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Fuel subsidy removal and household welfare during energy transition: Evidence from Southwest Nigeria

Aduralere O. Oyelade[a,*], Afeez Taiwo Tella[b]

[a]*Department of Economic, Chrisland University, Abeokuta 110104, Nigeria*
[b]*Ulster University, Louisa Ryland House, 44 Newhall Street, Birmingham B3 3PL, United Kingdom*

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Abstract

The removal of fuel subsidy is a policy lever employed to facilitate the development of cleaner and more efficient energy systems. However, its legitimacy depends upon social sustainability outcomes. The present study examined the relationship between the removal of fuel subsidy and household welfare during the energy transition. The investigation utilized a sample size of 3,600 sample sizes from the six states in the region, thereby providing robust evidence from Southwest Nigeria. The present study demonstrates that subsidy removal has a detrimental impact on household welfare through both direct price effects and indirect inflation transmitted via transportation expenses. These welfare impacts indicate that sustainability transitions require 'just transition' measures, such as targeted compensation, to reduce adverse effects on vulnerable households while energy-market reforms proceed.

Keywords: Direct effect, fuel subsidy removal, household, human welfare, indirect effect

1. Introduction

Subsidies represent an important reform in facilitating the transition to cleaner energy/efficient pricing. The amount of financial resources allocated by governments worldwide for the purpose of providing subsidies for energy particularly fuels is deemed astounding. This, in addition to the increasingly greater subsidies being made accessible to other alternative and renewable types of energy in the wake of global and national economic recession, definitely call for concern (Soile & Mu, 2015). According to the International Energy Agency (IEA) in their 2023 World Energy Outlook, as of 2022; 51 countries worldwide continue to subsidize fuel consumption. The total value of these fuel consumption subsidies was estimated to be approximately $600 billion, or approximately 0.6% of global GDP (IEA, 2023). The IEA report observed that while numerous countries have recently implemented measures to reform or phase out fuel consumption subsidies, a significant number continue to maintain such subsidies, which distort energy markets and undermine efforts to transition to cleaner energy sources (IEA, 2023).

The removal of fuel subsidies is frequently implemented as part of broader energy-transition reforms. By reducing price distortions and shielding consumers from real energy costs, subsidy reform can encourage more efficient energy use, shift demand away from heavily subsidized fossil fuels, and create space for cleaner energy investments. From the policy standpoint, the reform is frequently justified not only by fiscal considerations, but also by sustainability objectives, including emissions reductions and alignment with climate-related targets. However, given the transmission of energy prices are transmitted through the economy, subsidy removal may result in short-to-medium-term welfare losses, particularly for low-income households, through direct commodity price increases and indirect inflationary pressures. Therefore, the success of energy transition policies depends on their *social sustainability*, that is to say, whether households can maintain essential consumption level while transition measures are being proceeded.

According to a report of IEA, (2023), approximately 10 major oil-exporting countries have phased out or substantially reduced fuel consumption subsidies. This group of countries include Saudi Arabia, the United Arab Emirates, Indonesia, and Egypt, among others. Similar to many other oil-exporting nations worldwide, Nigeria has been gradually phasing out fuel subsidies since the 1970s. However, in recent times, the topic of subsidies has been the focus of extensive debates and discussions, largely due to their persistent nature and their substantial influence on the country's economy. Fuel subsidies have become unsustainable due to their significant drain on government resources and distortionary effects on the

* Corresponding author. Tel.: +2348057661634; fax: +2347068915939
Email: aoyelade@chrislanduniversity.edu.ng
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economy. This has resulted in inefficiencies in resource allocation, market distortions, and budgetary constraints for the government. The high cost of fuel subsidies imposes a significant financial burden on the government, diverting resources that could be allocated to critical sectors such as healthcare, education, and infrastructure development. Moreover, it has been demonstrated that this practice contributes to market distortions by insincerely lowering the price of fuel, thereby incentivizing overconsumption and hindering the development of alternative energy sources. The declaration of the removal of fuel subsidies has imposed a substantial burden on citizens, as evidenced by a substantial and widespread surge in inflation. The sudden and complete elimination of fuel subsidies further exacerbates the existing challenges of poverty and food insecurity in Nigeria (Inegbedion *et al.*, 2020).

Subsidy removal has implication on various sector of the economy, in addition to household essential commodities. The case of Nigeria is not an exceptional one and is not currently the focus of scholarly debate. The discourse pertains to the direct and indirect effects on the well-being of the populace. The removal of subsidies has a significant impact, particularly through the escalation of transportation costs due to the considerable increase in fuel prices. This, in turn, has a direct impact on agricultural production, given that the transportation of agricultural inputs and the operation of machinery in food production rely heavily on energy (Soile *et al.*, 2014). Consequently, the surging transportation expenses have intensified the issue of food insecurity in the nation, as consumers contend with the challenge of purchasing their daily meals at elevated prices (Okereke, 2017). Moreover, the elimination of fuel subsidies has served to exacerbate the preexisting income inequality within the country. It is acknowledged that the fuel subsidy was disproportionately beneficial to the economically advantaged more than the economically disadvantaged. However, its complete removal has disproportionately burdened low-income individuals (Onyeizugbe & Onwuka, 2012). These individuals are now confronted with escalating financial pressure as they strive to meet their basic dietary needs. Consequently, individuals are compelled to allocate a smaller proportion of their income to other crucial expenses, such as education and healthcare. Education and healthcare are cornerstones of societal advancement, and diverting less attention and resources to these sectors undermines the socioeconomic status of the nation (Mohammed *et al.*, 2020).

The impact of increasing prices on households' daily lives is significant and the interplay of these direct effects with the indirect consequences, such as inflationary pressure and shifts in consumption patterns, creates a complex and challenging economic landscape that warrants thorough examination (Raji *et al.*, 2018). The removal of subsidies, particularly on commodities such as fuel, food, and utilities, has been a recurring policy issue in Nigeria, driven by various economic and fiscal considerations. While the intention may be to enhance fiscal sustainability, improve resource allocation, and promote economic efficiency, the practical outcomes often involve increased financial burdens on households, worsened poverty levels, and heightened food insecurity (McCulloch *et al.*, 2021).

Research Questions

The following research questions were addressed: -

(i) What is the direct human welfare effect of the removal of fuel subsidy on household essential commodities in Southwest Nigeria?
(ii) What is the indirect human welfare effect of the removal of fuel subsidy on household essential commodities in Southwest Nigeria?

Aim and Objectives of the Study

The aim of this study is to evaluate the relationship between the removal of fuel subsidy and human welfare in some selected households in Southwest Nigeria.
The specific objectives are to:

(i) investigate the direct human welfare effect of the removal of fuel subsidy on household essential commodities in Southwest Nigeria,
(ii) evaluate the indirect human welfare effects of the removal of fuel subsidy on household essential commodities in Southwest Nigeria.

The Statement of the Hypotheses

$H0_1$: There is no direct significant effect of the removal of fuel subsidy on household essential commodities in Southwest Nigeria.
$H0_2$: There is no indirect significant effects of the removal of fuel subsidy on household essential commodities in Southwest Nigeria.

2. Literature Review

The discourse surrounding the removal of fuel subsidies and its implications for human welfare has attracted significant attention in both developed and developing countries. Fuel subsidies are financial supports provided by governments to lower the cost of fuel for consumers. While the objective of these subsidies is to alleviate poverty and stimulate economic growth, it is evident that they frequently result in market distortions and fiscal burdens. The removal of fuel subsidies is frequently proposed as a essential reform to enhance economic efficiency, redistribute resources, and improve government budgets. Studies by Widodo (2012) and Agboje (2018) emphasize the immediate impact of subsidy removal on household welfare. As indicated by the research of Widodo (2012), the elimination of subsidies has been demonstrated to result in a significant decline in welfare, particularly affecting low-income households. Agboje (2018) observes a similar phenomenon, noting that subsidy removal escalates living costs, with the effect being disproportionately burdensome on vulnerable populations. The indirect consequences of subsidy removal have been explored by Abdul Hakim *et al.* (2014) and Raji *et al.* (2018), who highlight how increased fuel prices lead to higher transportation costs, which in turn have a subsequent effect on the prices of essential goods. Abdul Hakim *et al.* (2014) argue that the Malaysian middle class faces unique challenges following subsidy rationalization, whereas Raji *et*

al. (2018) focus on the rural poor in Nigeria, noting that their welfare is significantly compromised due to rising living costs.

Del Granado *et al.* (2012) and Uzonwanne *et al.* (2015) analyse the regressive nature of fuel subsidies, demonstrating that wealthier households disproportionately benefit from them. Del Granado *et al.* (2012) highlight that subsidy reforms have an impact on all income groups; however, the adverse consequences are more pronounced among lower-income segments, who allocate a higher proportion of their budget to fuel and transportation. The necessity for compensatory measures to mitigate the adverse effects of subsidy removal is discussed by Adeniran (2016) and Cooke *et al.* (2016). Adeniran advocates for targeted cash transfers or social safety nets to support affected households, while Cooke *et al.* (2016) emphasize expanding cash transfer programs in Ghana to cushion the impacts of subsidy reform on the poor. Inegbedion *et al.* (2020) and Omitogun *et al.* (2021) provide an in-depth analysis of the environmental ramifications of subsidy removal. They argue that while the removal of subsidies can result in increased fuel prices and reduced consumption, it also offers potential benefits for sustainability by discouraging fossil fuel dependency. Environmental and climate arguments for subsidy reform are based on the correlation between energy pricing and energy demand. When fossil fuels are underpriced through subsidies, consumption tends to be inefficient, thus reinforcing high-carbon energy use and delaying the adoption of cleaner alternatives. The reforming of fuel prices is therefore often framed as an enabling step for the energy transition as it improves the functioning of energy markets, strengthens incentives for conservation and diversification (including renewable energy and cleaner fuels), and supports government fiscal space for sustainable energy spending. Nevertheless, transition pathways also depend on distributional outcomes: if welfare losses from reform are severe, households may resist reform implementation, limit the political durability of climate and sustainability measures, or substitute towards less safe/less sustainable coping strategies. Consequently, welfare transmission mechanisms - such as transportation-mediated price effects - are not only distributional concerns but also determinants of whether energy-transition policy can be sustained in a socially legitimate manner.

The studies reviewed utilize a variety of methodologies, including econometric models, descriptive analyses, and case studies. For instance, the employment of a computable general equilibrium model by Widodo (2012) enabled the assessment of household welfare impacts, while Adeniran (2016) utilized descriptive statistics to analyze transportation costs. This methodological diversity reflects the multifaceted nature of fuel subsidy reforms and the varying contexts of each study. It is evident that there are significant contextual differences in the effects of subsidy removal across studies. Research from developed countries, such as Erdogdu (2011), often focuses on economic efficiency and market dynamics. Conversely, studies on developing countries, such as Nwafor *et al.* (2006) and Mohammed *et al.* (2020), emphasize the socio-economic vulnerabilities exacerbated by subsidy removal. This discrepancy highlights a need to consider local economic conditions and social structures when evaluating the impacts of subsidy reform.

A critical theme across the literature is the distributional impact of subsidy removal. Many studies, including Gidigbi & Bello (2020) and Umeji & Eleanya (2021), argue that subsidy removal tends to have a greater impact on low-income households, frequently leading to an escalation of poverty and inequality. This critique of the regressive nature of subsidies underscores the significance of implementing compensatory strategies to protect vulnerable populations. The literature consistently emphasizes the need for compensatory measures. Cooke *et al.* (2016) and Agboje (2022) advocate for the implementation of targeted cash transfers and social safety nets as a means to alleviate the financial burdens on low-income households. However, gaps in the effectiveness of these measures are also evident, particularly regarding the provision of timely and adequate support for those affected. While many studies focus on economic and social impacts, the environmental implications of subsidy removal are increasingly being recognized. Inegbedion *et al.* (2020) argue that subsidy removal has the potential to reduce fossil fuel consumption and lower carbon emissions, thereby aligning with global sustainability goals. However, potential negative environmental outcomes, such as increased emissions during the transition period, are also noted.

Gaps in the Literature

Based on the literature reviewed, it was evident that there have been concerted global efforts to address issues related to subsidies. However, this study identified some gaps in the existing literature. Firstly, the issues of direct and indirect effects resulting from subsidy removal on household essential commodities remains largely unexplored in Nigeria, in contrast to the situation in Asia, where a significant number of studies have addressed these issues (Widodo, 2012; Abdul-Hakin *et al.*, 2014 & Razak *et al.*, 2014). Understanding the direct and indirect welfare effects of subsidy removal is essential for effective policymaking, sustainable economic growth, and the well-being of a country's citizens.

Lastly, the study enhances its analytical tools by incorporating cross-tabulation and Structural Equation Modeling (SEM) as additional techniques to address the objectives relating to the direct and indirect impact of subsidy removal on the well-being of households, particularly in terms of essential commodities. The integration of these methodologies serves to distinguish the present study from the previous study conducted by Widodo (2012), thus ensuring its distinctiveness and innovation. The utilization of cross-tabulation and Structural Equation Modeling (SEM) to address the objectives of this study offers several advantages and insights. Cross-tabulation facilitates allows a straightforward and comprehensive analysis of the relationship between subsidy removal and various variables related to human welfare. The report provides a clear picture of how different factors interact and affect households. SEM, on the other hand, is well-suited to the exploration of indirect effects. It allows for modelling complex relationships between subsidy removal and various mediating and moderating variables. This allows for a more in-depth understanding of how subsidy removal indirectly affects human welfare through multiple pathways, which can assist in elucidating the sequence of events and variables that link subsidy removal to human welfare.

3. Materials and Methods

3.1. Research design

Despite being conducted within the regional context of Southwest Nigeria, the empirical design of the study is a cross-sectional household survey. The case context of Southwest Nigeria is utilized to support policy interpretation of fuel subsidy removal within a bounded geographic setting defined by the six participating states. The region was selected due to its high population density, comprising both urban and rural areas, as well as a mixture of high-income and low-income households, which makes it a relevant context for examining household welfare and essential commodity expenditure responses to energy price reforms. The case boundary includes Ekiti, Lagos, Ogun, Ondo, Osun and Oyo states within the survey coverage period between 2023 and 2024, incorporating both urban and rural areas. A total of 600 households per state were selected, guided by the Nigerian Living Standards Survey of 2018/19.

3.2. Conceptual framework

The conceptual framework presented in Figure 3.1 provides a comprehensive overview of the potential direct and indirect effects of fuel subsidy removal. This framework is based on the work of Abdul-Hakim *et al.* (2014) and Razak *et al.* (2014) with some modifications. The direct effects outlined in the diagram were the immediate consequences of the removal of fuel subsidies, namely the increase in fuel prices and the rise in transportation costs (Abdul-Hakim *et al.*, 2014). The direct impacts are the most visible and tangible outcomes of the policy change. The removal of fuel subsidies would result in a direct and immediate increase in fuel prices, which impacted both households and businesses (Razak *et al.*, 2014). This price increase would have a far-reaching implication, as fuel is critical to various economic activities, from transportation and logistics to power generation and industrial processes (Adeniran, 2016). The increase in fuel prices would directly translate into higher transportation costs, as the cost of operating vehicles, whether for personal or commercial use, would increase (Evans *et al.*, 2023). This has a significant impact on the affordability and accessibility of transportation services, which are vital for the movement of people and goods throughout the economy.

The indirect effects of the removal of fuel subsidy, as depicted in the conceptual framework, encompass the long-term and systemic impacts that would unfold gradually as the economy adjusted to the new price levels. The increase in fuel prices and transportation costs would lead to a rise in the costs of producing and delivering goods and services across various sectors of the economy (Abdul-Hakim *et al.*, 2014 & Razak *et al.*, 2014). It is inevitable that businesses will pass on these higher input costs to consumers, resulting in overall price inflation for a wide range of products and services. As the costs of goods and services increased, households would experience a decline in their real purchasing power and disposable income (Adeoti *et al.*, 2016). This would result in a decline in consumption demand, as households would be compelled to reallocate their expenditure to cover the increased costs of essential goods and services, such as food, housing, and utilities. A decline in real household income and the resulting decrease in consumption demand would have a ripple effect throughout the economy. A decline in demand for goods and services would result in lower production, reduced investment, and the potential for increased unemployment, further exacerbating the economic impact of the removal of fuel subsidy (Evans *et al.*, 2023). Moreover, the rise in the costs of goods and services, coupled with the decline in real household income, would create inflationary pressures within the economy. This would result in a reduction of the purchasing power of consumers, leading to a further deterioration of their standard of living and potentially triggering a cycle of wage-price spirals (see Fig. 1).

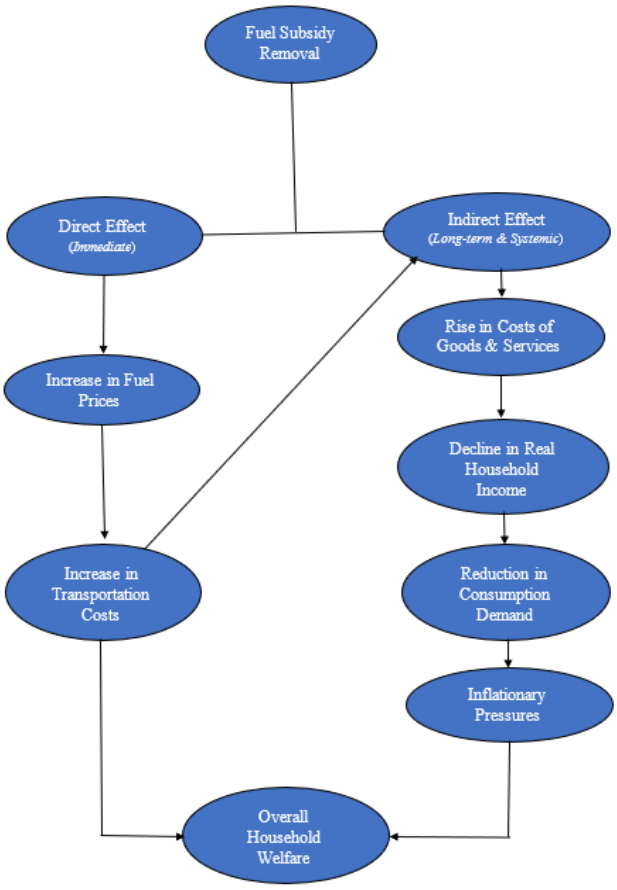

Fig. 1. Conceptual Framework of Fuel Subsidy Removal

3.3. Model specification

Model 1: Direct effect of the removal of fuel subsidy on household essential commodities in Southwest Nigeria

To assess both the direct and indirect impacts of subsidy removal on household essential commodities in Southwest Nigeria, the present study will adopt the methodology previously developed and utilized by Abdul-Hakim *et al.* (2014) and Razak *et al.* (2014). The effects of subsidy removal on household essential commodities can be categorized into two main components: the direct welfare effect (*DWE*) and the indirect welfare effect (*IWE*). The *DWE* is defined as the negative consequences experienced by households when they directly consume petroleum products (such as fuel for private

transportation) following the removal of subsidies.

Therefore, the *DWE* equation is given as follows:

$$DWE = \sum_{j=1}^{j} w_j^{oil} \Delta p_j^{oil} \quad (3.1)$$

where "w_j^{oil}" is the budget share of the j^{th} petroleum product, "Δp_j^{oil}" is the change in the price of the j^{th} petroleum product, and "j" is the number of petroleum products.

The calculation of the *DWE* involves a relatively straightforward process comprising three essential steps (Abdul-Hakim *et al.*, 2014). Firstly, the study identifies the specific petroleum products directly consumed by households that will experience price increases following subsidy removal. Secondly, the study determines the pre-price increase budget allocation for each of these petroleum products by households. Thirdly, the study identifies the magnitude of price increases for each of these petroleum products. Following the successful completion of these steps, the *DWE* can be computed by multiplying the budget share assigned to each petroleum product by the percentage increase in the price of that product and summing these values across all relevant petroleum products (Razak *et al.*, 2014).

Model 2: Indirect effect of the removal of fuel subsidy on household essential commodities in Southwest Nigeria

The concept of Indirect Welfare Effect (*IWE*) pertains to the negative consequences experienced by households when the prices of various goods and services, excluding fuel products, increase in response to higher petroleum prices. *IWE* was observed by Abdul-Hakim *et al.* (2014) and Razak *et al.* (2014) in their research work. The present study will also consider their model on IWE. The IWE equation is given as follows:

$$IWE = \sum_{j=1}^{s} w_j^{oil} \Delta q_j \quad (3.2)$$

where "w_j" is the budget share of the "j^{th}" good (or service), "Δq_j" is the change in the consumer price of the "j^{th}" good (or service), and "s" is the number of goods and services available in the economy.

In a scenario where the prices of all non-petroleum goods and services in the economy are influenced by an increase in petroleum prices, it can be assumed that

$$\Delta q_j = f_j(\Delta p^{oil}) \quad (3.3)$$

In this context, "q" represents the consumer price of a product, and "p" represents its producer price. The term "$f_j(\Delta p^{oil})$" signifies those changes in the consumer price of the j^{th} non-petroleum product, which depend on a function of the change in the overall producer price of petroleum products, denoted as "Δp^{oil}". Furthermore, the alteration in the aggregate price of petroleum products is defined as the weighted summation of the price changes across all petroleum products:

$$\Delta p^{oil} = \sum_{j=1}^{j} \delta_j \Delta p^{oil} \quad (3.4)$$

In this context, "δ_j" represents the quantity share of the "j^{th}" petroleum product. It is important to distinguish between the term "quantity share of a fuel product" and the term "budget share of a fuel product." The former specifically denotes the proportion of a particular fuel product's quantity in relation to the overall quantity of all fuel products. Conversely, the latter refers to the proportion of household expenditures allocated to fuel products compared to the total expenditures on all goods and services.

Substitution of Equation (3.3) and (3.4) into Equation (3.2) results in the following equation:

$$IWE = \sum_{j=1}^{s} w_j f_j(\Delta p^{oil}) = \sum_{j=1}^{s} w_j f_j \left(\sum_{j=1}^{j} \delta_j \Delta p^{oil} \right) \quad (3.5)$$

The total welfare effect is calculated as the sum of both the direct welfare effect and the indirect welfare effect.

$$TWE = \sum_{j=1}^{j} w_j^{oil} \Delta p_j^{oil} + \sum_{j=1}^{s} w_j f_j \left(\sum_{j=1}^{j} \delta_j \Delta p^{oil} \right) \quad (3.6)$$

The *IWE* is not directly observable due to its passage through the direct channel before affecting the *IWE*.

The analysis calculated the difference in average expenditure before and after the subsidy removal. It then determined the budget share (% of total energy expenditure) as well as the percentage change in prices before and after. The calculation of the direct effect entailed a multiplication of the budget share (% of energy expenditure) by the percentage change in price. This calculation was then divided by 100%. This was previously utilized by Abdul-Hakim *et al.*, (2014) and Razak *et al.*, (2024). The present research is consistent with these previous studies. Of particular note, the study utilized a benchmarking approach to analyze the prices of the selected energy sources in May 2023 with those in January 2024 to determine the price changes before and after the subsidy removal.

3.4. Data sources and measurement of the variables

The study employed a household survey across the six Southwestern states of Nigeria, utilizing the national master sample (NISH2) developed by the National Bureau of Statistics (NBS) from the 2006 Census enumeration areas. The sampling frame employed in this study was designed to ensure national representativeness and alignment with previous surveys including the Nigerian Living Standards Survey (2018/19). The target population comprised households in both urban and rural areas. A total of 600 households per state were selected, consistent with the Nigerian Living Standards Survey, allowing for comparability across studies. A multi-stage sampling approach was adopted, whereby primary sampling units (local government areas or enumeration areas) were first selected, followed by random selection of households within those units. The total number of local government areas covered was 137, thus providing a comprehensive overview of the the region's cultural and economic diversity. The selection of the Southwest region was guided by its large, heterogeneous population, including both high- and low-income households. This diversity makes it an ideal case for examining the distributional impacts of subsidy removal. The uniform sample size of 600

households per state simplified logistics, ensured balanced representation, and provided sufficient data for state-level analysis despite the presence of differences in population size. The focus on this resion was further justified by resources constraints. The survey instrument contained ten sections with 67 questions, covering household demographics, shocks from subsidy removal, and expenditures across food, energy, transportation, clothing, housing, health, education, and telecommunications. Data collection phase was scheduled to start in June 2023, with the fieldwork element conducted in January 2024 (see Table 1).

Table 1. Sample composition

State	Households that were Interviewed
Ekiliti	600
Lagos	600
Ogun	600
Ondo	600
Osun	600
Oyo	600
Total	3600

Source: Author's Compilation, 2024

3.5. Estimation techniques and procedures

Descriptive statistics, cross tabulation and Structural Equation Modelling (*SEM*) approach will be employed as the estimation techniques for this study. The utilization of both descriptive statistics and cross tabulation is to summarize the questionnaire. Descriptive statistics is a set of techniques used in data analysis to summarise and describe the main features or characteristics of a dataset (Marshall & Jonker, 2010). Cross tabulation is a technique to identify patterns, associations, or dependencies between the variables (White, 2004). For the *DWE* and *IWE* of subsidy removal, descriptive statistics and *SEM* was used because *SEM* is a powerful statistical technique used for modeling and analyzing complex relationships among variables (Mueller & Hancock, 2018). SEM is a powerful tool for testing complex theoretical models and understanding the relationships between latent and observed variables (Hair Jr *et al.*, 2021).

4. Results and Discussion

Table 2. Direct human welfare effect of fuel subsidy removal on household essential commodities in southwest

	Ekiti State	Lagos State	Ogun State	Ondo State	Osun State	Oyo State	Southwest
PMS	68.06	38.54	39.57	34.89	31.99	35.93	41.50
AGO	2.16	7.87	7.63	7.68	5.07	5.77	6.03
NHK	0.88	1.52	1.55	1.40	0.86	0.85	1.18
LPG	3.32	1.97	2.25	1.57	1.99	2.29	2.23
Total	74.42	49.9	51	45.54	39.91	44.84	50.94

Source: Author's Compilation, 2024

Note that as of January 31th, 2024, the removal of fuel subsidies resulted in average price changes of ₦656.97 for PMS, ₦1184.54 for AGO, ₦1341.38 for NHK & ₦5,089.39 for 5kg cylinder of LPG

The first objective concerning the direct human welfare effect of the removal of fuel subsidy on household essential commodities in the Southwest region of Nigeria, revealed that the removal of fuel subsidies led to an increase in the cost of PMS by 41.50% in the Southwest region. Large direct price increases following the removal of fuel subsidies indicate that transition-related reforms can quickly affect household affordability of essential energy and services. While such reforms may be intended to support long-term carbon reduction by correcting the distortion of fossil fuel price, their short-term effectiveness depends on whether households, particularly vulnerable groups, can maintain essential consumption during the adjustment period. Substantial welfare strain has the potential to undermine the social acceptability and thus the durability of energy-transition and emissions-reduction policies unless accompanied by "just transition" measures. This finding suggests that households consuming PMS experienced a significant price increase as a result of the subsidy removal. Moreover, the cost of AGO increased by 6.03% as a result of the subsidy removal in the Southwest region. This implied that consumers using AGO for their vehicles or other purposes experienced a moderate increase in expenses. Furthermore, the subsidy removal led to 1.18% increase in the price of NHK in the Southwest region. This indicated a relatively smaller impact compared to PMS and AGO. This may be attributed to the fact that NHK was predominantly utilized for lighting and culinary purposes within households with lower income levels. The removal of fuel subsidies resulted in a 2.23% increase in the price of LPG in the Southwest region. This finding suggested that households reliant on LPG for cooking or heating experienced a notable increase in their expenses. The cumulative effect of the subsidy removal on these essential commodities was found to be 50.94% increase in the Southwest region. This indicated a substantial impact on household budgets in the Southwest region, potentially leading to adjustments in spending habits, decreased purchasing power, and heightened economic strain for households, particularly those with lower incomes (see Table 2).

Higher fuel prices (PMS and AGO) have led to increased transportation costs for both individuals and businesses. This has impacted the cost of commuting, transportation of goods, and travel in general. Many industries are reliant on the utilization of fuel for production and transportation. In the event of a rise in fuel costs, businesses have passed on these increased costs to consumers in the form of higher prices for goods and services. Should the cost of fuel and fuel-related goods and services rise, this will result in inflation across the economy. This has had a deleterious effect on purchasing power, leading to a decline in overall economic activity. Also, the rise in fuel costs is likely to disproportionately impact low-income households that may spend a larger portion of their income on transportation and essential goods. Moreover, these price increases have had broader economic ramifications, influencing inflation rates, consumer behavior, and overall economic stability in the region. This finding aligns with the research conducted by Abdul-Hakim *et al.* (2014) and Razak *et al.* (2014), which similarly elucidated the differential impacts of subsidy removal policies on household welfare across various regions. These studies shed light on the heterogeneous effects of such policy changes on household welfare (Table 3).

Table 3. Indirect human welfare effect of fuel subsidy removal on household essential commodities in Southwest

Category	Ekiti State	Lagos State	Ogun State	Ondo State	Osun State	Oyo State	Southwest
Food	56.36	38.24	43.74	49.73	53.26	46.32	47.94
Transportation	6.56	11.02	8.67	5.94	7.35	9.29	8.14
Clothing & footwear	0.64	0.78	0.58	0.88	0.55	0.51	0.66
Housing & rent	5.43	11.17	7.12	4.50	3.91	4.83	6.16
Health	2.01	2.43	3.16	3.23	2.36	3.46	2.78
Education	6.25	7.22	10.50	8.06	9.13	9.82	8.50
Telecommunication services	2.92	4.16	3.45	3.47	3.07	3.39	3.41
Total	80.17	75.03	77.22	75.80	79.64	77.62	77.58

Source: Author's Compilation, 2024 (*The indirect effect is obtained by multiplying budget share (%) by price effect (%) to get impact on expenditure and then divide impact on expenditure by 100)*

Note that as of January 31th, 2024, the removal of fuel subsidies resulted in average price changes of ₦656.97 for PMS, ₦1184.54 for AGO, ₦1341.38 for NHK & ₦5,089.39 for 5kg cylinder of LPG

For the second objective, the study provided an answer to the question of the indirect human welfare effect of the removal of fuel subsidy on household essential commodities in Southwest Nigeria. The results revealed that the most significant indirect impact of the removal of fuel subsidy in the Southwest region was on food prices, with an estimated increase of 47.94%. This was likely due to the extensive use of fuel in the transportation and production of food. It is evident that transportation costs for agricultural products, fertilizer production, and food processing could all be impacted by fuel prices. Other sectors were also indirectly impacted by the removal of fuel subsidy, such as education with 8.50%. This was indirectly impacted by the removal of fuel subsidy as fuel was utilized to transport students and staff to and from schools, and to heat and cool school buildings. Furthermore, transportation costs were indirectly impacted by the removal of fuel subsidy with a percentage increase of 8.14%, and an increase in transportation cost also led to higher prices for goods transported over both short and long distances. The South West experienced a 6.16% increase in housing and rent in which fuel was utilized in the construction and transportation of building materials. Moreover, higher transportation costs made it more expensive to maintain rental properties in the region, therefore leading to an increase of 6.16%. The indirect effect of the removal of fuel subsidy also had an impact on telecommunication services (3.4%), health (2.78%), and clothing and footwear (0.66%) in the region. The cost of telecommunication services, health, and clothing and footwear increased due to the continued use of fuel for the operation and transportation of telecommunication services equipment, medical supplies and equipment, and to power hospitals and other medical facilities. The removal of fuel subsidies had far-reaching effects on the economy of the Southwest region, impacting various commodities and contributing to increased costs across essential commodities and services.

These findings are in line with previous research conducted by Abdul-Hakim *et al.* (2014) and Razak *et al.* (2014) that also exploited the indirect effect of subsidy removal. The findings of the present study are consistent with the conclusions drawn from their investigations, which illuminate the intricate consequences of the secondary effects resulting from such policy shifts. Furthermore, the findings of this research corroborate the observations made by Abdul-Hakim *et al.* (2014) and Razak *et al.* (2014), underscoring the persistence and universality of the indirect effects uncovered across different contexts (see Table 4).

Table 4. SEM Model to confirm whether fuel subsidy has indirect effect on household essential commodities via transportation cost in Southwest

Model / Variabel	Food	Clothing & footwear	Housing & rent	Health	Education	Telecommunication services
Direct effect (fuel subsidy)	-0.277 [0.077]*	-0.001 [0.813]	-0.020 [0.636]	-0.029 [0.587]	-0.157 [0.111]	0.011 [0.021]**
_cons (Direct)	18.897 [0.000]***	-5.125 [0.019]**	12.828 [0.272]	-5.125 [0.019]**	-4.776 [0.033]**	3.11 [0.011]**
Indirect effect (transportation cost)	-0.316 [0.000]***	-0.012 [0.000]***	-0.297 [0.000]***	-0.312 [0.000]***	-0.297 [0.000]***	-0.238 [0.050]***
_cons (Indirect)	-4.410 [0.051]*	0.011 [0.021]**	-0.353 [0.131]	0.011 [0.021]**	0.018 [0.016]**	0.011 [0.021]**
Mediating effect via indirect effect	Fuel ← transport → food	Fuel ← transport → clothing & footwear	Fuel ← transport → housing & rent	Fuel ← transport → health	Fuel ← transport → education	Fuel ← transport → telecommunication
Status	Yes	Yes	Yes	Yes	Yes	Yes

*** *p<0.01, ** p<0.05, * p<0.1*

Source: Author's Compilation, 2024

The Structural Equation Model (SEM) was conducted to confirm whether fuel subsidy indirectly affected household essential commodities through transportation costs in Southwest Nigeria. The findings of the study indicated that the indirect effect of fuel subsidy on household essential commodities via transportation cost was significant across all categories, with coefficients ranging from -0.238 to -0.316. This signified that an increase in transportation costs resulting from the removal of fuel subsidies had a negative impact on household expenditures on various essential commodities, including food, clothing & footwear, housing & rent, health, education, and telecommunication services. It is evident that welfare losses are transmitted through transportation costs. Therefore, compensation schemes should prioritize transport/market-price shocks to preserve essential consumption during transition period. The findings indicate that energy transition policies relying solely on price reform without protection mechanisms risk undermining social sustainability.

5. Conclusion

The study concluded that the removal of fuel subsidies in Southwest Nigeria had profound direct and indirect impacts on household welfare. The cost of essential commodities increased significantly, with PMS costs increasing by 41.50%, significantly straining household budgets, particularly for lower-income households. The subsequent rise in fuel price led to increased transportation costs, affecting various sectors including food, education, transportation, and housing. The Structural Equation Model confirmed the significant negative impact on household expenditures across these categories. The removal of fuel subsidy resulted in a 128.52% increase in household essential commodity costs in the Southwest region, a finding that emerges from a comprehensive analysis of both direct and indirect effects.

Based on the evaluation of the relationship between fuel subsidy and human welfare in Southwest Nigeria, the following policy recommendations are proposed:

(i) **The Implementation of Targeted Social Assistance Programmes:** To mitigate the negative direct effects of the removal of fuel subsidy on vulnerable households in Southwest Nigeria, the implementation of targeted social assistance programmes and direct cash transfers as well as investment in alternative energy sources should be implemented to offset rising essential commodity prices.

(ii) **The Promotion of Sustainable Practices:** To address the indirect effects of the removal of fuel subsidy on essential commodities in Southwest Nigeria, policy interventions should include the financial assistance for vulnerable populations, subsidized transportation, affordable housing initiatives, healthcare subsidies, and education support. Additionally, price stabilization mechanisms have been demonstrated to assist in the mitigation of volatility in essential commodity prices.

(iii) **Implement a "Just Transition" Support Package to Sustain Energy-Transition and Emissions-Reduction Goals:** To ensure that the removal of fuel subsidy is compatible with the objectives of sustainability and carbon-reduction, it is important that the implementation of accompanying policies should target the main welfare transmission channel identified in this study, namely transportation-mediated price increases. The policy options identified include temporary transport cost relief (e.g., vouchers or targeted mobility support), targeted social assistance linked to essential commodity affordability, and time-bound measures that protect food security and access to education and health services during the adjustment period. Such measures have the potential to enhance social sustainability, reduce the risk of backlash, and support the continuity of transition-oriented energy reforms.

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