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Black Pepper Price and its Determinants: A Panel Data Analysis using different Estimators

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Abstract: The study intends to identify the linkages between black pepper price and its determinants. Area harvested, production and yield of pepper are taken as the determinants of black pepper price in this study. The research is designed as a panel data analysis, using different estimators like random effect, fixed effect, mixed effect, generalised method of moments (GMM 1991 and GMM 1998) and panel quantile regression. Research design adopted is descriptive in nature. Analysis was done based on panel data of five pepper producing countries for a period of 51 years from 1969 to 2019. The study revealed that area and production are significant predictors of pepper price in all the countries, while yield cannot be considered as a significant determinant of pepper price across countries.

Keywords: Black pepper price; area harvested; production; yield of pepper; panel data analysis

INTRODUCTION

Spices, especially pepper had played a role in shaping the history of producing nations and it is still a source of revenue for many developing and yet-to-be-developed nations, pepper deserves a special attention. Although it has been enticing people all across the world, the conducive atmosphere and climate for its growth is limited to the tropical region. However, the climate change is posing a threat to its growth even in that limited region, which urges the farmers to adopt novel technologies and agricultural activities and scientists to produces new varieties of pepper that are able to withstand the climate change. While going through the related articles, it has been observed that studies ventured into predicting the price of black pepper with multiple antecedents at multiple time periods are nil, to the best knowledge of the researcher. Black pepper prices are really volatile and hence strong institutional supportive systems are required to protect the farmers from adverse effects of such price volatility (Sabu, Kuruvila & Manojkumar, 2019). In this study, it is proposed that area of cultivation, production, yield, export, consumption and inflation will have an impact on the price of pepper. As the basics of supply and demand delineate, an increase in any or all of these factors will result in an increase of supply, which will eventually drag the price down and vice versa. However, it should also be taken into account that an increase in area may not turn out to a decisive factor in increased production as changes in climate or weather can result in poor output. Hence, the impact of climate change is also studied in this study. Some literatures talked about the export potential and import pattern of pepper in the countries under study. There are many newspaper articles that depict the perils of import on the domestic market and the eventual decrease in the price of indigenous product. Since, the climate change has evolved as a bitter truth to confront with and the texture of soils have been changing, there is a need for conforming ourselves to the changes. The case of agriculture is also of no difference. The farmers must adopt novel technologies and agricultural practices to withstand the changes and the scientific community is required to develop new varieties that are compatible with the changing environment. Thus the application of such practices also requires a room in the study. Black pepper, being a trade dependent commodity, shows high degree of price fluctuations. The world pepper market is rather well integrated. Prices move in parallel in producing and consuming countries hence it is important to analyse the various determinants of pepper price in the international market. As pepper is highly used in food and other products like pharmaceuticals, the export performance by producing countries is increasing at a faster rate. The current supply is not able to meet the demand in the international market, which has made the exports more profitable. And this has led some of the countries to focus on black pepper export by increasing the area, production and yield. Recently, pepper consumption in the producing countries is increasing steadily. Change in food habit and the increasing preference for flavorful and healthy foods has resulted in improved consumption across world. With the increase in demand, it is seen that the old crop stocks are persistently declining in these countries. The growth in production, area harvested, yield, exports and consumption would generate rural employment and income to the producers and bring in efficiency to entire production process through better technology and international quality standards, which in turn will further improve the price of the commodity. Area under harvesting, production and lagged export quantity have been pointed out by previous literatures as the main drivers influencing pepper price in the world. The study has therefore been undertaken to identify the drivers for its price in the international market. To ascertain the drivers of pepper price at the macro

level, an empirical analysis was carried out using regression analysis. It is expected that besides farm-level inputs, other external factors also influence the current price of black pepper such as inflation. This study attempts to find out the relationship between black pepper price and its determinants.

LITERATURE REVIEW

The nexus between production and pepper price was depicted in the report of Shah & Anish (2017) . The report said that the price of pepper has plummeted to $4,050 per tonne in 2016-17 from $10,908 in 2014-15 per tonne due to the hike in the output of pepper. Here, it is proposed that the foremost factor that determines the price of pepper is its production itself. Besides, it is also assumed that an increase in output will lead to a decrease in price for the pepper owing to the abundant availability of the commodity (Anoopkumar, 2012). A study (as cited by Ravi) of Agricultural Market Intelligence Centre of Kerala Agricultural University in 2011 reported that the area under pepper cultivation in India had come down by 24% during the last nine years whereas production had shrunk by almost half during the period owing to dwindling productivity and spiralling production cost. Sivarajah & Wickramasinghe (2016) delineated the recent picture of pepper cultivation in Sri Lanka. The result of their study on the impact of land size on productivity, income and profits from pepper cultivation in Sri Lanka stated that fertiliser was the lone input applied by the small scale and large scale farmers. The annual mean yield of pepper for both the small scale and large scale farmers did not differ significantly, although the average extent of land used for the cultivation of pepper between the groups differed significantly. The global pepper market was dominated by Vietnam, which had contributed around 42% of the total production of pepper from across the globe. The new plantings in the country since 2014 seemed to create a situation of higher supply for the coming next few years. Besides, the production and export of pepper from Vietnam turned disadvantageous to India's top position in the global market. A hike in the global supply of pepper, mainly from Vietnam caused the price of Indian pepper to diminish by more than 30% (Shah & Anish, 2017). A report of International Pepper Community (IPC) indicated that the area for production of pepper in Vietnam in 2017 has increased significantly to 1,05,000 ha as compared to 2014 (85,500 ha) and 2015 (97,500 ha). Besides, the country produced an estimated 1,75,000 Mt. of pepper in 2016, which was 39% higher than the average production of pepper in the country during 2007 and 2016 (IPC Report). The production area of pepper in Vietnam is less than that of India and Indonesia. However, the productivity of pepper in the country was high-3.2 tonnes per ha (Aria, 2016). A report in 2016 stated the productivity of pepper in Indonesia was low although the country had the largest pepper production area (1,78,000 ha) in the world. Another report in 2017 indicated that the Indonesia secured the second position in terms of the production of black pepper (Shah & Anish, 2017). The report of Shah & Anish (2017) indicated that the production of pepper in Brazil has been on an upward trajectory since 2014-15 till the 2016-17. In 2014-15, the production of pepper in Brazil was 50 thousand Mt., which went up to 51 thousand Mt. in the following year. In 2016-17, the production was marked as 55 thousand Mt., an increment by 7.84% as compared to the previous year. The FAOSTAT crop data reported that the production of pepper in 2013 in Brazil was 42,312 tonnes and the pepper harvested area was 18,472 ha. In the following year, they slightly increased to 42,339 tonnes and 19,070 ha, respectively. In 2015, as stated above, the production has increased to 51,739 tonnes (an increase by 22.20%) and the area harvested increased to 22,105 ha (an increase by 15.91%). In 2016, the production was 54,425 tonnes (increased by 5.19%) and area harvested was 25,830 ha (increased by 16.85%). Finally in 2017, the production of pepper in Brazil was 79,371 tonnes (increased by 45.84%) and area harvested was 28,631 ha (increased by 10.84%). Another study found that the export of black pepper from Indonesia was affected by the Gross Domestic Product (GDP) of the importing country of pepper exported from Indonesia, the population of the importing country, the price of black pepper and white pepper and the forex rate against the USD. The result of a study to understand the long-term determinants of black pepper in Malaysia elucidated that the international price of black pepper, domestic supply of black pepper, stock of black pepper, introduction of steam sterilisation plant and changes in the taste and preferences of consumers in the importing countries were the determinants of the dependent variable (Kiong, Rahim & Shamsudin, 2010).

MATERIALS AND METHODS

Descriptive research design was used for the study. The study is quantitative in nature. Data pertaining to the variables considered for the study were collected for a period of 51 years from the year 1969 to 2019, for five pepper producing countries, namely India, Brazil, Indonesia, Sri Lanka and Vietnam. Data sources include International Pepper Community and FAO Stat. The data collected were analysed using statistical tools like GMM 1991 and GMM system.

The dependent variable used in the study is pepper price and is taken as annual average FOB price of black pepper (US$/MT). There are six independent variables used in the study, namely, area harvested, production of pepper, yield of pepper, export of pepper, consumption of pepper and inflation. Production of pepper is measured in metric tons. Yield is taken as metric tons per Hector, Area is measured in Hectors, export and consumption are measured in metric tons. Inflation is taken as CPI annual percentage.

RESULTS AND DISCUSSION

Descriptive Statistics

Table 1: Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Price	255	2280.304	2099.500	40.500	9764.050
Production	255	41174.423	32208.710	1505	175000
Yield	255	0.827	0.570	0.080	2.530
Export	255	0.808	0.627	0.000	3.000
Consumption	255	14458.691	14568.900	-10000	61000
Inflation	255	59.752	346.540	-30.670	4116.200
Area	255	77014.211	67988.970	2211.00	358570.000

Source: STATA Output

It is clear from the Table 4.3.1 that the average price of pepper is 2280.30 with a standard deviation 2099.50. However, the average pepper production is found to be 41174 MT and the standard deviation is 32208 MT. The Yield of pepper is having an average score of 0.827 with a standard deviation of 0.570. The total export of pepper is having an average of 0.808 and a standard deviation of 0.627. Consumption of pepper is reported to have a mean value of 14458 with a standard deviation of 14568 MT. The average inflation across the panel is found to be 59.75 with a standard deviation of 346.54, while area harvested is found to have an average of 77014 Ha and standard deviation of 67988 Ha. Price showed huge variation among the values hence the study used log of price as the indicator of price in all the further analysis.

Correlations among the Variables

After the summary statistics the study tested the correlation between the variables. Table 4.3.2 provides the correlation among the variables. None of the variables reported high correlation except price and area harvested and export and yield, which is quite reasonable to have high correlations.

Table 2: Correlations

	Area	Production	Yield	Export	Consumption	Inflation	Price
Area	1.000						
Production	0.1468	1.000					
Yield	-0.0928	0.2803	1.000				
Export	-0.1832	0.2442	0.9611	1.000			
Consumption	0.5058	0.0338	-0.4558	-0.4987	1.000		
Inflation	-0.0964	-0.0581	0.1648	0.1601	-0.1113	1.000	
Price	0.8371	0.2083	-0.1682	-0.2374	0.4266	-0.0653	1.000

Source: STATA Output

None of the variables reported high correlation except price and area harvested and export and yield, which is quite reasonable to have high correlations.

Determinants of Pepper Price: Panel Data Analysis

The study employed, various panel data estimation models to understand the relationship between the variables in the study. At first we have tested the relationship between Price and its various determinants using fixed effect, random effect and mixed effect models. The models are specified as follows:

$PP_{it}=\beta_1+\beta_2 X_{1it}+\beta_3 X_{2it}+\beta_4 X_{3it}+u_{it}+\varepsilon_i$ (1) - Random effect

$pp_{it}= \beta_2 x_{1it}+\beta_3 x_{2it}+\beta_4 x_{3it}+u_{it}$ (2) - Fixed effect

$yij = \beta 1x1ij + \cdots + \beta pxpij\ (1) + bi1z1ij + \cdots + biqzqij + \varepsilon ij$ (3) – Mixed effect

Mixed effect models are used to capture both random and fixed variations in the model. Here also, we have used seven different models to test the relationship between the variables. In this study it is essential to test whether there is any mixed effects in the model, as the study deals with five countries and 50 years. It is logical

to assume that the changes in the variables and the relationships established in the model may be due to the year effect as well as due to the country effect. The results are given in Table 3.

Table 3: Results of Random effect, fixed effect and mixed effect models

lnprice	Random effect	Fixed Effect	Mixed Effect
Area Harvested	0.000*** (0.00061)	0.000*** (0.000544)	0.000*** (00061)
Production of pepper	0.000*** (6.46E-06)	0.131 (2.54E-06)	0.000*** (6.46E-06)
Yield of pepper	0.108 (-0.54171)	0.581 (0.16738)	0.104 (-0.54171)
Export of pepper	0.785 (0.084075)	0.170 (-0.37226)	0.782 (0.084075)
Consumption of pepper	0.077** (-8.07E-06)	0.054** (-8.66E-06)	0.073** (-8.07E-06)
Inflation	0.195 (0.000191)	0.002*** (0.000405)	0.188 (0.000191)
Constant	0.000*** (5.830586)	0.000*** (5.919979)	0.000*** (5.830586)
Prob.>chi2=0.000, Prob.>F=0.000 R-squared =0.6698; Observations: 250; No.of Country: 5; Wald Chi2=665.45			

Source: STATA Output

The Wald test result is indicative of the significant contribution of explanatory variables together to the dependent variable, price of pepper. It is concluded that area harvested, production and consumption are statistically significant predictors of pepper price across countries at 5 percent and 10 percent levels of significance respectively, while export of pepper and inflation are not good predictors of pepper price in the random effect model. It is inferred that area harvested, inflation and consumption are statistically significant predictors of pepper price across countries at 5 percent and 10 percent levels of significance respectively, while production, yield and export of pepper are not good predictors of pepper price in the fixed effect model. Area harvested, production of pepper and consumption of pepper are statistically significant predictors of pepper price across countries at 5 percent and 10 percent levels of significance respectively. Yield, export of pepper and inflation are found to be not significant in predicting the pepper price across the participating countries, in the mixed effect model. R squared value is 0.6698, hence confirming the robustness of the model.

Generalised Method of Moments (GMM 1991, and GMM 1998)

The study has run dynamic panel estimators such as GMM 1991 and GMM1998 (GMM System) models to confirm the relationship between the endogenous and exogenous variables. The GMM model is specified as :

$$Y_{it} = \alpha_0 + \beta_1 \text{area}_{it} + \beta_2 \text{prod}_{it} + \beta_3 \text{yie}_{it} + \beta_4 \text{exp}_{it} + \beta_5 \text{cons}_{it} + \beta_6 \text{inf}_{it} + e_{it} \quad (4)$$

GMM (1991) and GMM System (1998) dynamic estimators are not robust in explaining the relationship envisaged in the model. Further to the specific advantages of quantile regression estimation over the, GMM, fixed effect and random effect estimations, we have examined the 25th, 50th and 75th quantiles for the model specified. The results are presented in Table 4.

The panel quantile models are specified as follows:

$$Q_{0.25}(\text{lnprice})it = \alpha_{0.25} + \beta_{0.25,1}(\text{area})it + \beta_{0.25,2}(\text{prod})it + \beta_{0.25,3}(\text{yie})it + \beta_{0.25,4}(\text{exp})it + \beta_{0.25,5}(\text{cons})it + \beta_{0.25,5}(\text{inf})it + \varepsilon it \quad (5)$$

$$Q_{0.50}(\text{lnprice})it = \alpha_{0.50} + \beta_{0.50,1}(\text{area})it + \beta_{0.50,2}(\text{prod})it + \beta_{0.50,3}(\text{yie})it + \beta_{0.50,4}(\text{exp})it + \beta_{0.50,5}(\text{cons})it + \beta_{0.50,5}(\text{inf})it + \varepsilon it \quad (6)$$

$$Q_{0.75}(\text{lnprice})it = \alpha_{0.75} + \beta_{0.75,1}(\text{area})it + \beta_{0.75,2}(\text{prod})it + \beta_{0.75,3}(\text{yie})it + \beta_{0.75,4}(\text{exp})it + \beta_{0.75,5}(\text{cons})it + \beta_{0.75,5}(\text{inf})it + \varepsilon it \quad (7)$$

Table 4: Results of GMM 1991 and GMM 1998

	Dynamic Panel		Panel Quantile Quantile regression		
lnpric	**GMM 1991**	**GMM 1998(System)**	**0.25**	**0.50**	**0.75**
lnpric L1.	0.000*** (0.915554)	0.000*** (0.909336)			
Area	0.000*** (4.77E-05)	0.000*** (5.35E-05	0.000*** (0.000703)	0.000*** (0.000493)	0.000*** (0.000439)
Production	0.557	0.018***	0.030***	0.000***	0.000***

	(2.30E-07)	(8.45E-07)	(8.72E-06)	(3.80E-06)	(1.85E-06)
Yield	0.065*** (0.057938)	0.621 (0.027755)	0.000*** (-0.62092)	0.000*** (0.422062)	0.030*** (0.155618)
Export	0.019*** (-0.0956)	0.003*** (-0.14304)	0.051** (-0.17549)	0.002*** (-0.45786)	0.036*** (-0.13733)
Consumption	0.175 (-1.61E-06)	0.025*** (-2.08E-06)	0.000*** (-1.2E-05)	0.000*** (-1.17E-06)	0.000*** (8.45E-07)
Inflation	0.089** (-4.6E-05)	0.016*** (-5.3E-05)	0.179 (0.000477)	0.219 (7.15E-05)	0.367 (-3.1E-05)
Constant	0.000*** (0.526392)	0.000*** (0.60215)	0.000*** (5.269763)	0.000*** (6.167055)	0.000*** (6.523787)
Wald chi2 =15699.57***; Sargan test= 0.553 AB Test Order 1=0.036***; AB Test Order 2=0.387, observations=255, Number of Countries=5					

Source: STATA Output

Table 4 presents the result of the impact of independent variables on pepper price. In these models, the Wald test result is indicative of the significant contribution of explanatory variables together to the dependent variable, price of pepper. Hence there is no need to remove those variables, rather we can consider them for identifying the relationship between pepper price and its determinants. Arellano-Bond test is used for testing zero autocorrelation in first difference errors. The above results from the Arellano-Bond test show that no autocorrelation exist in first difference errors. Sargan test is used for testing over-identifying restrictions in the model. Under the null hypothesis the over-identifying restrictions are considered valid. It is also inferred that these indicator variables are capable of predicting the pepper price across countries. Sargan test is used for testing over-identifying restrictions in the model. Under the null hypothesis the over-identifying restrictions are considered valid. Sargan test results are also conforming to this. All the variables except, production and consumption are significant in GMM 1991 model. However, in GMM system model, all the variables except yield of pepper are significant drivers of black pepper price. Area harvested, production, yield, export, and consumption are significant predictors of black pepper price, while inflations is not a significant predictor of price in the 25^{th} 50^{th} and 75^{th} quantiles.

CONCLUSION AND IMPLICATION

The study concluded that the variables, area, production, consumption and inflation are significant predictors of pepper price in all the countries, while yield cannot be considered as a significant determinant of pepper price in the random effect, fixed effect and mixed effect models. However, dynamic panel estimators like GMM 1991 and GMM stystem revealed that all the variables, except inflation are statistically significant and contributing to pepper price. The result is confirmed by panel quantile regression results also. Area and production being the major determinants of pepper price, it is advisable for countries to focus on these critical aspects to improve the pepper price in the domestic and international markets. Appropriate policy interventions are required to ensure that farmers are motivated and to cultivate pepper in more areas and to improve production by using innovative cultivation technologies, which will foster yield of pepper.

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