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UNDERSTANDING THE CLIMATIC CAUSES OF PRICE VOLATILITY IN DOMESTIC COFFEE MARKETS WITH SPECIAL REFERENCE TO COFFEE ECONOMY OF KERALA

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Abstract

Coffee is characterized with high price volatility in domestic as well as international markets. The price fluctuations in the Indian domestic coffee market due to climatic factors with special reference to coffee economy of Kerala was evaluated during the study. A linear regression model was fitted and step-wise regression analysis was employed to understand the climatic and other allied factors contributing to price volatility in Indian coffee markets. Among the 18 independent variables, eight variables were chosen for the fitted linear regression model after step-wise regression analysis. Among the eight independent variables, only six were found to be significant in the estimated model and found that the volatility of coffee wholesale prices in the domestic market is significantly dependent on various factors such as production and consumption of coffee, weather parameters and Indian Rupee-US Dollar exchange rates.

Key words: Coffee, Price volatility, Step-wise linear regression, Leap plot

Introduction

Coffee is a perennial crop cultivated in the tropics and subtropics. It has been considered as the most important beverage and is a globally traded commodity (Fitter and Kaplinksy, 2001). World coffee production is spread over more than 50 developing countries and carried out by more than 26 million producers (ITC, 2018). While production of coffee largely happens in developing countries, the consumption is mostly concentrated in developed countries. Thus, international trade in coffee typically flows from developing to developed countries. Brazil is the leading grower of coffee beans, contributing one-third of the world production in 2019-20 (ICO, 2020) and India is the third-largest Asian producer and exporter of coffee (IBEF, 2020).

In India, coffee was predominantly an export-oriented commodity and about 70 per cent of coffee produced in the country was exported, while the rest used to be consumed within the country (IBEF, 2020). The majority of Indian coffee plantations are in the southern states of Karnataka, Kerala and Tamil Nadu. Small growers contribute substantially to the coffee sector by accounting for over 90 per cent of the operational holdings and 70 per cent of the production (Upendranath, 2010). Coffee is considered as one of the excessive price volatile commodities in the world market (UNCTAD, 2011). The excessive volatility of coffee prices creates uncertainties and high risk to the coffee growers (Apergis and Rezitis, 2003).

Volatility is the variability of commodity prices around the trend (Deaton, 1999). Agricultural prices vary with production and consumption. Shocks to production and consumption transmit into price variability (Gilbert 2010). It is generally stated that the most important source of price variability in agricultural production is weather shocks. The extent to which given production and consumption shocks translate into price volatility depends on supply and demand elasticities, which in turn, reflects the responsiveness of producers and consumers to changes in prices (Christiaensen, 2009).

In this backdrop, the present study helps us to understand the climatic and other allied causes of price fluctuations in the Indian domestic coffee market with special reference to coffee economy of Kerala. The coffee economy of Kerala is virtually the coffee economy of Wayanad (Joy, 2004).

Materials and Methods

Sources of data

The time series data on coffee production at the state and national level, weather parameters in the study area (Wayanad), annual export and import of coffee from India, exchange rate of Indian rupee against US dollar and annual consumption of coffee in India, pertaining to the period from 1994-95 to 2019-20 (before covid-19 scenario) were analysed in the study. Except the weather data, all other time series data were collected from the Coffee Board, Bangalore. The weather data was collected from Regional Agricultural Research Station, Ambalavayal.

Step-wise linear regression analysis

To understand the reasons or causes of price fluctuation in the coffee market, several models were fitted. The large number of independent variables and occurrence of high multicollinearity with several regression equations, led to decrease in accuracy and mask the significance of the model. Among the fitted models, a liner regression model with numerically transformed variables was found the most appropriate with a good fit and statistical significance. A stepwise regression was attempted in the study. The price volatility (Coefficient of variation of wholesale coffee price) was hypothesized as a function of coffee production in Kerala and India, weather parameters in Wayanad, annual import of coffee and annual consumption of coffee in India. The specified linear regression function is given below:

$$Y = b_0 + b_1X_{1t} + b_2X_{2t} + b_3X_{3t} + b_4X_{4t} + b_5X_{5t} + b_6X_{6t} + b_7X_{7t} + b_8X_{8t} + b_9X_{9t} + b_{10}X_{10t} + b_{11}X_{11t} + b_{12}X_{12t} + b_{13}X_{13t} + b_{14}X_{14t} + b_{15}X_{15t} + b_{16}X_{16t} + b_{17}X_{17t} + b_{18}X_{18t}$$

$Y = Coefficient\ of\ Variation\ of\ coffee\ wholesale\ price$

$b_0 = Intercept$

$b_1 \rightarrow b_{18} = Regression\ coefficients$

$X_{1t} = Coffee\ production\ in\ India\ during\ t^{th} year$

$X_{2t} = Coffee\ production\ in\ Wayand\ during\ t^{th}\ year$

$X_{3t} = Quantity\ of\ coffee\ exported\ during\ t^{th} year\ from\ India$

$X_{4t} = Quantity\ of\ coffee\ imported\ during\ t^{th} year\ by\ India$

$X_{5t} = Quantity\ of\ coffee\ consumed\ in\ India\ during\ t^{th} year$

$X_{6t} = Temperature\ in\ first\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{7t} = Temperature\ in\ second\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{8t} = Temperature\ in\ third\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{9t} = Temperature\ in\ fourth\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{10t} = Rainfall\ in\ first\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{11t} = Rainfall\ in\ second\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{12t} = Rainfall\ in\ third\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{13t} = Rainfall\ in\ fourth\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{14t} = Relative\ humidity\ in\ first\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{15t} = Relative\ humidity\ in\ second\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{16t} = Relative\ humidity\ in\ third\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

$X_{17t} = Relative\ humidity\ in\ fourth\ quarter\ in\ the\ study\ area\ during\ t^{th} year$

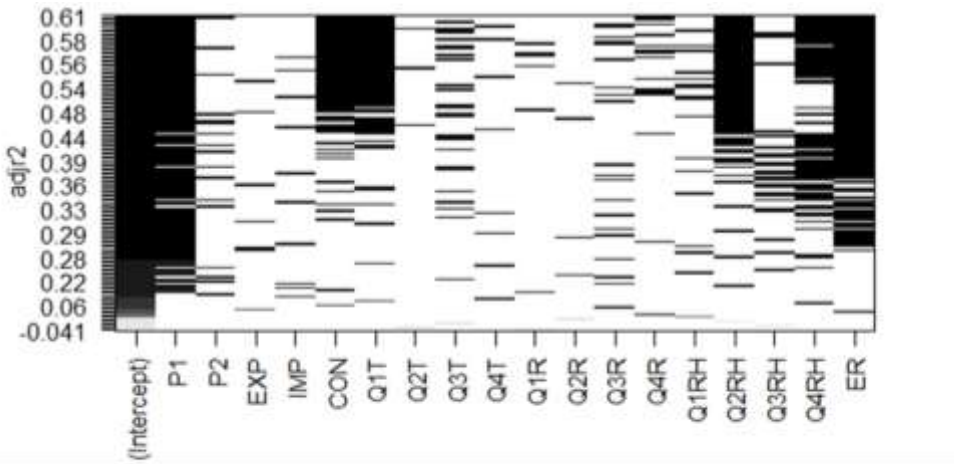
$X_{18t} = Average\ exchange\ rate\ of\ Indian\ rupee\ against\ US\ Dollar\ during\ t^{th} year$

The quarter taken are $first\ quarter(Q_1) = January - March$, $Second\ quarter(Q_2) = April - June$, $Third\ quarter(Q_3) = July - September$, $Fourth\ quarter(Q_4) = October - December$

Results and Discussion

A linear regression model was fitted and step-wise regression analysis was employed to understand the factors contributing to price volatility at domestic coffee markets considering its R^2, VIF and DWS. The specific combination of linear model was chosen based on leap plot results. The graphical representation of leap plot is presented in figure 1.0.

Figure 1. Step-wise regression- Leap's plot



*P1=X_{1t} , P2=X_{2t}, EXP=X_{3t}, IMP=X_{4t}, CON=X_{5t}, Q1T=X_{6t} Q2T=X_{7t}, Q3T=X_{8t}, Q4T=X_{9t} , Q1R=X_{10t} , Q2R=X_{11t} , Q3R=X_{12t} R=X_{13t} , Q1RH=X_{14t} , Q2RH= X_{15t}, Q3RH=X_{16t} , Q4RH=X_{17t} , ER= X_{18t}

Based on the number of black-coloured bands on leap plot, the specific significant linear combination with maximum adjusted R^2 was chosen as the fitted linear model. The fitted linear model is expressed as:

$$Y = b_0 + b_1X_{1t} + b_5X_{5t} + b_6X_{6t} + b_8X_{8t} + b_{13}X_{13t} + b_{15}X_{15t} + b_{16}X_{16t} + b_{17}X_{17t} + b_{18}X_{18t}$$

The estimates of fitted linear model is presented in Table 1 and Figure 2. Among the 18 independent variables, eight independent variables were chosen for the fitted linear regression model after step-wise regression analysis. Among the eight independent variables, only six were found to be significant in the estimated model. The coefficient of variation of coffee wholesale price was considered as the indicator of volatile price and the estimates indicate how these listed variables cause or influence the volatility in wholesale coffee prices.

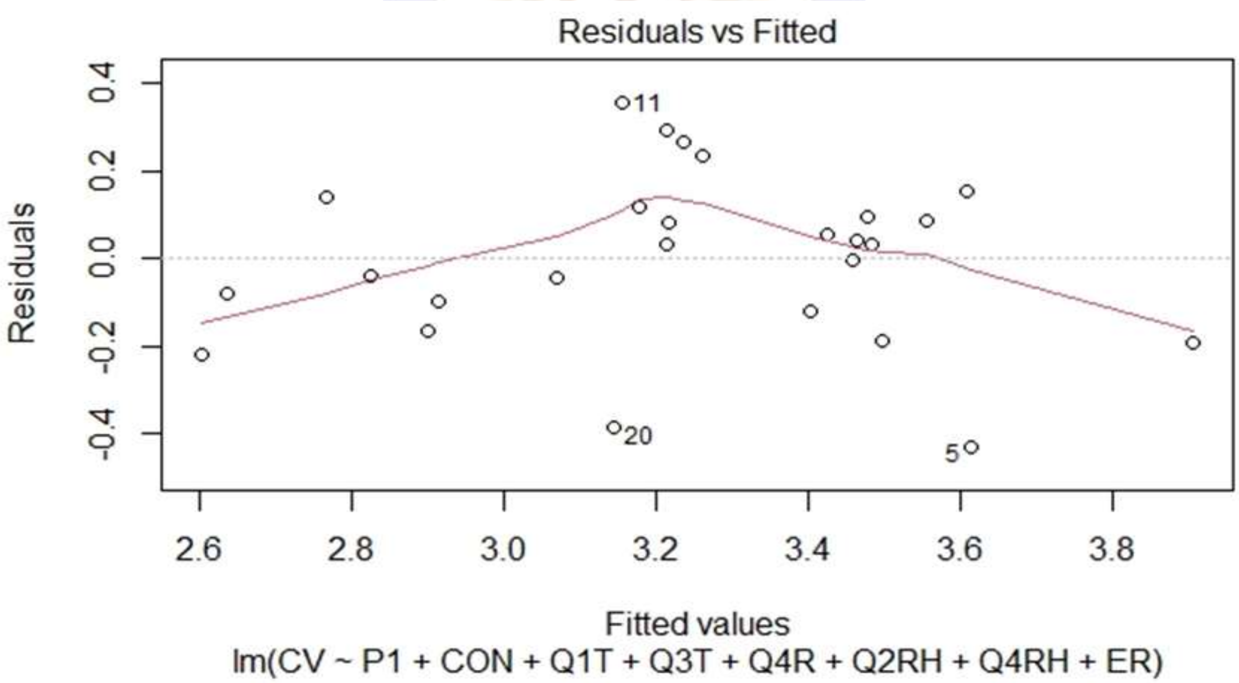


Figure 2. Fitted linear regression model

Table 1. Estimates of the fitted linear regression model for causes of price volatility in Indian domestic market

Particulars	Estimates	Standard Error	P value	VIF
Intercept	-56.21***	11.98	0.000211	
Production (National)	3.56***	0.67	0.000058	3.69
Consumption	1.41***	0.47	0.008704	2.93
Q I Temperature	8.08**	3.27	0.024429	1.55
Q III Temperature	2.79	1.95	0.171348	1.36
Q IV Rainfall	-0.18	0.12	0.165723	1.31
Q II Relative humidity	-7.45***	2.03	0.001923	2.45
Q IV Relative humidity	1.92**	0.87	0.041631	1.33
Exchange rate	-2.42***	0.53	0.000296	4.66
R^2	0.74	-	-	-
Adjusted R^2	0.67	-	-	-
Shapiro-wilk normality test	0.97	-	-	-
Durbin-Watson statistics	1.98	-	-	-

Note: *** denotes significant at one percent level, ** denotes significant at five per cent level

From Table 1, it is clearly evident that 74 per cent of the variation in CV of coffee prices could be attributed to eight independent variables. The linear regression model was subjected to post hoc tests to check autocorrelation, multicollinearity and normality for validation. The Variance Inflation Factor (VIF) values were less than five for all the independent variables and intercept, which indicated that the fitted model had the acceptable level of multicollinearity. The Durbin-Watson (DW) statistics value of 1.98~2 indicated that the fitted model was free from autocorrelation and the value of normality statistics also strongly recommended the validity and significance of the selected linear regression model.

The agricultural commodity prices vary with changes in production and consumption (Gilbert, 2010). The iterated regression estimates of the Indian coffee production indicated that a unit increase in production resulted in 3.56 per cent change in wholesale price volatility. Shocks to production and consumption transmit into price variability (Gilbert and Morgan, 2010). The obtained linear model implied a significant relation between consumption and price volatility. A unit increase in consumption results a 1.41 per cent increase in price volatility. Thus, the present study also confirmed the direct implications of changes in production and consumption on the volatility of coffee price and its direct transmission of volatility signals.

Weather shocks to agricultural yield is an inevitable factor causing price variability (Balcombe, 2009). In the present model, it was assumed that the effect of $(t-1)^{th}$ year weather factors was on the current year production variable. But the weather parameters such as rainfall, temperature and relative humidity in the study area during the t^{th} year have a direct significant effect on price volatility by influencing the physical markets. A unit increase in first quarter temperature resulted an 8.08 per cent change in price variability. The second and fourth quarter relative humidity also had significant implications on price volatility. The second quarter relative humidity also caused a decline in price volatility state by 7.45 per cent, where as a unit increase in the fourth quarter relative humidity results in a 1.92 per cent increase in price volatility. Even though the study is not discussing about the impact of weather parameters on production and its subsequent and indirect implications on coffee prices, the study gives hints regarding the direct effect of climatic factors on price volatility of coffee in the study area.

Demand shocks, income shocks and policy shocks such as changes in exchange rate also play an important role in price volatility (Christiaensen, 2009). The exchange rate in the specified model also had significant effects on volatility of coffee prices. It was found that a unit increase in exchange rate (value of Indian rupee against US dollar) caused a 2.42 per cent decline in price volatility.

In accordance with the findings of Gilbert, Morgan, Balcome and Christiaensen, it could be concluded that the volatility of coffee wholesale prices in the domestic market is significantly dependent on various factors such as production and consumption of coffee, weather parameters and Indian Rupee-US Dollar exchange rates. Coffee is a commodity which is characterized by a high price volatility. The timely dissemination and equipping of farmers on the use of market intelligence is very important to overcome the volatility crisis in the system. A practically implementable market intelligence system and price stabilization mechanism could be capable to ensure a profitable income for coffee farmers in Kerala.

Conclusion

The stepwise linear regression analysis showed that among the 18 chosen independent variables including weather parameters, only temperature (Q_1) and relative humidity (Q_2 and Q_4) showed significance among the weather parameters whereas production, consumption and exchange rate are the other variables showing significant effect on coffee price in the Indian domestic market.

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