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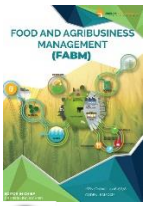

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RESEARCH ARTICLE

ESTIMATION OF AGGREGATE CONSUMPTION FUNCTION FOR NEPAL USING ARDL MODEL

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ABSTRACT

Estimating the consumption function is important for informing policy makers aimed at promoting sustainable economic growth, poverty alleviation, and social development. This research study estimated the aggregate consumption function for Nepal from 2000 to 2022 using the Auto regressive Distributed Lag Model (ARDL). Real income, real exchange rate, interest rate, and inflation rate are the determinants for the study. The study reveals a long-term association among these variables through ARDL based co-integration test. While the elasticity coefficient of real income is significantly positive, the coefficients of other variables are negative. In the long run, there is an inverse relationship between the real depreciation of domestic currency and real consumption. The real interest rate appears to create substitution effects on consumption, while the inflation rate triggers real balance effects on Nepal's aggregate consumption. The error correction coefficient (γ) was found to be -0.892.

KEYWORDS

Augmented Dickey and Fuller test, Bound test, Error Correction Model, Econometric analysis

1. INTRODUCTION

The consumption function, a fundamental concept in macroeconomics, is defined as the functional relationship between consumption and its determinants. Estimation of the aggregate consumption has been considered as an important exercise by macroeconomists for several decades (Dhakal et al., 2006). Estimating the consumption behavior is crucial for policymakers, economists, and development practitioners so as to run the economic trajectory effectively (Bhatta, 2023). In the context of Nepal, where consumption expenditure constitutes a significant portion of GDP, estimating the consumption function becomes important for informing policy decisions aimed at promoting sustainable economic growth, poverty alleviation, and social development (Chaudhary, 2017).

The modern theory of the consumption function was given by John Maynard Keynes in his book "The General Theory of Employment, Interest, and Money", published in 1936 (Keynes, 1936). Keynes stated that consumption function is influenced by both subjective and objectives factors such as current income, wealth, and interest rates and so on. Among these various factors, Keynes highlighted "Absolute level of income" as a primary factor that influences the consumption spending of the individual and the society too. According to the Absolute Income Theory, the consumption function is directly proportional to the income, i.e. as income increases, consumption also increases and viceversa. This theory is also known as the "Absolute income theory of consumption".

Mathematically,

$C = f(Y)$

Where, 'C' is consumption and 'Y' is income.

Keynes introduced the concept of the "Marginal Propensity to Consume" (MPC) in his theory, which represents the fraction of additional income that is spent on consumption. The MPC is always positive, indicating that as income increases, consumption also increases. However, the MPC is typically less than one, which means that individuals or households do not spend all of their additional income on consumption. Instead, they save a portion of it.

While Keynes stated the absolute income of individual/society as the main determinants of consumption function, Post-Keynesian economists have researched deeper into the underlying factors influencing consumption behavior. Economists Franco Modigliani and Richard Brumberg developed the "Life Cycle Hypothesis of Consumption" (Ando and Modigliani, 1963). This theory posits that individuals aim to maintain a stable standard of living over their lifetime, thus they smooth their consumption across different stages of life. According to this hypothesis, individuals borrow or save to finance consumption, depending on their current income relative to their expected future income.

Another theory of consumption that emerged during the same time was "Permanent Income Theory of Consumption", proposed by Milton Friedman (Darby, 1974). This theory suggests that individuals base their consumption decisions not only on current income but also on their long-term or permanent income. Temporary fluctuations in income, such as windfalls or short-term setbacks, have less impact on consumption compared to permanent changes in income.

An Americian economist James Duesenberry also put forward the "Relative Income Theory of Consumption" that suggests that people's consumption patterns are influenced more by their relative income rather than their absolute income (Laumas, 1975). The key idea behind the Duesenberry effect is that people often aspire to maintain or improve their relative social standing, which can change their consumption behavior. This means that even if their income increases, they may not necessarily

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increase their consumption if they feel that others around them are not also experiencing similar increases in consumption. It is also known as Duesenberry effect or Demonstration effect.

Despite the growing importance of consumption dynamics in Nepal, empirical research on the consumption function remains limited. In Nepal, there has been a notable upward trend in consumption expenditure, with the consumption to GDP ratio consistently exceeding 90 percent over an extended period (NRB, 2024). As a result, there exists a necessity to comprehend the evolving consumption trends among the Nepalese people to formulate efficient policies. This paper aims to address the substantial impact of real interest rates, foreign exchange rates, income, and inflation on both short-term and long-term aggregate consumption behavior in Nepal.

2. Materials and Method

2.1 Data collection

The data used in this study were obtained from official government bodies and agencies in Nepal from 1990 to 2022. Nominal GDP, Nominal GDC, average deposit rate, CPI of Nepal, deflator are taken from Nepal Rastrya Bank (NRB, 2024). CPI of USA was taken from World Bank (World Bank, 2024). After extracting data from different sources, following calculation are done to get the desirable variable in the study.

Real GDP/ Real Income (Y_t) = (Nominal GDP/Deflator)*100

Real GDC/ Real Consumption (C_t) = (Nominal GDC/Deflator)*100

Real Exchange Rate (E_t) = (CPI USA/CPI Nepal)* Nominal Exchange rate

Interest Rate (R_t) = Average deposit rate – Inflation rate

Inflation Rate (I_t) = Percentage change in CPI Nepal

2.2 Model specification

Based on the literature review and empirical studies, relationship between dependent variables C_t and the independent variables Y_t, E_t, R_t, I_t can be expressed in the following functional form:

$$Ct=f(Y_t, E_t, R_t, I_t) \quad (1)$$

According to the Gujarati, Porter, and Gunasekar (2012) and Wooldridge (2013) equation (1) can be converted into following semi log-lin econometric model:

$$\ln C_t= \alpha+\beta_1 \ln Y_t+\beta_2 \ln E_t+\beta_3 R_t+\beta_4 I_t+\varepsilon_t \quad (2)$$

Where, α= drift component

β = Regression coefficient

εt= white nose error term

2.3 Unit root test/stationary test

Before estimating the time series data, it is crucial to examine its asymptotic properties. Failing to do so may lead to spurious results in the regression model (Gujarati, Porter, & Gunasekar, 2012). A time series (Yt) is called stationary if its mean and variance over the time are constant and the covariance between two time periods is time invariant. There are various methods of stationary test of a variable: Kwiatkowski, Phillips, Schmidt, and Shin (KPSS) Test (Kwiatkowski, Phillips, Schmidt, & Shin, 1992), Dickey-Fuller (DF) Test (Dickey & Fuller, 1979), Philips-Perron (PP) Test (Phillips & Perron, 1988), Augmented Dickey-Fuller (ADF) Test, Dicky-Fuller generalized least square(ADF-GLS) test (Elliott, Rothenberg, & Stock, 1996), and so on.

In this study, ADF test has been used. As per the Augmented Dickey & Fuller test, a variable (eg. lnCt) can be arranged in the following regression for stationary test:

$$\Delta \ln C_t=\alpha_0+\alpha_1.t+\alpha_2.\ln C_{t-1}+\sum_{i=1}^{x} \alpha i\, \Delta \ln Ct-i+\varepsilon_t \quad (3)$$

Where, ε_t = pure white nose error term,

$\Delta \ln C_{t-1} = (\ln C_{t-1} - \ln C_{t-2})$, $\Delta \ln C_{t-2} = (\ln C_{t-2} - \ln C_{t-3})$ and so on

The inclusion of additional lagged terms is done to guarantee that the errors are not correlated.

The null hypothesis (H_0) and alternate hypothesis (H_a) are stated as follows:

H_0: $\ln C_t$ has a unit root and it is not a stationary variable i.e. $\alpha_2 = 0$

H_a: $\ln C_t$ doesn't have a unit root and it is a stationary variable i.e. $\alpha_2 < 0$

When the computed absolute value of t-statistics exceeds the absolute Augmented Dickey-Fuller (ADF) or McKinnon's critical values, we reject the null hypothesis (H0), indicating that the series is stationary denoted as I (0). Alternatively, if the series becomes stationary after taking the first difference, it is classified as integrated of order 1, denoted as I (1) (MacKinnon, 1991; Mishra, 2011).

2.4 Co-integration test

There are three main methods of testing for co-integration: the Engle-Granger approach, the Johansen-Juselius approach and the ARDL approach (Engle and Granger, 1987; Johansen, 1991; Pesaran et al., 2001).

When dealing with time series data where variables exhibit both integrated at level I(0) and integrated at first difference I(1) properties, Pesaran et al., showed that co-integrating systems can be estimated as Autoregressive Distributive Lag Model (ARDL) model (Pesaran et al., 2001). The ARDL regression model captures the dynamics between the variables by incorporating both lagged values and contemporaneous values of the variables. It allows for a comprehensive analysis of the short-term and long-term relationships among the variables, making it suitable for analyzing integrated time series data with mixed orders of integration.

2.5 ARDL approach

When estimating the ARDL model, the optimal lag length was chosen by using Akaike Information Criterion (AIC), while ensuring that the model's errors exhibit white noise properties. Once the suitable lag length is determined, the ARDL model is specified and estimated. The ARDL model can be expressed as follows:

$$\Delta \ln C_t = \propto +\Sigma\beta_{0i}\, \Delta \ln C_{t-i}+\sum\beta_{1i}\, \Delta \ln Y_{t-i}+\sum\beta_{2i}\, \Delta \ln E_{t-i}+\sum\beta_{3i}\, \Delta R_{t-i}+\sum\beta_{4i}\, \Delta I_{t-i}+\theta_0 \ln C_{t-1}+\theta_1 \ln Y_{t-1}+\theta_2 \ln E_{t-1}+\theta_3 R_{t-1}+\theta_4 R_{t-1}+\varepsilon_t \quad (4)$$

Where, εt = White nose error term,

Δ = first difference

∝ = drift component

Coefficients ($\theta_4 - \theta_0$) = the long run relationship

The remaining expression with summation sign (β4 - β0) represents the short run dynamics of the model.

The ARDL approach requires two steps. In the first step, the existence of any long run relationship among the variables of interest is determined by using the F-test.

The null and alternate hypothesis of this bound testing is as follows:

H_0: $\theta_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$ i.e. there doesn't exist cointegration.

H_a: $\theta_0 \neq \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq 0$ i.e. there exist cointegration.

The explanatory variables are assumed to be either integrated of order zero (I(0)) for lower bound values or integrated of order one (I(1)) for upper bound values. If the F statistic exceeds critical value for the upper bound I(1), then reject the null hypothesis and estimate the long run model i.e. Error correction model(ECM). Similarly, If the F statistic lower than critical value for the lower bound I(0), then accept the null hypothesis and estimate the short run model i.e. Auto Distributed Regression(ADRL) Model. And is the F statistic lies between upper and lower bound, then the test is inconclusive (Pesaran & Shin, 1999).

Pesaran et al. (2001) contend that Error Correction Models (ECMs) offer a direct means of estimating the pace at which a dependent variable reverts to its equilibrium level subsequent to a shift in other variables. Expanding upon Equation (4), the unrestricted ECMs allow for an extension of the short-term dynamics of the model in the following manner:

$$\Delta \ln C_t= \beta_0 + \Sigma\beta_i \Delta \ln C_{t-i} + \Sigma\rho_i \Delta \ln Y_{t-j} + \Sigma\delta_k \Delta \ln E_{t-k} + \Sigma\, £_x\, \Delta R_{t-x} + \Sigma\mu_y\, I_{t-y} + \gamma EC_{t-1}+\varepsilon_t \quad (5)$$

Where, γ = speed of adjustment parameter or (Error Correction Coefficient)

EC_t = the residuals that are obtained from the estimated co-integration model of equation (2) i.e. $EC_t = \ln C_t - \propto + \beta_1 \ln Y_t + \beta_2 \ln E_t + \beta_3 R_t + \beta 4\, I_t$

3. Result and Discussion

3.1 Trend analysis of the Real GDP and Real GDC and Real Exchange Rate

Real Consumption (C) and Real Income (Y) (placed on left axis) are increasing during the period of 2000 to 2010 but falls in 2011 and after that both the variables are again are in increasing order. On the other hand, real exchange rate (place on right axis) is increasing from 2000 to 2002 and after that it gets decreased up to the period of 2022.

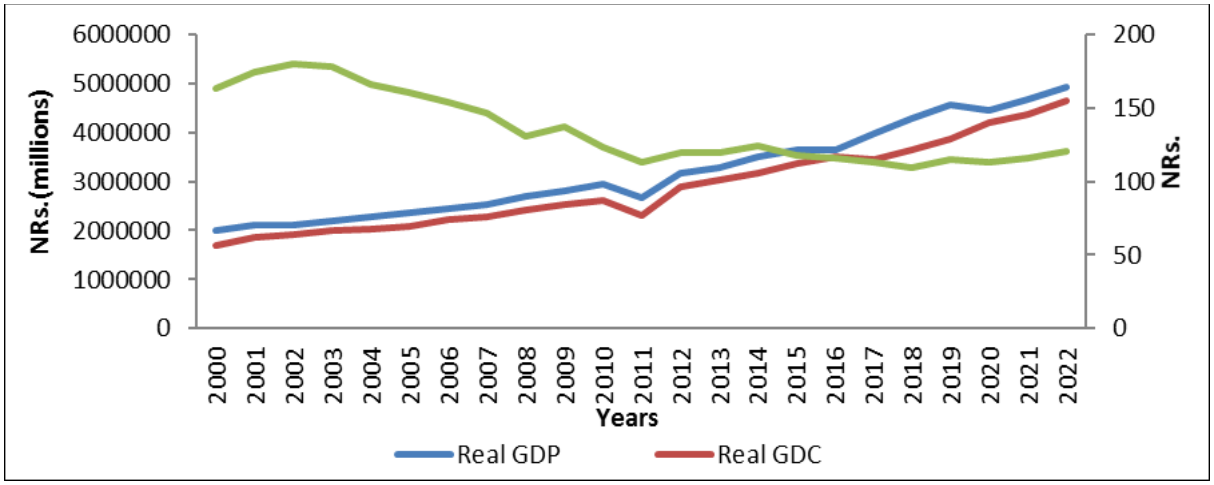

Figure 1: Trend analysis of Real GDP, Real GDC and Exchange rate

3.2 Trend analysis of Interest rate and Inflation rate

The highest and lowest record of interest rate was found to be at 2009 i.e. around 11% and at 2000 i.e. around 2% respectively. Similarly, the correspondence highest and the lowest inflation rate was found to be at 2009 (around 12%) and 2001 (around 2%) respectively.

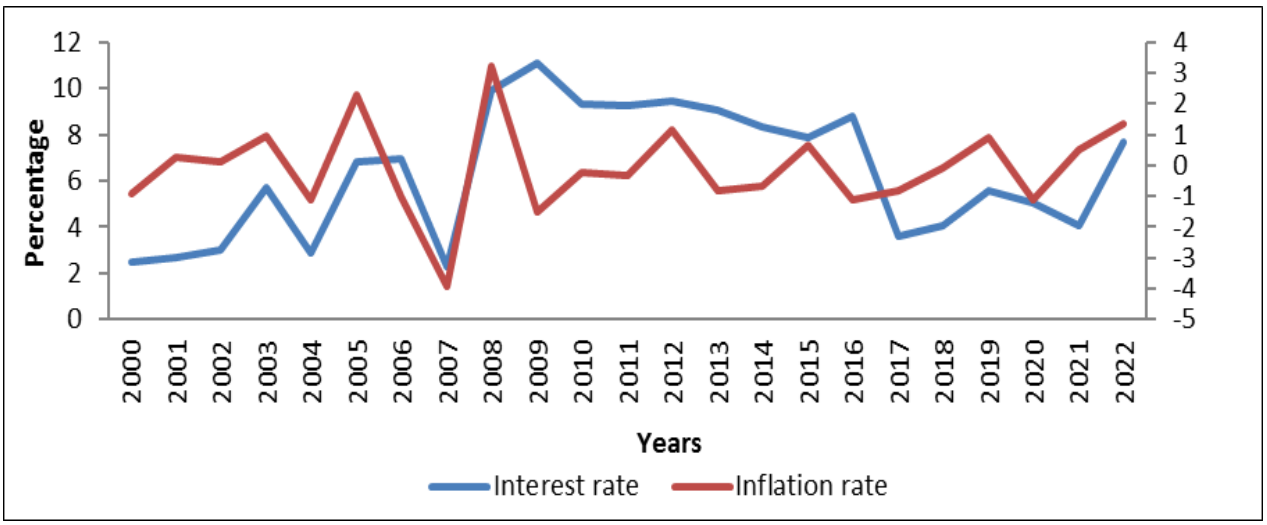

Figure 2: Trend analysis of Interest rate and Inflation Rate

3.3 ADF Test for stationary

The variables lnC_t, lnY_t and R_t are rejecting the null hypothesis at first difference I(1) at the 1% significance level, whereas variable lnE_t is rejecting the null hypothesis at first difference I(1) at the significance level of five percent. Similarly, variables I_t are rejecting the null hypothesis at I(0) at the significance level of one percent.

Table 1: Results of Augmented Dickey Fuller (ADF) Test for stationary

Variables	Level		First difference		Remarks
	Intercept	Intercept and trend	Intercept	Intercept and trend	
lnC_t	0.372 (0.9804)	-2.824 0.1882	-4.600*** (0.0001)	-4.638*** (0.0009)	I(1)
lnY_t	0.398 (0.9814)	-3.119 (0.1018)	-4.632*** (0.0001)	-4.569*** (0.0012)	I(1)
lnE_t	-1.641 (0.4617)	-0.697 (0.9734)	-3.041** (0.0312)	-3.723** (0.0209)	I(1)
R_t	-2.211 (0.2023)	-2.018 (0.5916)	-5.343*** (0.000)	-5.698*** (0.000)	I(1)
I_t	-1.866*** (0.3483)	-1.545*** (0.8131)			I(0)

Note: *** and ** shows 1% and 5% level of significance respectively; and non-parenthesis are t- statistics, parenthesis are MacKinnon p-value.

3.4 ARDL Model

Since the variables are stationary at first difference I(1) and I(0), hence the ARDL model are used. After that the optimal lag selection was done by using Akaike Information Criterion (AIC) criteria which suggests the proper lag structure in the model is 4. Lag structure of each models are 2, 4, 1, 1 and 2 for the series of lnC, lnY, lnE, R and I respectively by using AIC.

Table 2: Represents the criterion selecting the lag order

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	-12.885		4.5e-06	1.882	1.924	2.121
1	56.574	138.92	4.7e-08	-2.797	-2.544	-1.306
2	105.522	97.896*	7.7e-09	-5.318	-4.855	-2.584
3			0*			
4	2783.12			-282.96*	-282.16*	-278.237*

*Represents the criterion selecting the lag order. LR, FPE, AIC, SC, and HQ represent the sequential modified LR test statistic, final prediction error, Akaike information criterion, Schwarz information criterion, and Hannan–Quinan information criterion, respectively.

3.5 Bound test for co-integration

F –statistics value is 8.318 and all corresponding lower bound critical values and upper bound critical values are smaller than the F-statistics value at the 1 percent level of significance. Hence, the null hypothesis is rejected. The rejection of this hypothesis implies that there exists long run co-integration among the variables.

Table 3: Bound test for co-integration

F- Statistic = 8.318		
Significance level	**Lower Bound I(0)**	**Upper Bound I(1)**
10%	2.45	3.52
5%	2.86	4.01
1%	3.74	5.06

3.6 Long Run Coefficient Test Results/ Long Run Equilibrium of the Models

All the variables lnY_t, lnE_t, R_t and I_t used in the estimation of consumption function are found to be statistically significant at 1 % level of significance. The long run aggregate consumption function is given below:

$$lnC_t = 0.290 + 0.448lnY_t - 0.237lnE_t - 0.026R_t - 0.137I_t \quad (6)$$

Table 4: Estimated Long-run Coefficients of the Consumption Function

	Dependent Variable: lnC_t			
Independent Variables	**Coefficient**	**Standard error**	**t-statistic**	**p-value**
Constant term	0.290***	1.84	-3.08	0.014
lnY_t	0.548***	0.049	23.18	0.001
lnE_t	-0.237***	0.091	-2.73	0.011
R_t	-0.026***	0.002	-2.85	0.012
I_t	-0.137***	0.004	-1.51	0.007

Note: *** denotes the significance at 1% significance level respectively.

Equation (6) shows that if the real income get increased by 100 %, then the real consumption get increased by on average by 54.8%. Similarly, increase in real exchange rate by 100 % leads to the on average decrease in real consumption by 23.7%. Similarly, dealing with interest rate and inflation rate, 1% increase in these variables leads to the on average fall in real consumption by 2.6% and 13.7% respectively. The autonomous consumption was found to be around $e^{0.29}$ NRs.1.33 million, which was also found to be significant at 1% level of significance.

The long run consumption function shows that that the marginal propensity to consume (MPC) was found to be 0.448 which means that for a unit increase in income of Nepalese people, their consumption get increased by 0.448 unit on average. The inverse relationship between real consumption and real interest rate show that with a rise in interest rate, people consume less and save more which was in accordance to the Keynesian Theory of consumption (Ahuja, 2011). Similarly, negative relationship of real consumption and real inflation rate shows that with the increase in inflation, real value or purchasing power of people money balance and fixed financial assets get decreased which in turn leads to the downward shift of the consumption function. This effect is termed as real balance effect by Keynes.

3.7 Short-run Dynamics Results of ADRL Process

The short run effects or short run dynamics of the ARDL model (2, 4, 1, 1, 2) is shown in Table 5. In the model, the speed of adjustment parameter or the error correction coefficient (γ) is -0.892, which is also statistically significant at the 1 percent level of significance. This shows 89.2 percent correction of past error in the current year.

Table 5: Error Correction representation of the Model (2, 4, 1, 1, 2)

	Dependent Variable: lnC_t			
Independent variables	**Coefficient**	**Standard error**	**t-statistic**	**p-value**
ΔlnC_{t-1}	0.864	0.568	1.52	0.203
ΔlnC_{t-2}	-0.154**	0.298	-0.52	0.063
ΔlnY_t	0.289**	0.260	4.30	0.013
ΔlnY_{t-1}	0.250**	0.353	1.38	0.024
ΔlnY_{t-2}	0.192**	0.242	1.22	0.028
ΔlnY_{t-3}	-0.654**	0.393	-1.66	0.017
ΔlnY_{t-4}	-0.345**	0.333	-1.05	0.011
ΔlnE_t	-0.148*	0.462	-0.32	0.076
ΔlnE_{t-1}	-0.211*	0.416	-0.51	0.063
ΔR_t	0.020**	0.006	3.30	0.030
ΔR_{t-1}	-0.285**	0.016	-1.70	0.016
ΔI_t	-0.018**	0.010	-1.75	0.015
ΔI_{t-1}	0.109***	0.026	1.11	0.033
ΔI_{t-2}	-0.29	0.018	1.56	0.193
ECM_{t-1}	-0.892***	10.33	0.61	0.042
R^2= 0.9969	Adj.R^2= 0.9861 S.E=0.0308		F= 92.13(0.003)	

Note: ***, ** and * denotes the significance at 1%, 5% and 10% significance level respectively.

In the short run, with an increase in one percent of real income, the real consumption gets increased by 28.9% on an average. Likewise, 1% increase in real exchange rate the real consumption gets decreased on average by 14.8%. Similarly, with respect to the 100% increase in real interest rate and real inflation rate, the real consumption gets on average increase by 2% and decreased by 10.9% respectively. These coefficients were similar to that of long run coefficients.

4. Conclusions

This study undertook an analysis of the aggregate consumption function in Nepal spanning from 2000 to 2022, employing the ARDL approach to co-integration analysis introduced by Pesaran, Shin, and Smith (2001). The bound testing conducted on the estimated model confirmed the presence of a long-run relationship among the selected variables. Real income, exchange rate, interest rate, and inflation rate emerged as significant determinants of both short-term and long-term real aggregate consumption function in Nepal. Notably, the elasticity coefficient of real

income was observed to be higher compared to the coefficients of other variables, indicating a robust income-consumption relationship. Moreover, the coefficients of real interest rate and inflation rate were found to be significantly negative in both the short run and long run, suggesting that an increase in these variables leads to a reduction in real consumption. The negative sign associated with the real interest rate highlights its substitution effect on aggregate consumption, while the negative sign of the inflation rate points towards the real balance effect on aggregate consumption. Furthermore, the analysis revealed an inverse relationship between real depreciation and real consumption in the long run, indicating that the real depreciation of the domestic currency makes imports costlier, thereby dampening consumption. The error correction coefficient was calculated at 89.23 percent, signifying its significance in the model.

Policy Recommendation

Based on the results of our study, it can be suggested that the government and policymakers should plan economic policies that as the marginal propensity to consume is higher which leads to increase in the size of investment multiplier. Hence, fiscal policies that lead to economic growth and increases real income such as tax cut for middle- and lower-income groups should be implemented will increases the investment scenario in the country and untimely higher employment, higher output, higher GDP can be achieved. Similarly, an appreciated real exchange rate might reduce consumption of domestically produced goods as imports become cheaper, but could also increase overall consumption if consumers substitute expensive domestic goods with cheaper imports. Hence, excessive appreciation of the real exchange rate should be avoided which could harm domestic industries and employment. This could involve interventions in the foreign exchange market or policies that affect capital flows. Thirdly, study shows that higher interest rates typically reduce consumption as borrowing costs rise and savings become more attractive. In this situation policymakers should keep interest rates at a level that balances inflation control and economic growth. During economic downturns, lower interest rates to stimulate consumption and investment. On regarding to the inflation, higher inflation can erode purchasing power and reduce consumption. It can also create uncertainty about future prices, which may lead to higher savings and lower consumption. Hence the policymakers, government, economists should keep inflation low and stable which is crucial for sustaining consumption. This can be achieved through prudent monetary and fiscal policies that avoid overheating the economy.

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