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The Impact of Food Affordability on the Human Development Index in Pakistan

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Abstract

This research uses annual time-series data from 1990 to 2024 to determine the effect of food affordability (FA) on the human development index (HDI) in Pakistan. Food affordability index has been computed as the ratio of per capita income to the food price index. To measure the true effect of food affordability on the human development index certain control variables; GDP, government's expenditures on health and on education, and the food production index have been employed in the model. For the purpose of measuring the simultaneous long and short -term effects of the food affordability on human development index error correction model based on the autoregressive distributed lags technique has been employed. The outcome of this study shows that food affordability has a statistically significant positive impact on the HDI in both the long and short-term. These findings reveal that the high standard of living, health, and education in Pakistan improve as economic access to food increases. This research suggests that food affordability should be focused to increase the level of human development index, rather than traditionally focusing only on health and education.

Keywords: Food Affordability, Human development index, GDP, Government spending on health, Government spending on education, food production Index

1- Introduction

Human Development Index (HDI) is a development measurement tool way beyond mere economic growth, which is widely used by the United Nations Development Program (UNDP) since it was coined by Haq (1990). HDI is an index which has three large dimensions, as shown in Table 1.1 given below.

Table-1.1: ***HDI Dimensions and Indicators***

Dimensions	**Indicators**
Long and Healthy Life	Life Expectancy at Birth
Knowledge	Mean Years of Schooling
Standard of Living	GNI per Capita (PPP$)

Source: UNDP (United Nations Development Program)

Consistent with the Human Development Report 2023 of UNDP, Pakistan occupies 164th rank out of 193 countries, and its score even worsened to 168th in 2025 (UNDP, March 2024). Despite the steady rise in the HDI of the country since 2000 to 2015, the recent years have been marked by the stagnation of the growth rate of HDI due to the rise in inflation, weak institutional governance, and underinvestment in the development of major sectors of the country namely health and education.

The food affordability in an important economic variable that affects the human development index. Nevertheless, it remained as an extremely overlooked phenomenon, and it is more so in the case of Pakistan. Despite the fact that Pakistan is an agricultural country, food insecurity has been one of the greatest problems due to poverty, high rate of population growth, climate shocks and inefficient supply chains (Pakistan Vision 2025, 2015). Food affordability is a human right, and one of the primary bases of the standards of living, health, and educational outcomes, all of which have a direct impact on HDI.

In this study, the Food Affordability Index (FAI) is used to determine the influence of economic access to food on human development in Pakistan. This research addresses the knowledge gap since little research is known on the relationship between food affordability and HDI in the developing nations, particularly in Pakistan. This relationship is important to make efficient policies, especially when formulating food subsidies, price stabilization, and income support policies. We intend to test the impact of food affordability on HDI. The findings of this study will highlight the necessity for effective policy measures that can be used to regulate food prices in order to improve the human development index.

2- Literature Review

This section reviews the important literature to examine the combined impact of food affordability and other important structural factors, including GDP, food production index, and government spending on health and government expenditure on education, in the context of Pakistan. This section provides a review of the existing research to create a sense of the variables that influence the HDI in Pakistan.

A recent study on the issue examines the correlation between life expectancy and food affordability in 120 emerging economies (Shaif Jarallah, 2024). It was found that high food prices affect life expectancy in emerging economies more than in developed countries. This study, however, alters this notion by not concentrating on life expectancy only, but also on the larger aspects of the HDI, which include education, health, and income inequality in the case of Pakistan. Bintoro (2022) analyzed the impact of food security of households on HDI in West Nusa. The research determined the major influencing factors of food security in the regions with high and moderate levels of HDI. The results specify that the level of poverty, enrolment in the BPNT program (a social initiative in Indonesia), and household conditions, including access to toilets and children, were significantly relevant to household food security in the high-HDI areas.

Beyene (2023) tested the link between food insecurity and life expectancy, as well as the infant mortality rate through the Generalized Method of Moments (GMM) and the Granger causality tests in the sub-Saharan African nations. The results showed that food insecurity is damaging the health. In particular, a 1% rise in the mean quality of the diet causes a rise in life expectancy and a decrease in the infant mortality rate. Food affordability is one of the burning topics in Pakistan that still affects the human development indicators in the country. As such, this study is aimed at examining the correlations between the affordability of food and Pakistan's HDI to determine the effects of accessibility to affordable food on overall human development. Septrian (2024) examines how different government expenditures, particularly in the line of health, education, economic functions, and social security, affected the HDI in Bengkulu. Using panel data and multiple linear regression analysis, the results specify that health expenditures had a direct and strong effect on HDI and education-related expenditures had a negative effect.

Umukoro (2024) analyzed the role of government's sectoral spending in economic growth and development in the case of Nigeria using HDI as proxy of economic development. The results indicated that the government expenditure in education had a very negative effect on the economic development and no effect on economic development. In addition, the government expenditures on health were also found to insignificantly affect the economic growth. Sihaloho (2025) determined the relationship between the government expenditure on the food aid programs and the HDI in Indonesia. The study recommends that the Indonesian government ought to allocate more funds to the social food assistance program to improve the outcomes of human development.

Erdogan (2022) studied the effects of food production on sustainable development with the special attention to effect on life expectancy and carbon emissions in 23 developing countries. The findings report a significant effect of food production index on HDI, especially using the dimension of life expectancy. The paper highlighted the need to have sufficient food production as a stimulus for human development. Budiyanto (2024) analyzed the relationship between the economic growth (%GDP) of Yogyakarta and three key HDI components; education, health, and per capita spending. The results indicated that education has a positive impact on economic development, which validates the idea that investment in education raises productivity and wealth in the regions. He recommended that in order to reduce the income inequalities and enhance the well-being of regions complex policies are needed that focus on health investments, consumption, and education.

Selong (2024) analyzed the impact of government spending on education and health and GDP on HDI. He opined that an increase in budgets may not necessarily result in a better HDI, possibly due to issues with the utilization of the money as he did not find a measurable impact of health spending on HDI. However, he found that GDP significantly increases the HDI. These findings underscore the key fact that, although continuous economic growth leads to human growth, proper and well-organized government expenditure in the vital sectors is necessary to actually increase HDI.

The above literature review shows that no study has examined the effect of food affordability on HDI in case of developing countries like Pakistan, especially using the other key factors as control variables. This study intends to bridge this gap so that appropriate measures to improve the HDI in developing countries like Pakistan may be recommended.

3- Data and Methodology

This research uses a time-series econometric model to estimate the impact of food affordability on the HDI in Pakistan using the annual time series data during the period of 1990 to 2024. The selection of Pakistan is based on the fact that it has consistently faced food affordability issues. The study includes important control variables including government expenditure on health and government expenditure on education, the food production index, and GDP. In order to evaluate the affordability of food based on household food spending or survey data on access to a healthy diet is required but these are not available in the case in Pakistan. To overcome this shortcoming, the index was calculated by dividing the GDP per capita income by the food price index. This ratio shows the economic cost of food, where a high FAI value shows that it is affordable.

All the series are chosen on the bases of their theoretical literature relevance and evidence from other previous empirical studies.

The functional form in the long term of the model is shown as:

$$HDI_t = \beta_0 + \beta_1 FAI_t + \beta_2 GDP_t + \beta_3 FPI_t + \beta_4 HE_t + \beta_5 EDU_t + \varepsilon_t$$

In the above equation, HDI, FAI, GDP, FPI, HE and EDU represent human development index, food affordability index, gross domestic product, food production index, government expenditure on health, and government expenditure on education respectively, whereas $\mathscr{E}$ represents the error term. β_0 is the intercept and $\beta_1, \beta_2, \beta_3, \beta_4, and\ \beta_5$ represent the long-run elasticities of HDI with respect to FAI, GDP, FPI, HE, and EDU respectively. The time series data the above mentioned variables have been obtained from various issues of the World Development Indicators, United Nations Development Program, Food Agricultural Organization, and Pakistan Economic Survey. All the variables selected for this study have been used in the natural log form.

3.1 Econometric Techniques

This study employs the Autoregressive Distributed Lag (ARDL) model of cointegration presented by Pesaran, Shin and Smith (1996) and developed by Pesaran et al (2001). ARDL model is more advantageous than traditional techniques as it can deal all variables together of the same order i.e. it can deal variables having order I(0) and/or I(1) or even mixed order (Pesaran and Pesaran, 1997). In addition to this it provides consistent a precise estimates of long run coefficients when sample size is less. First of all the paper detects unit roots of all the factors using ADF unit root test. Then performs ARDL based Bounds Testing Approach to the cointegration to test the long run elasticities. The

optimal lag length to be employed in the ARDL model is chosen by Schwarz Bayesian Criterion. After having long run relationship, ECM will be employed to estimate the shorn run elasticities and error correction term. The ECM employed for this study takes the form,

$$\Delta HDI_t = \beta_0 + \sum_{i=1}^{q} \beta_{1i} \Delta FAI_{t-i} + \sum_{i=0}^{q} \beta_{2i} \Delta GDP_{t-i} + \sum_{i-0}^{q} \beta_{3i} \Delta FPI_{t-i} + \sum_{i-0}^{q} \beta_{4i} \Delta HE_{t-i} + \sum_{i-0}^{q} \beta_{5i} \Delta EDU_{t-i} + \gamma EC_{t-1} + U_t$$

In the above model q is the optimal lag length, Δ show the change, and β_1, β_2, β_3, β_4, and β_5 stand for the model's short-run dynamics. U_t stands for error term, γ is the speed of adjustment towards long term equilibrium.

A number of diagnostic tests; Breusch-Godfrey LM Test, Jarque-Bra Test, Breusch-Pagan-Godfrey Test, Multicollinearity Test, CUSUM and CUSUMSQ Test and Ramsey RESET Test, have been applied to check the performance of the model specified above.

4- Empirical Analysis

4.1 the results of Unit Root Tests

The unit roots of individual series are analyzed before applying the ARDL method of cointegration. Augmented Dickey-Fuller (ADF) and The Phillips-Perron (PP) tests have been used to check the unit root at a level and a first difference as presented in Table 4.1. The results of the two tests show that EDU is I(0), whereas all other variables are I(1). These results indicate the suitability of ARDL based cointegration test.

Table-4.1: ***Results of Unit Root Test Results***

Variable	ADF-Statistic (At Level)	Augmented ADF-Statistic (At 1st Difference)	PP-Statistics (At Level)	PP-Statistics (At 1st Difference)
HDI_t	-1.014933	-2.941019	-1.165793	-3.083316**
$lnFAI_t$	-2.2010	-4.86515*	-1.935328	-4.815406*
$lnGDP_t$	-0.089449	-3.830551*	-0.234210	-3.799185*
FPI_t	0.422324	-6.204720*	-0.616606	-6.198408*
HE_t	0.476891	-3.006700**	0.871850	0.871850**
EDU_t	-3.495844**		-3.358211**	

*** and ** show the stationary level at 1 and 5% respectively**

4.2 Lag Length Criteria and F-Statistics:

The optimum lag selection is determined by the Akaike information criterion (AIC). The result indicates that the optimum lag chosen for the model is mentioned in table 4.2.The results of the F-test for the absence or presence of cointegration shows that the calculated F-statistic (11.1863) exceeds the upper bound in all selected models and hence we can conclude to reject the null hypothesis of no long run relationship.

Table 4.2: ***Results of Cointegration Model***

Order of Lag	F- Statistic
3	11.1863

Table 4.3: ***Results of Long-Run Estimation of ARDL (1, 2, 1, 0, 2, 2)***

Regressor	Coefficient	Standard Error	t-Ratio	Prob.
FAI_t	0.0380	0.01328	2.8639	0.01*
FPI_t	0.001	0.0002	5.045	0.0001*
GDP_t	0.2085	0.091504	2.2795	0.0367*
HE_t	-0.06826	0.007324	-9.3205	0.0000*
EDU_t	-0.004	0.0032	-1.262010	0.2250

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***Shows a significant level at 5%, 1% and 10%**

The results given in table 4.3 show that the effect of all of the explanatory variables on the dependent variable is statistically significant at less than 5% significance level except the effect of EDU in the long run. The positive and significant long run effect of FA on HDI reveal that as the food affordability of the people of a Pakistan improves the HDI also improves. Similarly, the effects of food production index and GDP on HDI are also positive and significant which show that HDI increase with the increase in the food production and GDP of Pakistan in the long run. The findings also show that HDI is much impacted in the long term by GDP. However, the government health expenditures has an interestingly negative but statistically highly significant impact on HDI as also found by Yapanto (2023). This surprising result could point to inefficiencies in the health system, such as inadequate resource allocation or poor implementation, which might reduce the beneficial effects of health spending on development outcomes (Musngi1, Ronaldo R. Cabauatan, 2023). On the other hand, government expenditure on education (as a percentage of GDP) insignificantly affect the Human Development Index. This could be because of inefficiencies or a delay in the influence on educational attainment (Muhammad Khafid, 2022). This explains the need to spend funds effectively and well, instead of just raising budgetary allocations when one wants to enhance better human development outcomes.

The error Correction Model (ECM) represents the short-term estimations of the model as given in tables 4.4.

Table 4.4: ***Results of Short Run Estimations of the ARDL (1, 2, 1, 0, 2, 2) Model HDI***

Regressor	Coefficient	Standard Error	t-Ratio	Prob.
D($lnFAI_t$)	0.012	0.003	3.7012	0.0019*
D($lnFAI_{(t-1)}$)	0.007	0.003	1.9725	0.0661
$D(FPI_t)$	7.09E-0.5	6.96E-0.5	1.0186	0.3235
D($lnGDP_t$)	0.1249	0.0228	5.4771	0.0001*
D($lnGDP_{(t-1)}$)	-0.0636	0.0233	-2.727	0.0149*
D($lnGDP_{(t-2)}$)	0.1508	0.0229	6.5665	0.0000*
$D(HE_t)$	-0.0006	0.0010	-0.6772	0.5079
$D(HE_{(t-1)})$	0.0112	0.0027	3.9967	0.001*
$D(HE_{(t-2)})$	0.0111	0.0028	3.8268	0.0015*
$ECM_{(t-1)}$	-0.28	0.02713	-10.37	0.000*

Shows significant level at 5%, 1% and 10%

R^2 = 0.9326, Adj. R^2 = 0.9050, F (15, 16) = 20.34, Prob (F-stat) = 0.2034, DW = 2.2778

The Error Correction Model (ECM) is used to measure the short-run elasticities in addition to the error correction term. Table 4.4 presents that a steady long- term association between the variables is confirmed by the coefficient of the $ECM_{(t-1)}$, which is -0.28 and statistically significant at less than 1% level (P= 0.000). About 28.15% of the disequilibrium is adjusted annually, indicating a tendency towards equilibrium with the negative sign. D($lnFAI_t$) is significant at 1% level (P = 0.001), indicating, food affordability has a short-run positive effect on HDI. The short-term impact of government expenditure on health shows mixed effects. The first and second lag values are significant at 1% level, indicating lagged consequences on human development, even if the present period value $D(HE_t)$ is statistically insignificant (p =0.5079).

HDI is positively and significantly affected by the variable D($lnGDP_t$) and its second lag D($lnGDP_{(t-2)}$), whereas, at the 5% level, the first lag D($lnGDP_{t(-1)}$) is negatively significant. These findings imply that HDI is strongly but variably impacted in the short term by GDP per capita. However, the food production index has no impact on HDI.

Table-4.5: ***Results of Diagnostic Tests***

Test name	P-values	Null Hypothesis	Decision
Ramsey RESET Test	0.0679	No problem with functional form	Accept the null hypothesis
Breusch–Pagan–Godfrey Test	0.2034	No problem of Heteroscedasticity	Accept the null hypothesis

Breusch–Godfrey LM Test	0.8285	No problem of serial correlation	Accept the null hypothesis
Jarque–Bera (JB) Test	0.767160	Data is normally distributed	Accept the null hypothesis

The results of various diagnostic tests have been given in the table 4.5 with the relevant null hypothesis. The results show that the ECM employed in this study satisfies the requirements of various diagnostic tests.

In order to test the stability of the model, we used the plots of cumulative sum of recursive residual (CUSUM) and the cumulative sum of squares of recursive residual (CUSUMSQ). These plots have been given in Figures 4.1 and 4.2, respectively. We conclude that the model is structurally stable since the plots never cross the critical limits at the 5% level of significance.

FIGURE 4.1

Plot of CUSUM

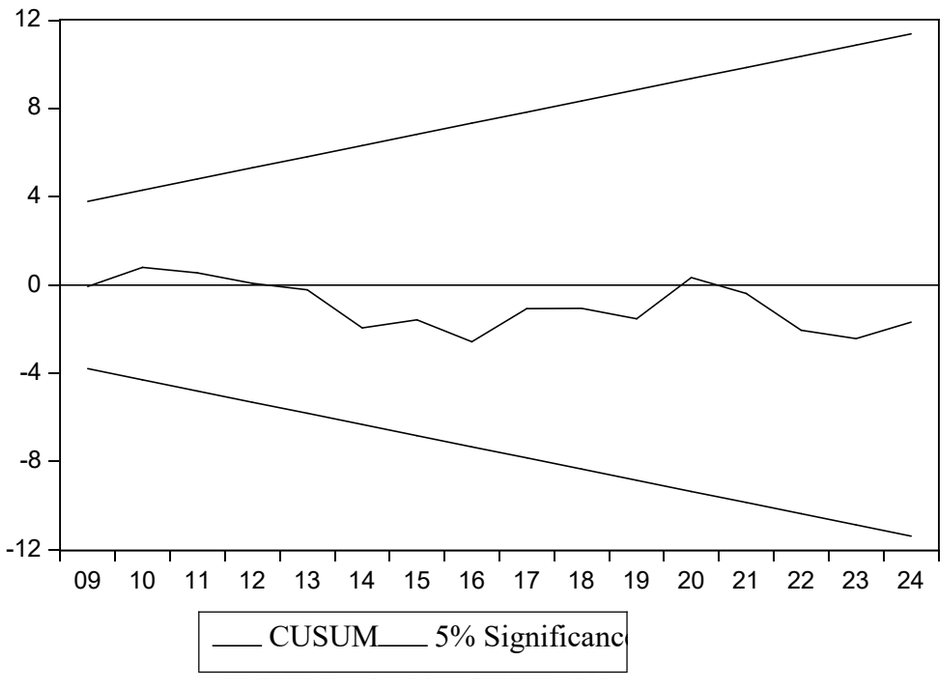
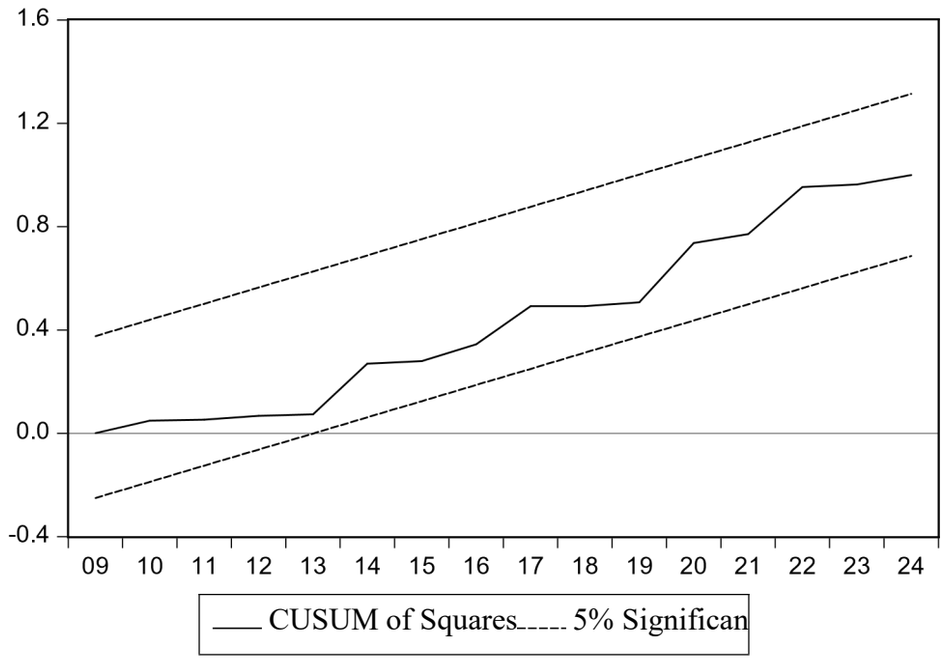


FIGURE 4.2: Plot CUSUMSQ



5. Conclusion and Policy Implications:

This study employed the time-series data to determine the effect of food affordability on the human development index in Pakistan using the annual time series data from 1990 to 2024 through the autoregressive distributed lag (ARDL) methodology. The study used government expenditure on health, government expenditures on education, GDP, and food production index as the control variables to help have an all-around picture of the determinants of human development index.

The findings confirm a positive and statistically significant effect of food affordability on HDI, both in the long run and short run. It shows that food affordability can significantly contribute to overall human welfare in developing countries, such as Pakistan, where a substantial percentage of domestic spending is allocated to food.

However, surprisingly, the findings revealed that government spending on education has no impact on HDI and, whereas the impact of government's health spending on HDI was significant but negative. These results indicate the implicit system's failures like poor distribution of funds, governance issues, and potential misappropriation of funds, which could restrict the potential of the public investment in these areas.

It was concluded that the Food Production Index has a statistically significant and positive long-term impact on the HDI, which means that the growth of the domestic food production might cause improvements in human development in the long term by stabilizing the food prices and availability. It had however a statistically insignificant short-run effect, indicating that it may take time before the gains of increased food production are felt. On the same note, GDP was favorably related with HDI in the long run, once again proving the importance of a long-run economic growth in the improvement of the living standards, although not as directly as the food affordability.

This study suggests that better food affordability, higher food production and higher GDP growth should be a priority for policymakers in Pakistan in the long run. The negative effect of government health expenditure on HDI suggests a dedicated research study in this area and meanwhile a need to improve the efficiency of spending instead of simply raising budgetary allocations. In general, the combined policy approach aimed at affordable food supply, effective government expenditures, and equitable economic development is a key to sustainable human development in Pakistan.

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