A QUANTITATIVE ASSESSMENT OF THE INFLUENCE OF TAXES, LEVIES, LANDED COSTS, STORAGE AND DISTRIBUTION EXPENSES ON PUMP PRICES IN KENYA

FIONA OKADIA

REGISTRATION NO: 66121

A RESEARCH REPORT SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IN PUBLIC POLICY MANAGEMENT AT STRATHMORE UNIVERSITY

February 2025

DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the dissertation contains no material previously published or written by another person except where due reference is made in the dissertation itself.

Fiona Okumu Okadia

Registration Number 66121

APPROVAL

The dissertation for Fiona Okumu Okadia was approved by the following:

Name of Supervisor

Dr. Thomas Kibua PhD

Strathmore Business School

Dr. Ceaser Mwangi

Executive Dean

Strathmore University Business School.

Prof. Bernard Shibwabo

Director, Office of Graduate Studies

DEDICATION

I dedicate this research to my beloved family, especially to my Chiiwo Okadia as this journey has not been mine alone. It is with profound gratitude and admiration that I dedicate this research to the pillars of my life - my family. To my parents, whose sacrifices and unwavering support have illuminated the path to knowledge, this research is a testament to the seeds of curiosity and diligence you planted within me. Your love is the fuel that propels me forward, and this effort is as much yours as it is mine. To my siblings, Julu and Udo, true companions in both joy and challenge, your shared laughter and understanding have been the backdrop to my academic pursuits. This research is a celebration of our collective resilience and the shared dreams that have made this journey richer. To my mentors and friends for your encouragement and guidance have been the compass guiding my scholarly activities. This dedication is an acknowledgment of the diverse perspectives and valuable insights you've woven into the fabric of my academic pursuits. In every line and citation, the echo of your influence resonates. This research is not merely a solitary endeavour; it is a collective dedication to the love, support, and shared experiences that have shaped me.

ACKNOWLEDGMENT

I extend my deepest gratitude to our benevolent God, whose boundless grace has been my steadfast companion on this remarkable journey. I wish to convey sincere appreciation to Dr. Thomas Kibua, whose articulate and precise guidance as my supervisor has been instrumental in refining and enhancing the relevance and meaning of this proposal. His wisdom has been a guiding light, shaping this journey into a more robust and purposeful contribution.

I also express my profound appreciation to Strathmore Business School for providing an environment conducive to learning and for arming me with the essential knowledge and opportunities required to pursue this academic degree. The university's commitment to excellence has played a pivotal role in shaping my educational path and fostering an atmosphere of growth and development.

ABSTRACT

This study provides a quantitative assessment of how taxes and levies, landed costs, and storage and distribution expenses influence petroleum pump prices in Kenya. It aims to inform policy decisions on fuel pricing by offering empirical evidence on the drivers of domestic petroleum prices. Between January 2018 and May 2024, prices for Super Petrol, Diesel, and Kerosene rose by 81%, 86%, and 121%, respectively. These increases have contributed to reduced fuel consumption especially for Kerosene and rising inflation.

The study had three objectives to assess the extent to which:

i. Taxes and levies influence the price of petroleum products.
ii. Landed costs for refined petroleum products influence their prices.
iii. Storage and distribution costs influence the price of petroleum products.

The research was guided by several economic theories: the economic theory of price control, Pigouvian taxation theory, price theory, the informal approach, and exchange rate theory. A quantitative longitudinal research design, utilizing a time series approach was employed, using secondary data from the Energy and Petroleum Regulatory Authority (EPRA). The analysis involved Pearson correlation, unit root tests using the Augmented Dickey-Fuller (ADF) method, co-integration testing, and the Auto-Regressive Distributed Lag (ARDL) model. Data analysis was performed in R-Studio and Microsoft Excel. The results showed that the model explained 58.63% of the variability in kerosene prices, 49.82% in diesel prices, and 31.03% in super petrol prices. Taxes and levies had the greatest impact on Super Petrol prices, while landed costs had a stronger influence on kerosene. Storage and distribution costs did not significantly affect diesel prices. The findings revealed that these factors have significant short-term effects, often influencing prices immediately or within one to two periods. However, the absence of long-term co-integration suggests they do not determine long-term trends in petroleum pricing. The study concludes that although taxes, levies, and logistical costs drive short-term price fluctuations, they lack a stable, long-term predictive relationship with fuel prices. These insights are essential for developing targeted, evidence-based fuel pricing policies in Kenya.

Keywords: Kenya's Petroleum Prices, Petroleum Taxes and Levies, International Platts prices, Petroleum Regulation Kenya, EPRA

Table of Contents

List of Figures

List of Tables

List of Abbreviations/Acronyms

EPRA-Energy and Petroleum Regulatory Authority

ERB- Energy Regulatory Board

ERC- Energy Regulatory Commission

KPC- Kenya Pipeline Company

KPRL- Kenya Petroleum Refineries Limited

NOCK- National Oil Company of Kenya

OTS- Open Tender System

SDG- Sustainable Development Goal

Definition of Key Terms

1. Kenya's Petroleum Prices: Refers to the prices at which petroleum products such as gasoline, diesel, and kerosene are sold within the country of Kenya. These prices are determined by various factors including international market rates, transportation costs, taxes, and government regulations.
2. Petroleum Taxes and Levies: These are taxes and fees imposed by the Kenyan government on petroleum products. They include taxes such as excise duty, value-added tax (VAT), and specific levies aimed at generating revenue for the government and regulating the consumption of petroleum products.
3. International Platts Prices: Platts is a leading global provider of energy and commodity price assessments. International Platts prices refer to the benchmark prices for crude oil and petroleum products established by Platts in global markets. These prices serve as reference points for trading and pricing negotiations in the petroleum industry worldwide.
4. Petroleum Regulation Kenya: Refers to the regulatory framework and agencies responsible for overseeing the petroleum industry in Kenya. This includes regulations related to the exploration, production, refining, transportation, distribution, and marketing of petroleum products. The regulatory body responsible for this in Kenya is the Energy and Petroleum Regulatory Authority (EPRA).
5. EPRA (Energy and Petroleum Regulatory Authority): EPRA is the regulatory agency in Kenya responsible for regulating the energy and petroleum sectors. It oversees various aspects of the petroleum industry, including licensing, pricing, quality control, safety standards, and consumer protection. EPRA plays a crucial role in ensuring compliance with regulations, promoting competition, and safeguarding the interests of both consumers and industry stakeholders in Kenya's petroleum sector.

CHAPTER ONE: INTRODUCTION TO THE STUDY

1.0 Introduction

This research is a quantitative assessment of the influence of taxes, levies, landed costs, storage and distribution expenses on pump prices in Kenya. Chapter 1 covers the global oil market context, Kenya's oil industry and its regulatory bodies, the petroleum pricing formula, the study's problem statement, objectives, research questions, and the scope and significance of the study.

1.1 Background of Study

Energy is a crucial developmental resource, prominently featured among the top ten Sustainable Development Goals (SDGs) under Goal 7 which calls for access to affordable reliable, sustainable, and modern energy for all. Among energy sources, crude oil remains dominant serving as the primary input for refined fuels like kerosene, gasoline and diesel. Oil, alongside information technology, container ships, trucks, and aircraft form the backbone of globalization and the current industrial ecosystem (Michaux, 2019).

The global distribution of crude oil is uneven, with some regions and countries richly endowed with this resource, while others lack it altogether. As indicated in a 2021 report by British Petroleum, the majority of oil reserves are concentrated in the Middle East region, specifically in countries such as Iran, Iraq, Kuwait, Saudi Arabia, and the United Arab Emirates (UAE). These global dynamics are of direct relevance to countries like Kenya, which are net oil importers. As a result, Kenya’s domestic fuel prices are heavily influenced by trends in the international oil market especially price volatility, supply shocks, and shifts in global demand.

Oil prices, like the prices of other products, hinge on the interplay of supply and demand, influenced by factors such as geopolitics, levels of economic activity in industrialized nations, exchange rates, and extent of industrialization in developing countries as argued by (Mats Olimb, 2010). Oil-importing nations like Kenya experience amplified effects when prices spike globally impacting domestic transport costs, inflation, and overall cost of living.

In such a dynamic market environment, oil-importing nations, like the US and its allies, boost demand with economic growth, while oil-exporting nations, such as Russia and Saudi Arabia, thrive on rising oil prices, fostering economic growth within their borders. In the 2022 Annual Statistical Review of World Energy Report published by British Petroleum, it was noted that in 2021, the average oil price stood at USD 70.91 per barrel, marking the second-highest level since 2015.

The report highlights a notable increase in oil consumption, amounting to 5.3 million barrels per day in 2021. However, this level remained 3.7 million b/d below the 2019 figures. The majority of this consumption growth stemmed from gasoline (1.8 million b/d) and diesel/gasoil (1.3 million b/d). Regionally, significant growth occurred in the US (1.5 million b/d), China (1.3 million b/d), and the EU (570,000 b/d). The United States, historically the largest consumer of crude oil, has shown flat or declining consumption since 2005, with recent global growth being driven by non-OECD countries, particularly China and Saudi Arabia (Mats Olimb, 2010). The upstream sector of the petroleum industry, covering exploration and production, significantly influences crude oil supply, thereby impacting downstream prices. Identifying bottlenecks in the upstream sector proves challenging during tight market conditions, making direct measurement difficult.

(Pelin Berkmen, 2005) asserts that OPEC stands as the primary entity in the crude market's supply side. Presently, OPEC contributes roughly 40% of the global supply and commands around 70% of the proven reserves, surpassing non-OPEC producers in both respects. Global oil production increased by 1.4 million barrels per day in 2021, with OPEC+ accounting for more than three-quarters of the increase (British Petroleum, 2022). Producers generate various grades of oil, and there is no distinct individual market price for most crude oils. Instead, prices are established based on benchmark oil prices, particularly Brent and West Texas Intermediate (WTI) (Holloway, 2012). Extensive literature exists that evaluates the impact of varying crude oil prices on the costs of refined products and finally how these fluctuations in refined product prices may affect pump prices. Zacharias (2020) observes that some studies find evidence in favour of asymmetric behaviour while others cannot provide any support to this claim.

The impact of fluctuating petroleum prices varies among countries, with some nations feeling the effects more acutely than others. To mitigate these fluctuations, several countries worldwide have implemented price regulations for petroleum products, establishing price ceilings i.e., price levels that prevail below the market equilibrium. Price regulation involves government interventions designed to govern the maximum prices of specific products. Examples of countries with price regulations include Belgium, China, Mexico, Egypt, Zambia, and Kenya. At a national level, control over high and escalating oil prices in the international market is typically achieved through two primary methods: universal price subsidies and reductions in taxes on petroleum products.

EPRA explains that petroleum prices in Kenya are shaped by both international and domestic factors as shown and described in the Table 1.1 below. International factors include the international platts prices, freight and insurance costs, exchange rate volatility, global supply dynamics. Domestically, pricing reflects landed costs, storage and distribution charges, transport and delivery costs, marketing and retail margins, and government regulation and strategic decisions.

Table 1: Factors Influencing Petroleum Prices in Kenya

Category	Factor	Description
International	Platts Prices	Benchmark reflecting average spot prices in international markets; directly impacts base cost of imports.
	Freight and Insurance Charges	Costs of shipping and insuring cargo from origin to Kenya; affected by global logistics, routes, and risks (e.g., sea disruptions).
	Exchange Rate Volatility	As oil is traded in USD, fluctuations in the KES/USD rate influence import costs.
	Global Supply Dynamics	Influenced by OPEC+ decisions, geopolitical tensions, sanctions, and global disruptions (e.g., wars, pandemics).
Domestic Factors	Taxes and Levies	Includes excise duty, VAT, Petroleum Development Levy, and Railway Development Levy, key contributors to pump prices.
	Landed Costs	The cumulative cost of purchasing refined fuel, including freight, insurance, and port handling fees.
	Storage and Distribution Charges	Costs at ports and depots (mainly managed by KPC), influencing the final consumer price.
	Transport and Delivery Costs	Costs for moving fuel from terminals to retail stations across Kenya.
	Marketing and Retail Margins	Cover operational costs and profit margins of fuel retailers and marketers.
	Government regulation and strategic decisions.	Includes the Open Tender System, strategic reserves, and deals like the 2023 UAE-Saudi fuel import agreement that shape competition and supply.

1.2 Kenyan Oil Industry

Since September 1st, 2013, the country has been importing all its petroleum products in refined form following the cessation of crude oil processing by Kenya Petroleum Refineries Limited (KPRL). KPRL and Kenya Pipeline Company were controlled by the government- KPRL 50% and KPC 100% (Ragui, 2013). In the last five years, the value of oil and oil-related imports amounted to 12 billion USD contributing up to 15% of the total imports bill (Mutuku, 2023). Over the past five years, over 80% of the total oil imports have predominantly originated from three main countries: the United Arab Emirates (32%), India (24%), and Saudi Arabia (20%). Additional sources include Bahrain (3%), Iran (3%), Oman (2%), the Netherlands (2%), and South Africa (2%) (Mutuku, 2023).

Kenya has an Open Tender System (OTS), that was implemented In November 2003, initially established under Legal Notice 197 of 2003 and subsequently revised in 2012 through Legal Notice 24 of 2012. The primary objective of the OTS was to streamline and centralize the importation process for the three petroleum products. This consolidation aimed to leverage economies of scale and enhance scheduling efficiency. In Kenya, there are 60 registered oil firms, yet the market is predominantly influenced by five major companies, collectively holding over 75% of the market share. These leading firms include Vivo Energy Kenya (28%), Total Kenya Limited (23%), Kenol Kobil (10%), National Oil Corporation of Kenya (7.4%), and Libya Oil Kenya (7.2%) (Mutuku, 2023). The latest domestic consumption of various petroleum fuels which is for the period spanning from September 2022 to September 2023, stood at about 3.275 million metric tonnes (KNBS, 2023).

Before the liberalization of the oil industry in October 1994, Kenya's oil sector exhibited a distinctive characteristic, a notable extent of direct government involvement and corresponding limited participation from the private sector. At that time, seven marketing and distribution companies were tasked with procuring and importing oil, highlighting the predominant role of the government in overseeing these crucial aspects of the oil industry. Before mid-1994, the government, in collaboration with oil marketers, determined consumer prices for petroleum products; however, since October 1994, the procurement, distribution, and pricing of these products have been liberalized to enhance operational efficiency and attract private capital (Ramos, 2013).

In 2006, the Energy Act No. 12 of 2006 was passed, resulting in the transformation of the former Electricity Regulatory Board (ERB) into the Energy Regulatory Commission (ERC). This change expanded the ERC's regulatory scope to include oversight of the petroleum and renewable energy sectors, in addition to electricity. Due to the volatility of oil product prices, the Kenyan government reinstated price regulation in December 2010. Before this, attempts were made to stabilize oil product prices using the National Oil Company of Kenya (NOCK), but with limited success. On December 15, 2010, the Government of Kenya introduced new legislation, the Energy (Petroleum Pricing) Regulations, 2010. The primary objectives of these regulations were to ensure the availability of specified petroleum products across all regions of Kenya, stabilize prices of these products nationwide, and reduce price discrepancies among different parts of the country (Ramos, 2013)

The reintroduction of price regulation in 2010 was a response to mounting pressure on the government from consumer advocacy groups and citizens, driven by frequent oil product price hikes from 2004 to 2011 (Wanjiku, 2011). Citizens, influenced by media reports, believed that OMCs colluded to establish high prices, maximizing their profit margins. OMCs, in turn, attributed the price increases to a government-controlled oil supply process, inefficiencies in the Government-administered OTS, upfront payment of excise and import duties through a tax system, outdated refinery technology, and capacity constraints in the storage and distribution network managed by KPC.

The Ministry of Energy faced scrutiny from Parliament, consumer groups, and trade unions regarding efforts to control rising oil prices and their impact on the cost of living. In response, the Energy (Petroleum Pricing) Regulations of 2010 were introduced, initiating price regulation for specific products, including super petrol (gasoline), regular petrol, kerosene, and automotive diesel (gasoil). These regulations empowered the ERC to set maximum monthly prices for these products at both retail and wholesale levels. Subsequently, the ERC was transformed into the Energy and Petroleum Regulatory Authority (EPRA) under Section 9(1) of the Energy Act 2019. EPRA's functions, outlined in Section 10 of the Energy Act 2019, include regulating, monitoring, and supervising upstream petroleum operations, as well as collecting, maintaining, and managing upstream petroleum data.

According to section 101(y) of the Petroleum Act 2019 and Legal Notice No. 192 of 2022, EPRA is mandated to calculate the maximum retail prices of petroleum products for a specified period, typically one month. EPRA oversees efficiency standards to prevent monopolistic tendencies and ensure consumer protection from sub-standard products. The legal framework for petroleum pricing is anchored in the Petroleum Act No.2 of 2019, Legal Notice No. 196 of 2010, and Legal Notice No. 26 of 2012. Legal Notice No. 196 includes a petroleum pricing formula that caps prices for Super Petrol, Diesel, and Dual-Purpose Kerosene. The formula mirrors the supply chain from importation, refining, storage, and transportation through to retailing.

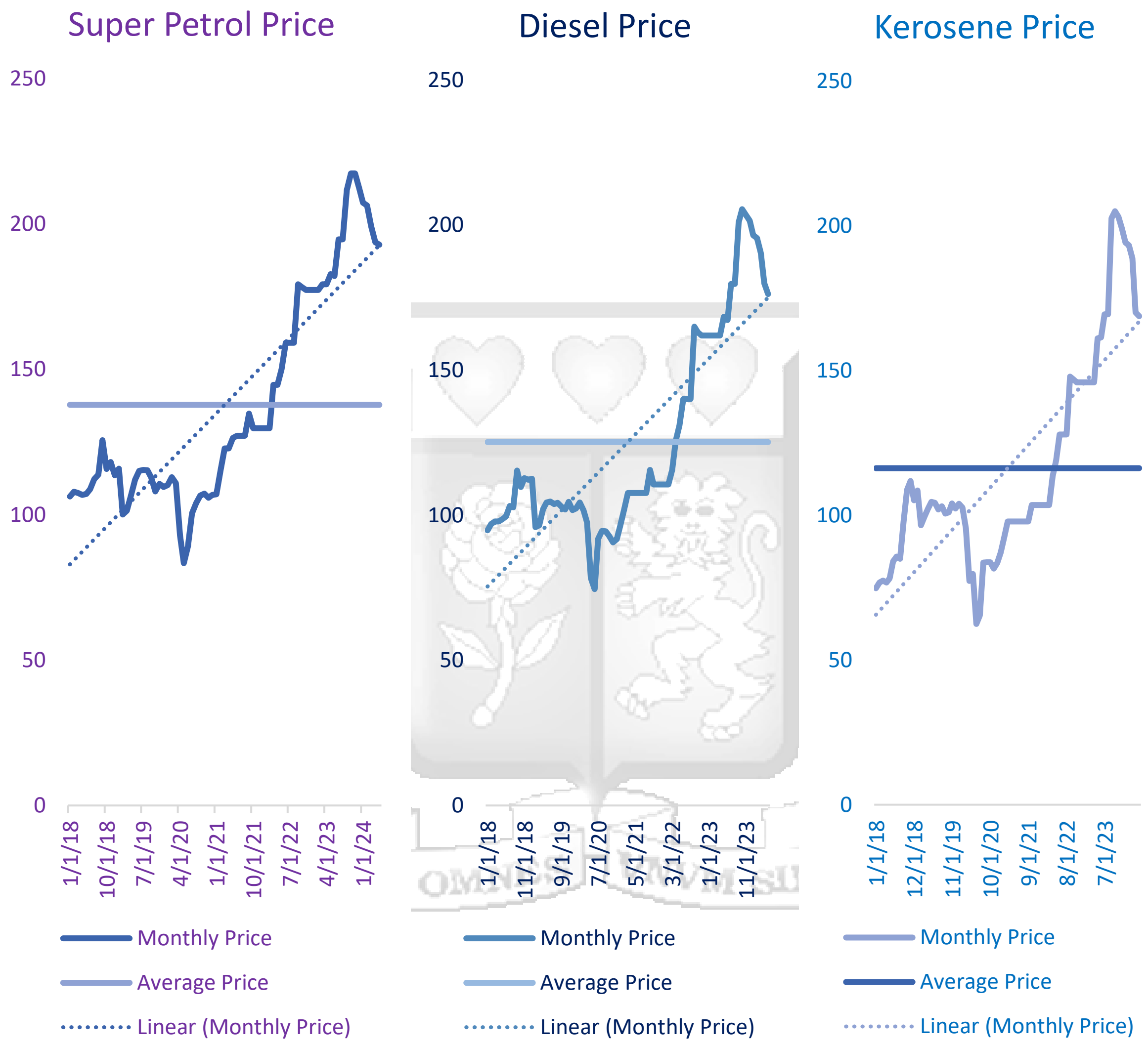
Despite achieving a certain level of liberalization in the Kenyan petroleum sub-sector, significant changes in price-setting mechanisms have not occurred, with the process remaining largely unaffected by market forces (Benjamin A. Okech, 1999). Although further reforms have been introduced over the decades, government involvement in pricing persists most notably through the reintroduction of regulation in 2010. This ongoing control, despite liberalization efforts, reveals a disconnect between policy intentions and actual outcomes, setting the stage for a deeper examination of the challenges shaping petroleum pricing in Kenya.

1.2 Problem Statement

In an ideal scenario, the Kenyan government strives to stimulate overall economic activity through concerted efforts. This involves maintaining stable prices for crucial petroleum products, which are vital for influencing production costs, transportation activities, and preventing inflationary pressures. The commitment to stability is evident in the maximum petroleum product prices that are released by EPRA on the 14th day of each month.

Despite this, the reality is that the prices of Super Petrol, Diesel, and Kerosene are on the rise and they follow a similar pattern, with prices rising and falling in tandem. These movements are largely in response to global crude oil prices, supply chain disruptions, and domestic taxation policies. Between January 2018 and May 2024, fuel prices increased by 81% for Super Petrol, 86% for Diesel, and 126% for Kerosene as shown in the Figure 1 below. The average price for each during this period was KSh 137.78 (Super Petrol), KSh 125.24 (Diesel), and KSh 116.28 (Kerosene)—thresholds that were crossed in the early months of 2022.

Figure 1: Monthly Petroleum Prices in Nairobi (Ksh/Litre)-2018 to 2024



Source: Energy Petroleum Regulatory Authority

These price hikes have led to various consequences, including a reduction in consumption and elevated inflation rates. The observed slowdown in consumption growth due to their increase in prices has impacted the different petroleum products differently based on their demand elasticity. For instance, as of September 2023, illuminating kerosene recorded a consumption level of 3.65 thousand metric tonnes (KNBS, 2023). This reveals a nuanced trend indicating a significant 52% decrease in illuminating kerosene consumption on an annual basis from September 2022 to September 2023.

In the context of kerosene products, the consumer group displays higher responsiveness to an increment in price. This group tends to abandon the product when faced with such a scenario. The rationale behind this behaviour lies in the availability of alternatives for consumers, providing them with choices in terms of products to purchase such as charcoal. Similar assertions have been articulated by (Authenticated US Government Information, 2024). Consumer price indices and inflation rates released every month constantly show that gas and other fuel components are amongst the highest drivers of inflation, always ranking top three (KNBS, 2024).

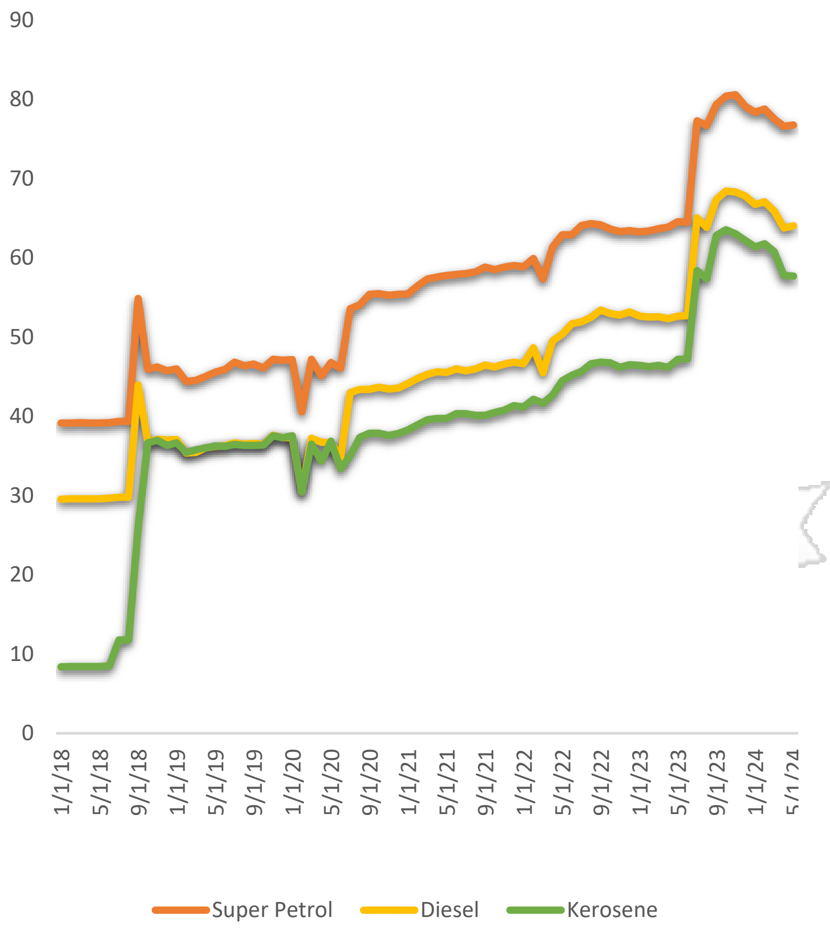
Given the prevailing circumstances, a segment of policymakers and consumers want to see a decrease in the prices of petroleum products in Kenya. In 2021, the parliamentary committee tabled a report dubbed 'Report on the Petroleum Products (Taxes and Levies) (Amendment) Bill (National Assembly Bill No. 42 of 2021) to cut the VAT on petroleum products from then 8% to 4% but this was not adopted. Their diverse arguments revolve around the belief that retail petroleum prices are significantly influenced by both international factors, particularly crude oil prices, and local elements such as taxes and levies. Those advocating for the impact of international prices often call on the EPRA to reduce prices when the Murban crude oil price decreases.

However, it is essential to note, in the field of energy economics, that the price of crude oil is a crucial factor mainly for two types of countries: net exporters of crude oil, where it directly affects their product's pricing and profitability; and countries with oil refineries, where the crude oil price serves as a key input cost. In the case of Kenya, policymakers and citizens alike may not fully recognize that the country neither produces oil nor possesses oil refineries. This distinction is crucial as it challenges the common assumption about the direct impact of crude oil prices on the nation's petroleum prices.

Conversely, those who argue that taxes are the main drivers do so empirically to show that, for instance, in January 2024, taxes accounted for 37.79% of the price of Super Petrol, 33.97% of the price of diesel, and 31.59% of the Kerosene price. This is the single unit that takes up the largest share (EPRA, 2024). Figure 2 shows that taxes and levies per litre have risen sharply between 2018 and 2024, with increases of 96% for Super Petrol, 117% for Diesel, and 589% for Kerosene. The 2018 introduction of the 8% Value Added Tax (VAT) and the KSh 18 Anti-Adulteration Levy triggered initial spikes, particularly for Kerosene. This was followed by steady increases due to excise adjustments, the Petroleum Development Levy, and, in 2023, a VAT hike to 16%. These changes were further amplified by a weakening Shilling, which inflated import-based taxes. Despite temporary relief from subsidies in 2022, taxes remain high into 2024—over KSh 80 for Super Petrol, KSh 63 for Diesel, and KSh 57 for Kerosene—fueling public concern about the tax burden on energy.

Figure 2: Total Taxes and Levies for Petroleum Products in Ksh- 2018 to 2024

Source: Energy Petroleum and Regulatory Authority



The discourse on taxes and international prices of crude oil influencing petroleum prices has prompted a significant discussion in the country, leading to an assessment of the extent to which certain components of petroleum pricing contribute to pump prices in Kenya and this is what this study hopes to bring out. Further, it is imperative that as policymakers advocate for a reduction in fuel prices, they have an understanding of how these components of petroleum pricing influence pump prices in Kenya, and this study aims to bridge this gap by assessing the extent of various components within petroleum pricing on the overall pump prices.

1.3 Research Objectives

The general objective of this study is to assess the extent to which specific components of the fuel pricing formula influence the overall pump prices of petroleum products in Nairobi County.

The specific objectives of the study are to assess the extent to which:

i. Taxes and levies influence the price of petroleum products.
ii. Landed costs for refined petroleum products influence their prices.
iii. Storage and distribution costs influence the price of petroleum products.

1.4 Research Questions

i. To what extent do taxes and levies contribute to fluctuations in fuel prices in Kenya?
ii. To what extent do landed costs for refined petroleum products influence the price of petroleum products?
iii. How do storage and distribution costs contribute to fluctuations in pump prices in Kenya, and how significantly do they influence the pump prices?

1.5 Scope of the Study

The scope of this study is Nairobi County. There are two primary reasons for selecting Nairobi as the focal area of investigation. Firstly, EPRA's specified maximum prices exhibit variation based on the different towns within the country. Notably, Nairobi is frequently provided with a detailed breakdown of prices by EPRA, facilitating more effective data disaggregation. Secondly, Nairobi, along with its adjacent counties like Kiambu and Machakos, holds a significant portion of Kenya's petroleum market. According to the 2019 Census, the total population stood at 8.1 million with Nairobi, Kiambu and Machakos being 4.3 million, 2.4

million, and 1.4 million respectively substantial market presence enhances the feasibility of extrapolating the study's findings to other regions across the country.

1.6 Significance of the Study

Energy is a pivotal driver in the economic development of any nation, and in Kenya, the reliance on imported refined petroleum products as a source of energy is paramount. Fluctuations or increases in the various components of petroleum prices result in unpredictable costs, depriving both petroleum consumers and the economy of the inherent advantages that come with predicting subsequent pump prices for effective planning. By investigating the extent to which various components—such as taxes, landed costs, and; storage and distribution costs—affect petroleum prices, this study contributes to the theoretical understanding of petroleum price formation, thus filling a gap in existing research. The findings from the study provide crucial insights into the key drivers behind petroleum price changes, which could lead to more effective pricing mechanisms and better-informed policy decisions.

The results of this study reveal that taxes and levies have a significant and strong influence on the prices of all petroleum products, with Super Petrol showing the most sensitivity to tax changes. This finding underlines the importance of fiscal policy in regulating fuel prices. Landed costs, particularly for Diesel and Kerosene, also play a crucial role, emphasizing the impact of import-related costs on fuel price determination. These results suggest that a more predictable and stable framework for managing taxes and import-related costs could help mitigate price volatility. On the other hand, storage and distribution costs were found to have a relatively minor impact across all fuel types, indicating that interventions in this area may not have as profound an effect on price stabilization as those in the areas of taxation and logistics.

By establishing the extent of these various components on petroleum product pricing in Kenya, this study will provide policymakers with valuable guidance in the formulation and adjustment of policies related to the stability of these elements. A more predictable pricing environment could foster improved economic planning, reducing the uncertainty faced by consumers and businesses alike. The insights into the relative significance of taxes, landed costs, and storage costs could also form the foundation for a review of the overall petroleum pricing formula in the country, enabling adjustments that better reflect the actual drivers of price changes.

The implications of these findings for petroleum consumption are significant. By understanding how international prices, taxes, and landed costs interact to determine fuel prices, the study will help consumers and businesses anticipate the potential impact of price fluctuations. Furthermore, policymakers could use this information to develop strategies for stabilizing fuel prices and mitigating the economic impact of sudden price hikes.

Scholars will benefit from the addition of specific insights into the relationship between retail oil pricing and the variables examined in this study. Economists, in particular, can use this information to predict the likely effects of changes in taxes, international prices, or logistics on fuel prices, providing a more nuanced understanding of the petroleum market dynamics. For the general public, who are often grappling with how fuel prices are determined, this study will offer transparency into the role of international prices, taxes, and other costs in shaping the final price at the pump.

1.7 Summary of Chapter One

In summary, this chapter provides a global overview of the oil sector before narrowing down to a detailed analysis of the evolution of Kenya's petroleum industry. It outlines the core problem, defines the research objectives, poses relevant research questions, and highlights the significance of the study. The central focus is on evaluating the influence of both international and domestic factors—including taxes and levies—on pump prices within Nairobi County. By unpacking the petroleum pricing dynamics, the chapter not only frames the core issues under investigation but also lays a critical foundation for the chapters that follow. The next chapter builds on this groundwork by introducing the theoretical and empirical framework and the chapter after that will go into the methodology that guide the study.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter entails a review of the previous literature about the subject under study. Various researchers, authors, analysts, and scholars have presented and given their thoughts on this subject. The chapter begins with a theoretical review, highlighting the theories on specific variables that affect oil prices and pricing that have been put forward by various scholars. It also elaborates on the Empirical review of these variables, oil pricing, and their relationships in other economies.

2.1 Theoretical Literature Review

This study draws on several economic theories to analyze the factors influencing petroleum prices in Kenya, directly aligning with the research objectives. First, Price Theory is foundational, explaining how cost components such as landed costs, storage, and distribution costs affect the supply curve. These factors shift the supply curve leftward when costs rise, leading to higher prices, and conversely, efficiency improvements in logistics could moderate price increases. Taxation Theory builds on this by examining how taxes and levies increase production costs, thus contributing to higher prices by shifting the supply curve. Price Control Theory then provides a critical lens for understanding the role of regulations, specifically how Kenya's price control mechanisms, like those employed by EPRA, influence price stabilization and volatility in a regulated market.

Additionally, the Informal Approach Theory highlights how external factors, such as speculation and market imperfections, introduce volatility, which is particularly relevant in assessing global market influences on domestic prices. Finally, Exchange Rate Theory connects the international oil market with local price dynamics, explaining how fluctuations in exchange rates can affect the cost of imported oil, thereby influencing domestic petroleum prices. Together, these theories provide a comprehensive framework to understand the complex and interrelated factors shaping fuel price trends in Kenya.

2.1.1 Economic Theory of Price Control

Price distortions occur when prices and production deviate from the levels expected in a competitive market (Global Economics Prospects, 2024). One source of such distortions is the imposition of price controls, which can take the form of either price ceilings or price floors on specific goods and services by authorities. Price floors are a situation when the price charged is more or less than the equilibrium price determined by market forces of demand and supply while in price ceilings, the price charged is more than or less than the equilibrium price determined by market forces of demand and supply. Virtually, all emerging markets and developing economies impose price controls on energy products, including electricity and petroleum products.

(Christopher Pass, 2000) asserts that the theory of demand focuses on understanding the factors influencing the market demand for goods and services, as well as the impact of both market demand and supply on the prices and quantities exchanged for specific goods and services. Regarding the theory of supply, the author expresses the viewpoint that it delves into the determinants of market supply for goods and services, examining how market supply, in conjunction with market demand, influences the prices and quantities transacted for particular goods and services.

For (Cheung, 1974) he argues that price control refers only to a set of regulations that satisfies three conditions. First, it must fix the price or income terms of private contacts; this categorically excludes any laws that regulate the distribution of income among the contracting parties on a share or percentage basis. Second, the control must involve no appropriation of proceeds to or from the government; taxation and subsidization are excluded. Finally, the fixing of the price must not be associated with direct government sales, purchases, or manipulation of resources to maintain the regulated prices, by this stipulation, price “support” is also excluded. He further opines that even under such terms, he is not oblivious to the fact that legal regulations to control prices are still many and varied.

Since Adam Smith's era, particularly in his book 'Wealth of Nations', where he introduced the concept of the "invisible hand," the issue of government control over prices has sparked intense controversy and passion among economists. Some advocate for government intervention in setting prices, while others argue against it. The ongoing debate over the merits and drawbacks of price controls has persisted, and a consensus on the matter has yet to be reached.

The primary criticism of price controls is that, by artificially keeping prices low, demand surges to a level where supply cannot keep pace, resulting in shortages of the price-controlled product (Miswa, 2019). Further, these shortages often lead to the emergence of black markets, where prices exceed those in the controlled sector. This is also exemplified by (Rockoff, 2023) who also argues that shortages arise because these price controls distort the allocation of resources and price ceilings in particular prevent prices from exceeding a certain maximum. Therefore, in the end, they fail to achieve their intended goals and are generally advised against. However, an absence of the aforesaid controls could lead to an immediate and large price increase, that can cause a shock to an economic system that can be difficult to address. The debate on the efficacy of price controls remains multifaceted and lacks a consensus among scholars and policymakers.

This theory directly relates to the study's objective as Kenya has a long history with price controls, dating back to the colonial and post-independence eras when the government tightly regulated the prices of essential goods to shield consumers from market volatility and inflation. During the 1970s and 1980s, especially under President Daniel arap Moi, price controls were common, often used as a policy tool to manage inflation and ensure political stability. However, this approach led to widespread market distortions, product shortages, and the growth of black markets.

Following the wave of liberalization in the 1990s, these controls were largely dismantled as Kenya embraced structural adjustment programs and market-led reforms. The liberalization of the fuel sector was part of this broader shift towards deregulation, aimed at improving efficiency and encouraging private sector participation.

However, the volatility in global oil prices and concerns over consumer welfare prompted a partial return to regulation in the 2000s. Fuel price regulation was formally reintroduced during President Mwai Kibaki's administration. The Energy (Petroleum Pricing) Regulations of 2010 and the Price Control (Essential Goods) Act, No. 26 of 2011, empowered the government to control the retail prices of key commodities, including petroleum products. These regulations are operationalized by the EPRA, which sets monthly pump prices using a pricing formula that accounts for landed costs, taxes and levies, and distributor margins. While such controls aim to stabilize consumer prices, they also create tension between affordability and market efficiency.

2.1.2 Taxation Theories

Adam Smith in his seminal work Wealth of Nations established the foundational principles of good taxation which include fairness, certainty, convenience and efficiency. These principles suggest that governments should design tax systems in a way that ensures taxes are collected efficiently, with minimal burden on citizens, and in areas where substantial tax revenue can be generated. The goal is to achieve a streamlined tax collection process that minimizes costs while ensuring fairness and equity in the system. Fuel taxes, as argued by (Gronau, 1994), exemplify this strategy: they are easy to collect, difficult to evade, and effectively linked to the use of petroleum products, especially in relation to vehicle consumption.

Taxation is commonly classified into direct and indirect taxes. Direct taxes—such as income tax, corporate tax, and capital gains tax are levied directly on individuals or entities based on income or wealth. In contrast, indirect taxes are applied to goods and services at the point of transaction and include value-added tax (VAT), excise duties, tariffs, and sales taxes. Petroleum taxes fall into the latter category. In Kenya, fuel taxes are embedded in the price consumers pay at the pump and include several levies such as excise duty, VAT (currently 16%), the Petroleum Development Levy, the Road Maintenance Levy, and the Railway Development Levy. These taxes collectively form a significant portion of the retail price of fuel.

The theory of Pigouvian taxes, introduced by Arthur Cecil Pigou, provides a justification for taxing petroleum products beyond revenue generation. Pigou argued that when private consumption imposes costs on society known as negative externalities, governments can use taxes to "internalize" these costs. For example, fuel consumption contributes to air pollution, traffic congestion, and climate change, all of which have social and economic costs not directly borne by consumers. By imposing taxes on fuel, the government seeks to align private costs with social costs, thereby influencing consumer behavior and promoting environmental sustainability.

In Kenya, Pigouvian principles are reflected in emerging policy conversations around carbon taxation, although a formal carbon tax has not yet been implemented. However, existing levies like the Petroleum Development Levy are designed partly to fund energy sector reforms, while the Excise Duty on fuel previously KSh 21.95 per litre of petrol has both revenue and regulatory implications. These taxes increase the cost of fuel, thereby discouraging excessive consumption and encouraging the adoption of energy-efficient alternatives, albeit with distributive effects across different income groups.

As noted by Hughes (1986), developed countries often rely on petroleum taxes as a significant source of government revenue. These taxes are typically earmarked for infrastructure projects, such as the financing of road networks. Fuel taxes, in this sense, serve a dual purpose: they generate revenue while also aligning with the principle of fairness by charging those who benefit from the infrastructure (e.g., drivers) to contribute to its maintenance. In Kenya, the Road Maintenance Levy Fund currently at Ksh 25 per litre of petrol and diesel explicitly earmarks funds for maintaining the national road infrastructure. This aligns with the benefit principle of taxation where those who use and benefit from public infrastructure contribute to its upkeep.

(Poonam Gupta, 1994) identifies five major reasons for levying taxes on petroleum. These are to charge for benefits and costs associated with petroleum consumption; to improve the distribution of income especially in countries with high levels of inequality; to raise revenue with low administrative costs; to conserve foreign exchange or to achieve energy security; and for oil exporting countries, to ensure that domestic petroleum sales reflect the export opportunity price thereby encouraging more efficient resource use. While Kenya is an oil-importing country, several of these justifications still apply. Fuel taxes help manage demand, reduce import bills, and fund critical public investments, even as they disproportionately affect lower-income households and small businesses reliant on transport.

This theoretical framework is directly aligned with the study’s specific objective of quantifying how taxes and levies influence the price of petroleum products. The quantitative focus of this objective requires and in-depth examination of the magnitude of taxes and levies imposed on petroleum products in Kenya and the correlation between changes in fuel taxes and the fluctuations in the final price of petroleum products at the pump. Finally, if these taxes affect more certain consumer groups more than others because they are the ones who tend to consume a particular petroleum product and to what extent.

2.1.3 Demand and Supply Theories

2.1.3.1 Price Theory

Graham Bannock, R.E. Baxter, and Evan Davis define price theory as the area of economics concerned with determining prices in individual markets. They further state that the two components of price theory are the demand side and the supply side; it is the interaction of the two that determines equilibrium output and price in the market.

(Christopher Pass, 2000) asserts that the theory of demand focuses on understanding the factors influencing the market demand for goods and services, as well as the impact of both market demand and supply on the prices and quantities exchanged for specific goods and services. Regarding the theory of supply, the author expresses the viewpoint that it delves into the determinants of market supply for goods and services, examining how market supply, in conjunction with market demand, influences the prices and quantities transacted for particular goods and services.

(Weber, 2012), expands this view, noting that price theory encompasses complete and imperfect markets, behavioral anomalies, externalities, rational choice, and strategic pricing. It explains economic activity by analyzing how value is created and transferred through the exchange of goods and services. At its core, price theory is grounded in the interaction between demand the quantity of a good consumers are willing and able to buy at various prices and supply the quantity producers are willing and able to offer.

At its core, price theory analyzes how shifts in supply and demand affect market prices. On the supply side, producers determine the quantity of a good they are willing and able to offer at varying price levels. This is influenced by factors such as production costs, technology, and resource availability. On the demand side, consumers' willingness and ability to purchase a good at different price points is equally critical. The equilibrium price is established where the supply and demand curves intersect.

In the case of oil, price theory is particularly useful for understanding how market dynamics and elasticity affect pricing outcomes. Oil supply is sensitive to geopolitical events, natural disasters, and technological changes. For instance, conflicts in oil-producing regions can restrict supply, causing the supply curve to shift leftward and driving up prices. Conversely, technological advancements—such as improved extraction techniques—can increase supply, shifting the curve rightward and reducing prices.

Demand elasticity also plays a key role. Oil demand is generally inelastic in the short run due to its limited substitutes and necessity across sectors such as transport and manufacturing. Consequently, even small disruptions in supply can lead to significant price changes, as consumers cannot easily reduce consumption in the face of price increases. When demand is elastic, by contrast, consumers respond more strongly to price changes, amplifying volatility.

Price theory also takes into account various market structures. The global oil market does not conform to the assumptions of perfect competition; instead, it displays characteristics of oligopoly, with a few dominant suppliers such as OPEC member countries capable of influencing global supply and, by extension, prices. Such structural features contribute to oil price volatility, which then transmits to domestic fuel prices in import-dependent countries like Kenya.

In Kenya, the domestic fuel pricing mechanism does not operate under free market conditions. Instead, prices are regulated by the EPRA through a cost-plus pricing model. Under this system, prices at the pump are determined by adding a regulated margin to the sum of key cost components—landed costs, storage, distribution, and taxes. As such, any increase in international oil prices, freight charges, or storage and distribution costs leads to a proportional adjustment in the regulated retail price. Classical microeconomic theory would predict that higher input costs shift the supply curve leftward, leading to higher equilibrium prices. In

Kenya's case, this effect is institutionalized via administrative adjustments rather than market forces.

Nonetheless, price theory remains relevant in analyzing the factors behind price changes. For example, a reduction in storage or distribution costs stemming from improved logistics infrastructure can reduce the total cost base, prompting EPRA to lower the regulated retail price. Similarly, while the immediate demand for petroleum products may be inelastic, sustained price increases could gradually reduce consumption as consumers seek alternatives or adopt more fuel-efficient technologies.

Thus, price theory supports the analysis of Objectives Two and Three of this study, which seek to evaluate how landed costs and logistical expenses influence petroleum product prices in Kenya. By applying the theoretical framework of supply and demand, the study elucidates how global and local cost factors are transmitted into domestic prices, albeit through a regulated mechanism.

Moreover, external shocks such as global oil supply disruptions due to conflicts or natural disasters can lead to shifts in the global supply curve. These shocks increase international prices, which then feed into Kenya's domestic prices through the cost of imported oil. Similarly, demand surges in major economies can increase global competition for oil, driving up prices that ultimately affect Kenya's pump prices. Price theory provides a lens to understand these transmission mechanisms, even within a regulated pricing regime.

2.1.3.2 The Informal Approach Theory

The informal approach theory analyses oil price behavior within a specific economic and political context. The theory postulates that changes in prices are due to speculation of oil derivatives over the past decade. An important assumption in the informal method is that speculation in oil derivatives may have a substantial impact on oil prices. Derivatives are financial instruments that derive their value from an underlying asset, such as oil. Here is the potential impact of speculative trading in derivatives on oil prices. However, speculation may make oil prices even more unpredictable. It becomes increasingly difficult to forecast future oil prices when a significant number of speculators join or leave the market quickly, leading to extreme price fluctuations. For companies and individuals depending on steady oil prices, this heightened volatility may bring unpredictability.

In analyzing the rise in oil prices, (Fattouh, 2007) Identified a wide range of factors including but not limited to robust demand, particularly from non-OECD countries, limited availability of oil reserves, logistical challenges in distribution, geopolitical and weather-related disruptions, and the growing influence of speculators and traders in determining prices. he further argues that the price increases were not driven by a single force, but rather by a complex interplay of global market dynamics. Speculation in oil derivatives, as discussed previously, can create a perception of scarcity and drive prices higher, even if supply and demand fundamentals don't necessarily warrant such an increase. This speculative activity adds another layer of complexity to the dynamics of oil price formation.

(Chevalier, 2011) opined that another factor driving oil price volatility is speculation, which is the holding of trading positions in a financial market that trades oil as a commodity. Most of this speculation occurs in the futures market, which determines global crude oil prices prone to unanticipated oil price shocks. According to (Juvenal L. & Petrella I, 2012), they found Significant changes have occurred in the oil market in the last ten years, resulting in oil prices being influenced by factors outside traditional supply and demand dynamics. (Xiong, 2012) went on further and pointed out that the current surge in oil prices is driven by speculation.

This theory is particularly relevant to Kenya's context. Although Kenya does not host a local commodities exchange for petroleum derivatives, its fuel pricing regime is indirectly exposed to speculation via global oil benchmarks. The EPRA sets retail pump prices using a formula in which the landed cost of imported petroleum—indexed to international spot prices such as Platts—plays a dominant role. These global spot prices are influenced by futures market activity, which is heavily driven by speculative sentiment. As such, price volatility in global oil futures markets is transmitted to the Kenyan retail fuel market.

Concrete examples illustrate this transmission mechanism. During the Russia–Ukraine conflict in early 2022, fears of prolonged geopolitical instability led to speculative spikes in futures contracts, pushing spot prices—and subsequently Kenya's landed costs—significantly higher.

EPRA data shows that the landed cost for super petrol rose from KSh 59.72 per litre in January 2022 to KSh 84.79 in May 2022, despite no immediate disruption in Kenya's domestic supply. This underscores how speculation-induced price surges abroad can affect pricing decisions at home, even under a regulatory framework. Similarly, during the COVID-19-induced crash in April 2020, global futures prices briefly turned negative, and while Kenya's landed costs did not plummet as dramatically (due to shipping lags and long-term supply contracts), they still fell, showing the responsiveness of Kenya's market to global speculative movements.

Comparative insights from other emerging markets reinforce this dynamic. Countries like India, Ghana, and Pakistan, which also rely on international benchmarks for oil imports, experience similar vulnerability to speculative swings. India's deregulated pricing model exposes consumers directly to global futures volatility, while Ghana and Pakistan often intervene through subsidies or delayed pass-throughs, just as Kenya did during 2022–2023. What differentiates Kenya is the semi-formulaic but politically moderated structure of EPRA's pricing approach, which cushions immediate volatility but cannot fully insulate the economy from speculative global pressures.

2.1.3.3 Exchange Rate Theory

Exchange rate theory states that movement in exchange rates may have a substantial influence on local oil price costs, especially in nations that heavily rely on imported fuel. The theory posits that fluctuations in the exchange rate between the local currency and the currency used for buying oil might impact the expenses of imports and subsequently the pricing of domestic fuel. Several countries depend on imports to fulfill their fuel demands. They acquire gasoline from global markets using foreign currencies, such as the US dollar (USD) or Euro (EUR).

(Khatib, and Mkilindi, 2013) argue that there exists a strong correlation between the exchange rate fluctuations in oil price costs and the fluctuations in the currency rate in Tanzania. For countries that import oil prices Kenya in particular the changes in international prices of oil products have a direct impact on the prevailing pump prices. When the domestic currency depreciates against these foreign currencies, the exchange rate requires a larger quantity of the domestic currency to buy the same amount of foreign currency. Consequently, the expense of importing gasoline rises, resulting in elevated domestic fuel costs. Fluctuations in the exchange rate may also impact the pricing of other imported commodities and services, including transportation expenses, equipment, and refinery inputs. Consumers may see increased gasoline prices as a result of these fluctuations in costs.

Kenya's domestic fuel prices are especially susceptible to exchange rate movements because the country has no local refining capacity and procures all petroleum products via international tender. Therefore, variations in the exchange rate between the Kenyan Shilling (KSH) and the USD directly influence the landed cost of fuel, a key input in the monthly price-setting formula regulated by the EPRA.

This theoretical linkage is observable in Kenya’s monthly pump price adjustments. For instance, between September 2022 and March 2023, the KES depreciated significantly against the USD, from approximately KES 120/USD to over KES 135/USD. During this same period, despite relatively stable global crude oil prices, EPRA’s published fuel prices rose consistently. This was partly attributable to the increased Cost, Insurance, and Freight (CIF) value, which is sensitive to exchange rate shifts. A depreciating currency inflates the CIF value of petroleum shipments, which in turn raises the base on which taxes and levies are applied—thereby compounding the final pump price.

(Fattouh, 2011) reinforces this argument by noting that oil prices in domestic markets are shaped not only by international market dynamics but also by the relative strength or weakness of the importing country's currency. In this regard, exchange rate pass-through effects are magnified in liberalized pricing environments such as Kenya’s, where prices are revised monthly to reflect global market conditions.

The degree of competition in the domestic petroleum sector can moderate how rapidly exchange rate fluctuations translate into consumer prices. In Kenya, although the market is liberalized, price-setting is centralized through EPRA’s formula, meaning fuel marketers have limited pricing discretion. As a result, exchange rate-induced increases in landed costs are passed through to consumers more directly and uniformly, particularly when government subsidies are absent or withdrawn. However, in more competitive downstream segments such as wholesale and retail fuel distribution, firms may absorb some exchange rate shocks to maintain market share, albeit temporarily.

This theory is directly applicable to Objective Two of the study, which examines how landed costs influence fuel prices in Kenya. Since landed costs are calculated in USD and converted into KES, the exchange rate is a pivotal determinant of these values. Moreover, there is an indirect linkage to Objective One, which focuses on taxes and levies: as taxes are often applied to the CIF value, any depreciation of the KES not only increases the base price but also inflates the absolute tax burden per litre. Thus, fuel prices can rise significantly even when tax rates remain constant.

2.2 Empirical Literature

This section delves into empirical research aimed at gauging the influence of various factors on retail petroleum prices across diverse settings. These studies contribute valuable insights into the factors shaping fuel prices and their implications for households, businesses, and the broader economy.

2.2.1 Factors That Influence Fuel Pricing Formulas

As per the US Energy Information Administration (EIA), the price consumers pay for a gallon of gasoline is determined by four key elements i.e., price of crude oil, taxes, refining costs and profits, and distribution and marketing costs and profits (United States Government Accountability Office, 2005). The distribution of these elements in terms of percentages is detailed in the Figure One, with crude oil accounting for 48%, taxes at 23%, refining costs at 17%, and distribution and marketing at 12%. The study further acknowledges that changes in gasoline taxes have impacted prices over the past decade. However, the relatively constant federal and state gasoline taxes in recent years have not significantly contributed to the recent volatility in gasoline prices. This study emphasizes how crucial it is to know the weighting of how each element affects the total price as a primary point for legislatures in countries that have a fixed petroleum pricing structure to be aware of what element to adjust to make the prices fair to consumers.

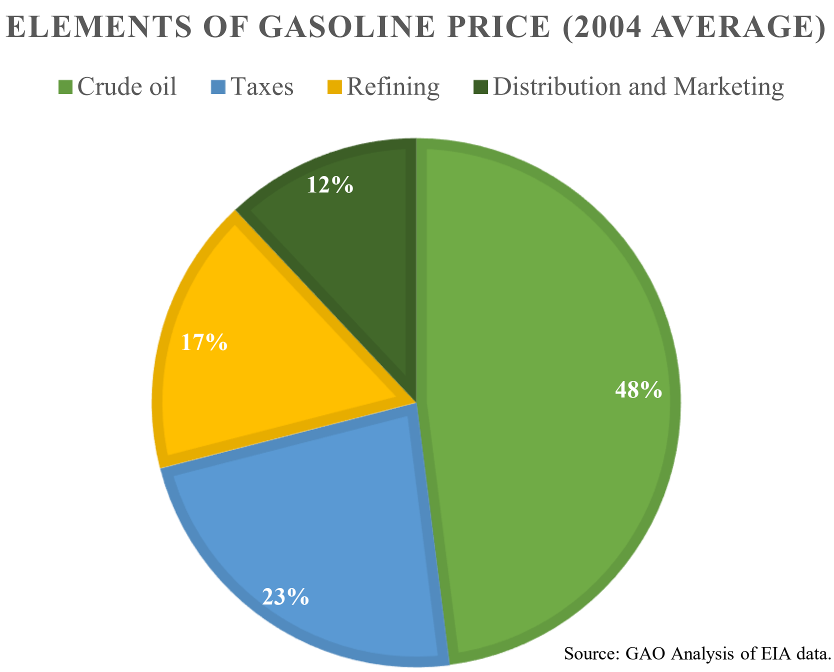


Figure 3: Elements of Gasoline Prices

In a study when explaining automatic fuel pricing mechanisms, David Coady et al argue that the adoption of such mechanisms is designed to ensure the complete pass-through of changes, both increases and decreases, in international fuel prices to domestic fuel prices. At the core of this mechanism is an explicit fuel pricing formula, determining domestic prices as the sum of the import price of fuel products, domestic wholesale and retail distribution margins, and fuel taxes. Domestic fuel prices change at predetermined regular intervals e.g., monthly, to accurately reflect variations in international prices. In instances where the government seeks to prevent a disruption in fuel markets, they may protect the margins of distributors by providing subsidies which is also a factor that ends up affecting petroleum prices. However, while I do agree that automatic fuel pricing mechanisms aim to ensure transparency and responsiveness to international changes, the provision of subsidies could strain government budgets and the complete pass-through of international fuel price changes to domestic prices as advocated by these mechanisms might lead to increased volatility in domestic fuel prices.

A related study by (Acaps, 2022) on conducting a fuel price analysis for Yemen, outlined various cost factors that are taken into account. These include the cost of fuel in the international market as acquired by the importer, fuel import taxes and customs, transportation, distribution, and operating costs, as well as demurrage. Additionally, other factors considered in the analysis encompass the value of the Yemeni Rial. In essence, the study on fuel price analysis in Yemen serves as a comparative reference point for understanding the multifaceted factors influencing fuel prices. By applying relevant insights to Kenya's context, researchers can enhance their understanding of the enabling factors shaping the country's fuel pricing dynamics.

In a comparative study investigating the repercussions of fuel price fluctuations on the transport sector and emissions, simulations conducted with TREMOVE, (Delsalle, 2002) revealed that the four primary domestic components influencing the variation in fuel prices at the pump, and subsequently aggravating or moderating the impact of changes in crude oil prices denominated in US dollars, include fluctuations in the US dollar to national currency exchange rate, variations in excise duties, potential changes in Value Added Tax (VAT) rates, and automatic adjustments linked to alterations in the tax base (net fuel price + excise duties). Additionally, a mark-up component serves as a 'proxy' for the profit margins of fuel production and distribution companies. Understanding these domestic components is essential for policymakers and stakeholders in the transport sector to devise strategies that effectively manage and respond to the repercussions of fuel price fluctuations, ensuring a balanced and sustainable approach to transport and emissions management.

To elucidate the reasons behind the increase in pump prices in the United States following the Russian invasion of Ukraine, Underwood & Stone (2022) outlined seven key factors to enhance public understanding of gasoline price determinants. These factors include crude oil prices, refining capacity, boutique/renewable fuel mandates, credit or debit card fees, taxes, oil futures market speculation, and distribution and marketing.

In South Africa, several levies have been introduced to address specific aspects of the fuel industry. These include the petroleum products levy, which reimburses pipeline users for the NERSA tariff on fuel transportation; it is determined by the Ministers of Energy and Finance in alignment with NERSA's budget. The IP Tracer dye levy is intended to reimburse the oil industry for acquiring and injecting IP tracer dye into illuminating paraffin (IP) to prevent its mixing with diesel. The Slate levy aims to fund the industry's cumulative under-recovery, applicable only when the cumulative Slate balance surpasses R250 million. Additionally, there's the Fuel levy imposed by the Minister of Finance, the Custom and Excise levy collected under the Customs Union Agreement, the Road Accident Fund (RAF) levy compensating those in vehicle accidents, and the Demand Side Management levy (DSML), introduced in 2006 to restrict the use of ULP 95 in the inland market. Further, the elements that go into the Basic Fuel Price are FOB; freight and average freight rate asses, insurance, ocean loss, demurrage, cargo dues, coastal storage, and stock financing costs.

As per the Energy and Water Regulatory Authority (Petroleum Price Setting) Rules, 2009 published on 7th January, Section 5 outlines the pricing formula in Tanzania, encompassing several components. These include CIF costs, local charges and levies, government taxes, distribution costs, and distribution margins. The rules under its table schedule elaborate on specific elements, detailing local costs in USD per metric tonne for various authorities. These include wharfage (1.6 + 20% VAT), destination inspection (1.2% of FOB), SUMATRA (USD 0.23 per metric tonne), TBS (0.20% of CIF), application and testing fees, TIPER fees (USD 0.15 per metric tonne plus 20% VAT), ocean loss (0.5$ MSP, 0.30% GO and IK of the CIF), demurrage estimates (implemented after 3 days per vessel), evaporation losses (0.5% MSP, 0.30% GO of the CIF), surveyors costs (0.15 per Metric Tonne), and financing costs (1.750% of the CIF). Government taxes include fuel levies and excise duty. Additionally, the pricing formula involves the EWURA levy and the overheads and margins of Oil Marketing Companies (OMCs). For wholesalers, prices comprise the dealer's margin and local transport charges.

According to the Energy and Water Utilities Regulatory Authority (Petroleum Products Price Setting) (Amendment) Rules, 2020, specific components of the pricing formula vary based on the port of entry, Dar es Salaam, Tanga, or Mtwara. Schedules 1, 2, and 3 of the Act outline these variations. For example, petroleum products entering the Tanga Port include a wayleave charge of USD 3 per metric ton and 18% VAT, a component not present in the breakdown for other points of entry. In as much as this is not a study, empirical information that enables the researcher to examine how Tanzania formulates its pump prices, encompassing elements such as fees, duties, margins, and taxes, offers a foundation for comparative analysis. Given Kenya's position as the leading economy in East Africa, it is plausible that there might be similarities between Kenya and Tanzania's pricing models. Neighboring countries often draw inspiration from Kenya's economic practices, making a comparative study with Tanzania particularly relevant for understanding potential shared approaches in fuel pricing.

In Zambia's case, the build-up to the pump price constitutes; the fuel terminal fee, respective statutory excise duty on the different products, OMC margin, dealer margin, transporters margins which are determined by the ERB, the ERB fees of 0.7% of turnover, the strategic reserves fund (for infrastructure development in the sector and procurement of strategic reserves) and VAT on products (CUTS International, 2020). Implementing such a system requires a meticulous legal framework to prevent the diversion of compensation funds. It presents a complex process where maintaining a uniform price involves subsidizing transportation costs for locations both near and far from the landing point. Managing this requires effective mechanisms for collecting and redistributing the subsidized funds particularly to transporters, as it is the transportation costs that are being subsidized.

(Wephukulu, 2011) analyzed the impact of crude oil prices on petroleum pump prices in Nairobi spanning from January 2000 to April 2009. He uses the log-linear model and the error correction model in this study. The choice of these models stems from their ability to distinguish between short-term deviations and long-term equilibrium relationships. The log-linear model captures the elasticity of fuel prices with respect to crude oil prices, while the error correction model quantifies the speed at which fuel prices adjust back to long-run equilibrium following shocks. This is especially useful in time series data where external shocks like global oil crises can temporarily distort domestic prices. However, ECMs require stationarity in the data and may be sensitive to how lag structures are specified, potentially limiting their predictive accuracy. The study's findings suggested that the prices of international crude oil significantly influenced domestic pump prices. Specifically, the study identified an inelastic relationship between the price of international crude oil and Premium and kerosene. On the other hand, concerning automotive oil and regular petrol, the relationship was found to be elastic. The results further indicated that approximately 91 percent of the variations in the pump prices of Automotive Oil and premium petrol, as well as Regular petrol and Kerosene, were attributable to changes in the international price of crude oil. This research lays the foundation for further investigation into additional international oil prices, specifically those concerning prices of refined petroleum products like Kerosene, Diesel, and Super Petrol. Given Kenya's status as a net importer of refined petroleum products rather than crude oil, there is a heightened significance in understanding how these particular prices impact domestic processes.

In the analysis of the effects of exchange rate fluctuations on changes in retail oil prices in Kenya, (Ramos, 2013) conducted a regression analysis utilizing monthly data spanning from January 2011 to June 2013. Regression analysis was chosen here for its capacity to isolate the effect of a single independent variable (exchange rate) on a dependent variable (retail fuel price), holding other factors constant. This method is straightforward and interpretable, making it a common tool for policy-relevant economic analysis. However, its limitation lies in its inability to fully capture dynamic, lagged responses or structural breaks in the data, especially in high-volatility environments like foreign exchange markets. The findings of the study revealed that for each unit increase in foreign exchange, the retail fuel price increased by 0.732 units. The model summary further indicated that only 34% of the variation in the average retail fuel price could be explained by the fluctuations in foreign currency exchange rates. The findings underscore the importance of considering multiple variables and external influences when analyzing the dynamics of retail fuel prices.

In Kenya, the wholesale price formula as outlined by EPRA has various components that focus on the storage and distribution elements. These are the primary storage facility costs (CP) that are incurred when products are stored at facilities like Kipevu Oil Terminal, and there is an associated cost, including a minor factor known as LPS (primary storage loss) due to the volatility of the products. The Pipeline tariff (Pt) is another factor in which historically Kenya has had an 80% pipeline and 20% road transportation split for most products, except for jet fuel. However, for super petrol and diesel, the ratio was reversed. Post-2018, the entire product transportation shifted to the pipeline, aiming for potential cost savings. LPt, representing the standard pipeline loss, adheres to the international benchmark of 0.25%, but Kenya has achieved even lower losses, as low as 0.07%. Secondary storage becomes significant as products move from locations like the KPC depot in Nairobi to storage depots owned by OMCs. Secondary storage costs include expenses for depot oil maintenance and staff employment. Additionally, a loss factor in this phase contributes to the overall pricing considerations.

2.2.2 The Impact of Taxes and Levies on Retail Petroleum Products

Catherine & Giraldo (2019) in their comprehensive review of how fuel taxes impact the rebound effect, used French households as a case study. They highlight that taxes constitute over half of fuel prices in European Union countries, with the share of these taxes being 64% for unleaded petrol and 59% for diesel in France. Originally designed to reduce reliance on oil imports, fuel taxes in Europe now serve as incentive tools to stimulate the purchase of more fuel-efficient and low-emission cars. The authors argue that increasing fuel taxes may reduce fuel demand by inducing changes in household behavior, such as driving fewer kilometers or opting for more fuel-efficient vehicles. Public intervention through price signals aims to guide people's choices toward more efficient and cleaner driving, resulting in positive externalities for air quality and CO2 reduction. Similarly, in Kenya, fuel taxes and levies account for a significant proportion of the final retail price, but the policy emphasis has often leaned more toward revenue generation than environmental incentives. Unlike in France where taxes drive cleaner vehicle adoption, Kenya's system still lacks a strong linkage to emissions-based incentives, which could weaken its potential to shift consumer behavior toward fuel-efficient alternatives.

Sällberg & Numminen (2018) assert that fuel taxes influence passenger car choices, with fuel economy restrictions leading consumers to opt for smaller, less powerful cars. Higher gasoline prices prompt consumers to substitute less fuel-efficient vehicles. However, the implementation of a biofuel mandate alone, signifying a portion of all fuel being biofuel, is deemed insufficient for reducing the diesel vehicle fleet in Europe, considering the current structure of fuel taxes. The authors establish a connection between higher taxes, resulting in elevated retail prices, and subsequent shifts in consumer behavior in the market.

Rietveld & Woudenberg (2005) investigated the significant differences in fuel prices between countries and identified three primary factors, one of which is taxes. They emphasize that in many countries, taxes constitute the most substantial component of the fuel price borne by consumers. For instance, in the Netherlands, taxes make up approximately 70% of the fuel price, indicating that tax rates are the primary source of variation in fuel prices. In contrast, in other countries like the USA, taxes contribute to about 25% of the overall fuel prices. This shows then that taxes are a great contributor to the price levels of petroleum products in countries around the world.

In their study on the economic implications of a fuel levy reform in South Africa, Ramos Mabugu et al (2009) employed the SAM multiplier disaggregation approach to model how price changes resulting from an increase in fuel taxes permeate through the economy, particularly affecting the household sector. The authors noted that the pump price of petrol in South Africa primarily consists of a basic fuel price, with a levy comprising approximately 50% and a tax of around 30%. Since 2000, the fuel tax has consistently been a significant contributor to the overall fuel pump price. The study covered the period from the financial year 2003/4 to 2010/11, emphasizing the recognition that alterations in fuel taxes directly impact fuel prices, subsequently influencing various segments of the economy. The significance of this approach lies in its ability to offer a thorough analysis of the ripple effects of alterations in fuel taxes across the entire economy. Its importance is underscored by its attempt to quantify the percentage change in welfare, considering factors such as gross domestic product, total revenue, and imports, in response to a 10 percent shift in fuel prices. This kind of economy-wide modeling would be particularly valuable in Kenya, where changes in fuel taxes ripple through various sectors, from transport to agriculture. Similar to South Africa, fuel levies in Kenya significantly affect household welfare, especially among low- and middle-income groups who face increased transport and food costs due to high pump prices. However, Kenya lacks a comprehensive economy-wide analysis like the SAM approach to quantify these cascading impacts.

The study by (Gitonga, 2018) observed that the imposition of a railway development levy on petrol has resulted in elevated fuel costs for consumers, subsequently increasing the overall cost of living and imposing additional economic burdens on the public in the country. Furthermore, the same study indicated a positive correlation between excise tax and fuel prices in Kenya. Additionally, the research found that heightened excise tax rates on petrol have played a role in the escalation of the retail price of petrol in Nairobi and other towns. The study demonstrated that 26.16% of the variance in excise tax in the current month can be attributed to its lag and lags in petrol prices, railway development levy, and road maintenance levy.

In a report presented during the 12th Parliament's fifth session in Kenya in 2021, focusing on the investigation into the surge in petroleum and petroleum product prices, it was detailed that a breakdown of taxes and levies pointed to excise duty, VAT, RML, and the anti-adulteration levy as the primary contributors to the increased prices (The National Assembly, 2021). The report highlighted that, for Super Petrol, the most substantial tax components were excise duty (38%), RML (31%), and VAT (17%). Diesel's major contributors were the RML (39%), excise duty (25%), and VAT (17%), while kerosene saw the anti-adulteration levy (45%), excise duty (28%), and VAT (18%) as its primary taxes and levies. This analysis is important as it aims to illustrate which specific taxes and levies play a crucial role in driving up the component of taxes and levies in fuel prices, subsequently influencing the overall price, which, in turn, has a significant impact on the prices of other goods and contributes to Kenya's inflation rates.

2.2.3 The Impact of International Prices for Refined Petroleum Products on Domestic Fuel Prices

Kpodar & Imam (2020) delved into the relatively sparse empirical literature concerning fuel price dynamics, aiming to elucidate the factors influencing the transmission of international fuel prices to domestic retail fuel prices by a fixed-effect estimator. Analyzing data from 109 developing countries spanning the years 2000-2014, the study revealed that the pass-through effect is more pronounced when international price fluctuations are minimal, moderate, and less volatile. Additionally, a more flexible pricing mechanism was associated with increased pass-through, while factors such as exchange rate depreciation and lower retail fuel prices in neighboring countries acted as inhibitors. The findings also highlighted that countries with higher inflation rates tended to experience lower pass-through effects. Conversely, those nations with elevated levels of public debt exhibited larger pass-through effects in the context of international fuel price dynamics. This study is important as it shows that whether or not international petroleum prices affect domestic factors is dependent on many other factors and not as direct as one would assume.

This section shows that the transmission of international fuel prices to domestic prices central to understanding landed costs is influenced by a range of factors, including pricing mechanisms, exchange rates, inflation, and public debt. In Kenya, these international dynamics directly affect the landed cost component of petroleum pricing, making this section relevant in explaining how global market trends shape final pump prices through the country’s pricing formula.

2.3 Summary of Literature Review and Research Gap

The literature review investigates retail petroleum pricing across diverse global contexts, emphasizing the United States, Kenya, Tanzania, Zambia, South Africa, and Europe. It identifies four key themes: pricing components and mechanisms, the impact of taxes and levies, the influence of international petroleum prices, and methodologies used in existing studies. The examination of pricing components underscores the intricate dynamics involving crude oil prices, taxes, refining costs, and distribution or marketing expenses. Automatic fuel pricing mechanisms are explored, and comparative analyses with Yemen, South Africa, and Zambia offer insights into regional variations.

Taxes and levies play a significant role in determining retail petroleum prices, with studies from Europe and South Africa highlighting their impact on consumer behavior and the need for a delicate balance to mitigate negative consequences. The review delves into the transmission of international fuel prices to domestic markets, challenging assumptions of a direct and uniform impact. Empirical evidence suggests a multifaceted relationship influenced by pricing mechanisms, exchange rates, inflation rates, and public debt levels. Various methodologies, including regression analyses and SAM multiplier disaggregation approaches, are employed in existing studies to assess factors such as crude oil prices, exchange rate fluctuations, and taxation reforms on retail petroleum prices.

Table 2: Summary of Previous Studies and Identified Research Gaps

Study	Authors	Key Findings	Research Gaps Identified
Motor Fuels: Understanding Factors that Influence the Retail Price of Gasoline.	United States Government Accountability Office. (2005)	Four key components determine gasoline price: crude oil (48%), taxes (23%), refining costs (17%), and distribution/marketing (12%).	Weighting structure specific to U.S.; limited applicability to refined product importing countries like Kenya.
The Unequal Benefits of Fuel Subsidies	David Coady, Valentina	Automatic pricing mechanism passes	Subsidies may distort pricing and strain budgets;

Revisited: Evidence for Developing Countries	Flamini, and Louis Sears (2015)	international price changes to domestic prices; can include subsidies.	impact on volatility in net importer countries not fully addressed. This study showed how subsidies affected prices of petroleum products in Kenya.
Yemen: Impact of the truce on fuel supply dynamics and fuel price structures using satellite imagery and price modelling.	Acaps. (September 2022)	Factors include international fuel cost, taxes, transportation, demurrage, and currency exchange.	No in-depth analysis of how each factor interacts in an importing country like Kenya.
The effects of fuel price changes on the transport sector and its emissions – simulations with TREMOVE.	Jacques Delsalle (January 2002)	Domestic price influenced by exchange rate, taxes (excise, VAT), and distributor margins.	Simulation approach lacks real-world application in an African context; impact on low-income consumers unexamined.
South Africa pricing framework for petroleum products	South Africa Department of Minerals and Energy	Various levies such as petroleum levy, Slate levy, and DSML; detailed cost breakdown.	Institutional cost framework differs from Kenya's; limited discussion on impact of each cost.
Energy and Water Regulatory Authority (Petroleum Price Setting) Rules, 2009 published on 7th January-Tanzania	Tanzania’s Energy and Water Regulatory Authority	CIF costs, taxes, margins, local charges like wharfage, demurrage, etc.; port-based cost variations.	No analysis of how pricing affects end-consumer affordability or regional parity.
The Petroleum Industry in Zambia: Challenges and Opportunities.	CUTS International (2020)	Pump price includes ERB fees, excise duty, VAT, transport subsidies, and strategic reserve fund.	Limited evaluation of efficiency of subsidy allocation or its burden on fiscal policy.

Impact of Crude Oil Prices on Petroleum Pump Prices in Kenya: A Case Study of Nairobi.	Joseph Wephukulu, (September 2011)	Crude oil price changes significantly impact pump prices; elastic vs. inelastic product responses identified.	Does not account for refined fuel import prices which are more relevant to Kenya.
The effect of exchange rate fluctuations on changes in retail oil prices in Kenya	Patrick Kioko Ramos (November 2013)	Exchange rate changes affect retail fuel price (0.732 coefficient); 34% price variation explained.	Exchange rate is just one factor; other influences on fuel price left unexplored.This study explored taxes, landed costs, storage and distribution costs influence on fuel price.
How Fuel Taxes Impact Rebound Effect? Empirical Evidence from French Households.	Catherine Benjamin and Alejandra Giraldo Hurtado (2019)	Taxes constitute over 50% of fuel prices in EU countries; increasing taxes reduces demand through behavior changes (e.g., fewer kilometers driven, more fuel-efficient vehicles).	No focus on developing countries like Kenya, where tax structures and behaviors differ. The study focuses on Kenya and taxes influence on fuel prices.
Why Fuel Prices Differ	Rietveld, Piet and van Woudenberg, Stefan (January 2005)	Taxes are a significant factor influencing fuel prices, accounting for 70% of price in Netherlands; lower in countries like the USA.	Limited exploration of how tax structures in low- and middle-income countries (e.g., Kenya) impact prices. The study focuses on Kenya and taxes influence on fuel prices.
The Economic Consequences of a Fuel Levy Reform in South Africa.	Ramos Mabugu, Margaret Chitiga and, Hammed	Fuel taxes make up a substantial portion of the pump price (50%), with tax changes influencing	Research does not analyze fuel tax reform in countries with different tax structures

	Amusa (September 2009)	economic sectors, including household expenditure.	and economic conditions for example Kenya.
Effect of Fuel Taxation on Fuel Price in Kenya.	Lawrence Nkoroi Gitonga (November 2018)	Railway development levy and excise taxes positively correlated with rising fuel costs, increasing living costs in Kenya.	Lack of detailed analysis of the broader economic impacts of such taxes and levies on different income groups.
Report on Inquiry Into The Cause of Increase In Prices of Petroleum and Petroleum Products.	The National Assembly of Kenya (2021)	Breakdown of taxes and levies: excise duty, VAT, road maintenance levy (RML), and anti-adulteration levy contribute significantly to price increases.	Limited focus on the dynamic relationship between taxes and market conditions that drive retail prices in Kenya.
To Pass (or Not to Pass) Through International Fuel Price Changes to Domestic Fuel Prices in Developing Countries: What Are the Drivers?	Kagni R Kpodar and Patrick A.Imam (September 25th,2020)	Pass-through effect is influenced by international price fluctuations, exchange rate depreciation, and inflation; flexible pricing mechanism enhances pass-through.	Lack of analysis on how these factors specifically affect fuel pricing in countries like Kenya, with different fiscal and market conditions.

While existing literature offers valuable insights into fuel pricing, much of it is based on contexts that differ significantly from Kenya's, focusing largely on high-income and fuel-producing countries with frameworks, simulations, and institutional setups that do not translate well to net fuel-importing nations like Kenya. The reviewed studies highlight several research gaps relevant to Kenya's context, including limited analysis of how pricing components such as subsidies, taxes, and levies interact in the local market, and insufficient exploration of consumer affordability and behavior particularly among low-income groups. Additionally, there is inadequate attention to the real-world impact of pricing models and tax reforms in African settings.

This study seeks to address some of these gaps by examining the taxes and levies included in Kenya's petroleum pricing model, with a focus on how they are aggregated and applied. It also explores the relationship between the landed costs of refined petroleum products and the retail prices of various fuels, and investigates the role of storage and distribution costs in shaping fuel prices. Through this analysis, the study aims to contribute new, context-specific insights to the existing body of knowledge on fuel pricing in Kenya.

2.4 Conceptual Framework

The conceptual framework provides the foundational structure for analyzing the determinants of retail petroleum prices in Kenya and their broader economic effects. It illustrates the interaction between international market factors, domestic fiscal and policy instruments, and moderating influences that shape the retail price of petroleum products such as super petrol, diesel, and kerosene.

International factors include global crude oil prices, refined product prices, exchange rate movements, freight and insurance costs, and price volatility linked to global oil supply dynamics. Domestic factors comprise taxes (Excise Duty, VAT, Road Maintenance Levy, Railway Development Levy, Anti-Adulteration Levy), storage and distribution costs, marketing margins, and government subsidies or price interventions.

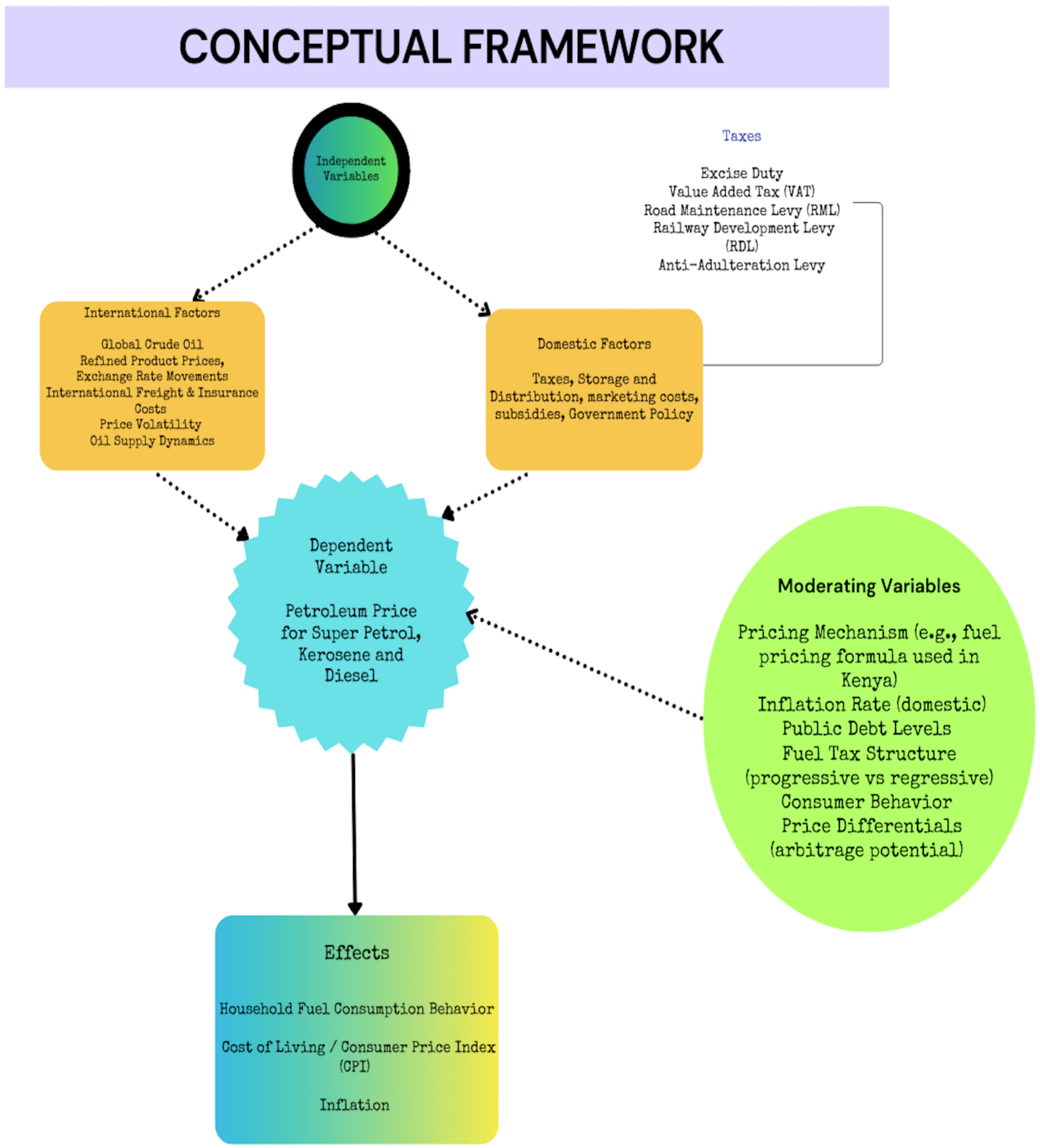
Taxes and levies are further disaggregated into fixed and variable components, affecting the base price and price sensitivity to market changes. These inputs are processed through a fuel pricing mechanism, influenced by moderating factors such as domestic inflation, public debt levels, fuel tax structure (progressive vs regressive), consumer behavior and vehicle efficiency, and cross-border fuel arbitrage opportunities.

The resulting retail price impacts key economic indicators, including:

- Household fuel consumption behavior
- Consumer Price Index (CPI)
- Inflation levels
- Transport and goods pricing (as spillover effects)

This framework enables structured analysis of the economic consequences of petroleum price dynamics in a liberalized but state-influenced pricing regime.

Figure 2: Fundamental Structure Guide of the Factors Influencing Retail Petroleum Product Prices in Kenya



Source: Author, 2025

2.4.1 Operationalization of Variables

I. International Factors (Independent Variables)

Variable	Operational Definition	Measurement/Indicator
Global Crude Oil Prices	Benchmark price of unrefined oil	USD/barrel (e.g., Brent, Murban)
Refined Product Prices	Import prices of processed petroleum products	USD/tonne (e.g., PMS, AGO, IK)
Exchange Rate Movements	Value of KES against USD	Average monthly KES/USD exchange rate
Freight & Insurance Costs	Shipping and insurance charges for fuel imports	USD/tonne or % of import value
Price Volatility	Instability of international prices	Coefficient of variation or standard deviation
Oil Supply Dynamics	Availability of crude due to geopolitical or production factors	Supply disruptions (Yes/No), % change in global output

II. Domestic Factors (Independent Variables)

Variable	Operational Definition	Measurement/Indicator
Excise Duty	Per-litre tax on fuel	Ksh/litre
VAT	Tax on value of fuel and services	16% or as per the 2023 Finance Act
RML	Road fund for infrastructure	Fixed charge per litre
RDL	Tax to support rail infrastructure	Percentage of import value
Anti-Adulteration Levy	Fee to discourage kerosene mixing	Ksh/litre
Storage, Distribution & Marketing Costs	Local handling and retail markup	Ksh/litre (broken down)
Government Policy	Laws and regulations affecting fuel pricing	Existence of price control, subsidies, tax reforms

III. Moderating Variables

Variable	Operational Definition	Measurement/Indicator
Fuel Pricing Mechanism	Method used to set retail prices	Price control formula (Yes/No), update frequency
Domestic Inflation Rate	General rise in prices	% change in CPI (monthly/yearly)
Public Debt Levels	Government's debt stock	Debt-to-GDP ratio, Ksh billions
Fuel Tax Structure	Nature of tax incidence (equity)	Tax burden as % of income across quintiles
Consumer Behavior	Demand response to fuel prices	Change in fuel volume consumption, modal shifts
Cross-border Price Differentials	Variation in prices with neighboring countries	Ksh/litre price differences

IV. Dependent Variable

Variable	Operational Definition	Measurement/Indicator
Retail Petroleum Prices	Prices of Super Petrol, Diesel, and Kerosene	Ksh/litre

V. Effects (Outcomes)

Variable	Operational Definition	Measurement/Indicator
Household Fuel Consumption Behavior	Changes in volume and type of fuel used by consumers	Monthly/annual consumption data per fuel type
Cost of Living / CPI	Cost of basket of goods influenced by fuel	Monthly CPI, CPI Transport Index
Inflation	General increase in prices across economy	Headline and core inflation rates
Transport & Goods Prices	Indirect effects of fuel prices on other sectors	Change in fare rates, food prices, freight charges

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter presents the research methodology employed to assess the influence of both international and domestic factors on the pricing of petroleum products in Kenya. It is structured into seven sections: research philosophy, research design, target population and sampling, data collection, research quality, data analysis, and ethical considerations.

3.2 Research Philosophy

Positivism was adopted as the underpinning philosophy; which emphasizes the importance of empirical evidence and scientific methods in studying and understanding the world. Positivist research tends to focus on quantitative data, which can then be measured and analyzed using statistical techniques allowing researchers to identify patterns, relationships, and trends within data.

According to Collins (2010) positivism "as a philosophy, is in line with the empiricist view that knowledge stems from human experience. It has an atomistic, ontological view of the world as comprising discrete, observable elements and events that interact in an observable, determined, and regular manner". The choice of this philosophy was informed by the researcher's need for objectivity and to enable her to distance herself from personal views while conducting this study and her role was limited to data collection and interpretation of these results.

3.3 Research Design

This study employed a quantitative longitudinal research design, utilizing a time series approach to investigate the dynamics influencing petroleum product prices in Kenya. A research design provides the framework for collecting, analyzing, and interpreting data, ensuring that the research questions are addressed systematically and coherently (John Creswell, 2018)

In particular, a longitudinal design was appropriate as it allows for the observation of the same phenomenon over an extended period, thereby capturing changes and trends that occur over time (Babbie, 2013). Within this framework, the study applied a time series analysis, which is a statistical method used to analyze data points collected at regular time intervals. While time series is not a research design in itself, it is an analytical strategy that fits within the broader longitudinal design, especially when the focus is on exploring temporal relationships among variables (Damodor Gujarati, 2009)

The study analyzed monthly data spanning six years and five months on key variables including petroleum product prices, taxes and levies, landed costs, and storage and distribution costs. This timeframe was deemed sufficient to capture both short-term fluctuations and long-term trends in fuel pricing.

Time series techniques such as Pearson correlation and auto-regressive distributed lag analysis were applied to identify and quantify the relationships among these variables. These techniques are particularly suited to longitudinal datasets, as they account for trends, seasonal effects, and autocorrelation, thereby offering more reliable insights into the factors influencing petroleum prices (Sanders, 2014). The choice of this research design enabled a rigorous and nuanced understanding of the interplay between domestic and international factors in shaping petroleum product prices in Kenya.

3.4 Target Population and Sampling

3.4.1 Target Population

In research methodology, a population refers to the complete set of units be they individuals, objects, events, or observations that share a set of characteristics relevant to the study's objective (Kothari, 2004). Shukla (2020) further emphasizes that the target population encompasses all elements that exhibit the variables under investigation and to which the study's findings are meant to generalize.

In the context of time series analysis and applied econometrics, the term "population" is often extended to refer to the full dataset of observations over a defined time horizon (Damodor Gujarati, 2009). This includes all temporal data points that represent the behavior of variables under study, particularly when the focus is on repeated observations over time rather than individual subjects.

Accordingly, this study defines its target population as the monthly retail prices of three key petroleum products in Kenya—Diesel, Super Petrol, and Illuminating Kerosene—alongside the corresponding variables that influence these prices: taxes and levies, storage and distribution costs, and landed costs. These variables were chosen due to their relevance in determining domestic fuel prices, especially under Kenya's fuel pricing regulatory framework. The scope of the population spans from December 2010, marking the start of fuel price regulation in Kenya, to May 2024, covering approximately 180 monthly observations excluding the revisions by EPRA.

3.4.2 Sampling and Sample Size

According to Dana P. Turner (2020), sampling involves selecting a subset of a population to represent the whole in a research study. Since it is often impractical to involve the entire population, researchers rely on smaller, representative groups for data collection. In this study, the sample was drawn from the target population outlined earlier, which included retail prices and influencing components of petroleum products in Kenya.

The study focused on Nairobi County and analyzed data spanning six and a half years from January 2018 to May 2024 comprising 77 monthly observations. These data points included the retail prices of Super Petrol, Diesel, and Illuminating Kerosene, along with their associated taxes and levies, landed costs, and storage and distribution costs. Instances of mid-month price revisions were excluded to maintain consistency, as the EPRA typically publishes monthly maximum retail prices for the three petroleum products under investigation.

The sample size was determined with reference to previous studies using time series data. For example, (Ramos, 2013) relied on approximately 30 monthly observations, while (Wephukulu, 2011) used 38. This study deliberately expanded the sample to 77 data points to improve the robustness and reliability of the findings by capturing longer-term trends and fluctuations.

Practical considerations also influenced the chosen sample size. A feasibility assessment revealed significant limitations related to data access and collection. While EPRA disseminates pricing data via its website and social media platforms, these sources are subject to content limitations and frequent updates, making historical retrieval difficult. Additionally, delays associated with bureaucratic procedures at government agencies further constrained efforts to obtain a larger dataset.

To navigate these challenges, the study employed a combination of purposive and convenience sampling. This dual approach ensured the inclusion of data that was both relevant to the study's objectives and practically attainable, thereby striking a balance between methodological rigor and operational feasibility.

3.5 Data Collection Methods and Tools

According to Denzin and Lincoln (2000), a data collection instrument is a structured tool used to gather standardized information, enabling comparison, aggregation, and statistical analysis. In this study, secondary data collection was employed, utilizing publicly available records from the EPRA.

EPRA, the statutory regulator of Kenya's energy and petroleum sector, publishes monthly press releases—typically on the 14th of each month—detailing maximum pump prices effective from the 15th. These releases provide disaggregated pricing information for Super Petrol, Diesel, and Illuminating Kerosene. Each product's retail price is broken down into five main components: landed cost, storage and distribution cost, supplier margin, price stabilization fund (surplus/deficit), and taxes and levies. These components, in turn, consist of several sub-elements that collectively determine the final retail price.

The data were manually retrieved from EPRA's official website, focusing on archived monthly fuel pricing press releases. Where press releases were unavailable on the website, alternative sources were consulted, including EPRA's official social media platforms (primarily Twitter and Facebook), Newspaper publications, and publicly shared government repositories. Each press release was reviewed to extract the relevant data points, which were then entered into a structured Microsoft Excel spreadsheet for organization and validation. This process ensured accuracy by applying a consistent format across all entries and performing double-entry checks for key values.

The study covered the period from January 2018 to May 2024, resulting in a dataset of 77 monthly observations. This timeframe was purposively selected for three reasons. First, it includes critical policy and economic events such as the COVID-19 pandemic, changes to fuel taxation, and the introduction and removal of subsidies. Second, from 2018 onward, EPRA's data publications became more consistent and detailed. Third, logistical constraints—including limited archival access and bureaucratic delays—made earlier data harder to retrieve reliably.
Once compiled, the dataset was uploaded into R-Studio and Microsoft Excel for analysis. Descriptive statistical methods were applied to identify patterns and price movements over time. For four months within the dataset where official records could not be obtained,

imputation was used to fill the gaps. The missing values were estimated using the average of the two immediately preceding data points, a method deemed appropriate due to the low volatility in month-to-month fuel price changes. The imputed values are clearly indicated in Annex 3, using Super Petrol as an illustrative case.

3.6 Research Quality

This section outlines the steps taken to ensure the quality and trustworthiness of the study, focusing on two critical dimensions: validity and reliability. According to Sürücü and Maslakci (2020), these concepts, while closely related, serve different purposes. Validity refers to the accuracy and meaningfulness of the research findings, while reliability concerns the consistency and stability of those findings under repeated conditions. Ensuring both dimensions enhances the credibility and applicability of the research outcomes.

3.6.1 Validity

Validity in research refers to the degree to which results obtained from data analysis accurately represent the phenomenon under investigation (Mugenda Afuma Esy, 2003).

In this study, the researcher ensured validity through the following strategies:

1. Use of credible data sources. Data was collected from the EPRA, a statutory and reputable institution mandated to regulate petroleum pricing in Kenya. Its monthly publications are standardized and peer-reviewed, which adds to the authenticity of the data.
2. Comprehensive data coverage. The dataset captured all the key components that influence petroleum prices, including landed costs, storage and distribution charges, supplier margins, the price stabilization fund, and taxes and levies. This broad scope of variables helped ensure content validity by addressing the full structure of price formation.
3. External validity through literature triangulation. Findings were compared with patterns, themes, and conclusions reported in previous studies, as outlined in Chapter Two. This approach helped verify the generalizability of the results and ensured the study reflected broader trends observed in similar research.

3.6.2 Reliability

Reliability pertains to the consistency of data collection and analysis procedures over time. It is an indication of the stability and repeatability of the measurements when applied under similar conditions (Lütfi Sürücü, 2020). Several measures were undertaken to ensure reliability:

1. Systematic and uniform data collection. Monthly data was retrieved from EPRA's consistent publications released on the 14th of each month. These reports follow a uniform structure, thereby reducing variability that could arise from inconsistent formats.
2. Handling of missing data. In four instances where data was unavailable, missing values were estimated using the average of the two immediately preceding data points. This simple imputation method was chosen based on the observed month-to-month price stability, helping to maintain continuity in the time series without introducing distortions.
3. Triangulation of data sources. Although secondary data was the sole source, triangulation was achieved by cross-verifying information from EPRA's official website, archived documents, and social media platforms. In cases of data gaps or inconsistencies on one platform, alternative sources were used to confirm accuracy, thereby enhancing the dependability of the dataset.
4. Transparent data documentation. A clear and traceable record of the entire dataset—including the imputed values, original data sources, and collection dates—was maintained in a secure database. This practice supports reproducibility and auditability, which are hallmarks of reliable research.

3.7 Data Processing and Analysis

Data analysis in this study involves transforming raw data into meaningful insights through regression and time-series techniques. This process adds value to statistical output, helping to identify data gaps, inform survey design, and establish quality objectives. Data presentation, on the other hand, focuses on clearly communicating the results to stakeholders and audiences.

3.7.1 Analysis of Quantitative Data

Quantitative data was utilized to explore the relationship between various variables and the retail pump price through a regression analysis. The researcher analysed the average monthly retail fuel pump price in the Nairobi region, examining its correlation with average data for different variables using the Pearson's correlation formula. An auto-regressive distributed lag model analysis was also employed to assess the influence of the various components as independent variables on changes in retail oil prices in Kenya. This is because unlike traditional models that require variables either to be all stationary or non-stationary, this model can handle a mix of both. Microsoft Office application and R-studio were used to analyze the information and present the results through figures, graphs, and tables.

The Pearson's correlation formula for this study took the form of:

$$r = \frac{\sum(X_i - \bar{X})(Y_i - \bar{Y})}{\sqrt{\sum(X_i - \bar{X})^2} \ \sqrt{\sum(Y_i - \bar{Y})^2}}$$

Where:

- Xi = Independent variable (e.g., taxes and levies, storage and distribution costs, landed costs on a monthly basis)
- Yi = Each corresponding retail fuel pump price for that month
- X¯, Y¯ = Mean of X and Y
- ∑ = Summation over all observations

.

The auto-regressive distributed lag (ARDL) model where the dependent variable (price) is explained by its own past value ($Price_{t-1}$) and other independent variables, including total taxes and levies, landed costs, storage and distribution.

The equation for this study took the form of:

$$Price_t = \beta_0 + \beta_1 Price_{t-1} + \beta_2 TTL_t + \beta_3 LCost_t + \beta_4 Scost_t + e_t$$

Where:

Price: This is the dependent variable, representing the current price of petroleum products i.e., kerosene, diesel, or super petrol. It is what we were trying to predict or explain based on the independent variables.

$Price_{t-1}$: This is one of the independent variables and represents the lagged or previous price of petroleum products. It captured the effect of past prices on the current price, indicating whether there is a relationship between current and past prices.

TTL (Taxes and Levies): This is another independent variable and represents the total taxes and levies imposed on petroleum products. It captured the effect of taxation policies on the current price of petroleum products.

LCost (Landed Costs): This independent variable represents the landed costs of petroleum products, which include costs associated with transportation, importation, and handling. It captured the effect of global market dynamics and transportation logistics on the current price of petroleum products.

Scost (Storage Costs): This independent variable represents the storage costs of petroleum products, including costs associated with storage facilities, inventory management, and distribution. It captured the effect of storage infrastructure and logistics management on the current price of petroleum products.

β0, β1, β2, β3, β4: These are the coefficients or parameters of the regression equation. They represent the strength and direction of the relationship between the independent variables ($Price_{t-1}$, TTL, LCost, Scost) and the dependent variable (Price). The coefficients indicated the extent to which one-unit change in each independent variable affected the dependent variable, holding other variables constant.

e: This represents the error term or residual, capturing the difference between the actual observed price and the price predicted by the regression equation. It accounted for factors not included in the model that may influence the price of petroleum products, such as changes in market demand, geopolitical events, or unexpected disruptions in the supply chain.

However, many times in time series datasets, these variables may move in the same direction fluctuating around a long-run equilibrium. In statistics, this long-run equilibrium is tested and measured using the concept of co-integration. The data analysed was presented using tables and graphs.

3.8 Assumptions Check

Before interpreting the results, a comprehensive evaluation of the assumptions associated with multiple regressions was conducted. These assumptions include linearity, independence of errors, homoscedasticity, normality of residuals, and the absence of multicollinearity among predictors. It was imperative to adhere to these assumptions as they contributed to the validity and reliability of the subsequent analysis. Diagnostic tests, such as the co-integration test, unit root test and the akaike information criterion were employed to ensure the robustness of the regression model.

3.8.1 Unit Root Test

Many statistical and econometric models assume that the underlying data is stationary meaning its statistical properties, such as the mean and variance, remain constant over time. Using non-stationary data can result in misleading or spurious relationships, where variables appear correlated simply due to shared trends rather than any meaningful economic relationship.

To assess stationarity, the researcher applied unit root tests to each variable. Specifically, the researcher used the Augmented Dickey-Fuller (ADF) test, which tests the null hypothesis that a time series has a unit root (i.e., is non-stationary) against the alternative that it is stationary. A p-value below the 0.05 significance level leads to rejection of the null hypothesis, indicating that the series is stationary. Conversely, a p-value above 0.05 suggests the presence of a unit root and non-stationarity. This approach ensures that the residuals used in regression analysis are stationary, thereby supporting the validity of the model.

3.8.2 Co-Integration Test

The Johansen cointegration test was applied to examine whether a long-term equilibrium relationship exists between petroleum product prices and their associated cost components namely, taxes and levies, landed costs, and storage and distribution costs.

The test results are presented using trace statistics, which assess the number of cointegrating relationships (denoted by r) among the variables. Each row in the results corresponds to a hypothesis about the maximum number of cointegrating vectors. For instance:

- $r = 0$ tests the null hypothesis of no cointegration.
- $r \leq 1$ tests whether there is at most one cointegrating vector.
- $r \leq 2$ tests for at most two, and so on.

For each hypothesis, the test statistic is compared to critical values at the 10%, 5%, and 1% significance levels. If the trace statistic exceeds the critical value, the null hypothesis is rejected, suggesting that more than r cointegrating vectors exist. Conversely, if the test statistic is lower, the research fails to reject the null hypothesis.

This test helps determine whether the variables share a common stochastic trend that is, if they move together over the long term despite being individually non-stationary. Establishing cointegration supports the use of models like the Vector Error Correction Model (VECM), which account for both short-term dynamics and long-term equilibrium.

3.8.3 The Akaike Information Criterion (AIC)

A lag selection analysis was conducted to determine the optimal number of lagged terms (past values) to include in the time series models. In time series analysis, the inclusion of lagged terms enables the model to capture the dynamic relationships between variables, particularly how past values influence current outcomes. The AIC was used as the primary model selection metric, where models with lower AIC values are preferred due to their better balance between model fit and complexity.

The analysis involved estimating several model specifications for each of the three fuel types—super petrol, diesel, and kerosene. Each specification varied by the inclusion and lag length of the explanatory variables. Specifically, a lag of 1 represents a first difference, a lag of 2 represents a second difference, while a lag of 0 indicates that the variable was excluded from that particular model specification.

The dependent variable in all cases was the natural logarithm of the fuel price (ln_price). The explanatory variables included:

- ln_TTL – the natural logarithm of taxes and levies
- ln_LCost – the natural logarithm of landed cost
- ln_SCost – the natural logarithm of storage and distribution cost

Model combinations were systematically evaluated based on their AIC scores, and the specifications with the lowest AIC were selected as the most appropriate for further analysis. This approach ensured that the final models retained parsimony while effectively capturing the underlying time-dependent relationships in fuel pricing dynamics.

3.9 Ethical Issues in Research

This study was committed to maintaining ethical standards. Permission was sought from Strathmore University School of Business by getting clearance through the Institutional Ethics Review Committee, the letter of approval is attached to this study as Appendix 4. The findings of this study were only utilized for academic purposes, and the researcher will adhere to academic writing ethics. The researcher recruited and trained one research assistant to support the researcher in gathering the quantitative data.

CHAPTER FOUR: RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This Chapter presents the results of the detailed data analysis work. The data characteristics under consideration were first uploaded into Microsoft Excel. The analysis was then conducted using R-studio and Microsoft Excel. The results are presented using graphs, tables, and descriptive statistics. Data was tested for stationarity and co-integration. The data used for analysis is found in Appendix 2 for all the three petroleum products.

4.2 Preliminary Analysis

Before examining the effect of the variables (taxes, landed costs, and storage costs) on fuel prices in Kenya, preliminary data analysis was carried out. This is to provide a foundational understanding of the central tendencies, dispersion, and distribution shapes of the key variables influencing domestic fuel prices for each petroleum product in Kenya.

4.2.1 Descriptive Analysis

Descriptive statistics such as the mean, standard deviation, standard error, minimum, and maximum help summarize and understand key characteristics of a dataset. The mean shows the central tendency, the standard deviation indicates variability, and the standard error reflects the precision of the mean estimate. Minimum and maximum values define the range and highlight potential outliers. In this analysis, descriptive statistics were applied to each individual petroleum product across key variables including price components, taxes and levies, storage and distribution costs, and landed costs to provide a clear overview of trends, variability, and relationships within the data.

Table 4.1: Descriptive Statistics for Super Petrol and its Components (N=77)

Variable	Mean	Std. Dev.	Std. Error	Min	Max
Total Taxes & Levies	56.42	11.98	1.36	39.14	80.57
Super Petrol Price	137.78	37.11	4.23	83.33	217.36
Landed Costs	68.41	27.97	3.19	21.02	130.6
Storage Costs	3.57	0.42	0.05	2.88	4.42

Source: Author's Own Calculations (2025)

The observations for all variables span 77 months from January 2018 to May 2024. The Table 4.1 describes the characteristics of all variables for Super Petrol. The mean price of Super Petrol in Nairobi is Ksh 137.784, with total taxes and levies at Ksh 56.415, landed costs at Ksh 68.413, and storage costs at Ksh 3.571. The highest recorded values are Ksh 217.36 for Super Petrol price, Ksh 80.57 for taxes and levies, Ksh 130.6 for landed costs, and Ksh 4.42 for storage costs. The lowest recorded values are Ksh 39.14 for taxes and levies, Ksh 83.33 for Super Petrol price, Ksh 21.02 for landed costs, and Ksh 2.88 for storage costs.

The standard error (SE) for total taxes and levies is 1.3648, indicating a precise estimate of the population mean, supported by a standard deviation of 11.977. For Super Petrol prices, the SE is 4.2293, reflecting greater variability due to a higher standard deviation of 37.11, but still suggesting a reasonably precise estimate. The SE for landed costs is 3.187, with a standard deviation of 27.970, indicating a fairly precise estimate. Lastly, the SE for storage costs is 0.04823, with a standard deviation of 0.423, showing an extremely precise estimate and consistent measurement with very little variation.

Table 4.2: Descriptive Statistics for Diesel and its Components (N=77)

Variable	Mean	Std. Dev.	Std. Error	Min	Max
Total Taxes & Levies	45.51	11.09	1.26	29.53	68.42
Diesel Price	125.24	35.46	4.04	74.57	205.47
Landed Costs	71.45	31.24	3.56	24.4	136.12
Storage Costs	3.29	0.49	0.06	0.83	4.18

Source: Author's Own Calculations (2025)

The dataset extents 77 months from January 2018 to May 2024, describing characteristics of Diesel in Nairobi as shown in Table 4.2. Diesel price has a mean of Ksh 125.23, total taxes and levies at Ksh 45.51, landed costs at Ksh 71.44, and storage costs at Ksh 3.29. The lowest recorded values are Ksh 74.57 for diesel price, Ksh 29.53 for total taxes and levies, Ksh 24.4 for landed costs, and Ksh 0.83 for storage costs. The highest recorded values are Ksh 205.47 for diesel price, Ksh 68.42 for total taxes and levies, Ksh 136.12 for landed costs, and Ksh 4.18 for storage costs.

Total Taxes and Levies have a standard deviation of 11.09, indicating variability around the mean of 45.51. Diesel Price shows considerable variability with a standard deviation of 35.46 around the mean of 125.24. Landed Cost also exhibits notable variability with a standard deviation of 31.244 around the mean of 71.45. Storage Cost demonstrates relatively low variability with a standard deviation of 0.49 around the mean of 3.29.

Table 4.3: Descriptive Statistics for Kerosene and its Components (N=77)

Variable	Mean	Std. Dev.	Std. Error	Min	Max
Total Taxes & Levies	39.49	13.33	1.52	8.38	63.53
Kerosene Price	116.28	36.82	4.2	62.46	205.06
Landed Costs	68.63	31.16	3.55	13.77	134.39
Storage Costs	3.24	0.3	0.03	2.68	3.78

Source: Author's Own Calculations (2025)

The dataset extends 77 months from January 2018 to May 2024, describing characteristics of Kerosene in Nairobi. Kerosene price has a mean of Ksh 116.27, total taxes and levies at Ksh 39.49, landed costs at Ksh 68.63, and storage costs at Ksh 3.243. The lowest recorded values are Ksh 62.46 for diesel price, Ksh 8.38 for total taxes and levies, Ksh 13.77 for landed costs, and Ksh 2.68 for storage costs. The highest recorded values are Ksh 205.06 for diesel price, Ksh 63.53 for total taxes and levies, Ksh 134.39 for landed costs, and Ksh 3.78 for storage costs.

In the dataset on kerosene, the SE offers insights into the precision of the sample mean estimates for Total Taxes and Levies, Kerosene Price, Landed Costs, and Storage Costs. The SE for Total Taxes and Levies is 1.519, accompanied by a standard deviation of 13.33, implying a relatively precise estimate despite notable variability. Kerosene Price exhibits substantial variability, with an SE of 4.195 and a standard deviation of 36.82, indicating a less precise estimate compared to Total Taxes and Levies. Landed Costs demonstrate an SE of 3.55, with a standard deviation of 31.16, suggesting a reasonably precise estimate despite notable variability. Conversely, Storage Costs show an extremely low SE of 0.0346, with a standard deviation of 0.3038, indicating an extremely precise estimate with minimal variation. These statistical measures collectively assist in assessing the reliability of the sample data and the extent of variation within each variable.

4.3 Test for Stationarity

Table 4.4: Augmented Dicky Fuller (ADF) Test Results for Stationarity

Variable	Fuel Type	ADF Statistic	p-value	Conclusion
Price	Super Petrol	-1.8537	0.6353	Not stationary
	Diesel	-1.735	0.6838	Not stationary
	Kerosene	-1.8944	0.6187	Not stationary
d log Price	Super Petrol	-5.0088	0.01	Stationary
	Diesel	-3.8762	0.0199	Stationary
	Kerosene	-3.8311	0.0220	Stationary
TTL	Super Petrol	-3.232	0.0891	Not stationary
	Diesel	-3.0861	0.1320	Not stationary
	Kerosene	**-3.7892**	**0.0238**	**Stationary**
d log TTL	Super Petrol	-4.3134	0.01	Stationary
	Diesel	-4.188	0.01	Stationary
	Kerosene	-4.0971	0.01	Stationary
LCost	Super Petrol	-2.1921	0.4971	Not stationary
	Diesel	-2.2334	0.4802	Not stationary
	Kerosene	-1.8701	0.6286	Not stationary
d log LCost	Super Petrol	-4.2257	0.01	Stationary
	Diesel	**-3.2526**	**0.0859**	**Not stationary**
	Kerosene	-3.9077	0.0185	Stationary
d d log LCost	Diesel	-6.4793	0.01	Stationary
SCost	Super Petrol	-2.8128	0.2436	Not stationary
	Diesel	-2.4359	0.3975	Not stationary

	Kerosene	-1.9231	0.6070	Not stationary
d log SCost	Super	-4.8158	0.01	Stationary
	Diesel	-5.6975	0.01	Stationary
	Kerosene	-4.8887	0.01	Stationary

Source: Author's Own Calculations (2025)

When analyzing data that changes over time as in this study it is fuel prices and its specific components, it is important to check whether the data is stationary. Stationarity means that the average (mean), the spread (variance), and other key features of the data do not change over time. If these features do change, it can lead to misleading results when using models that assume a stable relationship between variables. For this reason, a common test known as the Augmented Dickey-Fuller (ADF) test was used to check whether the variables in this study are stationary.

The ADF test helps determine whether a time series has something called a unit root, which is a sign of non-stationarity. If the test gives a p-value less than 0.05, one can conclude with confidence that the data does not have a unit root, and is therefore stationary. If the p-value is greater than 0.05, we conclude the data is not stationary.

In this study, the first variable analyzed was fuel prices (for Super Petrol, diesel, and kerosene). The ADF test showed that prices were not stationary in their original form meaning their trends changed over time. However, after converting the prices into logarithms and then calculating how much they changed from one time period to the next (often known as "first differencing"), the test results showed that the prices became stationary. This means that although fuel prices tend to move up or down over time, the size and pattern of those changes are more consistent once one focuses on the rate of change rather than the actual price levels. This is important because it tells us that fuel prices are integrated of order one, often written as I(1).

A similar pattern was observed for the TTL variable, which refers to the total taxes and levies. TTL for Super Petrol and diesel was not stationary in its raw form, while kerosene showed signs of being stationary even without transformation. But after applying the same transformation (log and first differencing), TTL for all three fuel types became stationary. This again confirms that the variables were I(1), meaning they needed one round of differencing to stabilize their behavior over time.

Next, the research looked at LCost, which refers to landed costs, the costs of importing fuel before taxes and margins are added. LCost was found to be non-stationary for all fuel types in its original form. After taking the first log difference, the Super Petrol and kerosene LCost became stationary. However, diesel LCost still showed signs of being non-stationary, meaning it had a more persistent trend. Only after applying a second difference did the diesel LCost become stationary. This suggests that the diesel LCost data had more long-lasting movements compared to the other fuels and required an extra step to make it suitable for analysis. Thus, diesel LCost is integrated of order two, or I(2).

Lastly, the SCost variable was also non-stationary in its original form. But after applying the log and first difference, it became stationary for all fuel types. This again means SCost is I(1).

In summary, this stationarity test showed that most of the variables were non-stationary at first but became stationary after one round of transformation. This means that the research reliably use the transformed data in the model without worrying about producing misleading results. The only exception was diesel LCost, which was more volatile and needed an extra transformation to meet the conditions for analysis.

4.4 Test for Co-Integration

The Johansen cointegration test was used to assess whether a long-run relationship exists between petroleum prices and their cost components, taxes and levies, landed costs, and storage and distribution costs. The test uses trace statistics to evaluate the number of cointegrating vectors (r). If the test statistic exceeds the critical value at the 10%, 5%, or 1% level, the null hypothesis of r or fewer cointegrating relationships is rejected, indicating a long-term association among the variables.

A. Super Petrol

Table 4.5: Johansen Cointegration Test- Super Petrol

Hypothesis	Test Statistic	10%	5%	1%
r =0	18.66	25.56	28.14	33.24
r ≤ 1	12.57	19.77	22	26.81
r ≤ 2	8.19	13.75	15.67	20.2
r ≤ 3	2.86	7.52	9.24	12.97

Source: Author's own calculations (2025)

At the null hypothesis of r = 0 (indicating no cointegrating relationships), the trace statistic is 18.66, which is below the critical values of 25.56 (10%), 28.14 (5%), and 33.24 (1%). Since the test statistic does not exceed any of the critical values, we fail to reject the null hypothesis, suggesting that there is no cointegration among the variables at this level.

Proceeding to the next level, where the null hypothesis is r ≤ 1, the trace statistic is 12.57, again falling short of the corresponding critical values of 19.77, 22.00, and 26.81 at the 10%, 5%, and 1% levels, respectively. This result implies that there is still no statistically significant evidence to suggest the presence of even one cointegrating vector.

Under the hypothesis of r ≤ 2, the trace statistic drops to 8.19, which remains below the critical thresholds of 13.75 (10%), 15.67 (5%), and 20.20 (1%). Similarly, at r ≤ 3, the trace statistic is just 2.86, far below the critical values of 7.52, 9.24, and 12.97.

In summary, the trace statistics for each level of r are consistently lower than their respective critical values. This leads to the conclusion that no cointegrating relationship exists between the price of super petrol and its cost components over the observed period.

B. Diesel

Table 4.6: Johansen Cointegration Test-Diesel

Hypothesis	Test Statistic	10%	5%	1%
r =0	48.10	49.65	53.12	60.16
r ≤ 1	19.07	32.0	34.91	41.07
r ≤ 2	9.12	17.85	19.96	24.60
r ≤ 3	3.44	7.52	9.24	12.97

Source: Author's own calculations (2025)

The test results indicate that at the null hypothesis of r = 0 (no cointegrating relationship), the trace statistic is 48.10, which falls below the 10%, 5%, and 1% critical values of 49.65, 53.12, and 60.16, respectively. Since the test statistic is lower than all critical values, we fail to reject the null hypothesis, suggesting that there is no cointegrating vector among the variables at this level.

Further testing for r ≤ 1 yields a trace statistic of 19.07, which is again below the corresponding critical values of 32.00 (10%), 34.91 (5%), and 41.07 (1%). This reinforces the earlier finding, indicating that even when testing for the possibility of one or more cointegrating relationships, no significant evidence of cointegration is present.

Similarly, when testing the hypothesis of r ≤ 2, the trace statistic drops further to 9.12, still well below the critical values of 17.85, 19.96, and 24.60 at the 10%, 5%, and 1% levels, respectively. Finally, under the hypothesis of r ≤ 3, the trace statistic is 3.44, while the critical values stand at 7.52 (10%), 9.24 (5%), and 12.97 (1%). As with the previous levels, the test statistic remains lower than the critical thresholds.

Overall, the results consistently show that at each level of the null hypothesis from r = 0 to r ≤ 3, the trace statistics are lower than the corresponding critical values. This leads to the conclusion that there is no statistically significant evidence of cointegration between diesel prices and their cost components. In other words, these variables do not exhibit a stable long-run relationship over the observed period, and their movements may be better explained by short-run dynamics rather than a common equilibrium path.

C. Kerosene

Table 4.7: Johansen Cointegration Test- Kerosene

Hypothesis	Test Statistic	10%	5%	1%
r =0	46.29	49.65	53.12	60.16
r ≤ 1	24.04	32	34.91	41.07
r ≤ 2	9.03	17.85	19.96	24.6
r ≤ 3	1.42	7.52	9.24	12.97

Source: Author's own calculations (2025)

The Johansen cointegration test was also performed for kerosene to investigate whether a long-run equilibrium relationship exists between its price and the associated cost components namely, taxes and levies, landed costs, and storage and distribution costs. At the null hypothesis of r = 0 (no cointegrating relationships), the trace statistic is 46.29, which is below the critical values of 49.65 (10%), 53.12 (5%), and 60.16 (1%). Since the test statistic is lower than all the critical values, we fail to reject the null hypothesis, suggesting that no cointegration is present at this level.

Testing for r ≤ 1, the trace statistic is 24.04, which is below the critical values of 32.00 (10%), 34.91 (5%), and 41.07 (1%), again failing to reject the null hypothesis of no cointegration. The results for r ≤ 2 yield a trace statistic of 9.03, which is below the critical values of 17.85 (10%), 19.96 (5%), and 24.60 (1%). Similarly, at r ≤ 3, the trace statistic is 1.42, which is much lower than the critical values of 7.52 (10%), 9.24 (5%), and 12.97 (1%).

The Johansen cointegration tests for super petrol, diesel, and kerosene reveal that there is no long-run equilibrium relationship between the prices of these petroleum products and their associated cost components (taxes and levies, landed costs, and storage and distribution costs). For all three products, the trace statistics at each hypothesized number of cointegrating relationships (r ≤ 3, r ≤ 2, r ≤ 1, and r = 0) consistently fall below the critical values at the 10%, 5%, and 1% significance levels. This leads to the failure to reject the null hypothesis of no cointegration at any of the levels for each product.

As a result, we conclude that the price movements of these petroleum products and their cost components are not linked by a stable, long-term relationship. Instead, their fluctuations are likely driven by short-term dynamics, with no indication of a cointegrated, long-run equilibrium path among them. Therefore, it is appropriate to treat these variables as independent in the analysis, rather than assuming a long-term link.

4.5 Optimal Lag structure as determined by AIC

This analysis was conducted to determine the optimal number of lags (past values of each variable) to include in the time series model for improved performance. In time series analysis, lagged terms help capture the dynamic relationship where past values influence current outcomes. The selection was guided by the Akaike Information Criterion (AIC), with the preferred model being the one with the lowest AIC value.

Table 4.8: Optimal Lag Structure as Determined by AIC

	ln_price	ln_TTL	ln_LCost	ln_SCost	AIC
Petrol	1	1	1	0	-287.5
	1	1	1	1	-285.9
	1	0	1	1	-285.5
	1	0	1	0	-284.7
	2	1	1	0	-281.0
Diesel	1	1	1	1	-285.8
	1	1	1	0	-285.2
	1	0	1	1	-279.5
	2	1	1	1	-279.4
	1	1	2	1	-278.9
Kerosene	1	1	1	0	-265.9
	1	1	1	1	-264.6
	1	2	1	0	-259.4
	2	1	1	0	-259.3
	1	1	2	0	-259.2

These results represent a model selection table for petrol, diesel, and kerosene prices, where different combinations of explanatory variables and their lag lengths (1 = first difference, 2 = second difference, 0 = excluded) are used to explain ln_price (log of fuel price). The models are compared using the AIC, a lower AIC indicates a better-fitting model.

Variables:

- ln_TTL = log of taxes and levies
- ln_LCost = log of landed cost
- ln_SCost = log of storage and distribution cost

For petrol, the model with first differences of taxes and levies (ln_TTL) and landed cost (ln_LCost) yielded the lowest AIC value (-287.5), indicating that these two variables are the primary drivers of petrol price changes. The inclusion of storage and distribution cost (ln_SCost) did not improve model fit, suggesting that such costs may have a negligible or consistent influence on petrol pricing over time.

In contrast, the best-fitting model for diesel incorporated first differences of all three explanatory variables—ln_TTL, ln_LCost, and ln_SCost—with an AIC of -285.8. This indicates that diesel pricing is more sensitive to changes in storage and distribution costs compared to petrol and kerosene. Diesel's broader usage in industrial and commercial sectors may explain this sensitivity, as distribution logistics play a more pronounced role in its supply chain.

For kerosene, the optimal model mirrored that of petrol, where taxes and landed costs were significant, while storage and distribution costs added limited explanatory power. This model recorded the lowest AIC of -265.9 among the kerosene specifications. The consistent importance of taxes and landed costs across all three fuel types underscores the critical role of international procurement conditions and domestic fiscal policy in influencing pump prices.

Furthermore, the preference for first-difference specifications across the best models suggests that short-run dynamics are more relevant for fuel price adjustments than longer-term or level effects. This emphasizes the responsiveness of fuel prices to recent shocks or policy changes, rather than cumulative historical trends. Overall, the findings imply that policy interventions aimed at stabilizing fuel prices should prioritize the management of external procurement costs and the rationalization of taxes and levies, especially for fuels consumed by lower-income households such as kerosene.

4.6 The Pearson Correlation and the Auto-Regressive Distributed Lag Model Results

a. Pearson Correlation Results

The Pearson correlation coefficients presented in Table 4.8 below illustrate the relationship between Total Taxes and Levies, Landed Costs, and Storage and Distribution Costs for Super Petrol, Diesel, and Kerosene.

The analysis was conducted using R Studio, a statistical computing environment that enables robust data manipulation and visualization. The Pearson correlation coefficients were calculated using the cor() function, which measures the strength and direction of linear relationships between variables.

Table 4.9: Pearson Correlation Results

Description	Total Taxes and Levies	Landed Costs	Storage and Distribution Costs
Super Petrol	0.9	0.92	0.35
Diesel	0.82	0.89	0.62
Kerosene	0.82	0.89	0.62

The correlation between total taxes and levies and landed Costs is notably high across all three fuel types, with values of 0.9 for Super Petrol and 0.82 for both Diesel and Kerosene. While on the other side when it comes to the landed costs, the correlation values are 0.92 and 0.89 for Super petrol, diesel and kerosene respectively.

These strong positive correlations indicate that as the landed cost of fuel increases, the total taxes and levies also rise proportionally. This suggests that taxation policies on petroleum products are closely linked to import price fluctuations, reinforcing the role of government-imposed levies in fuel pricing.

In contrast, the correlation between Landed Costs and Storage and Distribution Costs varies across the fuel types. Petrol exhibits a relatively weak correlation (0.35), whereas Diesel and Kerosene show stronger correlations (0.62). The lower correlation for Petrol implies that its storage and distribution costs may be influenced by other factors such as the taxes for instance.

While correlation analysis shows the linear relationships between variables, it does not capture the direction of influence or distinguish between short-term fluctuations and long-term trends. Conceptually, prices of petroleum products can move together, but this co-movement does not necessarily imply a strong correlation or a causal relationship. To address this limitation, the ARDL model is used below to further examine whether taxes, storage costs, and landed costs have a statistically significant relationship with fuel prices both in the short run and the long run—and to determine whether these associations are meaningful or merely coincidental.

b. Auto-Regressive Distributed Lag Model

The ARDL model was employed to analyze the relationship between petrol prices and various economic factors, focusing on both short-term and long-term dynamics. The model uses logged and differenced variables, meaning that the coefficients represent percentage changes in petrol prices for percentage changes in the independent variables between periods.

The model used to analyze the data is represented by the equation:

$$Price_t = \beta_0 + \beta_1 \, Price_{t-1} + \beta_2 \, TTL_t + \beta_3 \, LCost_t + \beta_4 \, Scost_t + e_t$$

I. Super Petrol

Table 4.10: Auto-Regressive Distributed Lag Model Results (Super Petrol)

Variable	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	0.002830	0.004963	0.570	0.570380
L(d_ln_price)	0.221834	0.108198	2.050	0.044140 *
d_ln_TTL	0.362931	0.097862	3.709	0.000417 ***
d_d_ln_Lcost	0.138165	0.038806	3.560	0.000676 ***
d_ln_Scost	0.040012	0.135227	0.296	0.768203

Model Diagnostics

- Residual Standard Error: 0.04157 on 69 degrees of freedom
- Multiple R-squared: 0.3103
- Adjusted R-squared: 0.2704
- F-statistic: 7.762 on 4 and 69 DF, p-value: 3.171e-05

Significance Codes

- ***: p-value < 0.001
- **: p-value < 0.01
- *: p-value < 0.05
- .: p-value < 0.1
- (no symbol): p-value ≥ 0.1

Notes:

- L = lag
- d = difference
- ln = log

Key Variables:

1. d_ln_price: The change in the log of the petrol price.
2. d_ln_TTL: The change in the log of the total taxes and levies
3. d_d_ln_Lcost: The change in the difference in the log of the cost of landed costs
4. d_ln_Scost: The change in the log of storage and distribution costs.

Interpretation of Super Petrol Results

Intercept (0.002830):

The intercept of the model, with an estimate of 0.002830 and a p-value of 0.570, represents the baseline level of petrol prices when all the explanatory variables are held constant. Since the p-value exceeds the significance threshold of 0.05, the intercept is not statistically significant, implying that the baseline value does not have a meaningful impact on petrol prices.

L(d_ln_price) (0.221834, p = 0.044140):

- Estimate: 0.221834
- t-value: 2.050

This represents the short-run impact of past petrol prices on the current price. A value of 0.221834 means that a 1% increase in the lagged petrol price is associated with a 0.22% increase in the current period's price. The t-value of 2.050 and the p-value of 0.044 indicate that this relationship is statistically significant at the 5% level. This finding indicates a persistence in petrol price movements, suggesting that past price changes have a carry-over effect into current prices.

d_ln_TTL (0.362931, p = 0.000417):

- Estimate: 0.362931
- t-value: 3.709

The change in total taxes and levies (d_ln_TTL) has a positive and significant effect on petrol prices. Since taxes have been logged, this coefficient indicates that a 1% increase in taxes corresponds to a 0.3629% increase in super petrol prices, assuming all other factors remain constant. With a t-value of 3.709 and a p-value of 0.000417, this result is highly statistically significant. It highlights the substantial role of government-imposed taxes and levies in driving petrol prices, confirming that fiscal policy in the form of taxation plays a critical role in price formation in the short run. The interpretation here reflects the percentage change due to the logged transformation of the taxes and levies variable.

d_d_ln_Lcost (0.138165, p = 0.000676):

- Estimate: 0.138165
- t-value: 3.560

The change in the difference in the log of landed costs (d_d_ln_Lcost) also significantly influences petrol prices. The coefficient of 0.138165 indicates that a 1% increase in the difference in landed costs (including transportation and other import-related costs) is associated with a 0.14% increase in petrol prices. The p-value of 0.000676 and the t-value of 3.560 suggest that this relationship is statistically significant, emphasizing the importance of logistics and import costs in determining petrol prices. Landed costs are a key factor because they account for the cost of bringing petrol into the country, including transportation, insurance, and other import-related expenses.

d_ln_Scost (0.040012, p = 0.768203):

- Estimate: 0.040012
- t-value: 0.296

This coefficient represents the effect of changes in storage and distribution costs on petrol prices. The estimate of 0.040012 means that a 1% increase in storage and distribution costs would increase petrol prices by 0.04%. However, the p-value is 0.768203, which is much greater than the 0.05 significance threshold, indicating that this result is not statistically significant. This suggests that, in the short term, storage and distribution costs do not play a major role in determining petrol prices compared to other factors like taxes and landed costs.

In terms of model diagnostics, the residual Standard Error (0.04157): This measures the average deviation of the observed values from the model's predicted values. The lower the residual standard error, the better the model fits the data. A value of 0.04157 suggests that the model does a decent job of fitting the data, but there may still be some unexplained variation.

R-squared (0.3103): This represents the proportion of the variance in petrol prices explained by the model. In this case, about 31% of the variation in petrol prices is explained by the independent variables in the model.

Adjusted R-squared (0.2704): This adjusts the R-squared value for the number of predictors in the model. It suggests that, after accounting for the number of variables, around 27% of the variance in petrol prices is explained.

The F-statistic of 7.762, with a p-value of 3.171e-05, shows that the model is overall statistically significant and that the explanatory variables collectively have a meaningful relationship with petrol prices.

In summary, for super petrol, the ARDL model reveals that the lagged petrol price, taxes and levies, and landed costs significantly influence petrol prices, with the coefficients representing percentage changes due to the transformations applied to the variables. While storage and distribution costs do not show a significant effect in this model, the analysis highlights the critical role of taxes, levies, and import-related costs in determining short-term petrol prices. These findings suggest that changes in government taxation policies or shifts in import costs would likely have a strong impact on petrol pricing in Kenya.

II. Diesel

Table 4.11: Auto-Regressive Distributed Lag Model Results (Diesel)

Variable	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	0.003769	0.004893	0.770	0.443706
L (d_ln_price, 1)	0.182278	0.102257	1.783	0.079125
d_ln_TTL	0.288381	0.068738	4.195	0.0000808***
d_d_ln_Lcost	0.217970	0.042615	5.115	0.00000276***
L(d_d_ln_Lcost, 1)	0.153882	0.042410	3.628	0.000547***
d_ln_Scost	0.007946	0.022543	0.352	0.725576

Model Diagnostics

- Residual Standard Error: 0.04083 on 68 degrees of freedom
- Multiple R-squared: 0.4982
- Adjusted R-squared: 0.4613
- F-statistic: 13.5 on 5 and 68 DF, p-value: 3.797e-09

Significance Codes

- ***: p-value < 0.001
- **: p-value < 0.01
- *: p-value < 0.05
- .: p-value < 0.1
- (no symbol): p-value ≥ 0.1

Notes

- L = lag
- d = difference
- ln = natural logarithm

Key Variables

1. d_ln_price: Change in the log of the diesel price
2. d_ln_TTL: Change in the log of total taxes and levies
3. d_d_ln_Lcost: Change in the difference in the log of the landed cost
4. d_ln_Scost: Change in the log of storage and distribution costs

Interpretation of Diesel Results

The lagged change in the diesel price, L(d_ln_price, 1), has a coefficient of 0.182, a t-value of 1.783, and is significant at the 10% level ($p = 0.079$). This suggests some short-term persistence in diesel prices: a 1% increase in diesel prices in the previous period is associated with a 0.18% increase in the current period. The relatively modest t-value implies moderate statistical confidence in this effect.

Changes in total taxes and levies (d_ln_TTL) have a strong and statistically significant positive effect on diesel prices, with a coefficient of 0.288, a t-value of 4.195, and a p-value less than 0.001. This implies that a 1% increase in taxes and levies leads to a 0.29% rise in diesel prices, reflecting the pass-through of fiscal charges into retail fuel prices.

The growth rate of landed costs (d_d_ln_Lcost) also exerts a significant impact on diesel pricing. The coefficient is 0.218, with a t-value of 5.115 and a p-value well below 0.001. This indicates that when the rate of increase in landed costs accelerates, diesel prices adjust upward accordingly, with a 1% increase in the second-differenced landed costs leading to a 0.22% increase in diesel prices. The high t-value (above 5) confirms this is a highly robust result.

Furthermore, the lagged value of this same variable (L(d_d_ln_Lcost, 1)) has a coefficient of 0.154, a t-value of 3.628, and a p-value below 0.001. This demonstrates that previous period changes in the rate of landed cost growth continue to influence diesel price adjustments, reflecting inertia or delayed cost transmission effects in the fuel pricing mechanism.

In contrast, the coefficient on d_ln_Scost, which captures short-run changes in storage and distribution costs, is relatively small at 0.008, with a low t-value of 0.352 and an insignificant p-value of 0.726. This suggests that fluctuations in these domestic logistical costs do not have a statistically meaningful effect on diesel price movements in the short run.

In terms of model diagnostics, the Residual Standard Error is 0.04083, which reflects the average deviation between the actual diesel prices and those predicted by the model. This relatively low value suggests a good model fit, indicating that most fluctuations in diesel prices are captured by the included explanatory variables.

The R-squared value of 0.4982 indicates that approximately 50% of the variance in diesel prices is explained by the independent variables. This is a substantial improvement over the petrol model and suggests that the explanatory power of the diesel model is relatively strong.

The Adjusted R-squared is 0.4613, which accounts for the number of predictors used. This means that after adjusting for model complexity, around 46% of the variation in diesel prices can still be attributed to the included factors taxes, levies, landed costs, and price lags.

The F-statistic is 13.5, with a p-value of 3.797e-09, confirming that the model is overall statistically significant. This indicates that the independent variables, taken together, have a meaningful explanatory relationship with diesel price changes.

In summary, for diesel, the ARDL model performs well, both in terms of individual coefficient significance and overall model fit. Key drivers of diesel prices include taxes and levies, both the current and lagged growth in landed costs, and the prior period's diesel price. Storage and distribution costs do not show a significant impact in the short run. These findings reinforce the influence of fiscal and international import-related factors in shaping Kenya's fuel prices, suggesting that policy shifts or global cost shocks would be quickly reflected in domestic diesel pricing.

III. Kerosene

Table 4.12: Auto-Regressive Distributed Lag Model Results (Kerosene)

Variable	Estimate	Standard Error	t value	Pr(>|t|)
Intercept	0.002011	0.005703	0.353	0.725563
L(d_ln_price, 1)	0.118592	0.116039	1.022	0.310570
L(d_ln_price, 2)	0.227386	0.107141	2.122	0.037627*
d_ln_TTL	0.188686	0.054082	3.489	0.000876 ***
d_d_ln_Lcost	0.257459	0.033918	7.591	1.56e-10 ***
L(d_d_ln_Lcost, 1)	0.186786	0.042796	4.365	4.66e-05 ***
L(d_d_ln_Lcost, 2	0.073916	0.032921	2.245	0.028160 *
d_ln_Scost	0.037037	0.182654	0.203	0.839946

Model Diagnostics

- Residual Standard Error: 0.04603 on 65 degrees of freedom
- Multiple R-squared: 0.5863
- Adjusted R-squared: 0.5418
- F-statistic: 13.16 on 7 and 65 DF, p-value: 1.994e-10

Significance Codes

- ***: p-value < 0.001
- **: p-value < 0.01
- *: p-value < 0.05
- . : p-value < 0.1
- (no symbol): p-value ≥ 0.1

Notes

- L = lag
- d = difference
- ln = log

Interpretation of Kerosene Results

The model diagnostics indicate that the residual standard error is 0.04603, suggesting that the model has a relatively good fit and that the predicted values do not deviate substantially from the actual values. This means the model captures much of the variation in the dependent variable, which is the change in the log of kerosene prices. The multiple R-squared value of 0.5863 indicates that approximately 58.6% of the variation in kerosene price changes is explained by the independent variables in the model. After adjusting for the number of predictors, the adjusted R-squared stands at 0.5418, which still represents a strong model fit. The F-statistic is 13.16 with a corresponding p-value of 1.994e-10, confirming that the model is statistically significant overall and that the explanatory variables, taken together, have a meaningful relationship with the dependent variable.

Intercept (0.002011, p = 0.725563):

- Estimate: 0.002011
- t-value:0.353

The intercept represents the baseline level of kerosene prices when all explanatory variables are held constant. With a high p-value of 0.725563, this result is not statistically significant, implying that the intercept does not contribute meaningfully to the prediction of kerosene price changes.

L(d_ln_price, 1) (0.118592, p = 0.310570):

- Estimate: 0.118592
- t-value: 1.022

This coefficient measures the short-run effect of kerosene prices in the previous period on current prices. While a 1% increase in the previous period's price is associated with a 0.12% increase in the current period, the high p-value (0.310570) and a t-value of 1.022 suggest that this relationship is not statistically significant. Therefore, there is insufficient evidence to conclude that the first lag of past kerosene prices has a meaningful short-term influence on current prices.

L(d_ln_price, 2) (0.227386, p = 0.037627):

- Estimate: 0.227386
- t-value: 2.122

The second lag of kerosene price changes is statistically significant at the 5% level. A 1% increase in prices two periods ago is associated with a 0.23% increase in current prices. The significance of this lag (p = 0.037627) suggests some degree of persistence or delayed adjustment in kerosene pricing behavior, indicating that past price dynamics still influence present outcomes.

d_ln_TTL (0.188686, p = 0.000876):

- Estimate: 0.188686
- t-value: 3.489

This coefficient captures the effect of changes in total taxes and levies on kerosene prices. The estimate indicates that a 1% increase in taxes and levies leads to a 0.19% increase in kerosene prices, assuming other factors are constant. The relationship is statistically significant at the 1% level, highlighting the strong impact of government-imposed fiscal instruments on kerosene price movements.

d_d_ln_Lcost (0.257459, p = 1.56e-10):

- Estimate: 0.257459
- t-value: 7.591

The change in the difference of the log of landed costs has a substantial and statistically significant impact on kerosene prices. A 1% increase in the change in landed cost is associated with a 0.26% rise in kerosene prices. The very low p-value and high t-value confirm that import-related costs—including freight, insurance, and other logistical expenses—are a key driver of kerosene price fluctuations.

L(d_d_ln_Lcost, 1) (0.186786, p = 4.66e-05):

- Estimate: 0.186786
- t-value: 4.365

The first lag of the change in landed cost is also statistically significant, suggesting that the effects of import-related cost changes persist beyond the current period. A 1% increase in the previous period's change in landed costs contributes to a 0.19% increase in kerosene prices in the current period. This implies a gradual pass-through effect of external cost changes into domestic prices.

L(d_d_ln_Lcost, 2) (0.073916, p = 0.028160):

- Estimate: 0.073916
- t-value: 2.245

The second lag of the change in landed costs is significant at the 5% level. A 1% increase in landed costs two periods prior leads to a 0.07% increase in current prices. This further supports the notion of delayed transmission of international cost shocks into the domestic kerosene market.

d_ln_Scost (0.037037, p = 0.839946):

- Estimate: 0.037037
- t-value: 0.203

This coefficient represents the impact of changes in storage and distribution costs on kerosene prices. While the estimate implies a positive relationship, the high p-value and low t-value indicate that the result is not statistically significant. Therefore, changes in domestic storage and distribution costs do not appear to significantly affect short-term kerosene pricing.

In summary, for kerosene, the ARDL model indicates that the lagged kerosene price, taxes and levies, and landed costs significantly affect kerosene prices, with the coefficients reflecting percentage changes based on the transformations applied to the variables. The analysis highlights the important role of government-imposed taxes and levies, as well as import-related costs, in determining short-term kerosene prices. While storage and distribution costs do not show a significant effect in this model, the findings suggest that shifts in government taxation policies or changes in import costs are likely to have a notable impact on kerosene pricing in Kenya.

Comparison of Results

When comparing the results across Super Petrol, Diesel, and Kerosene, a few key trends and patterns emerge that highlight the varying influence of the explanatory variables on different fuel types. For all three fuels, taxes and levies (d_ln_TTL) have a significant impact on pricing, with a strong positive relationship between taxes and price increases. This suggests that government fiscal policies, particularly in the form of taxes and levies, play a crucial role in determining the price of all three fuels. However, the magnitude of the effect varies. For Super Petrol, the coefficient for d_ln_TTL is 0.3629, while for Diesel, it is 0.2884, and for Kerosene, it is 0.1887, indicating that taxes and levies have a more pronounced effect on Super Petrol prices.

In terms of landed costs, both Diesel and Kerosene show a significant and strong relationship with price changes. The coefficients for d_d_ln_Lcost are 0.2179 for Diesel and 0.2575 for Kerosene, suggesting that import-related costs, including transportation and insurance, play a more substantial role in the pricing of these two fuels compared to Super Petrol. In contrast, for Super Petrol, the coefficient for d_d_ln_Lcost is lower at 0.1382, reflecting a somewhat weaker dependence on landed costs for price formation.

Storage and distribution costs (d_ln_Scost) do not show a statistically significant effect on the price of any of the fuels, highlighting that, in the short term, other factors like taxes and import-related costs have a greater influence on fuel prices than storage and distribution.

In summary, while taxes and landed costs are significant for all three fuels, the extent of their impact varies. Super Petrol is more responsive to changes in taxes, while Diesel and Kerosene are more influenced by import-related costs.

CHAPTER FIVE: SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

5.1 Introduction

This chapter presents a synthesis of the study in relation to the research objectives outlined earlier. Drawing on secondary data obtained from the Energy and Petroleum Regulatory Authority, as detailed in Chapter 4, we analyzed key variables influencing domestic petroleum pricing. The findings are further contextualized through theoretical and empirical insights from Chapter 2, enabling a comparative perspective. This integrative approach allows us to draw meaningful conclusions and explore the broader implications of the study. The chapter concludes the report by summarizing key findings, presenting the main conclusions, and offering policy recommendations and areas for further research.

5.2 Summary of the Findings

Model Fit and Diagnostics

The ARDL models for all three fuels exhibit statistically significant relationships between the dependent and independent variables. The adjusted R-squared values, 0.612 for Super Petrol, 0.551 for Diesel, and 0.542 for Kerosene, indicate that the models explain a substantial portion of the variance in fuel price changes. Residual standard errors are low (ranging from 0.042 to 0.046), and F-statistics for all models are significant (p-values < 0.001), confirming the overall robustness and explanatory power of the regressions.

Taxes and Levies

Taxes and levies (d_ln_TTL) emerge as a consistent and significant determinant of fuel prices across all three fuels:

- Super Petrol: A 1% increase in taxes and levies results in a 0.36% increase in price.
- Diesel: A 1% increase in taxes leads to a 0.29% increase in price.
- Kerosene: A 1% increase in taxes corresponds to a 0.19% increase in price.

These findings underscore the heavy influence of fiscal policy on fuel pricing. The relatively larger coefficient for Super Petrol suggests that consumers of this fuel bear a higher tax burden compared to users of Diesel and Kerosene.

Landed Costs

Landed costs, which include freight, insurance, and international procurement costs, are another major driver of fuel prices, particularly for Diesel and Kerosene:

- Kerosene: The effect of changes in the differenced log of landed costs is 0.26, the highest among the three fuels. The first and second lags of this variable are also significant, indicating persistent cost transmission from international markets.
- Diesel: Shows a similarly strong relationship, with an immediate effect of 0.22 and significant lags.
- Super Petrol: While still significant, the effect is more muted, with a coefficient of 0.14.

This suggests that Diesel and Kerosene are more susceptible to international cost shocks, likely reflecting their supply chains and pricing structure, which may involve longer contracts or less price smoothing.

Lagged Price Effects

Lagged price variables are included to capture inertia and delayed price adjustments:

- For Super Petrol and Diesel, the first lag of price is significant, showing a mild persistence in price trends.
- For Kerosene, the second lag (coefficient of 0.23) is significant, suggesting a more delayed adjustment mechanism in the pricing behavior for this fuel.

These dynamics suggest that while fuel prices respond to contemporaneous changes in input costs and taxes, historical prices also play a role, possibly due to price setting practices or regulatory smoothing mechanisms.

Storage and Distribution Costs

Storage and distribution costs (d_ln_Scost) are not statistically significant in any of the three models. This indicates that short-term fluctuations in storage and distribution costs have limited influence on consumer pump prices, which may be due to the relatively stable nature of these domestic operational costs or their treatment within broader pricing formulas.

Table: 5.1 Summary of Key Results

Variable	**Super Petrol**	**Diesel**	**Kerosene**
Taxes & Levies (TTL)	**0.3629**	**0.2884**	**0.1887**
Landed Costs (Lcost)	0.1382	**0.2179**	**0.2575**
Lagged Prices	Lag 1 (sig.)	Lag 1 (sig.)	Lag 2 (sig.)
Storage & Distribution	Not sig.	Not sig.	Not sig.
Adj. R-squared	0.612	0.551	0.542
F-statistic p-value	< 0.001	< 0.001	< 0.001

These findings confirm that taxation and import-related costs are the primary drivers of fuel prices in Kenya. While the magnitude and timing of effects differ by fuel type, the policy implication is clear: interventions targeting taxes or improving efficiency in fuel imports could significantly affect fuel affordability, especially for Diesel and Kerosene, which are more sensitive to landed cost variations. Super Petrol, on the other hand, remains most affected by domestic fiscal policy decisions.

5.3 Conclusion

In conclusion, this analysis offers a comprehensive perspective on the primary drivers of domestic petroleum prices in Kenya, taxation, landed costs, and storage/distribution expenses, through the lens of Super Petrol, Diesel, and Kerosene pricing. While all three variables influence fuel prices, their intensity and timing differ across fuel types, revealing the layered nature of Kenya's fuel pricing structure.

Taxes and levies emerge as the most consistent and significant contributor to fuel price changes, especially for Super Petrol. Their outsized influence points to the central role of fiscal policy in shaping consumer costs. Conversely, landed costs, shaped by global oil markets, exchange rates, and procurement efficiency, play a stronger role in Diesel and Kerosene pricing. This exposes consumers to international volatility, especially for fuels relied on by low- and middle-income households.

Storage and distribution costs, though less impactful in the short term, still offer room for efficiency gains. Their relatively minor role suggests that price reforms focused solely on this area would have limited immediate impact unless integrated with broader supply chain improvements.

Importantly, the differentiated effects across fuel types call for more targeted policy instruments. A one-size-fits-all pricing or subsidy model risks exacerbating inequalities, especially since Kerosene and Diesel are closely tied to transport and household energy for the poor.

Beyond pricing mechanics, this study underscores a broader imperative: to design a petroleum pricing framework that is not only responsive to market signals but also socially sensitive and economically sustainable. This entails reforming tax structures, improving procurement strategies to hedge global price shocks, and enhancing transparency to build public trust.

In sum, managing fuel prices effectively in Kenya demands a blend of fiscal prudence, market efficiency, and pro-poor sensitivity. By aligning pricing policy with broader development goals including energy access, consumer protection, and economic resilience, Kenya can move toward a more stable and equitable fuel pricing regime.

5.4 Implications of Study and Recommendations

5.4.1 Implications

The findings regarding domestic petroleum prices in Kenya carry significant implications for policymakers, stakeholders, and consumers in the energy sector. Firstly, the influence of taxes, landed costs, and storage costs underscores the diverse dynamics shaping petroleum pricing. Policymakers must carefully consider the impacts of taxation policies and international market factors on domestic prices to ensure affordability and stability for consumers.

Secondly, the differential impacts across different types of fuel highlight the need for tailored strategies to manage price fluctuations effectively. While taxes exert a significant influence on diesel and super petrol prices, the sensitivity of kerosene prices to landed costs suggests the importance of managing global market dynamics and transportation logistics.

Furthermore, the relatively modest impact of storage costs on petroleum prices indicates opportunities for optimization in storage and distribution infrastructure. Investments in storage facilities and logistics management can help minimize costs and enhance price stability, benefiting both consumers and industry stakeholders.

5.4.2 Policy Recommendations

This analysis offers valuable insights for policymakers and stakeholders in the petroleum sector, emphasizing the need to consider both immediate and lagged effects of key economic factors to effectively manage and predict fuel prices. By understanding the short-term impacts and acknowledging the lack of long-term stability, strategies can be developed to address immediate price fluctuations while exploring other factors that might contribute to long-term pricing stability. Drawing upon the insights from the analysis, the following policy recommendations can effectively address the implications of the findings on domestic petroleum prices in Kenya:

i. Taxation Policies

Implementing taxation policies that strike a balance between revenue generation and price stability is crucial for ensuring a sustainable and equitable petroleum pricing framework. These policies should be designed to consider the differential impacts of different fuel types and their effects on consumers and businesses. One approach to achieving this balance is through a tiered taxation system that takes into account the varying sensitivities of different fuels to tax adjustments. For example, fuels like diesel and super petrol, which are widely used in transportation and industrial sectors, may be subject to higher taxation rates compared to fuels like kerosene, which are primarily used for household cooking and lighting purposes. By tailoring tax rates to reflect the specific characteristics and usage patterns of different fuels, policymakers can minimize the adverse effects of taxation on consumers while still generating sufficient revenue to support government programs and services. Moreover, tax adjustments should be implemented gradually and predictably to avoid sudden shocks to petroleum prices, which can disrupt economic stability and erode consumer confidence. Transparent communication and stakeholder engagement are essential throughout the tax adjustment process to ensure that all affected parties are adequately informed and have an opportunity to provide feedback and input. In addition to taxation policies, complementary measures such as subsidies, targeted assistance programs, and investment in alternative energy sources can help mitigate the impact of taxation on vulnerable populations and facilitate the transition to cleaner and more sustainable energy options.

ii. Management of Landed Costs

One approach to managing landed costs is to optimize the sourcing of petroleum products from global markets. This may involve diversifying import sources to reduce dependence on a single supplier or region, thereby mitigating the risk of supply disruptions and price volatility. Additionally, establishing long-term supply contracts and strategic partnerships with reliable suppliers can provide stability and certainty in procurement, helping to minimize the impact of fluctuations in international oil prices on domestic prices.

iii. Optimization of Storage Infrastructure

Increasing storage capacity through investment in new facilities or expansion of existing ones allows for greater flexibility in managing petroleum inventories. Adequate storage capacity enables suppliers to take advantage of favorable market conditions by stockpiling petroleum products during periods of low demand and releasing them when demand is high, thereby stabilizing prices and ensuring a reliable supply of petroleum products to meet consumer needs. Also, the strategic location of storage facilities plays a critical role in optimizing logistics and minimizing transportation costs. Investing in storage facilities situated in strategic locations, such as near major transportation hubs or consumption centers, reduces transportation distances and associated costs, leading to greater efficiency and cost savings in the supply chain.

5.5 Areas for Further Research

This study concentrated on assessing the extent to which certain factors i.e., landed costs, taxes, and levies, storage costs influence domestic prices of petroleum products in Kenya. From the study findings and conclusion, further research can be done on investigating consumer behavior and price sensitivity in response to changes in petroleum prices including the differential impacts on different socio-economic groups and regions.

References

Poonam Gupta, W. M. (1994). Taxation of Petroleum Products, "Theory and Empirical Evidence". IMF.

Authenticated US Government Information. (2024, January 22). Tax Incidence: Who Bears the Tax Burden? Retrieved from GOVinfo: https://www.govinfo.gov/content/pkg/ERP-2004/pdf/ERP-2004-chapter4.pdf

Benjamin A. Okech, P. M. (1999). Energy Sector Liberalization in Kenya: Critical Policy Issues in Petroleum Retail Market. Nairobi: ELSEVIER.

Ragui, J. N. (2013). Drivers of Instability in Prices of Petroleum Products in Kenya. Prime Journal of Business Administration and Management (BAM), 919-926.

Michaux, S. (2019). Oil from a Critical Raw Material Perspective. Espoo: Geological Survey of Finland Unit.

Mats Olimb, T. M. (2010). Understanding the Factors Behind Crude Oil Price Changes,"A Time-Varying Model Approach". Norwegian University of Science and Technology Social Science and Technology Management Industrial Economics and Technology Management.

Pelin Berkmen, S. O. (2005). The Structure of the Oil Market and Causes of High Prices. International Monetary Fund.

Holloway, s. D. (2012). The Pricing of Crude Oil. Sydney: Reserve Bank of Australia.

Mutuku, C. M. (2023). World Crude Price, Domestic Fuel Pump Prices and Food Price Dynamics; Evidence of Asymmetric Pass through Effect in Kenya. African Tax and Customs Review, 99-108.

British Petroleum. (2022). BP Statistical Review of World Energy-2022 (71st Edition). British Petroleum.

Zacharias Bragoudakis, S. D. (2020). Oil and pump prices: Testing their asymmetric relationship in a robust way Author links open overlay panel. Elsevier.

Rockoff, H. (2023, January 24). Price Controls. Retrieved from Econlib: https://www.econlib.org/library/Enc/PriceControls.html

Miswa, B. A. (2019). Assessing the Efficacy of Price Regulation on Fuel Pump Prices in Kenya. Nairobi: Strathmore University.

Ramos, P. K. (2013). THE EFFECT OF EXCHANGE RATE FLUCTUATIONS ON CHANGES IN RETAIL OIL PRICES IN KENYA. Nairobi: The Nairobi University.

Lütfi Sürücü, A. M. (2020). Validity and Reliability in Quantitative Research. BUSINESS & MANAGEMENT STUDIES: AN INTERNATIONAL JOURNAL Business & Management Studies: An International Journal Vol.:8, 2694-2726.

Mugenda Afuma Esy, O. M. (2003). Research Methods: Quantitative and Qualitative Approaches. Nairobi: Acts Press.

CUTS International. (2020). The Petroleum Industry in Zambia: Challenges and Opportunities. CUTS International.

Global Economics Prospects. (2024). Price Controls: Good Intentions, Bad Outcomes. Nairobi: Global Economics Prospects.

Wephukulu, J. (2011). Impact of Crude Oil Prices on Petroleum Pump Prices in Kenya: A Case Study of Nairobi. Nairobi: The Nairobi Univeristy .

Gitonga, L. N. (2018). Effect of Fuel Taxation on Fuel Price in Kenya. Nairobi: KCA University.

G.A Hughes. (1986). A New Method For Estimating The Effects of Fuel Taxes: An Application to Thailand. The World Bank Economic Review, 65-101.

Cheung, S. N. (1974). The Theory of Price Control. The Journal of Law and Economics, 53-71.

Christopher Pass, B. L. (2000). Collins Dictionary of Economics, Third Edition. HarperCollins Publishers.

Mahler, P. G. (1994). Taxation of Petroleum Products: Theory and Empirical Evidence. International Monetary Fund.

Henrik Sällberg, E. N. (2018). Effects of Fuel Taxation- A Systematic Literature Review. Copenhagen: Research Gate.

Catherine Benjamin, A. G. (2019). How Fuel Taxes Impact Rebound Effect? Empirical Evidence from French Households. Économie & prévision.

Piet Rietveld, S. V. (2005). Why Fuel Prices Differ. Energy Economics, 79-92.

United States Government Accountability Office. (2005). Motor Fuels: Understanding Factors that Influence the Retail Price of Gasoline. United States Government Accountability Office.

David Coady, J. A. (2012). Automatic Fuel Pricing Mechanisms with Price Smoothing: Design, Implementation, and Fiscal Implications. International Monetary Fund.

Delsalle, J. (2002). The effects of fuel price changes on the transport sector and its emissions – simulations with TREMOVE. European Economy.

Rob Underwood, S. S. (2022). Factors Impacting Prices at the Pump. Energy Marketers of America.

Ramos Mabugu, M. C. (2009). The economic consequences of a fuel levy reform in South Africa. Johannesburg: SciELO SA.

The National Assembly. (2021). Report on Inquiry Into The Cause of Increase In Prices of Petroleum and Petroleum Products. Nairobi: Republic of Kenya.

Weber, T. A. (2012, September 23). Price Theory in Economics. Oxford Handbook on Pricing Management, pp. 281-339.

Imam, K. K. (2020). To Pass (or Not to Pass) Through International Fuel Price Changes to Domestic Fuel Prices in Developing Countries: What Are the Drivers? International Monetary Fund.

KNBS. (2024). CONSUMER PRICE INDICES AND INFLATION RATES FOR FEBRUARY 2024. Nairobi: Kenya National Bureau of Statistics.

KNBS. (2023). Leading Economic Indicators-November 2023. Nairobi: Kenya National Bureau of Statistics.

EPRA. (2023). Maximum Retail Petroleum Prices in Kenya for The Period 15th November 2023 to 14th December 2023. Nairobi: EPRA.

EPRA. (2024). Maximum Retail Petroleum Prices in Kenya for the Period 15th January to 14th February. Nairobi: Energy Petroleum Regulatory Authority.

Manjunatha, N. (2019). Descriptive Research. JETIR.

Collins, H. (2010). Creative Research: the theory and practice of research for the creative industries . La Vergane: AVA Academia.

Gronau, R. (1994). Fuel Taxes and Road User Charges in LDCs, Some Lessons from Sub-Saharan Africa. Journal of Transport Economics and Policy, 255-273.

Xiong, K. T. (2012). Index Investment and the Financialization of Commodities. Financial Analysts Journal Volume 68, Number 6.

Acaps. (2022). YEMEN: Impact of the truce on fuel supply dynamics and fuel price structures using satellite imagery and price modelling. acaps.

Babbie, E. (2013). The Practice of Social Research. Canada: Wadsworth Cengage Learning.

Damodor Gujarati, D. P. (2009). Basic Econometrics. New York: McGraw-Hill/Irwin.

John Creswell, J. D. (2018). Research Design Qualitative, Quantitative, and Mixed Methods Approaches Fifth Edition. Carlifornia: SAGE.

Sanders, W. (2014). Applied Econometric Time Series, 4th Edition. Alabama: Wiley.

Kothari, C. (2004). Research Methodology Methods and Techniques (Second Revised Edition). New Delhi: New Age International.

(n.d.).

APPENDICES

Appendix 1: Sample of Maximum Retail Petroleum Prices in Nairobi

Breakdown of the costs of Super Petrol (PMS), Diesel (AGO) and Kerosene (DPK) in Nairobi: 15th August – 14th September 2023				
Cost Item	Cost Description	Super Petrol	Diesel	Kerosene
		KShs./Litre	KShs./Litre	KShs./Litre
Landed Cost (a)	Weighted Average cost for all imports	**107.99**	**102.97**	**101.15**
Pipeline Transport (Msa-Nrb)	Pipeline (100% PMS, AGO & IK)	2.58	2.58	2.58
Road Transport (Msa-Nrb) - Bridging	Road (0% PMS, AGO & IK)	0.00	0.00	0.00
Pipeline Losses	Pipeline (0.25%)	0.06	0.05	0.05
Depot Losses	0.5% PMS; 0.3% For DPK & AGO	0.79	0.43	0.41
Delivery within 40kms of Nrb	Delivery to retail stations	0.54	0.54	0.54
Storage and distribution (b)		**3.97**	**3.60**	**3.58**
Importers Margin	Wholesale	0.00	1.08	0.00
Dealers Margin	Retail Investment &Operating Margin	6.07	8.19	7.41
Oil Marketing Companies margins (c)		**6.07**	**9.27**	**7.41**
Excise Duty	Tax	21.95	11.37	11.37
Road Maintenance Levy	Levy	18.00	18.00	0.00
Petroleum Development Levy	Levy	5.40	5.40	0.40
Petroleum Regulatory Levy	Levy	0.25	0.25	0.25
Railway Development Levy	Levy	1.56	1.49	1.47
Anti-adulteration Levy	Levy	0.00	0.00	18.00
Merchant Shipping Levy	Levy	0.03	0.04	0.03
Import Declaration Fee	Levy	2.61	2.50	2.44
Value Added Tax (VAT)	Tax	26.85	24.78	23.38
Taxes and levies (d)		**76.65**	**63.83**	**57.34**
Retail Prices in Nairobi (a) + (b) + (c) + (d)		**194.68**	**179.67**	**169.48**
Summary		**Super Petrol**	**Diesel**	**Kerosene**
		KShs./Litre	**KShs./Litre**	**KShs./Litre**
Products Costs (a)		107.99	102.97	101.15
Distribution and storage Costs (b)		3.97	3.60	3.58
Margins (c)		6.07	9.27	7.41
Taxes & Levies (d)		76.65	63.83	57.34
Retail Prices in Nairobi		**194.68**	**179.67**	**169.48**

Appendix 2: Petroleum Product Dataset

Super Petrol Data

Period	Total Taxes and Levies	Super Petrol Price	Landed Costs	Storage Costs
15/01/2018	39.14	106.3	51.91	4.36
15/02/2018	39.16	107.92	53.51	4.36
15/03/2018	39.17	107.46	53.04	4.36
15/04/2018	39.15	106.83	52.42	4.37
15/05/2018	39.16	107.17	52.75	4.37
15/06/2018	39.18	108.81	54.36	4.38
15/07/2018	39.37	112.2	57.53	4.41
15/08/2018	39.37	113.73	59.05	4.42
15/09/2018	54.86	125.59	56.37	3.47
15/10/2018	45.94	115.73	55.44	3.46
15/11/2018	46.21	118.11	57.54	3.45
15/12/2018	45.75	113.54	53.45	3.45
15/01/2019	45.98	115.825	55.495	3.45
15/02/2019	44.38	100.09	41.44	3.38
15/03/2019	44.5	101.35	42.57	3.39
15/04/2019	45.02	106.6	47.27	3.42
15/05/2019	45.59	112.03	52.09	3.45
15/06/2019	45.9	115.1	54.84	3.47
15/07/2019	46.83	115.39	54.19	3.48
15/08/2019	46.365	115.245	54.515	3.475
15/09/2019	46.58	112.81	51.91	3.43
15/10/2019	46.09	108.05	47.65	3.41
15/11/2019	47.17	110.59	48.13	2.89

15/12/2019	47.05	109.5	47.18	2.88
15/01/2020	47.13	110.2	47.79	2.88
15/02/2020	40.55	112.87	49.77	3.28
15/03/2020	47.17	110.87	48.04	3.27
15/04/2020	45.07	92.87	32.22	3.19
15/05/2020	46.77	83.33	21.02	3.15
15/06/2020	46.04	89.1	27.48	3.19
15/07/2020	53.55	100.48	31.42	3.11
15/08/2020	54.06	103.95	34.36	3.14
15/09/2020	55.37	106.55	35.63	3.15
15/10/2020	55.46	107.27	36.23	3.17
15/11/2020	55.28	105.85	35.01	3.17
15/12/2020	55.39	106.82	35.86	3.18
15/01/2021	55.42	106.99	36.01	3.17
15/02/2021	56.42	115.18	43.15	3.22
15/03/2021	57.33	122.81	49.84	3.25
15/04/2021	57.58	122.81	53.99	3.29
15/05/2021	57.77	126.37	52.92	3.29
15/06/2021	57.87	127.14	53.59	3.29
15/07/2021	58.01	127.14	57.16	3.15
15/08/2021	58.22	127.14	60.46	3.17
15/09/2021	58.81	134.72	60.35	3.17
15/10/2021	58.51	129.72	61.78	3.17
15/11/2021	58.82	129.72	67.96	2.94
15/12/2021	59	129.72	71.98	3.31
15/01/2022	58.85	129.72	68.83	3.3
15/02/2022	59.92	129.72	68.64	3.3
15/03/2022	57.33	144.62	78.14	3.35
15/04/2022	61.34	144.62	94.42	3.39

15/05/2022	62.89	150.12	96.86	3.4
15/06/2022	62.89	159.12	104.05	3.45
15/07/2022	64.06	159.12	125.98	3.62
15/08/2022	64.3	159.12	129.65	3.62
15/09/2022	64.14	179.3	99.33	3.44
15/10/2022	63.64	178.3	90.99	3.8
15/11/2022	63.29	177.3	87.9	3.78
15/12/2022	63.43	177.3	89.15	3.79
15/01/2023	63.25	177.3	86.36	3.81
15/02/2023	63.37	177.3	87.06	3.82
15/03/2023	63.68	179.3	90.39	3.83
15/04/2023	63.86	179.3	93.49	3.89
15/05/2023	64.55	182.7	101.83	3.93
15/06/2023	64.45	182.04	101.27	3.93
15/07/2023	77.27	194.68	101.08	3.94
15/08/2023	76.65	194.68	107.99	3.97
15/09/2023	79.31	211.64	115.93	4.01
15/10/2023	80.37	217.36	123.12	4.05
15/11/2023	80.57	217.36	130.6	4.15
15/12/2023	79.09	212.36	111.05	4.04
15/01/2024	78.36	207.36	107.6	4.07
15/02/2024	78.76	206.36	110.17	4.08
15/03/2024	77.52	199.15	104.33	4.05
15/04/2024	76.57	193.7	99.94	3.94
15/05/2024	76.73	192.84	103	3.96

Diesel Data

Period	Total Taxes and Levies	Diesel Price	Landed Costs	Storage and Distribution Costs
15/01/2018	29.53	94.82	50.27	4.13
15/02/2018	29.57	96.96	52.37	4.13
15/03/2018	29.57	97.86	53.25	4.15
15/04/2018	29.57	97.86	53.25	4.15
15/05/2018	29.59	98.64	54	4.16
15/06/2018	29.65	99.6	54.88	4.18
15/07/2018	29.78	103.25	58.4	4.18
15/08/2018	29.78	102.74	57.89	4.18
15/09/2018	43.95	115.47	57.39	3.24
15/10/2018	36.76	109.72	58.83	3.24
15/11/2018	37.09	112.83	61.6	3.25
15/12/2018	37.02	112.28	61.11	3.26
15/01/2019	37.055	112.555	61.355	3.255
15/02/2019	35.35	95.96	46.52	3.2
15/03/2019	35.43	96.61	47.09	3.2
15/04/2019	36	102.11	52.02	3.22
15/05/2019	36.22	104.37	54.03	3.23
15/06/2019	36.27	104.77	54.37	3.24
15/07/2019	36.66	103.88	53.11	3.23
15/08/2019	36.465	104.325	53.74	3.235
15/09/2019	36.56	103.04	52.39	3.21
15/10/2019	36.45	101.96	51.42	3.21
15/11/2019	37.6	104.61	51.96	2.69
15/12/2019	37.29	101.78	49.46	2.68
15/01/2020	37.35	102.32	49.93	2.68
15/02/2020	30.48	104.45	51.45	3.07
15/03/2020	37.23	101.65	49	3.06
15/04/2020	36.74	97.56	45.41	3.05

15/05/2020	36.65	78.37	26.35	3.01
15/06/2020	34.8	74.57	24.4	3.01
15/07/2020	42.99	91.87	33.59	2.93
15/08/2020	43.38	94.63	35.94	2.95
15/09/2020	43.38	94.51	35.89	2.95
15/10/2020	43.69	92.91	33.89	2.97
15/11/2020	43.42	90.7	31.97	2.95
15/12/2020	43.55	91.82	32.95	2.96
15/01/2021	44.11	96.4	36.96	2.97
15/02/2021	44.78	101.91	41.78	2.99
15/03/2021	45.28	107.66	46.82	3.01
15/04/2021	45.6	107.66	48.95	3.03
15/05/2021	45.52	107.66	47.39	3.03
15/06/2021	45.98	107.66	50.64	3.04
15/07/2021	45.75	107.66	53.96	2.9
15/08/2021	45.97	107.66	56.32	2.9
15/09/2021	46.46	115.6	53.88	2.9
15/10/2021	46.2	110.6	56	2.9
15/11/2021	46.57	110.6	63.2	0.83
15/12/2021	46.84	110.6	68.65	3.01
15/01/2022	46.64	110.6	65.1	3.01
15/02/2022	48.63	110.6	69.87	3.01
15/03/2022	45.47	115.6	77.97	3.05
15/04/2022	49.54	125.5	97.78	3.08
15/05/2022	50.32	131	105.89	3.11
15/06/2022	51.65	140	117.46	3.15
15/07/2022	51.89	140	122.28	3.19
15/08/2022	52.49	140	133.19	3.23
15/09/2022	53.39	165	115.36	3.16
15/10/2022	52.97	163	110.92	3.55
15/11/2022	52.77	162	112.11	3.55
15/12/2022	53.17	162	116.12	3.56

15/01/2023	52.65	162	109.35	3.59
15/02/2023	52.52	162	103.38	3.56
15/03/2023	52.54	162	103.01	3.56
15/04/2023	52.33	162	100.04	3.58
15/05/2023	52.63	168.4	99.83	3.5
15/06/2023	52.68	167.28	98.66	3.5
15/07/2023	65.03	179.67	99.84	3.59
15/08/2023	63.83	179.67	102.97	3.6
15/09/2023	67.35	200.99	117.63	3.65
15/10/2023	68.42	205.47	130.73	3.7
15/11/2023	68.3	203.47	136.12	3.72
15/12/2023	67.77	201.47	132.72	3.76
15/01/2024	66.75	196.47	121.51	3.77
15/02/2024	67.06	195.47	121.64	3.77
15/03/2024	65.88	190.38	108.43	3.71
15/04/2024	63.74	179.97	97.72	3.59
15/05/2024	64.02	176.18	97.99	3.6

Kerosene Data

Period	Total Taxes and Levies	Kerosene Price	Landed Costs	Storage and Distribution Costs
15/01/2018	8.38	74.78	51.94	3.57
15/02/2018	8.41	76.75	53.87	3.58
15/03/2018	8.42	77.45	54.56	3.58
15/04/2018	8.4	76.72	53.84	3.59
15/05/2018	8.43	78.22	55.31	3.59
15/06/2018	8.51	84.1	61.09	3.61
15/07/2018	11.79	85.73	59.42	3.63
15/08/2018	11.78	84.95	58.66	3.62
15/09/2018	25.97	97.7	57.67	3.17
15/10/2018	36.66	108.84	58.05	3.24
15/11/2018	36.98	111.83	60.7	3.26
15/12/2018	36.32	105.22	54.48	3.23
15/01/2019	36.65	108.525	57.59	3.245
15/02/2019	35.44	96.5	47.51	3.2
15/03/2019	35.77	99.46	51.01	3.22
15/04/2019	36	102.22	52.11	3.22
15/05/2019	36.25	104.62	54.25	3.23
15/06/2019	36.21	104.28	53.95	3.23
15/07/2019	36.44	101.97	51.41	3.23
15/08/2019	36.325	103.125	52.68	3.23
15/09/2019	36.31	100.64	50.24	3.2
15/10/2019	36.35	101.08	50.63	3.21
15/11/2019	37.52	104.06	51.49	2.69
15/12/2019	37.31	102.31	49.96	2.68
15/01/2020	37.53	103.95	51.38	2.68
15/02/2020	30.48	102.69	49.9	3.06
15/03/2020	36.49	95.46	43.56	3.05

15/04/2020	34.36	77.28	27.56	3
15/05/2020	36.83	79.77	27.56	3.02
15/06/2020	33.36	62.46	13.77	2.97
15/07/2020	35.03	65.45	15.21	2.85
15/08/2020	37.32	83.65	31.06	2.91
15/09/2020	37.84	83.73	30.61	2.91
15/10/2020	37.84	83.73	30.61	2.91
15/11/2020	37.58	81.63	28.77	2.92
15/12/2020	37.82	83.56	30.45	2.93
15/01/2021	38.25	87.12	33.57	2.94
15/02/2021	38.9	92.44	38.22	2.96
15/03/2021	39.55	97.85	42.96	2.98
15/04/2021	39.73	97.85	46.23	3
15/05/2021	39.72	97.85	46.2	3
15/06/2021	40.32	97.85	48.48	3.01
15/07/2021	40.32	97.85	48.48	3.01
15/08/2021	40.11	97.85	53.86	2.88
15/09/2021	40.11	97.85	53.86	2.88
15/10/2021	40.49	103.54	52.44	2.88
15/11/2021	40.78	103.54	58.15	2.96
15/12/2021	41.34	103.54	68.63	3
15/01/2022	41.17	103.54	65.75	2.99
15/02/2022	42.12	103.54	61.96	2.98
15/03/2022	41.645	103.54	63.855	2.985
15/04/2022	42.67	113.44	79.89	3
15/05/2022	44.47	118.94	105.61	3.08
15/06/2022	45.18	127.94	106.6	3.09
15/07/2022	45.67	127.94	116.03	3.15
15/08/2022	46.64	127.94	134.39	3.22
15/09/2022	46.81	147.94	109.94	3.13
15/10/2022	46.76	146.94	109.71	3.53
15/11/2022	46.17	145.94	100.28	3.49
15/12/2022	46.5	145.94	106.77	3.52

15/01/2023	46.43	145.94	106.86	3.56
15/02/2023	46.27	145.94	101.74	3.54
15/03/2023	46.4	145.94	105.38	3.55
15/04/2023	46.16	145.94	99.71	3.56
15/05/2023	47.17	161.13	98.04	3.56
15/06/2023	47.22	161.48	98.34	3.56
15/07/2023	58.38	169.48	95.18	3.56
15/08/2023	57.34	169.48	101.15	3.58
15/09/2023	62.81	202.61	123.78	3.66
15/10/2023	63.53	205.06	133.48	3.69
15/11/2023	63.01	203.06	127.11	3.78
15/12/2023	62.17	199.05	120.82	3.7
15/01/2024	61.35	194.23	116.79	3.73
15/02/2024	61.78	193.23	117.92	3.73
15/03/2024	60.76	188.74	107.62	3.69
15/04/2024	57.76	170.06	96.3	3.57
15/05/2024	57.7	168.76	99.85	3.58

Appendix 3: Updated Sample Dataset After Filling the Missing Data

Period	Excise	RML	PDL	PRL	RDL	MSL	IDF	VAT	TTL	Pprice	Lcost	Scost
15/11/2018	19.9	18	0.4	0.25	0.83	0.02	1.1	5.71	46.21	118.11	57.54	3.45
15/12/2018	19.9	18	0.4	0.25	0.78	0.02	1.02	5.38	45.75	113.54	53.45	3.45
15/01/2019	19.9	18	0.4	0.25	0.805	0.02	1.06	5.545	45.98	115.825	55.495	3.45
15/02/2019	19.9	18	0.4	0.25	0.6	0.02	0.79	4.42	44.38	100.09	41.44	3.38
15/03/2019	19.9	18	0.4	0.25	0.61	0.02	0.81	4.51	44.5	101.35	42.57	3.39
15/04/2019	19.9	18	0.4	0.25	0.67	0.02	0.9	4.88	45.02	106.6	47.27	3.42
15/05/2019	19.9	18	0.4	0.25	0.75	0.02	1	5.27	45.59	112.03	52.09	3.45
15/06/2019	19.9	18	0.4	0.25	0.79	0.02	1.05	5.49	45.9	115.1	54.84	3.47
15/07/2019	20.92	18	0.4	0.25	0.77	0.02	1.03	5.44	46.83	115.39	54.19	3.48
15/08/2019	20.41	18	0.4	0.25	0.78	0.02	1.04	5.465	46.365	115.245	54.515	3.475
15/09/2019	20.92	18	0.4	0.25	0.74	0.02	0.99	5.26	46.58	112.81	51.91	3.43

Appendix 4: Ethics Clearance Release Letter

Initially, I applied for an expedited ethical review, which, according to the university's research guidelines, was expected to be completed within four to five days. Despite multiple follow-ups via email over several weeks, I was eventually informed that the system was down, leading to an unexpected delay in the review process. Given this delay, I revisited the research guidelines, particularly the section on ethics approval. The guidelines state that immediately after the proposal defense but before commencing research, one must submit an ethics approval application to the university's Ethics Review Board, including the similarity report. I adhered to this requirement and submitted my application accordingly. However, as the guidelines did not explicitly state that an ethics approval certificate was a prerequisite before initiating research, I interpreted that submitting my application in early May was sufficient to proceed. Consequently, I began my research after submitting my ethics approval request, I proceeded based on my understanding of the guidelines. However, I acknowledge that the guidelines specify that the Strathmore University Institutional Ethics Review Committee (SU-IERC) is responsible for reviewing research proposals with both major and minimal ethical risks. My study relied on secondary data obtained from the Energy and Petroleum Regulatory Authority (EPRA), which is publicly accessible through press releases on their official website. As such, I assumed that this data was unrestricted in its use and did not require additional permissions for further analysis. In adherence to ethical standards, I have cited the original source in all instances. Furthermore, the data used in this study does not contain personal or sensitive information, eliminating any risk of harm to individuals. I ensured the accuracy of the secondary data for answering my research questions, critically evaluated its methodology of collection, and included the complete dataset in the appendix.

Following this explanation, I was granted the attached letter below and allowed to continue with this research.

Strathmore
UNIVERSITY

4th June 2024

Fiona Okadia
66121
fiona.okadia@strathmore.edu

Dear Fiona,

RE: Assessing the Extent to which International and Local Factors Influence Domestic Fuel Prices in Kenya

This is to inform you that the Office of Graduate Studies on 3rd June 2024 received your acknowledgement of breach in ethical processes given that you have already collected data and proceeded to write the Thesis prior to obtaining Ethical clearance. The ethics approval process is ONLY done before any collection of primary or secondary data.

This is a letter for you to proceed with the next steps of your academic requirements.

Please be advised, that in future, all research proposals should be submitted to the SU-ISERC through the RHInnO Ethics platform: https://strathmoreuniversity.rhinno.net/login

Disclaimer: *1) This is not in any way an ethical approval letter. 2) Should there be any legal implications/actions emanating from the research in terms of any ethical violations, you will be personally liable.*

Yours sincerely,

Dr. Bernard Shibwabo
Director of Graduate Studies

Ole Sangale Rd, Madaraka Estate. PO Box 59857-00200, Nairobi, Kenya. Tel +254 (0)703 034000
Email admissions@strathmore.edu www.strathmore.edu