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THE EFFECT OF EXCHANGE RATE DEVALUATION ON DOMESTIC INFLATION IN ETHIOPIA

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A Research Paper Submitted to the Department Economics, College of Business and Economics of Addis Ababa University in Partial Fulfillment for the Requirements of Master of Arts in Economics

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Declaration

I, the undersigned declare that this research paper entitled '*THE EFFECT OF EXCHANGE RATE DEVALUATION ON DOMESTIC INFLATION IN ETHIOPIA'* is my original work Submitted for the partial fulfillment of requirement for Master of Arts (BA) Degree in Economics in the Department of Economics, Addis Ababa University, It has not been presented for the award of any degree or other similar title in any other institution of higher learning, and that all sources of materials used for this thesis have been duly acknowledged.

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List of Acronyms

ADF: Augmented Dickey Fuller

AIC: Akaike Information Criterion

ARDL: Auto Regressive Distributed Lag Model

BOP: Balance of payment

CPI: Consumer Price Index

EC: Ethiopian calendar

ECM: Error Correction Method

EPRDF: Ethiopian People Revolutionary Democratic front

ERPT: Exchange Rate Pass Through

FDI: Foreign Direct Investment

FPE: Final prediction error

ECT: Error Correction Term

GDP: Gross Domestic Product

GoE: Government of Ethiopia

Gov Exp: Government Expenditure

HQ: Hannan-Quinn information criterion

HQ: Hannan-Quinn information criterion

IFS: International Financial Statistics

IMF: International Monetary Fund

IMP: Import Price

MOFE: Ministry of Finance and Economic Development

MSS: Money supply

NBE: National Bank of Ethiopia

NTB: Non-Tariffs Barriers

PPP: Purchasing Power Parity

REER: Real Effective Exchange Rate

RGDP: Real GDP

RGDP: Real Gross Domestic Product

SC: Schwarz information criterion

SSA: Sub Saharan Africa

UNDP: United Nation Development Program

VAR: Vector Autoregressive

VECM: Vector Error Correction Model

WD: Durban Watson

WB: World Bank

ABSTRACT.

Exchange rate devaluation has been used as a policy tool by Ethiopia, a small open economy, particularly during this period. It is unclear if this policy has had a beneficial or negative impact on inflation in particular and the economy as a whole. The focus of this study was to assess the effects of devaluation on inflation from 2010Q1 to 2024Q4 using ARDL model. The finding of this study shows that REER is statistically insignificant effects on CPI; devaluation leads to increase the inflation of a country. Therefore, the researcher for this finding recommended NBE and government of Ethiopia to communicate transparently with the public regarding the reasons for devaluation and its expected impact on inflation and promote policies that encourage domestic production of goods and services to reduce reliance on imports.

Keywords: Devaluation, Consumer Price Index Real Effective Exchange Rate, Money supply

CHAPTER ONE: BACKGROUND OF THE STUDY

1.1. Introduction

Economic issues plagued the economies of the third world, including a widening trade deficit, dwindling foreign exchange reserves, and extreme inflation. The World Bank (WB) and International Monetary Fund (IMF) supported stabilization and structural adjustment programs that certain countries were forced to undertake in order to address these issues. Befirdu (2019) states that exchange rate policy is one of the adjustment strategies that developing nations utilize to address their economic issues.

Exchange rate policy refers to the set of rules, regulations, and strategies that a government or central bank employs to manage the value of its currency relative to other currencies. Exchange rate policies are either devaluation or revaluation of one countries currency in terms of another countries currency. Therefore, this policy can influence a country's economic performance in general and domestic inflation in particular, (Mankiw, 2016).

As Sanam and Fetullah quoted Dornbusch's study, the link between inflation and exchange rates is crucial, particularly in rising economies. This is because of emerging economies are often relying heavily on imported goods and services, including essential commodities like food and energy. A weaker exchange rate increases the cost of these imports, leading to higher overall price levels (imported inflation). In these economies, exchange rate fluctuations can significantly affect the general level of the prices. When the exchange rate falls, that is, when the domestic currency appreciates, prices are expected to fall in the general level (Sanam and Fetullah, 2017).

The Government of Ethiopia (GoE) also uses market based exchange rate system with the goal to safeguard macro-financial stability and rebalance and sustain economic growth. In addition, this market based exchange rate system helps to address foreign exchange distortions, reduce inflation, and strengthen the financial sector, ultimately aiming for a more resilient and competitive economy, (NBE), 2024). For instance, the Ethiopian Birr (ETB) immediately depreciated by about 30% (the first day) following the reform. The ETB continued its decline in value over the subsequent days, reaching a rate of 126.43 Birr per US Dollar as of January 5, 2025. This represents a devaluation of ETB approximately by118 %, (NBE), 2024).

On the other hand, the annual inflation rate in Ethiopia ticked up to 17% in December 2024, from 16.9% in the previous month. Inflation Rate in Ethiopia averaged 18.95 percent from 2006 until 2024, reaching an all-time high of 64.20 percent in July of 2008 and a record low of 4.10 percent in September of 2009. Specifically according to the quarterly report of NBE, over the previous seven years, the Ethiopian CPI has not shown a constant pattern. For example the annual inflation rate from 2017 to 2023 was 14.60%, 12.60%, 19.90%, 20.20%, 33.80%, 32.50 % and 26.6% respectively. Which means the inflation rate started to decline from 14.60% to 12.60%, in 2017/18 but it again increase from 2017 to 2021 and start to decline from the pick point of 33.80% to 17% in December 2024, (NBE), 2024).

When the exchange rate declined from 58 birr to the US dollar to 126 birr to the US dollar in 2023 and 2024, according to the NBE's report; the inflation rate has also declined from 26.6% to 17% in the same year so that the government's argument on large devaluation still leads to decline on the rate of inflation. However researchers like Tafesse, Goda and others argues that devaluation leads to increase the Ethiopian inflation. For instance there is a research conducted by Tafesse, on the effects of devaluation on inflation in Ethiopia. He claims that devaluation resulted in a high rate of inflation, which had a negative impact on the nation's home and foreign markets (Tafesse, 2019).

Goda said that, it is clear that devaluation of the nominal effective exchange rate increases the consumer price index in Ethiopia due to the impact on import costs and this leads to an increase in inflation. When Ethiopian birr weakens against foreign currencies, imported goods and services become more expensive in local currency, leading to higher consumer prices. This effect can be particularly pronounced in Ethiopia, which is because of Ethiopia relies heavily on imports of various goods and services, (Goda et al. 2018).

Therefore, devaluation of an exchange rate has an effect on inflation and understanding this effect is essential for effective policy and decision making. In the light of this background, the purpose of this essay is to examine how Ethiopian inflation is affected by devaluation.

1.2. Problem statement

Ethiopian economy is facing several challenges that affect its macroeconomic stability. According to Quarterly Economic report of United Nations Development Program (UNDP), the Ethiopian macro economy shows signs of vulnerability and an accumulation of risks because of the country's interest rate and currency rate policies, (UNDP, 2023).

As the Ethiopian birr devaluates against major foreign currencies, the cost of imported goods rises, which can lead to increased prices for consumers and businesses reliant on these imports. This situation is exacerbated by the country's dependence on foreign goods, including essential items such as fuel, food, and machinery. The resulting inflationary pressures can erode purchasing power, disproportionately affect low-income households, and destabilize the overall economy, (Cogent Economics & Finance, 2023).

Many researches have been made their research on this topic. For example, there is a research conducted by World Bank (WB) on the effects of devaluation in Ethiopian inflation. According to WB, Inflation can be significantly and negatively impacted by currency devaluation. Devaluation can lead to increased import prices and higher inflation, potentially affecting the overall economy, especially for a country heavily reliant on imports like Ethiopia. These adverse effects come mainly from rising prices of imports which further affects the poor citizen of Ethiopians, (WB, 2017).

Additionally, Maru et al. (2024) evaluate how devaluation affects Ethiopia's inflation and economic growth, devaluation of a currency results in a higher price of imported goods when measured in the domestic currency. This price increase impacts the demand for domestic products, leading to an increase in demand. Moreover, the price of domestic commodities also tends to rise. In conclusion, devaluation leads to elevated prices of imported goods in the domestic currency, which stimulates the demand for domestic products and creates upward pressure on domestic commodity prices, (Maru et al., 2024).

Another researcher Ezezew and Wendimnew assessed on empirical investigation of exchange rate transmission into general inflation level in Ethiopia. According to their finding, a unit change in the nominal effective exchange rate (appreciation) was associated with a reduction of 0.059 in consumer prices after 1 year. Which means that devaluation of exchange rate leads to

increase the price level in Ethiopia so that they suggested that the government of Ethiopia should have to stabilize and control the exchange rate to control the inflation, (Ezezew and Wendimnew, 2023).

There is also a study by befekadu and kebre published in 1994 on assessment of post devaluation Ethiopian economy. According to their finding devaluation is inherently inflationary so that the effects of devaluation on inflation is both directly and indirectly through increased demand from the tradable sectors and the greater cost of imported products and services, (befekadu and kebre , 1994).

However, According to the NBE financial stability report, the government of Ethiopia controls the Ethiopian inflation because of the adoption of devaluation. Specifically, before the adoption of devaluation of exchange rate the Ethiopian inflation was double digit which is 33.8%. When the country starts to devaluate her currency the inflation rate was reduced to 18.5 percent, (NBE, 2024).

Therefore the hot argument between the researcher and the government of Ethiopia motivates this researcher to conduct this study. Meaning that does the government's argument is right or the researcher's argument is right? On the other hand, of course the previous researcher conducted this study as mentioned in above but they used annual time series data which omits seasonal fluctuations, important trends and others. Those important trends and seasonal shocks are captured in high frequency data like quarterly data rather than annual data. For example, the inflation during January and during June cannot be aggregated in the same way because as we know January is the month of holidays' and wedding. But June is not as such similar with January. Taking this in to account is very important to conduct the inflation trends. Therefore this study aims to investigate the effects of devaluation on inflation in the case of Ethiopia using high frequency data (quarterly data).

1.3. Objectives of the Study

1.3.1. General objective

This study's main goal was to evaluate how Ethiopia's domestic inflation was affected by currency rate devaluation.

1.3.2. The study's specific goals are

- ✓ To evaluate Ethiopia's domestic inflation and exchange rate trends.
- ✓ To investigate the factors explaining the recent divergence contradiction between exchange rate devaluation and inflation trends

1.4. Scope of the study

The devaluation of exchange rates has an effect on the economy of a country in general and domestic inflation in particular. As far as this study is concerned, geographically, this study was focused on Ethiopia, periodically from the period 1st quarter of 2010 up to 4th quarter of 2024. In addition this research used the ARD model as methodology.

1.5. Significance of the study

The government of Ethiopia has been implementing devaluation as the policy instrument to overcome the economic problem, hence this study is important as it would give directions for further studies and suggests some policy recommendations on how devaluing the currency affects domestic inflation.

CHAPTER TWO: LITERATURE REVIEW

2.1. Definition and mechanisms of currency devaluation

According to Hilde C. Bjornland (2009) and Dornbusch (1976), currency devaluation is the deliberate decrease in the market exchange value of the home currency through official intervention, either directly from the government or through a change market. Furthermore, currency devaluation refers to the intentional use of monetary policy adjustments, foreign exchange market intervention, and structural economic policies like trade and fiscal policies by the government or central bank to lower how much the home currency is worth in relation to the foreign currency.

2.2. Theoretical Literature

This section focuses on theoretical literature regarding with the exchange rate and inflation.

2.2.1. Dornbusch theory on the effects of devaluation on inflation

In 1987, Dornbusch provided the first explanation of the connection between inflation and the currency rate. He claims that it created an econometric model and looked at how prices were impacted by the exchange rate. . In his analysis of the connection between domestic pricing and exchange rates, Dornbusch studied import volume, import substitutes, market density, and domestic production channels.

Agenor and Montiel (1996) mentioned four major transmission mechanisms of how exchange rate fluctuations affect inflation:

I. An open economy can directly affects the price of imported substitute goods and goods subject to trade.

II. It can indirectly increase the price of the final goods through imported input prices.

III. Due to fluctuations in the exchange rate, the uncertainties in foreign currency prices can affect domestic price makers and increase domestic prices.

IV. Finally, it increases the prices by the means of wages.

According to Shojaeipour and Akin (2017) one of the role of the exchange rate in the monetary transmission mechanism and the exchange rate affects inflation rate through:-

An open economy's exchange rate fluctuations impact the relative costs of domestic and foreign goods, which in turn influences demand for domestic goods from both domestic and foreign consumers. As a result, net exports will have an impact on both the indirect inflation rate and overall demand.

However, changes in the exchange rate have an immediate effect on the prices of the imported completed goods in terms of national currencies, which in turn affects inflation. The price of imported finished goods has an impact on the inflation rate, which typically manifests before the indirect impact of net exports.

Finally, the way that changes in exchange rates affect nominal wages is through the influence of imported middle prices in terms of national currency on the Consumer Prices Index. The cost of domestic goods influences the inflation rate when these two impacts are taken into account,(Shojaeipour and Akin, 2017).

As an asset price, the exchange rate is a future variable and an anticipated variable, which brings us to our second key point regarding the exchange rate's function in the inflation targeting method. As a result, it helps to establish expectations that play a big role in monetary policy. The final crucial aspect is that the national economy is one of the external issues affecting the exchange rate. Domestic demand produced by foreign exchange rates is directly impacted by changes in variables like the external inflation rate or international interest rates. Likewise, Woo (1984) identifies four ways that the exchange rate affects domestic inflation.

Exchange rate variations have a direct impact on the current account, which in turn affects total demands and changes in total demands. how price rises are impacted by imported items. In addition to the previously mentioned imported cost and imported input cost channels, there is a real balance channel.

Therefore, the devaluation will raise the prices of the traded items relative to the non-traded goods, which will raise the level of prices overall. The overall level of prices rises in proportion to the weight of the items in the consumer basket ,(Cravino and Andrei A, 2015).

2.2.2. PPP Theory (Purchasing Power Parity):

According to PPP, the exchange rate between two countries is determined by the relative buying power of their respective currencies. The rate at which the two purchasing capabilities are equal will be such. A given arrangement of items, for instance, can be purchased for £1 in Britain and a comparable assortment in India for Rs. 80. This indicates that the purchasing power of £1 in Britain is equivalent to Rs. 80 in India, (Dornbusch (1987), (Ghadoliya, 2018).

Purchasing Power Parity (PPP) is closely linked to both devaluation and inflation, as it helps to explain how changes in a country's currency value and price levels affect the relative purchasing power of that currency. When a currency is devalued, the immediate effect is that the cost of imported goods becomes more expensive in local currency terms. If the prices of domestically produced goods do not adjust accordingly, the purchasing power of consumers decreases. In terms of PPP, this means that the exchange rate may no longer reflect the relative price levels of goods and services between countries ,(Kwabena, Yusif et al., 2023).

PPP is useful as a reminder that monetary policy has long-run impact on the real exchange rate. The exchange rate, however, can deviate persistently from its PPP value in response to real shocks (Wilson, 2011).

A country's exchange rate is depressed when its inflation rate rises in comparison to another country's when exports decline and imports rise. According to this relationship, a nation's declining currency value results in lower exports and higher imports, which fuel inflation? This is because, according to Gustav Cassel (1918), "imported inflation" will occur in a country where another country imports goods due to inflation in that country (Badara 2019).

2.3. Systems of exchange rates

The current market price of the home currency converted to a foreign currency is known as the exchange rate (Obstfeld et al., 1995). There are three different kinds of exchange rate regimes, according to Klein & Shambaugh and numerous other economists. These include pegged or fixed exchange rate regimes, pegged floating or managed floating exchange rate regimes, and free floating or flexible exchange rate regimes, (Anderson, et al 2008)(Tafesse, 2019), (Klein & Shambaugh, 2009).

1. A regime of floating (flexible) exchange rates: in this system, the value of a currency is set by supply and demand in the foreign exchange market, free from government interference..

2. Fixed (pegged) exchange rate regime: a country's currency is fixed against the value of another single currency, or to another measure of value, like gold. This type of exchange rate regime may be relevance for Ethiopia through several dimensions. For example, fixed exchange rate can provide a sense of stability in the economy of Ethiopia by reducing exchange rate volatility so that this can help a businesses plan future and foster a more predictable economic environment. It also helps to anchor expectations about future inflation which is particularly important in the economy when inflation rates have historically been high.

3. Mixed exchange rate System: Hybrid of the two

A mixed exchange rate system offers a compromise between the rigidity of fixed exchange rates and the unpredictability of floating rates. By allowing for market determination while providing room for intervention, it aims to create a stable economic environment conducive to growth and investment. However, careful management is essential to avoid potential pitfalls associated with this approach.

2.3.1. Benefits of Currency Devaluation

According to Yohannes (2023), Johnson (2013), Krugman and Obstfeld (2008) and many other economists, currency devaluation can have several advantages and disadvantages. The benefits of currency devaluations are mentioned as follows.

• Boosting export competitiveness: devalued currency makes exports cheaper, encouraging foreign buyers to purchase more goods and services from the country, generating more revenue for the country's economy so that it will also improve the country's balance of payment, (Krugman and Obstfeld, 2008).

• Encourage investment- led growth, (Tafesse, 2019).

• Encouraging local production: A devalued currency makes imported goods more expensive, discouraging their importation and promoting local production, (Yohannes 2023) and (Genye, 2011).

• Stimulating tourism sector

2.3.2. Disadvantages of Currency Devaluation

Currency devaluation has a detrimental effect on inflation and a nation's growth, even though it has an expansionary effect, (Nalin, 2020). The followings are the dis advantages of currency devaluation.

• Higher Inflation: A devalued currency can increase the cost of imported goods leading to higher inflation levels, which could be damaging to the living standards of the local population, (Goldberg, 1990; Stryk et al, 2000).

• Reduce economic growth in the long run: Long-term profits may be zero for nations that employ devaluation as a growth strategy and offer low prices in international markets, (Tafesse, 2019).

• Capital Flight: Investors may withdraw their investments from the country due to concerns about the country's economic stability and increased financial risk, which could result in capital flight, Johnson (2013).

• Devaluation can lead to political unrest because people become frustrated with the effects of a devalued currency, such as higher prices for goods and services, on the one hand, and social problems like rising poverty levels and rising living expenses, which could negatively impact the nation's population on the other, can result from the local population's purchasing power declining as imports become more expensive due to a devalued currency (Yohannes 2023).

2.4. The History of Exchange rate system in Ethiopia

The history of the exchange rate system in Ethiopia is marked by various economic policies, political changes, and global economic trends. Here's an overview of key developments in the exchange rate system in Ethiopia:

1. System of Exchange Rates in Imperial Era: Pre-1974:

During the time of Emperor Haile Selasie (before the 1974 revolution), Ethiopia had a relatively stable and fixed exchange rate system. During this era, one US dollar was exchanged on average by 2.4 birr, (IMF, 2006)

2. Exchange rate System during Derg Regime: Between 1974-1991

Derg used socialist policies, nationalizing many industries and farms. During this period, the exchange rate system became more regulated. The Birr was devalued several times and one USD was exchanged on average by 2.75 birr. The Derg government devalues the Ethiopian birr to address trade imbalances, but these measures often led to inflation and shortages of foreign currency. The Derg regime also imposed strict controls on foreign exchange, leading to a black market for currency. The official exchange rate was significantly different from the market rate, creating distortions in the economy, (IMF, 2014)

3. Exchange rate System during Front for Ethiopian Revolutionary Democracy (EPRDF): Between 1991-2018

In 1991, EPRDF came to power, marking the beginning of a new era in Ethiopia's economic policy and used market-oriented exchange rate policy. The government began to move away from strict controls on exchange rates. In 1992, Ethiopia implemented a managed as well as floats exchange rate mechanism, allowing the Birr to vary within a fixed range. However, the government still intervened in the foreign exchange market to stabilize the currency when

necessary. The exchange rate policy during this period was characterized by periodic devaluations aimed at addressing trade deficits, (IMF, 2019).

Throughout the early 2000s, Ethiopia continued its efforts to liberalize its economy. The government maintained a managed float exchange rate system but faced challenges such as inflation and currency depreciation. In 2003, Ethiopia adopted a new monetary policy framework aimed at controlling inflation and stabilizing the Birr. The government also sought to increase foreign reserves and improve the balance of payments. Generally, during the time of EPRDF, the exchange rate was devalued from 2.75 to 27.43, (NBE, 2020).

1. From 2018-Present: Recent Developments

In recent years, Ethiopia has faced significant economic challenges, including high inflation rates and a growing trade deficit. In 2018, the Ethiopian government announced plans to further liberalize the economy and attract foreign investment. This included discussions about reforming the exchange rate system. In July 2024, Ethiopia implemented a significant devaluation of the Birr as part of broader economic reforms. The government moved towards a more flexible exchange rate regime to improve competitiveness and attract foreign investment.As of 2023, Ethiopia continues to navigate challenges related to its exchange rate system. The central bank manages the exchange rate while also trying to control inflation and support economic growth. Overall, Ethiopia's exchange rate history reflects a transition from a fixed system under imperial rule to more flexible arrangements under various regimes. Economic reforms continue to evolve as the country seeks to stabilize its economy and integrate into the global market.

2.5. Evaluation of Empirical Literature

2.5.1. Research in Underdeveloped Nations

In Ghana, for instance, research has demonstrated that exchange rates have a full or partial pass-through effect on inflation (Sanusi, 2010; Frimpong & Adam, 2010; Adu et al., 2015; Amoah & Aziakpono, 2018; Asafo, 2019). This suggests that depreciation of the Cedi may have the effect of raising the general price level (inflation). However, Cpi was found to be negatively impacted by REER in a recent study by Duodu, Baidoo, Yusif, and Frimpong (2022), indicating that the real effective exchange rate has no effect on domestic pricing in Ghana. Notably, none of these research on Ghana took into account the threshold influence of the exchange rate on inflation; as

a result, this analysis includes the threshold effect to increase awareness about both exchange rate are and inflation relationship.

Fetai, Sergius et al. (2017) empirically investigate the relationships between exchange rates and inflation in Western Balkan nations using panel methods data, such as the Fixed and Random Effects Model and the "Hausman-Taylor instrumental variables IV" model from 1996-2014. Outcome shows that the primary cause of inflationary pressures in Western Balkan nations continues to be the exchange rate. Because a flexible exchange rate system is likely to have more costs than advantages, policymakers must consider the relative costs and benefits of implementing such a regime in small open economies.

The two economist Shireen Alazzawi and Vladimir Hlasny utilize 71 commodity categories and services (12 broad categories and 59 separated food and necessary items) using monthly consumer price index data featuring in household budgets) for all eight Egyptian regions between 2008 and 2015, Alazzawi and Hlasny examine how the cost of living changes following a significant devaluation in the case of Egypt in 2016. They do this by estimating disaggregated exchange rate pass-through regressions. They discovered that devaluation of currency caused a rise in the cost of different commodities, ensuing wealth burden on households, and its prevalence across socioeconomic classes (Alazzawi and Hlasny, 2016).

There was a working paper made by an International Growth Center on An Empirical Analysis of Exchange Rate Dynamics and Pass-Through Effects on Domestic Prices in Ghana via identifying the sources of the exchange rate movements and their implications for price stability. The results also reveal a high but incomplete pass-through effect of exchange rate movements on domestic prices, (Adu-et-al-2015).

There was a research paper conducted by Eatzaz Ahmad and Saima Ahmed in 1999 on simultaneous determination of nominal exchange rate and domestic price level in Pakistan. Enough dynamics are included in the estimated model to track the pattern and rate of change in the two variables in response to either transient or permanent shocks. According to the study, the short-term impacts of a transient shock on the exchange rate and price level are divergent, while the long-term consequences are convergent. This indicates that the system has a propensity to return to relative parity over time, even while purchasing power parity does not hold in the short

term. Additionally, if shocks remain, there may be a continuous but non-accelerating discrepancy between the inflation rate and rate of devaluation, (Ahmad and Ahmed.A, 1999)

2.5.2. Studies in Ethiopia

According to Kevin C. Ahlgrim researchers are argued on the effects of devaluation on inflation, (Ahlgrim, 2012). Some researcher said that devaluation has a positive effect on inflation while the other said that devaluation has negative effects on inflation. From those who agreed on the positive effects of devaluation on inflation, the following has mentioned.

Study by Geda and Meskel (2006) investigates the impact of the Ethiopian birr devaluation on inflation rates from 1990 to 2005. The authors employed ARDL model to assess the dynamic relationship between exchange rates and inflation. Based on their findings, devaluation raises import prices, which causes inflation rates to rise significantly, especially in the short term, (Geda and Meskel, 2006)

Tafesse analyzed the pass-through effects of exchange rate changes on domestic prices using a structural econometric model. The results indicate that a 1% depreciation of the birr results in an average increase of 0.5% in inflation within six months. The study emphasizes the importance of considering external factors such as global commodity prices in understanding this relationship, (Taffese, 2011):

Fikadu's recent study examines the relationship between exchange rate volatility and inflation in Ethiopia, particularly after major devaluations in 2010 and 2015. By employing an Autoregressive Distributed Lag (ARDL) model, the research finds that increased exchange rate volatility significantly contributes to rising inflation rates. The study underscores the importance of stabilizing exchange rates to manage inflation effectively, (Fikadu, 2022).

A pivotal study by Alemayehu et al. (2022) analyzed the effects of devaluation of the 2021's Ethiopian Birr on inflation. The authors employed ARDL model to assess the impact of exchange rate fluctuations on inflation over a two-year period following the devaluation. Their findings indicated a significant positive correlation between devaluation and inflation, with a lag effect observed in price adjustments. Specifically, they reported that inflation increased by approximately 5% within six months post-devaluation, driven by heightened import costs.

Using the ARDL approach, Sheferaw and Sitotaw evaluate the empirical study of exchange rate transmission into Ethiopia's overall inflation level. This study used recursive ARDL analysis to examine how Ethiopian domestic prices were affected by exchange rate pass-through (ERPT) between 1975 and 2020. A unit change in the nominal effective exchange rate (appreciation) was associated with a 0.059 drop in consumer prices one year later, according to Sheferaw and Sitotaw's (2023) research.

For example there is a research by Bachewe et al. (2016) on the effects of devaluation on Ethiopian inflation using ARDL model from 2000 up to 2014. This study found that devaluation encourages local production by leads imported goods more expensive. As a result, consumers turn to domestically produced goods, which can lead to increased investment in local industries. The growth in local production can help balance supply and demand, potentially leading to price stabilization and reduced inflation in the long term. Which means devaluation reduce inflations indirectly, (Bachewe et al. 2016).

Woldemichael also did a research on the effects of devaluation on inflation from 2000 to 2017 using ARDL model. His study highlights that devaluation of Ethiopian Birr can attract foreign direct investment (FDI) as investors seek opportunities in a country with lower currency valuations and FDI will increase so that capital inflow will increases which further leads to increase economic growth.. A stronger economy can absorb inflationary pressures more effectively, leading to a more stable price environment, (Woldemichael, 2018).

Other researchers also assess the effects of devaluation on Ethiopian inflation from 2000 up to 2021 using ARDL model. According to their study, devaluation can encourage economic diversification by prompting industries to shift focus towards sectors less reliant on imports. As businesses adapt to changing market conditions, they may invest in new technologies and processes, leading to greater efficiency and reduced costs over time. A diversified economy is often better equipped to manage inflationary pressures, (Alemayehu et al. (2020).

To sum up the above findings, researchers had an argument regarding with the effects of devaluation on Ethiopian inflation. Some of the researcher like Geda and Fikadu argued that, devaluation of Ethiopian Birr leads to increase Inflation due to the fact that Ethiopia is an import based country therefore, when Ethiopian birr devalues, the cost of imported goods will increase directly. On the other hand other researchers like Bachewe and Woldemichael argued that devaluation reduce the Ethiopian inflation in indirect way. According to them, when the country's currency devalues, Ethiopian export becomes more competitive and on the other hand FDI increase so that products and production level will increase that further leads to reduce the price level of the country indirectly.

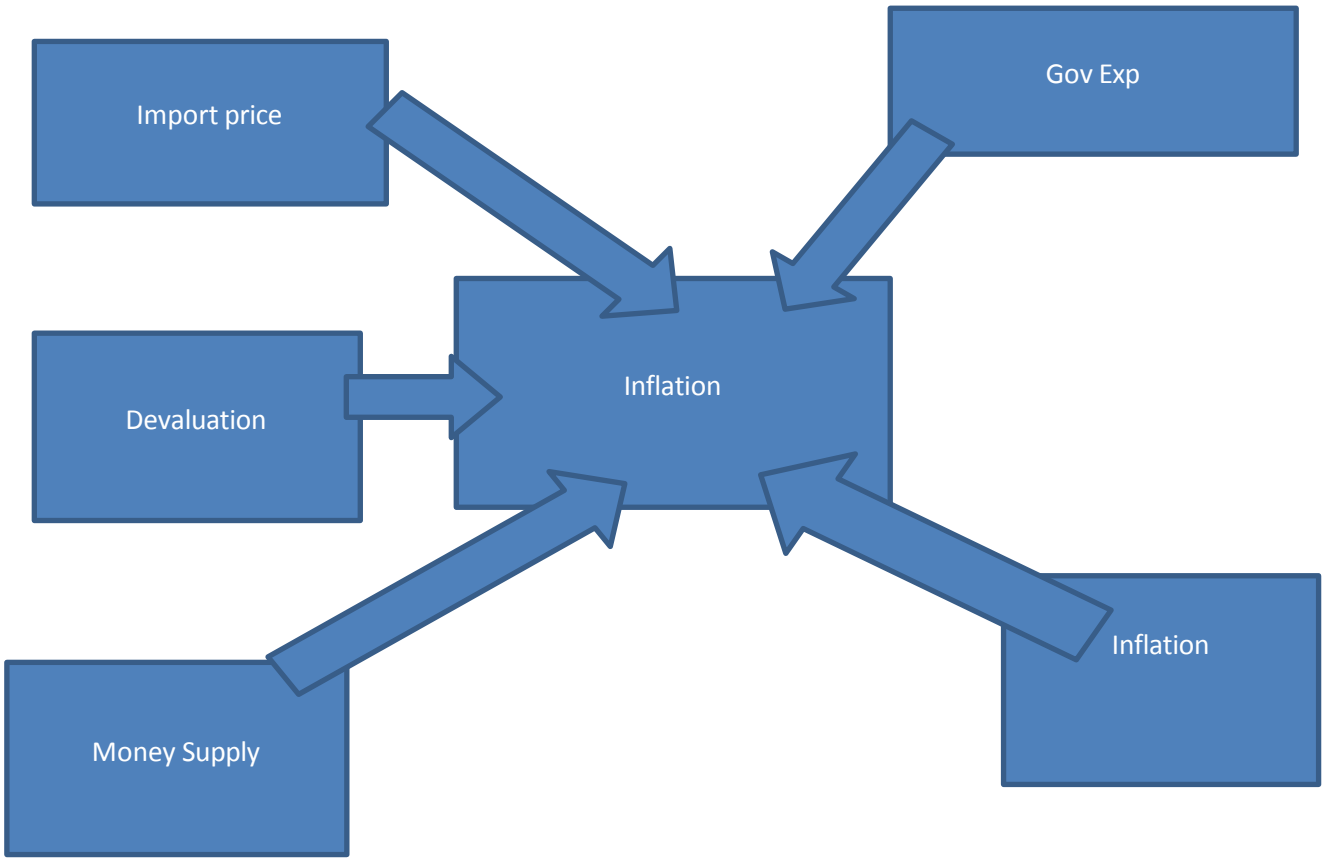
2.6 Research GAP

From the above studies this finding concludes that, their findings are inconsistent. Some of the researcher found that devaluation has positive effects on inflation; while the other researcher found that devaluation has negative effects on inflation indirectly. Ambiguous result is observed, the current government of Ethiopia actively used devaluation as a policy instruments, (Yilkal, 2012). Therefore; this finding tried to assess the effects of devaluation on domestic inflation in the Ethiopian context using current data.

Most of those researchers used annual time series data for their analysis. Yearly data aggregates information over a 12-month period, which can obscure important trends, seasonal patterns, or fluctuations that occur within the year. The economic, social, and political context may change significantly. Yearly data may not adequately reflect these shifts, making it difficult to draw relevant conclusions across different periods. However, this study uses high frequency data (quarterly data) to examine how devaluation affects domestic inflation in the case of Ethiopia.

2.7. Conceptual Framework

As the country Ethiopia is an import based country, devaluation of exchange rate affects inflation mainly through import price (Nguyen, 2011). In addition, exchange rate indirectly affects economic growth through RGDP, Gov Exp and money supply channels. The impact transmission channels of exchange rate and inflation can be generalized according to Fig. below:



Source: summary of literature review

Fig: Conceptual Framework: The impact of exchange rates on inflation

Devaluation → Import Prices: The immediate effect of devaluation is an increase in import prices, which raises overall production costs.

CPI → Money Supply: If inflation rises significantly, central banks may adjust the money supply to stabilize prices, although excessive increases can lead to hyperinflation.

• Money Supply → RGDP: An increase in money supply can stimulate economic activity, but if not matched by real output growth, it may lead to further inflation.

• Government Expenditure → RGDP: Increased government spending can stimulate demand and support RGDP growth but may also fuel inflation if the economy is already under pressure from rising prices.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1. Data Types, Sources and variables

This study was examined the effects of devaluation on domestic inflation for the period from 2010q1 to 2024Q4 mainly by taking in to account secondary data obtained from NBE, IMF, WB and International Financial Statistics (IFS). The selection of variables in the ARDL model for analyzing the effects of devaluation on inflation in Ethiopia is guided by PPP theory, empirical evidence, and the specific context of the Ethiopian economy. Therefore dependent variable is Inflation Rate Measured by Consumer Price Index (CPI) and the independent variables are real effective exchange rate (REER), Money supply (MSS), Real Gross Domestic Product (RGDP), Government expenditure (Gov Exp) and Import Prices (IMP).

3.2. Description of Variables

The variables listed below were used in the investigation.

I. CPI: This measure tracks shifts in the average cost of goods and services for consumers.

II. REER: is weighted average of bilateral rate with the weights proportional to the shares of trade of various partners. In short it is a measure of the value of a currency against a weighted average of several foreign currencies divided by a price deflator or index of costs (Pilbeam 1998). The researcher was used indirect term of real effective exchange rate measures (dollar/birr).Therefore an increase in REER means devaluation of the domestic currency while the its reverse is also true.

III. MSS: Broad Money supply (M2).

IV. Often referred to as "constant-price," "inflation-corrected," or "constant dollar" GDP, RGDP is an inflation-adjusted metric that represents the total value of goods and services generated by an economy in a given year (expressed in base-year prices).

V. Gov Exp: refers to the purchase of goods and services by the government, which includes public consumption and public investment, and transfer payments consisting of income transfers (pensions, social benefits) and capital transfer.

VI. IMP: refer to the costs associated with purchasing goods and services from foreign countries.

Tab: 3.1. Overview of variables, measurements, and predicted indicators

S.No	Variables	Symbol	Source	Expected sign
1	Index of Consumer Prices	CPI	IMF	-
2	Actual effective exchange rate	REER	NBE	+/-
3	Government expenditure	Gov Exp	IMF	-
4	Money supply	MSS	NBE	+
5	Real gross domestic product	RGDP	IMF	+
6	Import Prices	IMP	IMF	+

3.3. Model Specification

The theoretical Foundation for the effects of a change in exchange rate on domestic inflation is associated with Purchasing Power Parity (PPP) Theory. The reason to choose PPP Theory is because this theory can provide valuable insights for policy makers. It can inform decisions regarding monetary policy, exchange rate management, and trade policies aimed at stabilizing the economy.

This study was assessed the effect of currency devaluation on domestic inflation for the period 2010 1st quarter – 4th quarters of 2024 using Auto Regressive Distributed Lag Model (ARDL) by following researchers like Gudina G and Destaw A, K. R, (2018), to adopt the following model specification:

$$CPI_i\square = c_i + \sum\square_{=1}{}^{p}((\sum\square_{=1}{}^{n}\varphi_i\square\square CPI\_(k,-tj))) + \in_i\square \quad \text{.....(3.1)}$$

We can specify the equation in a log-log form for easy estimation as below:

$\log CPI_i\square = c_i + \sum\square_{=1}{}^{p}((\sum\square_{=1}{}^{n}\varphi_i\square\square \log CPI\_(k,-tj))) + \in_i\square$ ..... (3.1)

The general form of ARDL model is

$\log CPI\square = c_1 + \varphi_{11} \log CPI\square_{-1} + \varphi_{12} \log REER\square_{-1} + \varphi_{13} \log MSS\square_{-1} + \varphi_{14} \log RGDP\square_{-1} + \varphi_{15} \log Gov\ Exp\square_{-1} + \varphi_{16} \log IMP\square_{-1} + \in_1 \square$ ..... (3.2)

Where:-

- ✓ c =Constant term
- ✓ φ =Coefficient of the variables
- ✓ $\log CPI_t$= Logarithm of Consumer price index at time t, and t-i
- ✓ $\log REER_t$= Logarithm of real effective exchange rate at time t and t-i
- ✓ $\log MSS_t$=Logarithm of money supply at time t and t-i
- ✓ $\log RGDP_t$= Logarithm of real gross domestic real product at time t and t-i
- ✓ $\log Gov\ Exp_t$= Logarithm of government expenditure at time t and t-i
- ✓ $IMP\square$ = Import prices at time t
- ✓ U_t = the random error at time t.

Once the co-integration is established using Johansson cointegration test, the VECM was specified and its general form is similar with ARDL Model

3.4. Research design

In a time series data type, there are different models which mainly categorize based on the variables order stationary and existence of co integration, (Tibebu, 2023).

All variable are stationary at level and this paper uses ARDL Model. Both Engle-Granger Approach and Johansen co-integration techniques are used tests the co integration of variables of the same order of stationarity in a large sample size (Tirsit, 2019).

3.5. Method of Data Analysis

The descriptive statistics and econometric methods were used throughout this study to discuss and analyze the time series data. Initially examining the characteristics (stationarity and long run relationship behaviors of variables) of the time series data is mandatory before any model estimation.

The ARDL model was estimated after the time series data's features were examined using the ECM. The ARDL model is used to analyze effects of devaluation on inflation in Ethiopia using quarterly data because it can identify the effects of shocks on endogenous variables, establish a causal relationship between the variables, and induce shocks to the system.

The phrase "error-correction" refers to the way that the short-term dynamics of a period are influenced by the error, or departure from a long-term equilibrium. Accordingly, ECMs provide a direct estimate of how quickly a dependent variable regains equilibrium following a change in other variables (Mulusew, 2012).

3.6.Diagnostic Test

All the necessary diagnostic tests such as normality, hetroscedasity omitted variable and others were conducted.

CHAPTER FOUR: DESCRIPTIVE DATA ANALYSIS

4.1. The Overview

Results from this chapter used quarterly data from 2010Q1 to 2024Q4 to demonstrate how devaluation affected Ethiopian inflation. Two sections make up this chapter. The descriptive nature of the variables and the trends in inflation and the real exchange rate throughout the period under review were covered in the first part of the chapter. With discussions of the diagnostic checks, the econometric analysis results are presented in the second part of the chapter.

4.2. Descriptive Data Analysis

4.2.1. Trend of Consumer price index in Percentage Changes

Gaining a fundamental understanding of how the consumer price index behaves over time is the goal of trend analysis.

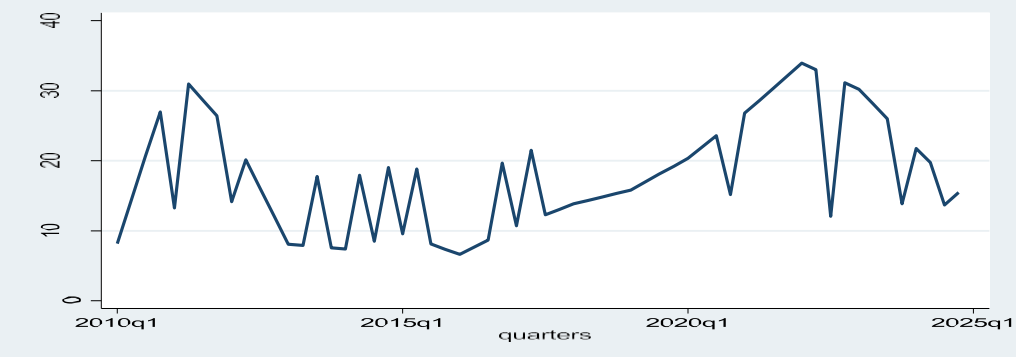


Fig 4.1: Trend of CPI in Percentage Changes Source: Researchers own computation from STATA, 2025

Consumer price index for Ethiopia has not a consistent trend over time. As shown from the above figure, CPI increase from 2010 q1 to 2010q4 and reduce from 2010q4 to 2011q1. CPI fluctuates from the minimum value of 2016q1 to the highest value of 2021q4. From this one can understand that CPI fluctuates more and more even within one fiscal year. As shown from the above graph, the Ethiopian Inflation varies from time to time due to a number of factors, including political instability, supply-side constraints, cost-push effects (like external shocks), inflation expectations, and macroeconomic policies. These factors have varying degrees of influence over different periods.

4.2.2. Trend of REER in Percentage Changes

Fig 4.2: Trend of REER in Percentage Changes, (Source: Researchers own computation from STATA, 2025)

From the above graph, REER in Ethiopia has an increasing trend which means the values of Ethiopian birr continuously decrease starting from the first quarters of 2010 to the fourth quarter of 2024. This is due to several factors, primarily related to the country's economic structure and policies. According to the current state of the economy, a complex interaction of economic factors, such as trade imbalances, inflation, governmental policies, and external shocks, is to blame for Ethiopia's dropping REER. According to the REER, these factors all work together to cause the Ethiopian Birr to weaken against other major currencies even from quarter to quarter.

4.2.3. Trend of CPI and REER in Percentage Changes

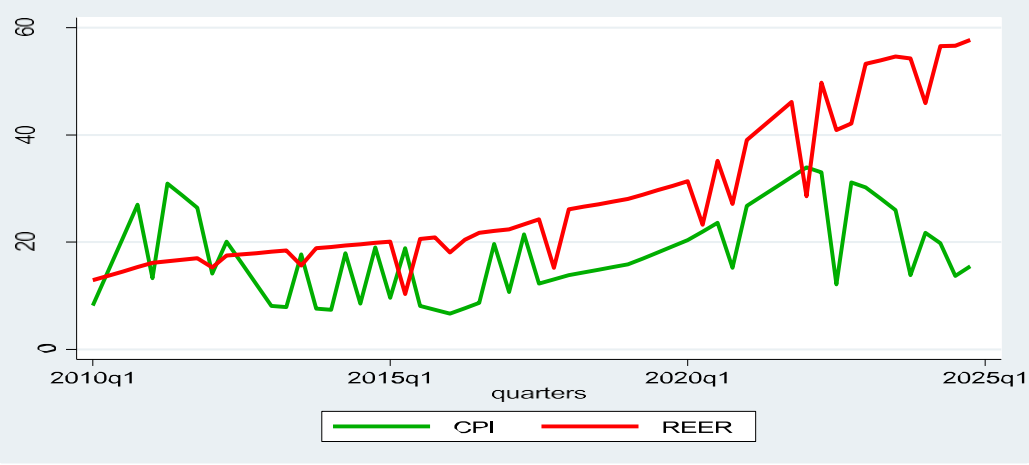


Fig 4.3: Trend of CPI and REER in Percentage Changes, (Source: Researchers own computation from STATA, 2025)

Based on the above graph, from the first quarters of 2010 to the first quarter of 2012 , when REER continuously increases, CPI has fluctuates more and more. However starting from the second quarters of 2012 to the last quarters of 2019, CPI and REER has almost the same trend and they fluctuate around with the values of 20. On ward from that, REER continuously fluctuate and increases from 2020q1 to 2024q4, but CPI fluctuates and decline in the same period. Therefore, one can understand that CPI declines when REER increase beginning in 2022's first quarter and ending in 2024's last quarter.

4.3. Econometric Data Analysis

4.3.1. Stationarity Tests

Testing for stationarity in time series is the first step in the Johansen process. There are two primary ways to determine whether or not time series are stationary: the formal test and the informal graphical method. Prior to the official exams, this study initially displays the graph plot visually. The Augmented Dickey-Fuller is the official test used. These tests are crucial because they provide information about the data set's trends, stationarity, and structural breaks (Brooks, 2008).

4.3.1.1. Stationarity Tests using graphical methods

The researcher for this study tests the Stationarity for all dependent and independent variables which includes CPI, REER, RGDP, MSS and Gov Exp respectively.

I. Stationarity Tests for Logarithm of CPI

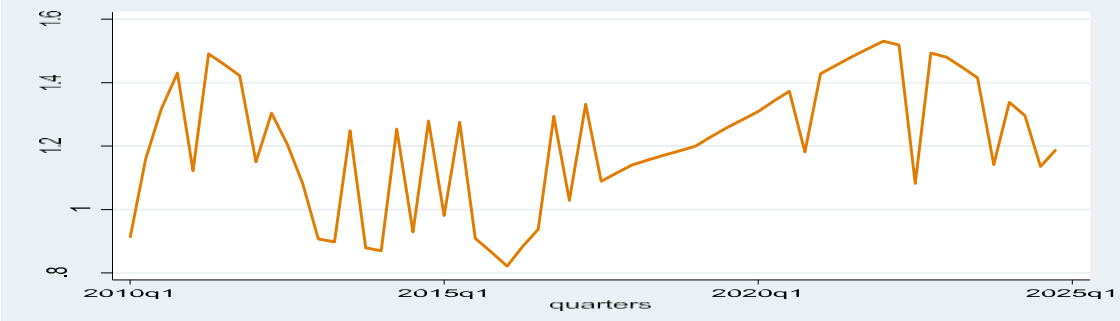


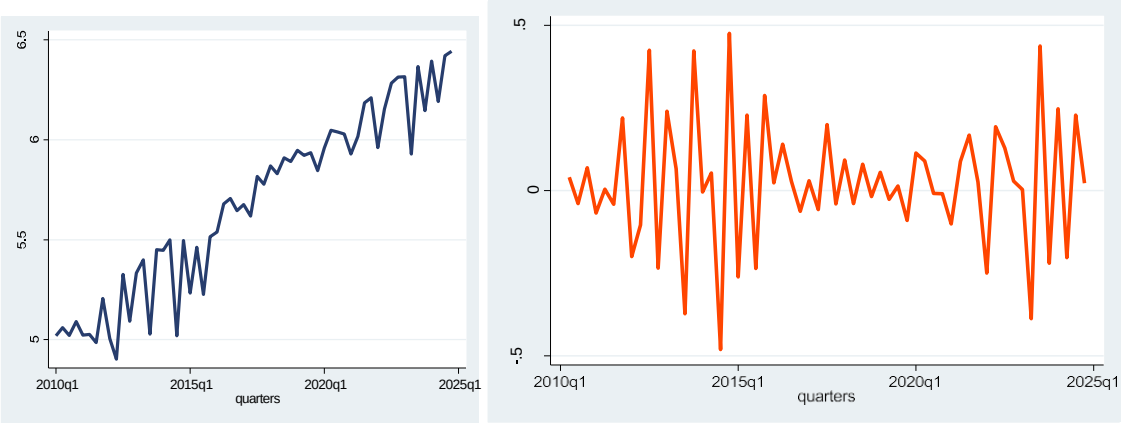
Fig 4.4: Stationarity Tests for logCPI, Source: Researchers own computation from STATA, 2025
As we have been seen on the graph, logarithm of Consumer price index is neither trend, seasonal nor cyclical so that it is stationary at level.

II. Stationarity Tests for Logarithm of REER

a. Fig For log REER ***b. Fig For DlogREER***

Fig 4.5: Stationarity Tests for logREER (Source Researchers own computation STATA, 2025)
As we have seen on the above graph, logarithm of Real Effective Exchange rate has an increasing trend so that it seems be non-stationary at level. Therefore, one of the mechanisms for solving non stationarity is Differencing and so that the researcher for this paper use this mechanism to solve the problem of non stationarity. When the log of REER is differenced a new variable called diff_logREER is generated. The right side of the above graph is for the first difference of log REER so that is neither trending nor cyclical so that is stationary.

III. Stationarity Tests for Logarithm of MSS



a. Fig for logMSS b. Fig For DlogMss

Fig 4.6: Stationarity Tests for logMSS,(Source Researchers own computation STATA, 2025)

As we have seen on the above graph, logarithm of Money Supply has an increasing trend so that it seems non-stationary at level. Therefore, one of the mechanisms for solving non stationarity is Differencing and so that the researcher for this paper use this mechanism to solve the problem non stationarity. When the log of MSS is differenced a new variable called diff_logMSS is generated and it is stationary as we have seen from the above graph.

IV. Stationarity Tests for Logarithm of MSS

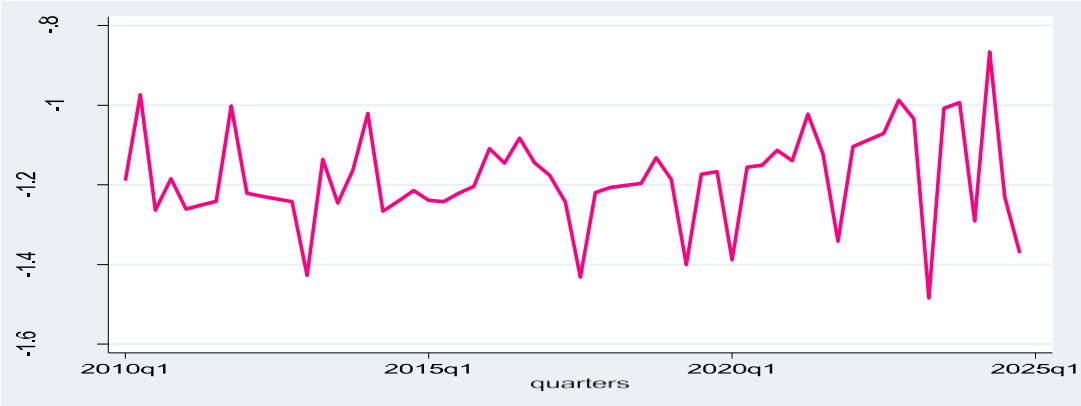


Fig 4.7: Stationarity Tests for logMSS, (Source Researchers own computation STATA, 2025)

Based on the above graph, logarithm of Government Expenditure is neither trend, seasonal nor cyclical so that it is stationary at level.

V. Stationarity Tests for Logarithm of RGDP

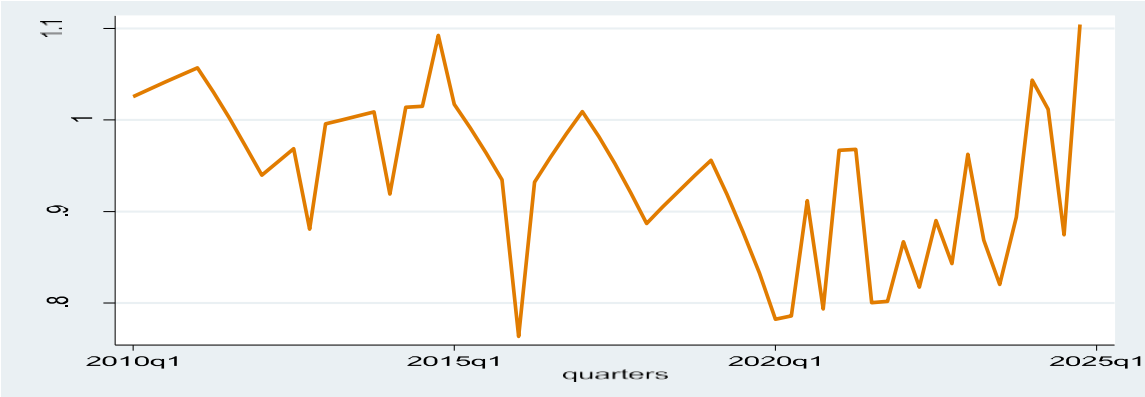


Fig 4.8: Stationarity Tests for logRGDP, (Source Researchers own computation STATA, 2025)

Based on the above graph, logarithm of Real GDP is neither trend, seasonal nor cyclical so that it is stationary at level.

VI. Stationarity Tests for Logarithm of IMP

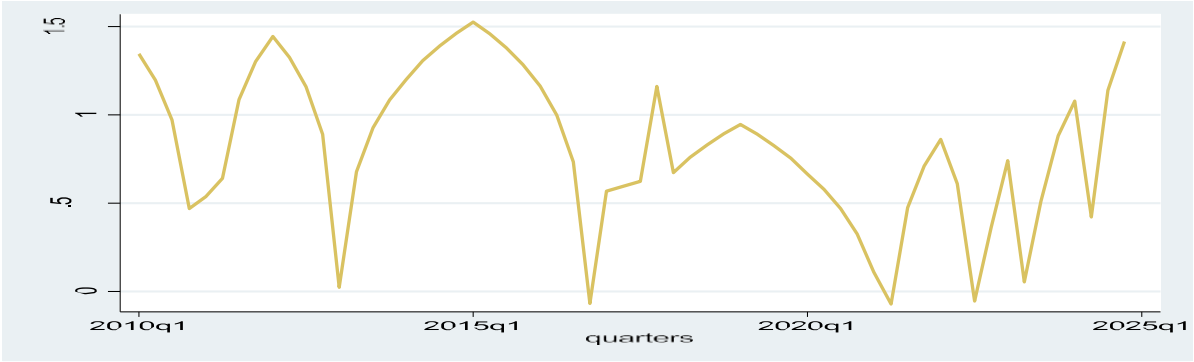


Fig 4.9: Stationarity Tests for logIMP, (Source Researchers own computation STATA, 2025)

The graph above shows that the import price logarithm is stationary at level and neither trending nor cyclical.

Due to its informal nature, the informal method is insufficient to determine that data is steady; therefore, a more formal approach is required to supplement it. Other formal tests were therefore carried out to corroborate the conclusions drawn from the graphical data. The findings are shown in the following table. In this context, the Augmented Dickey-Fuller and Phillips-Perron were used. However, because the Dickey-Fuller test for stationarity can be made with or without a

constant term or drift, or with a constant and/or a trend, which leads to the augmented Dickey–Fuller (ADF) test, these graphs are very essential.

Most Economist and researcher used the following rule of thumb to identify constant term, drift and trend for ADF test is: - A Dickey-Fuller test without a constant term (or "drift") should be used if the series seems to be straying or varying around a sample average of zero. Use a Dickey-Fuller test with a drift if the series seems to be straying or varying around a sample average that is not zero. Use a test with a trend if the series seems to be straying or varying around a linear trend. Thus, these criteria are used to test the formal procedures.

4.3.1.2. Stationary test using Formal Test

4.3.2.1. Stationary test using Formal Test

A. Results of the Augmented Dickey-Fuller test for stationarity

Tab 4.1 (a) Results of the Augmented Dickey-Fuller test for stationarity

Order of integration	Variables	T-statistics	Critical values/ Significance level			P-Values
			1%	5%	10%	
Level	Log CPI	-4.54	-2.394	-1.672	-1.297	0.0000
Level	Log REER	-1.746	-3.567	-2.923	-2.596	0.4078
1st difference	dlogREER	-14.145	-3.569	-2.924	-2.597	0.0000
Level	Log Gov Ex	-7.829	-2.394	-1.672	-1.297	0.0000
Level	log MSS	-1.588	-3.567	-2.923	-2.596	0.4897
1st difference	dlogMSS	-16.252	-3.569	-2.924	-2.597	0.0000
Level	dlog RGDP	-3.912	-2.394	-1.672	-1.297	0.0001
Level	log IMP	- 3.372	-2.394	-1.672	-1.297	0.0007

Source: Researchers own competition from STATA, 2025

From the above table except for real effective exchange rate and money supply, every t statistic's absolute value is higher than the absolute values of every critical value at a level for every variable, including the logarithms of the consumer price index, real GDP, government spending, and import price. These logarithms are all stationary at a level. Furthermore, the variable's p-value is significant because it is less than 5%, allowing the null hypothesis—that the variables were stationary at level—to be accepted. On the other hand, for real effective exchange rate and money supply, those variables are non-stationary at level because the t statistics are less than their critical values and their p-vales are greater than the 5% level of significance, while they become stationary at first difference.

A. Stationarity results of Phillips-Perron (PP) Tests

A more thorough explanation of unit root non-stationarity can be found in the Phillips-Perron tests. According to Gujarati (2004), the Phillips-Perron method does not use lagged difference terms and instead uses non-parametric statistical techniques to address serial correlation in the error terms. The tests are comparable to ADF tests, but they include an automatic adjustment to the DF process to account for auto correlated residuals (Brooks, 2008). The asymptotic distribution of the PP and ADF tests is same. According to Brooks (2008), the PP tests frequently get the same results and have many of the same significant drawbacks as the ADF tests.

Tab. 4.2: Phillips-Perron (PP) Tests for stationary

Order of integration	Variables	Statistics	Values	Critical values/ Significance level			P-Values
				1%	5%	10%	
Level	Log CPI	Z(rho)	-34.433	-26.006	-19.962	-16.926	0.0004
		Z(t)	-4.820	-4.130	-3.491	-3.175	
Level	Log REER	Z(rho)	-2.937	-19.062	-13.372	-10.754	0.7062
		Z(t)	-1.122	-3.567	-2.923	-2.596	
1st difference	dlogREER	Z(rho)	-79.895	-19.044	-13.364	-10.748	0.0000

		Z(t)	-18.370	-3.569	-2.924	-2.597	
Level	logMSS	Z(rho)	-1.691	-19.062	-13.372	-10.754	0.8078
		Z(t)	-0.838	-3.567	-2.923	-2.596	
1st difference	dlogMSS	Z(rho)	-84.868	-19.044	-13.364	-10.748	0.0000
		Z(t)	-24.216	-3.569	-2.924	-2.597	
Level	logGex	Z(rho)	-64.655	-26.006	-19.962	-16.926	0.0000
		Z(t)	-7.984	-4.130	-3.491	-3.175	
Level	logRGDP	Z(rho)	-35.163	-26.006	-19.962	-16.926	0.0029
		Z(t)	-4.130	-4.130	-3.491	-3.175	
Level	logIMP	Z(rho)	-22.302	-26.006	-19.962	-16.926	0.0556
		Z(t)	-3.369	-4.130	-3.491	-3.175	

Source: Researchers own competition from STATA, 2025

The results of the Phillips-Perron test, which incorporates an automatic correction to the DF process to account for auto-correlated residuals, are identical to those of the ADF tests, as the above table illustrates. The researcher uses the Phillips-Perron test to determine that except, REER and MSS, all variables are stationary at the 5% and 10% level of significance based on the aforementioned results. Real effective exchange rate and money supply becomes stationary at first difference.

4.3.2. Using AIC, SIC, and HQIC to determine the best lag selection criteria

Finding the ideal latency comes after testing stationarity with the ADF unit root. There is a trade-off in time series data analysis between differencing data until it becomes stationary and losing information as a result. In time series data, this process of eliminating the risk of false regression and the information lost tradeoff becomes difficult. Choosing the ideal lag time is necessary to get over this trade-off issue. According to the idea that the best ARDL model in a given lag is the one with the lowest value, and that lag is regarded as the model's optimal lag, the ARDL model employed the information criterion AIC, SIC, and HQIC.

Tab. 4.3: Optimum lag selection criteria using AIC, SBIC and HQIC

Optimal Lag Selection

Selection order Criteria Sample 2011 Q1 -2024Q4			**Number of observation=56**					
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	121.805				6.4e-10	-4.1359	-4.05177	-3.9189
1	218.103	192.6	36	0.000	7.5 e-11	-6.2894	-5.70049	-4.77039*
2	269.227	102.25	36	0.000	4.6e-11	-6.82954	-5.73583*	-4.00851
3	314.037	89.621*	36	0.000	3.8e-11*	-7.14419*	-5.5457	-3.02115
4	338.692	49.31	36	0.069	7.2e-11	-6.73902	-4.63574	-1.31397

Source: Researchers own competition from STATA, 2025

Notes:

- ✓ *: shows the lag order that the criterion chose.
- ✓ LR: sequential modified LR test statistic (each test at 5% level)
- ✓ FPE: Final prediction error
- ✓ SC: Schwarz information criterion
- ✓ HQ: Hannan-Quinn information criterion
- ✓ AIC: Akaike information criterion

The researcher uses the lag chosen by the majority of information criteria and with a minimum value of -7.14419 to get the optimum lag from the preceding table. This means that the third lag is the ideal lag. The Akaike information criterion (AIC) was also chosen.

4.3.3. Tests for Co-integration

As we have get the results of stationarity using Augmented Dickey-Fuller test, CPI, Real GDP, and government expenditure and import price are stationary at level while the remaining variables such as real effective exchange rate and money supply are stationary at first difference. Therefore, the researcher for this finding was used bound test for co-integration.

4.4.1. ARDL Bounds tests for cointegration

ARDL bounds testing approach is a cointegration method developed by Pesaran et al. (2001) to test presence of the long run relationship between the variables. This procedure, relatively new method, has many advantages over the classical cointegration tests. Firstly, the approach is used irrespective of whether the series are I (0) or I(1). Secondly, unrestricted error correction model (UECM) can be derived from the ARDL bounds testing through a simple linear transformation. This model has both short and long run dynamics. Thirdly, the empirical results show that the approach is superior and provides consistent results for small sample. The ARDL model used in this study is expressed as follows:

$$LogCPI_t=\beta_0+\beta_1 logCPI_{t-1}+\beta_2 logRGDP_{t-1}+\beta_3 logGex_{t-1}+\beta_4 dlogMSS_{t-1}+\beta_5 dlogREER_{t-1}+\beta_6 logIMP_{t-1}\sum\beta_7 logTB_{t-i}+\sum\beta_8 logRGDP_{t-i}+\sum\beta_9 logGex_{t-i}+\sum\beta_{10} dlogMSS_{t-i}+\sum\beta_{11} logdREER_{ti}+\mu_{it}+\sum\beta_{12} logIMP_{t-i} \quad \ldots\ldots 4.1$$

In this model β**'s** indicates the long run and short run coefficients that are represented as:-

The hypothesis of no cointegration deals with

H0: $\beta_1 = \beta_2 = \beta_3 = \ldots = \beta_{10} = 0$……There is No co- integration

H1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \ldots = \beta_{10} \neq 0$…… There is co- integration

Next step is to compare the calculated F-statistic with critical values from Narayan (2005) which were generated for small sample sizes of 60 observations. One set assumes that all variables in the model are I (0) and the other set assumes they are all I (1). If the calculated F-statistic exceeds the upper critical bounds value, then the H0 is rejected. If the F-statistic falls within the bounds then the test is inconclusive. Lastly, if the F-statistic falls below the lower critical bounds value; it implies that there is no co-integration.

Before conducting the bound test for co-integration test for this paper, the following steps are conducted:-

- ✓ The optimal lag length for each variables are conducted using a command ***varsoc***
- ✓ Estimate the ARDL model by installing ARDL using the command ***ssc install ardl and ardl logcpi loggovex logrgdp logimp diff_logreer diff_logmss,maxlags(4) aic.***
- ✓ Select the optimal lag length for all variables using the command ***matrix list e (lags).*** So, the optimal lag for CPI, IMP, REER and Mss are 2 while for RGDP and Gov Exp are zero. Those are the lags that we are going to use when performing bound test. The results for those steps are put on the annex part of this research.
- ✓ Bound test using the STATA command ***"ardl logcpi loggovex logrgdp logimp diff_logreer diff_logmss, lags(2 0 0 2 2 2) ec btest"*** The result for bound test is mentioned in the following table.

Table 4.4: Bound test for long run relationship

```
Pesaran/Shin/Smith (2001) ARDL Bounds Test
H0: no levels relationship              F =  3.141
                                        t = -2.925

Critical Values (0.1-0.01), F-statistic, Case 3

        |  [I_0]    [I_1]  |  [I_0]    [I_1]  |  [I_0]    [I_1]  |  [I_0]    [I_1]
        |    L_1      L_1  |    L_05     L_05  |   L_025   L_025  |    L_01     L_01
--------+--------------------+--------------------+--------------------+--------------------
  k_5   |   2.26     3.35  |   2.62     3.79  |   2.96     4.18  |   3.41     4.68
accept if F < critical value for I(0) regressors
reject if F > critical value for I(1) regressors

Critical Values (0.1-0.01), t-statistic, Case 3

        |  [I_0]    [I_1]  |  [I_0]    [I_1]  |  [I_0]    [I_1]  |  [I_0]    [I_1]
        |    L_1      L_1  |    L_05     L_05  |   L_025   L_025  |    L_01     L_01
--------+--------------------+--------------------+--------------------+--------------------
  k_5   |  -2.57    -3.86  |  -2.86    -4.19  |  -3.13    -4.46  |  -3.43    -4.79
accept if t > critical value for I(0) regressors
reject if t < critical value for I(1) regressors

k: # of non-deterministic regressors in long-run relationship
Critical values from Pesaran/Shin/Smith (2001)
```

(Source Researchers own computation STATA, 2025)

The decision criteria for the bound test is that if F-Statistics is less than the lower bound series or if T-Statistics is greater than the lower bound, there is no co-integration and the reverse is true for the existence of co-integration. Now, the F-statistics of the result is 3.141 which are almost greater than the upper critical bounds values and the T-Statistics is -2.925 that is less than all the upper critical values. There for we reject the null hypothesis of no co-integration. The researcher for this finding conclude that there is co-integration/long run relationship between the variable so that we need to use Vector Error correction Model to check the long run and short run relation between the variables.

4.5. Estimation Results and Interpretation

4.5.1. Vector Error Correction Model (VECM)

The detection of a co-integration equation in the previous section means that a VECM can be used. This has led to a distinction between the long and short run impacts of variables so as to establish the extent of influence that real effective exchange rates has on inflation. Using the results from the co-integration test the VECM was specified.

I. Long Run Relationships

Table 4.5 Results of the Long Run Co-integration Equation

```
. ardl logcpi loggovex logrgdp logimp diff_logreer diff_logmss, lags(2 0 0 2 2 2) ec

ARDL(2,0,0,2,2,2) regression

Sample: 2010q4 - 2024q4                         Number of obs      =         57
                                                R-squared          =     0.6522
                                                Adj R-squared      =     0.5471
Log likelihood =   40.488897                    Root MSE           =     0.1369
```

D.logcpi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ADJ						
logcpi						
L1.	-.3900698	.1333553	-2.93	0.005	-.6590063	-.1211333
LR						
loggovex	.6602492	.4958624	1.33	0.190	-.3397526	1.660251
logrgdp	.5210833	.7427651	0.70	0.487	-.9768452	2.019012
logimp	-.3969454	.1637755	-2.42	0.020	-.7272302	-.0666607
diff_logreer	1.667867	2.147892	0.78	0.442	-2.663769	5.999504
diff_logmss	-.5133511	.9587502	-0.54	0.595	-2.446855	1.420153

(Source Researchers own computation STATA, 2025)

The long run effect of real effective exchange rates on inflation as presented in Table 4.4 is illustrated using Equation 4.1:

$LogCPI=\beta_0+\beta_1 logCPI+\beta_2 logRGDP+\beta_3 logGex+\beta_4 dlogMSS+\beta_5 dlogREER+\beta_6 logIMP$ 4.2

Which is given by:-

LogCPI=0.71-0.39logCPI+0.52logRGDP+0.66logGex-0.51dlogMSS+1.67dlogREER-0.39logIMP..... 4.3

V.E.C.M's coefficients of the lag variables, also known as the error correction term (ECT) or speed of adjustment, show how each variable's historical values affect the dependent variable's current value—in this paper, the CPI. The error correction term's coefficient shows how quickly things are adjusted to return to equilibrium. Larger absolute values indicate faster corrections, while a negative value indicates that the system will gradually return to equilibrium if it is out of balance.

The adjustment value or coefficient is also called the speed of adjustment for this model is negative, (39%). That means it has the right sign and significant at 1 percent level of significance. Interpretation for the long run relationship is given as follows.

The above equation shows that REER (log REER), Gov Ex (Log Gov Ex) and RGDP (Log GDP) have a positive long run relationship with CPI (LogCPI). On the other hand, IMP (logIMP) and MSS (LogMSS) have a negative long run relationship with CPI (LogCPI). All the variables except IMP are statistically insignificant in explaining consumer price index since; their p-values greater than 0.05.

What does the above variable indicates?

The real effective exchange rate (logREER) has positive sign and it is statistically insignificant in explaining consumer price index in the long run. On average, an increase in real effective exchange rate by one percent results in an increase in CPI by 1.67 percent, (Ceteris paribus).

Even though, exchange rate has no significant effect on inflation, it leads to

In the long run on average an increase in government expenditure (Log Gov Ex) by one percent leads to increase consumer price index by 0.66 percent, (Ceteris paribus). Government expenditure has a positive and insignificant effect on Ethiopian inflation implying that, large size of government expenditure goes to recurrent expenditure. Thus, recurrent expenditure may have impeded growth by reducing the resources available for capital expenditure. Defense expenditure, poverty targeted expenditure, inflation targeted expenditure, and voting campaign expenditure and expenditure on interest payment constitute the most important components of current expenditure.

Concerning with RGDP, on average an increase in RGDP by one percent leads to increase consumer price index by 0.52 percent, (Ceteris paribus) as a result, long run responsiveness of real GDP to the change in government final consumption expenditure is 0.52 percent. This is explained by the fact that government spending of money for the purchase of consumption goods and services leads to the increase of the aggregate demand for goods and services. Therefore, in the long run RGDP has positive and insignificant effects on Ethiopian inflation.

Money supply (log MSS) has a negative but insignificant long run effect on consumer price index in the long run. On average a one percent increases in money supply leads to a decrease in consumer price index by 0.51 percent, (Ceteris paribus).

Finally, Import Price (log IMP) has a negative and significant long run effect on consumer price index in the long run. On average a one percent increases in import price leads to a decrease in consumer price index by 039 percent, (Ceteris paribus).(This result seems in invalid even for this researcher. However future researcher can give more emphasis on it).

II. Short Run Dynamics

Table 4.6 Short Run Error Correction Model Results

```
. ardl logcpi loggovex logrgdp logimp diff_logreer diff_logmss, lags(2 0 0 2 2
>  2) ec

ARDL(2,0,0,2,2,2) regression

Sample: 2010q4 - 2024q4                         Number of obs     =         57
                                                R-squared         =     0.6522
                                                Adj R-squared     =     0.5471
Log likelihood =  40.488897                     Root MSE          =     0.1369
```

D.logcpi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
SR						
logcpi						
LD.	-.3249798	.114994	-2.83	0.007	-.5568873	-.0930722
logimp						
D1.	.09892	.0671411	1.47	0.148	-.036483	.2343229
LD.	.1705624	.0634357	2.69	0.010	.0426321	.2984927
diff_logreer						
D1.	-.6378175	.5671685	-1.12	0.267	-1.781622	.5059868
LD.	-.529994	.2764679	-1.92	0.062	-1.087545	.0275567
diff_logmss						
D1.	.0457565	.3004464	0.15	0.880	-.5601515	.6516644
LD.	-.2022147	.1501978	-1.35	0.185	-.5051174	.1006879
_cons	.7109273	.3862605	1.84	0.073	-.0680413	1.489896

Source, Researcher own construction STATA, 2025

When we see the short run effects of the variables we get the above tables and so that the researcher for this finding presented as.

$logCPI=\beta_0+\beta_1 logCPI_{t1}+\beta_2\sum logRGDPt+\beta_3\sum logGext+\beta_4\sum dlogMSSt+\beta_5\sum dlogREERt+\beta_6\sum logIMP$ t.4.2

which means that

$logCPI_t=0.72-0.32logCPI_{t-1}+0.09logIMP_t+0.17logIMP_{t-1}-0.63logREER_t-0.52logREER_{t-1}+0.04logMSS_t-0.2logMSS_{t-1}$

The interpretation for the short rum model is:-

with regard to level of significance, $logCPI_{t-1}$, $logIMP_{t-1}$ and $logREER_{t-1}$ are statistically significant because their p-values are less than 5% level of significance while, the other variables are statistically insignificant at 5% level of significance.

Other thing remains constant, on average if the previous values of CPI increase at one percent, the consumer price index in the current year will be decreased by 0.32 percent. it could indicate several economic scenarios:

- ✓ Deflation: A decrease in the CPI suggests that the overall price level is falling. This can occur during periods of deflation, where demand for goods and services decreases, leading to lower prices.
- ✓ Economic Recession: An economic downturn may lead to reduced consumer spending, causing businesses to lower prices to stimulate demand. If many businesses lower their prices, the CPI may reflect this decrease.
- ✓ Supply Chain Improvements: If there are improvements in supply chains or production efficiencies, the costs of goods may drop, leading to a decrease in the CPI.
- ✓ Decrease in Demand: If consumer confidence falls or if there are changes in consumer behavior (such as a shift to saving rather than spending), demand for goods and services may decline, resulting in lower prices.
- ✓ Government Policies: Policies such as tax cuts or subsidies can also affect prices. If consumers have more disposable income, they might initially drive prices up, but if such

policies are reversed or if there are new taxes imposed, it could lead to a decline in consumer spending and thus a decrease in CPI.

- ✓ Seasonal Effects: Some goods and services have seasonal price fluctuations. For example, prices for certain food items may rise during certain seasons and then fall afterward, affecting the overall CPI.

Concerning with real effective exchange rate, if exchange rate increased by one percent, the consumer price index will decrease by 0.63 percent for the current values of real effective exchange rate and by 0.52 percent for the previous values of real effective exchange rate respectively, (other thing remains constant). That means, devaluation of exchange rate leads to increase inflation in the short run.

For Import price, an increase in import price by one percent leads to increase consumer price index 0.09 percent for the current period and by 0.17 for the previous period, (other thing remains constant). That means an increase in import price leads to increase the consumer price index in the short run.

4.6. Diagnostic Test

Tests of Normality**,** serial correlation, and heteroscedasticity on the residuals of the vector error correction models are conducted with the help of Lagrange-multiplier test, Jarque-Beta test, White-heteroscedasticity test respectively. From the tests, it was found that the nulls of no serial correlation, normality and constant variance could not be rejected.

- ❖ **Normality Test using Jarque Bera Tests**

Ho: Not normally distributed H1: Ho is not true

Table 4.6 Normality Test using Jarque Bera Tests

Sktest CPI REER RGDP Gex MSS IMP

----------Skewness/Kurtosis tests for Normality----------

----------Joint----------

Variable	Obs	Pr (Skewness)	Pr (Kurtosis)	adj chi2 (2)	Prob>chi2

---

logCPI |	60	0.3834	0.0190	5.90	0.0523
logREER	60	0.1811	0.0348	5.89	0.0526
logRGDP |	60	0.2303	0.2922	2.67	0.2634
log Gex |	60	0.8958	0.3467	0.93	0.6275
logMSS |	60	0.6619	0.0002	11.68	0.0029
logIMP	60	0.2274	0.3943	2.28	0.3197

Conclusion: If the P-Value for chi2 (2) is greater than 0.01 we reject Ho and the reverse is true. There for the p-value for our case is greater than 0.01 so that the data for the above variable is normally distributed.

- **Serial Correlation of Durbin Watson Test**

Ho: Serial Correlation H1: Ho is not true

```
. dwstat

Durbin-Watson d-statistic( 14,     57) =  2.037011

.
```

Conclusion: if the values d-statistic is between 1.5 and 2.5 we to reject the null hypothesis of serial correlation and if the values are less than 1.5 or greater than 2.5 we fail to reject the null hypothesis of serial correlation. Based on our result we can conclude that there is no serial correlation in our model.

- **Breusch Pagan Test for Heteroskedasticity**

Ho: Constant variance H1: H0 is not true

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of logcpi

         chi2(1)      =     2.70
         Prob > chi2  =   0.1004
```

Conclusion: if the values p value for chi 2 distribution is greater than 0.05 then we to fail to reject the null hypothesis of Constant variance. Based on our result we can conclude that there is no heteroscedasticity in our model since the p value for chi 2 distribution is 0.1004 which is greater than 0.05.

Ramsey's RESET Test for Omitted Variables in Regression Model

H0: there is omitted variable in the model

H1: Hi is not true

. ovtest

Ramsey RESET test using powers of the fitted values of logcpi

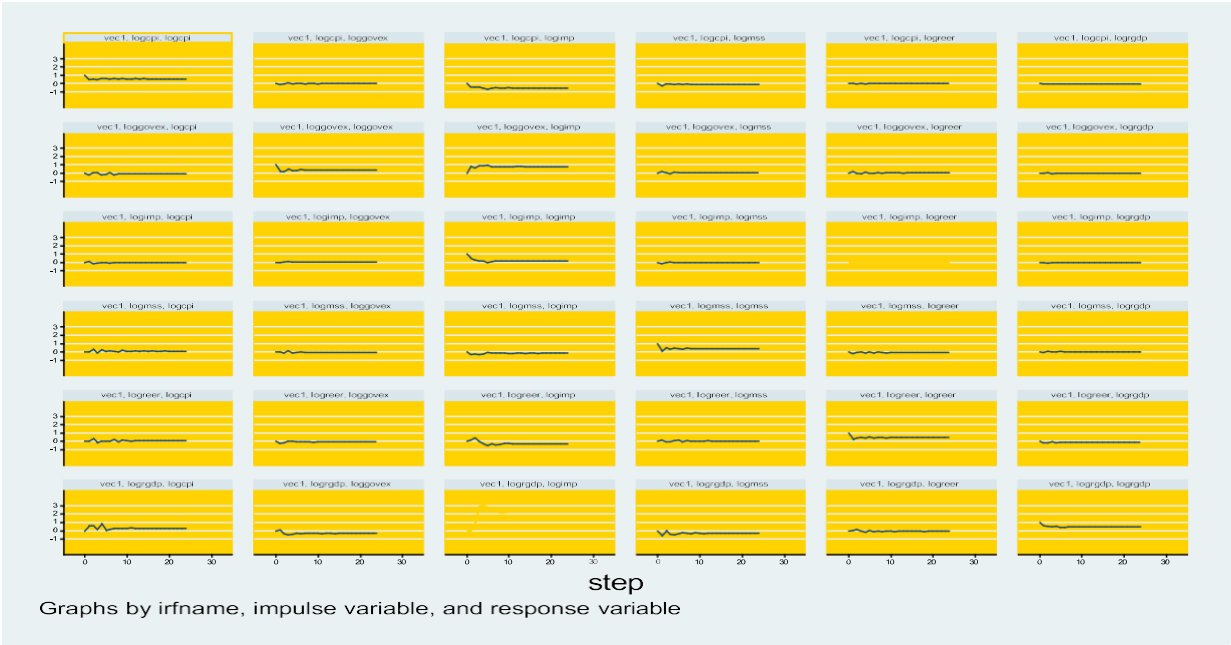
Ho: model has no omitted variables

F(3, 51) = 1.51

Prob > F = 0.2224

Conclusion: if the P-Value is less than 5 percent we fail to reject H0 and the reverse is true so that the p value for the above test is greater than 5 percent we reject the null hypothesis of there is omitted variable in the model. Therefore there is no omitted variables in our model since p-values are greater than 0.05.

4.7. Impulse Response Function of VECM model



Source: Researchers own competition from STATA, 2025

Interpretation: The first graph of IRF, shows that the effect on the response of CPI on standard deviation shock CPI. Based on that, from period 0 to period 1, CPI, initially decrease but it is positive. Afterward it continuously increases and decreases. We can conclude that, the response of CPI to standard deviation shock of CPI itself is fluctuating in the short run and almost constant in the long run. The same is true for the interpretation of rest of the graphs

CHAPTER FIVE: RESULTS AND SUGGESTIONS

5.1 Conclusions

These days, devaluation is a tactic employed to increase economic growth worldwide, particularly in third-world countries specifically. It was put up by the IMF as a growth strategy, particularly for developing countries. One of the developing nations that have adopted this approach since 1992 is Ethiopia.

Evaluating the effects of devaluation on Ethiopian inflation has been the aim of this study. NBE and IMF secondary data served as the study's primary source of information. Using the ARDL estimation model, the study also employed the Granger causality test, stability test, serial correlation test, and Vector Error Correction Model (VECM) by bound test of co-integration. Data from the first quarter of 2010 to the fourth quarter of 2024 was used to estimate the models.

According to the thesis's findings, the study's descriptive analyses portion demonstrates that the consumer price index varies increasingly, even within a single fiscal year. There are several possible causes for this, including macroeconomic policies, political unpredictability, and other outside influences. From the first quarter of 2010 to the fourth quarter of 2024, the value of Ethiopian birr will steadily decline because to the rising trend of REER in Ethiopia.

The paper's econometric findings demonstrated that the real effective exchange rate (logREER) has positive sign and it is statistically insignificant in explaining consumer price index in the long run. On average, an increase in real effective exchange rate by one percent results in an increase in CPI by 1.67 percent, (Ceteris paribus).

Even though, exchange rate has no significant effect on inflation, it leads to

In the long run on average an increase in government expenditure (Log Gov Ex) by one percent leads to increase consumer price index by 0.66 percent, (Ceteris paribus). Government expenditure has a positive and insignificant effect on Ethiopian inflation implying that, large size of government expenditure goes to recurrent expenditure. Thus, recurrent expenditure may have impeded growth by reducing the resources available for capital expenditure. Defense expenditure, poverty targeted expenditure, inflation targeted expenditure, and voting campaign

expenditure and expenditure on interest payment constitute the most important components of current expenditure.

Concerning with RGDP, on average an increase in RGDP by one percent leads to increase consumer price index by 0.52 percent, (Ceteris paribus) as a result, long run responsiveness of real GDP to the change in government final consumption expenditure is 0.52 percent. This is explained by the fact that government spending of money for the purchase of consumption goods and services leads to the increase of the aggregate demand for goods and services. Therefore, in the long run RGDP has positive and insignificant effects on Ethiopian inflation.

Money supply (log MSS) has a negative but insignificant long run effect on consumer price index in the long run. On average a one percent increases in money supply leads to a decrease in consumer price index by 0.51 percent, (Ceteris paribus).

Finally, Import Price (log IMP) has a negative and significant long run effect on consumer price index in the long run. On average a one percent increases in import price leads to a decrease in consumer price index by 039 percent, (Ceteris paribus).(This result seems in invalid even for this researcher. However future researcher can give more emphasis on it).

In the short run, other thing remains constant, on average if the previous values of CPI increase at one percent, the consumer price index in the current year will be decreased by 0.32 percent. Concerning with real effective exchange rate, if exchange rate increased by one percent, the consumer price index will decrease by 0.63 percent for the current values of real effective exchange rate and by 0.52 percent for the previous values of real effective exchange rate respectively, (other thing remains constant). That means, devaluation of exchange rate leads to increase inflation in the short run.

For Import price, an increase in import price by one percent leads to increase consumer price index 0.09 percent for the current period and by 0.17 for the previous period, (other thing remains constant). That means an increase in import price leads to increase the consumer price index in the short run.

5.2. **SUGGESTIONS/RECOMENDATION**

At the moment, devaluation seems to work best when the nation has a significant surplus. But in Ethiopia's case, there isn't any surplus; rather, Ethiopia can't meet its demand on the global market. This paper makes the following crucial policy suggestions and recommendations.-

- ✓ Diversify Import Sources: Encourage businesses to diversify their import sources to mitigate the impact of increased prices due to currency devaluation. This could involve seeking suppliers from countries with stable currencies or lower production costs.
- ✓ Promote Domestic Production: Implement policies that incentivize local production of goods that are typically imported. This can help reduce dependency on foreign goods and mitigate price increases from imported inflation.
- ✓ Prioritize Essential Spending: The government should focus its expenditure on essential services and infrastructure projects that promote economic growth without exacerbating inflation. Non-essential spending should be curtailed to avoid further inflationary pressures.
- ✓ Implement Fiscal Discipline: Adopt measures to ensure fiscal discipline, including reducing budget deficits that can lead to increased money supply and inflation. This may involve reviewing and adjusting public sector wages and benefits.
- ✓ Stimulate Economic Growth: Implement policies that promote real GDP growth, such as investing in infrastructure, education, and technology. A growing economy can help absorb some of the inflationary pressures by increasing overall productivity.
- ✓ Encourage Export Growth: Promote exports by providing incentives for local businesses to enter international markets. A stronger export sector can help improve the trade balance and stabilize the currency.
- ✓ Educate the Public: Clear communication from the government and central bank regarding the reasons for devaluation and the measures being taken to mitigate its effects can help manage public expectations about inflation.
- ✓ Transparency in Policy Decisions: Regular updates on monetary and fiscal policies will build trust and confidence among consumers and investors, which can help stabilize economic conditions.

- ✓ By implementing these recommendations, policymakers can mitigate the negative effects of currency devaluation on inflation while promoting economic stability and growth. Balancing monetary policy, managing import prices, controlling government expenditure, and supporting real GDP growth are critical components in addressing the challenges posed by devaluation. This paper does not include world price, oil price and others so that the future researcher can use these variables for more investigations.

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Appendix

Results from STATA

Stationarity test Using AD Fuller Test

```
. dfuller logcpi, drift lags(0)

Dickey-Fuller test for unit root                    Number of obs    =         59

                                 ------------ Z(t) has t-distribution ------------
                   Test          1% Critical        5% Critical       10% Critical
                 Statistic            Value              Value             Value
------------------------------------------------------------------------------------
 Z(t)              -4.594             -2.394             -1.672            -1.297
------------------------------------------------------------------------------------
p-value for Z(t) = 0.0000

.


. dfuller logreer, trend lags(0)

Dickey-Fuller test for unit root                    Number of obs    =         59

                                 ---------- Interpolated Dickey-Fuller ----------
                   Test          1% Critical        5% Critical       10% Critical
                 Statistic            Value              Value             Value
------------------------------------------------------------------------------------
 Z(t)              -6.176             -4.130             -3.491            -3.175
------------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000

.


. dfuller loggovex, drift lags(0)

Dickey-Fuller test for unit root                    Number of obs    =         59

                                 ------------ Z(t) has t-distribution ------------
                   Test          1% Critical        5% Critical       10% Critical
                 Statistic            Value              Value             Value
------------------------------------------------------------------------------------
 Z(t)              -7.829             -2.394             -1.672            -1.297
------------------------------------------------------------------------------------
p-value for Z(t) = 0.0000
```

```
. dfuller logmss, trend lags(0)

Dickey-Fuller test for unit root                    Number of obs    =        59

                                 ———— Interpolated Dickey-Fuller ————
                 Test         1% Critical        5% Critical       10% Critical
               Statistic           Value              Value             Value
------------------------------------------------------------------------------
 Z(t)            -8.947            -4.130             -3.491            -3.175
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000


. dfuller logimp, drift lags(0)

Dickey-Fuller test for unit root                    Number of obs    =        59

                                 ———— Z(t) has t-distribution ————
                 Test         1% Critical        5% Critical       10% Critical
               Statistic           Value              Value             Value
------------------------------------------------------------------------------
 Z(t)            -3.372            -2.394             -1.672            -1.297
------------------------------------------------------------------------------
p-value for Z(t) = 0.0007


. dfuller logrgdp, drift lags(0)

Dickey-Fuller test for unit root                    Number of obs    =        59

                                 ———— Z(t) has t-distribution ————
                 Test         1% Critical        5% Critical       10% Critical
               Statistic           Value              Value             Value
------------------------------------------------------------------------------
 Z(t)            -3.912            -2.394             -1.672            -1.297
------------------------------------------------------------------------------
p-value for Z(t) = 0.0001
```

Stationarity test using Phillips-Perron Test

```
. pperron logcpi, lags(0) trend

Phillips-Perron test for unit root                  Number of obs    =        59
                                                    Newey-West lags  =         0

                                 ———— Interpolated Dickey-Fuller ————
                 Test         1% Critical        5% Critical       10% Critical
               Statistic           Value              Value             Value
------------------------------------------------------------------------------
 Z(rho)         -34.433           -26.006            -19.962           -16.926
 Z(t)            -4.820            -4.130             -3.491            -3.175
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0004
```

```
. pperron logreer, lags(0) trend

Phillips-Perron test for unit root                  Number of obs    =         59
                                                    Newey-West lags  =          0

                                 ------------ Interpolated Dickey-Fuller ------------
                    Test         1% Critical       5% Critical      10% Critical
                  Statistic         Value             Value            Value
------------------------------------------------------------------------------------
 Z(rho)           -48.067          -26.006           -19.962          -16.926
 Z(t)              -6.176           -4.130            -3.491           -3.175
------------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

```
. pperron logmss, lags(0) trend

Phillips-Perron test for unit root                  Number of obs    =         59
                                                    Newey-West lags  =          0

                                 ------------ Interpolated Dickey-Fuller ------------
                    Test         1% Critical       5% Critical      10% Critical
                  Statistic         Value             Value            Value
------------------------------------------------------------------------------------
 Z(rho)           -69.273          -26.006           -19.962          -16.926
 Z(t)              -8.947           -4.130            -3.491           -3.175
------------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

```
. pperron loggovex, lags(0) trend

Phillips-Perron test for unit root                  Number of obs    =         59
                                                    Newey-West lags  =          0

                                 ------------ Interpolated Dickey-Fuller ------------
                    Test         1% Critical       5% Critical      10% Critical
                  Statistic         Value             Value            Value
------------------------------------------------------------------------------------
 Z(rho)           -64.655          -26.006           -19.962          -16.926
 Z(t)              -7.984           -4.130            -3.491           -3.175
------------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0000
```

```
. pperron logrgdp, lags(0) trend

Phillips-Perron test for unit root                   Number of obs   =        59
                                                     Newey-West lags =         0

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -35.163           -26.006           -19.962           -16.926
 Z(t)             -4.318            -4.130            -3.491            -3.175
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0029


. pperron logimp, lags(0) trend

Phillips-Perron test for unit root                   Number of obs   =        59
                                                     Newey-West lags =         0

                               ---------- Interpolated Dickey-Fuller ---------
                  Test         1% Critical       5% Critical      10% Critical
               Statistic           Value             Value             Value
------------------------------------------------------------------------------
 Z(rho)          -22.302           -26.006           -19.962           -16.926
 Z(t)             -3.369            -4.130            -3.491            -3.175
------------------------------------------------------------------------------
MacKinnon approximate p-value for Z(t) = 0.0556
```

Data

Time	cpi	reer	mss	gov_ex	imp	rgdp	logcpi	logreer	logmss	loggovex	logrgdp	logimp	years	quarters	diff_logre	diff_logm
2010Q1	8.134	12.8909	104432	15.483	22.106	10.6	0.910304	1.11028	5.01884	-1.18986	1.02531	1.34451	2010	2010q1		
2010Q2	14.409	13.6976	114669	9.419	15.719	10.8	1.15863	1.13664	5.05944	-0.97401	1.03342	1.19642	2011	2010q2	0.026361	0.040609
2010Q3	20.683	14.5044	104905	18.356	9.333	11	1.31561	1.1615	5.02079	-1.26378	1.04139	0.970021	2012	2010q3	0.024855	-0.03865
2010Q4	26.958	15.3111	123141	15.292	2.946	11.2	1.43069	1.18501	5.0904	-1.18446	1.04922	0.469233	2013	2010q4	0.023507	0.069607
2011Q1	13.232	16.1178	105377	18.228	3.441	11.4	1.12163	1.20731	5.02275	-1.26074	1.0569	0.536685	2014	2011q1	0.022299	-0.06766
2011Q2	30.957	16.4018	106382	17.833	4.365	10.725	1.49076	1.21489	5.02687	-1.25122	1.0304	0.639984	2015	2011q2	0.007586	0.004124
2011Q3	28.682	16.6857	96738.9	17.438	12.171	10.05	1.45761	1.22234	4.9856	-1.2415	1.00217	1.08533	2016	2011q3	0.007453	-0.04127
2011Q4	26.407	16.9696	160393	10.043	19.976	9.375	1.42172	1.22967	5.20519	-1.00186	0.971971	1.30051	2017	2011q4	0.007327	0.219585
2012Q1	14.132	15.2536	101399	16.648	27.782	8.7	1.1502	1.18337	5.00603	-1.22136	0.939519	1.44376	2018	2012q1	-0.0463	-0.19915
2012Q2	20.117	17.4889	79877.5	16.925	21.101	9	1.30356	1.24276	4.90242	-1.22853	0.954243	1.3243	2019	2012q2	0.05939	-0.10361
2012Q3	16.102	17.7242	212356	17.202	14.42	9.3	1.20688	1.24857	5.32706	-1.23558	0.968483	1.15897	2020	2012q3	0.005804	0.424641
2012Q4	12.086	17.9594	123835	17.479	7.738	7.6	1.08228	1.25429	5.09284	-1.24252	0.880814	0.888629	2021	2012q4	0.005725	-0.23422
2013Q1	8.071	18.1947	215314	26.756	1.057	9.9	0.906927	1.25994	5.33307	-1.42742	0.995635	0.024075	2022	2013q1	0.005653	0.240228
2013Q2	7.904	18.4147	250922	13.688	4.751	10	0.897847	1.26516	5.39954	-1.13634	1	0.676785	2023	2013q2	0.00522	0.066467
2013Q3	17.738	15.6348	106530	17.62	8.445	10.1	1.2489	1.19409	5.02747	-1.24601	1.00432	0.9266	2024	2013q3	-0.07107	-0.37207
2013Q4	7.571	18.8548	282138	14.552	12.138	10.2	0.879153	1.27542	5.45046	-1.16292	1.0086	1.08415	2025	2013q4	0.08133	0.42299
2014Q1	7.404	19.0748	279747	10.484	15.832	8.3	0.869466	1.28046	5.44676	-1.02053	0.919078	1.19954	2026	2014q1	0.005038	-0.0037
2014Q2	17.945	19.33	316142	18.445	20.235	10.325	1.25394	1.28623	5.49988	-1.26588	1.01389	1.3061	2027	2014q2	0.005772	0.053117
2014Q3	8.487	19.5852	104538	17.405	24.638	10.35	0.928754	1.29193	5.01927	-1.24067	1.01494	1.39161	2028	2014q3	0.005696	-0.48061
2014Q4	19.028	19.8404	312933	16.366	29.041	12.375	1.27939	1.29755	5.49545	-1.21394	1.09255	1.46301	2029	2014q4	0.005622	0.476179
2015Q1	9.569	20.0956	171329	17.326	33.444	10.4	0.980867	1.3031	5.23383	-1.2387	1.01703	1.52432	2030	2015q1	0.005551	-0.26162
2015Q2	18.834	10.3482	289813	17.473	28.711	9.8	1.27494	1.01486	5.46212	-1.24237	0.991226	1.45805	2031	2015q2	-0.28824	0.228288
2015Q3	8.099	20.6007	168298	16.649	23.978	9.2	0.908431	1.31388	5.22608	-1.22139	0.963788	1.37981	2032	2015q3	0.299017	-0.23604
2015Q4	7.363	20.8533	326782	15.9876	19.245	8.6	0.867055	1.31917	5.51426	-1.20378	0.934498	1.28432	2033	2015q4	0.005293	0.28818
2016Q1	6.628	18.1059	345266	12.843	14.512	5.8	0.821383	1.25782	5.53815	-1.10867	0.763428	1.16173	2034	2016q1	-0.06135	0.023896
2016Q2	7.643	20.4328	477302	13.987	9.96	8.553	0.883264	1.31033	5.67879	-1.14572	0.932118	0.998259	2035	2016q2	0.052508	0.140639
2016Q3	8.657	21.7598	509337	12.098	5.407	9.105	0.937367	1.33765	5.70701	-1.08271	0.95928	0.732956	2036	2016q3	0.027327	0.028213
2016Q4	19.672	22.0867	441373	13.95	0.855	9.658	1.29385	1.34413	5.64481	-1.14457	0.984887	-0.06803	2037	2016q4	0.006476	-0.0622
2017Q1	10.687	22.4137	473409	14.987	3.698	10.21	1.02886	1.35051	5.67524	-1.17571	1.00903	0.567967	2038	2017q1	0.006383	0.03043
2017Q2	21.474	23.3373	415200	17.515	3.951	9.583	1.33191	1.36805	5.61826	-1.24341	0.981501	0.596707	2039	2017q2	0.017537	-0.05698
2017Q3	12.26	24.261	656991	27.043	4.205	8.957	1.08849	1.38491	5.81756	-1.43205	0.952163	0.623766	2040	2017q3	0.016858	0.199302
2017Q4	13.047	15.1846	598782	16.571	14.458	8.33	1.11551	1.1814	5.77727	-1.21935	0.920645	1.16011	2041	2017q4	-0.20351	-0.04029
2018Q1	13.833	26.1082	740573	16.099	4.711	7.703	1.14092	1.41678	5.86957	-1.2068	0.88666	0.673113	2042	2018q1	0.235374	0.092299
2018Q2	14.327	26.5947	677118	15.913	5.74	8.037	1.15616	1.4248	5.83066	-1.20175	0.905094	0.758912	2043	2018q2	0.008018	-0.0389
2018Q3	14.822	27.0813	813662	15.726	6.769	8.37	1.17091	1.43267	5.91044	-1.19662	0.922725	0.830525	2044	2018q3	0.007874	0.07978
2018Q4	15.316	27.5678	780208	13.54	7.798	8.704	1.18515	1.4404	5.89221	-1.13162	0.939719	0.891983	2045	2018q4	0.007733	-0.01823
2019Q1	15.81	28.0543	886753	15.353	8.827	9.037	1.19893	1.448	5.9478	-1.18619	0.956024	0.945813	2046	2019q1	0.007597	0.055593
2019Q2	16.946	28.8764	834476	25.132	7.772	8.292	1.22907	1.46054	5.92141	-1.40023	0.918659	0.890533	2047	2019q2	0.012544	-0.02639
2019Q3	18.082	29.6985	862199	14.911	6.717	7.547	1.25725	1.47273	5.93561	-1.17351	0.877774	0.827175	2048	2019q3	0.012192	0.014194
2019Q4	19.218	30.5206	699923	14.69	5.662	6.802	1.28371	1.48459	5.84505	-1.16702	0.832637	0.75297	2049	2019q4	0.011859	-0.09056
2020Q1	20.354	31.3427	908935	24.469	4.607	6.057	1.30865	1.49614	5.95853	-1.38862	0.782258	0.663418	2050	2020q1	0.011543	0.113483
2020Q2	21.964	23.2611	1.10E+06	14.302	3.777	6.109	1.34171	1.36663	6.04739	-1.1554	0.78597	0.577147	2051	2020q2	-0.12951	0.08886
2020Q3	23.574	35.1795	1.10E+06	14.134	2.947	8.161	1.37243	1.54629	6.0386	-1.15027	0.911743	0.46938	2052	2020q3	0.17966	-0.00879
2020Q4	15.184	27.0979	1.10E+06	12.967	2.117	6.213	1.18139	1.43294	6.02963	-1.11284	0.793301	0.325721	2053	2020q4	-0.11335	-0.00897
2021Q1	26.794	39.0163	848266	13.799	1.287	9.265	1.42804	1.59125	5.92853	-1.13985	0.966845	0.109579	2054	2021q1	0.158311	-0.1011
2021Q2	28.58	41.4041	1.00E+06	10.524	0.848	9.289	1.45606	1.61704	6.01704	-1.02218	0.967969	-0.0716	2055	2021q2	0.025797	0.088512
2021Q3	30.366	43.7918	1.50E+06	13.249	2.984	6.314	1.48239	1.64139	6.1852	-1.12218	0.800305	0.474799	2056	2021q3	0.02435	0.168154
2021Q4	32.152	46.1796	1.60E+06	21.973	5.119	6.338	1.50721	1.66445	6.21047	-1.34189	0.801952	0.709185	2057	2021q4	0.023057	0.025267
2022Q1	33.938	28.5673	915310	12.698	7.254	7.362	1.53069	1.45587	5.96157	-1.10374	0.866996	0.860578	2058	2022q1	-0.20858	-0.2489
2022Q2	33.008	49.7462	1.40E+06	12.229	4.068	6.564	1.51862	1.69676	6.15509	-1.08739	0.817169	0.609381	2059	2022q2	0.240891	0.193523
2022Q3	12.079	40.9252	1.90E+06	11.759	0.881	7.767	1.08203	1.61199	6.284	-1.07037	0.890253	-0.05502	2060	2022q3	-0.08477	0.128906
2022Q4	31.149	42.1041	2.10E+06	9.721	2.306	6.969	1.49344	1.62432	6.31323	-0.98771	0.84317	0.362859	2061	2022q4	0.012334	0.02923
2023Q1	30.219	53.283	2.10E+06	10.82	5.492	9.171	1.48028	1.72659	6.31615	-1.03423	0.962417	0.739731	2062	2023q1	0.102264	0.002922
2023Q2	28.101	53.9528	847609	30.5	1.132	7.391	1.44872	1.73201	5.9282	-1.4843	0.868703	0.053846	2063	2023q2	0.005425	-0.38795
2023Q3	25.983	54.6227	2.30E+06	10.179	3.228	6.611	1.41469	1.73737	6.36631	-1.00771	0.820267	0.508934	2064	2023q3	0.005359	0.43811
2023Q4	13.864	54.2925	1.40E+06	9.858	7.588	7.831	1.14189	1.73474	6.14648	-0.99379	0.893817	0.880127	2065	2023q4	-0.00263	-0.21983
2024Q1	21.746	45.9623	2.50E+06	19.538	11.948	11.051	1.33738	1.6624	6.39408	-1.29088	1.0434	1.0773	2066		-0.07234	0.247604
2024Q2	19.764	56.5485	1.60E+06	7.345	2.643	10.271	1.29587	1.75242	6.19163	-0.86599	1.01161	0.422097	2067		0.090019	-0.20245
2024Q3	13.673	56.662	2.60E+06	16.985	13.765	7.491	1.13586	1.75329	6.42019	-1.23007	0.87454	1.13878	2068		0.000871	0.228556
2024Q4	15.452	57.762	2.80E+06	23.539	25.984	12.711	1.18898	1.76164	6.44311	-1.37179	1.10418	1.41471	2069		0.00835	0.022926