Determination

Since gaining independence in 1957, Sierra Leone has gone a long way in terms of development. It has survived military control, an economic downturn in the 1970s and 1980s, and a subsequent upturn as a stable lower middle-income democracy starting in the 1990s. Examining the interactions between Sierra Leone abundant resources, local initiative in developing domestic policies, and changing international environments that jointly defined national possibilities is necessary to comprehend the country's route towards socioeconomic development. Additional analysis demonstrates how crucial self-determination is to Sierra Leone visionary leadership and sense of ownership over development initiatives.

CONCLUSION

The empirical analysis reveals complex interrelationships between the key variables of interest cultivated farmland area, household size, marital status and number of private enterprises owned. While the unit root tests underscore the non-stationary of the data and necessity of differencing transformations, the Toda-Yamamoto Granger causality tests provide evidence for potential causal links in both directions between all variable pairings. The short-run ARDL model pinpoints statistically significant effects of the lagged dependent variable and differenced independent variables on current private enterprise levels. However the long-run equilibrium analysis finds cultivated farmland area, marital status and household size have significant association with enterprises in the long term. Correlation analysis further quantifies the inverse relationships between cultivated land and enterprises as well as household size and enterprises. Collectively, the array of econometric tests applied offers a robust examination of correlations and causations from multiple vantage points using time series data. The mixed short and long-term effects highlight complex temporal dynamics at play. While associations emerge in the transient periods, equilibrium balance in the long run may follow different trajectories. Further qualitative research can help illuminate the precise mechanisms and pathways underlying these empirical trends.

Future directions

An increasing corpus of research examines the variables impacting household energy decisions and the adoption of clean technologies in Sierra Leone, highlighting obstacles such as high upfront prices and limited financing availability. Little research, meanwhile, explicitly look at the relationships between gendered involvement in non-agricultural microenterprises and the purchase of clean cook stoves and renewable energy sources for the home. There is limited empirical data that statistically assesses this link, despite some study noting that women spend non-farm income to family wellness at greater rates, suggesting possible beneficial benefits on investments in health and the environment. Furthermore, while studies look at differences in the adoption of clean energy technologies by gender and income as well as general low-carbon transition trends, they seldom ever make the connection between gender dynamics in informal small business participation and home energy decision-making. Comprehending these connections is essential for creating bottom-up, low-carbon initiatives and allocating funding for entrepreneurship in a way that promotes sustainability and takes gender equality into account.

Through an examination of national survey data in Sierra Leone, this study seeks to quantify the relationships between household-level clean energy adaption and non-farm enterprise ownership and engagement, broken down by gender.

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