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Price determinants of dry Chilies in Karnataka

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Abstract

Objectives: Chilli is an important spice crop grown throughout India and accounts for 36% of world's production. Karnataka is the second largest producer of Chillies with 12% share in Indian production after Andhra Pradesh (57% share in Indian Production). Price of chilies depends on various factors such as quality of chillies, grades, and seasonality. Impact of each of these factors, are yet to be estimated. Objective of this study is to quantify the factors that affect the price of dry chilies.
Methods: We estimate a hedonic price function, which explains the price of chillies in terms of their characteristics. We use a least squares regression model after corrections for the heteroscedasticty and multicollinearity to explain variability in price.
Findings: The model indicates that statistically significant differences exist in the prices of varieties, and across markets even after controlling for quality characteristics. Also, with every 1% increase in arrivals, the price of chillies increased by 0.05%.
Applications: Results from our model could be useful for improved marketing and appropriate policy design. Relationships between price and quality characteristics could be utilized to optimize farmer revenues.
***Keywords*:** Dry chillies, Hedonic Price analysis, Chilly price determinants, Chilli quality characteristics.

1. Introduction

Chilli is an important spice crop grown throughout India. India accounts for 36% of world's production. Karnataka is the second largest producer of chillies with 12% share in Indian production after Andhra Pradesh (57% share in Indian Production). Dharwad, Belgaum, Shivamogga, Mysore districts of Karnataka account for majority of total area of production [1,2]. Price of chillies varied between ₹38 to ₹19,878 per Quintal during the study period. Given the importance of the chillies, it remains to be estimated as to what factors affect the price of chillies in study region. The objective of our study is to quantify the factors that affect the price of chillies. It is hypothesized that price differs significantly between varieties and across markets even after controlling for quality characteristics. We estimate a hedonic price function using least squares estimators after appropriate adjustments for heteroscedasticity. Results from our model indicate that with every 1% increase in arrivals, the price of chillies increased by 0.05%. Also, market specific effects, seasonality, are statistically significant determinants of price.

Dried chillies are consumed for their taste, color and the oleoresin content. Dried Powder is consumed directly in the Indian cuisine for its spicy taste. Color and Oleo resins are extracted for Industrial purposes such as in cosmetics and dyes. Byadgi variety is consumed for its mild spicyness and rich color. ASTA color value is 159.9 and the Capsaicin content is 0.59%. Guntur variety is consumed for its pungency. The fruit is short, thick and red. ASTA color value is 32.11 and the capsaicin content is 0.226% [3].

This study uses a Cross sectional, analytic study design. Data is a market level panel data set published by Ministry of Agriculture at APMC *Krishimarata Vahini* website and it spans over fifteen-year period from 2002 to 2017. This paper is organized as follows –Section on Literature review is followed by a section on Methodology. The results section presents the results obtained, followed by conclusions. There is an extensive literature on hedonic price analysis. Chilli prices exhibit significant price volatility over time and across markets [4]. We estimate our model after log transformation on the dependent variable.

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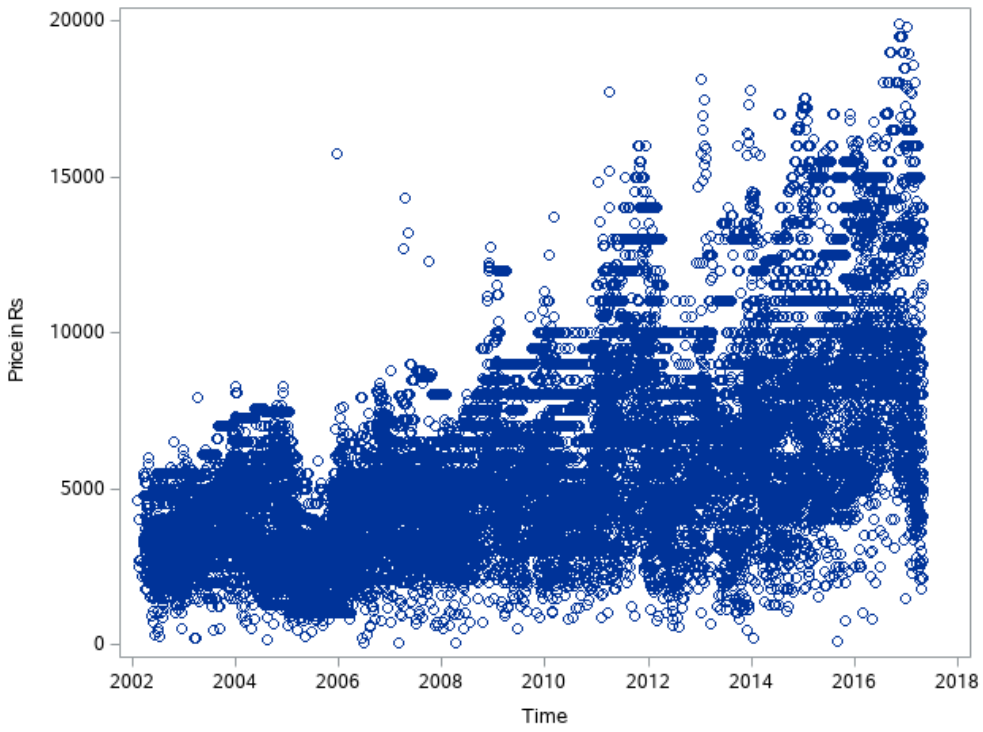
Seasonality in prices is also an important aspect [5]. Month of March received highest prices while September received lowest price. The variations in prices are not irregular [6]. We account for the variations by month specific dummy variables. Grades of chillies also differ across markets [1]. In [7,8] the authors compared the most commonly used model specifications for the price function in the case of computer industry. Log-log specification performs better compared to other specifications. Following the literature, we specify hedonic price model with variables measuring quantity, qualitative characteristics and seasonality.

2. Methodology

This study uses a cross sectional, analytic study design. Data is a market level panel data set published by Ministry of Agriculture at APMC *Krishimarata Vahini* website and it spans over fifteen-year period from 2002 to 2017. We estimate a regression model with Least Squares estimates and heteroscedasticity consistent White's standard errors. Description of Variables used in the study is given below.

Figure 1. Price of Chilies over time



Dependent variable of the study is Price. The prices are nominal and reported are per quintal. Price varies from a minimum of ₹38 (Sringeri market) and a maximum of ₹19,878 (at Hubli market). Mean price was ₹6060 with a standard deviation of ₹3258. It can be observed from these statistics that the coefficient of variation is around 53.7%. Mean prices across markets also differ. Higher mean prices were observed in Managalore, Bangalore markets compared to other markets such as Byadgi. Chillies of average grade received a higher mean price than other grades. Observed mean price also differed over time. An increasing trend can be observed (Figure 1) over time from 2002 to 2017. The volatility of the price has also increased over time. Seasonality is also an important factor affecting the price. It can also be observed that mean prices are different between peak arrival period and lean period.

Chillies arrivals (in quintals) also exhibit seasonality. Over 82% of all arrivals occur in the period from December to April each year. Peak arrivals could be observed in February (22.7%), followed by March (22%). Lean period is June to October accounting for 10% of all arrivals. Mean of arrivals is 326 with a standard deviation is 1552 quintals. Arrivals quantity is treated as exogenous in this study, as the production is dependent on the planted crop, which is done much ahead of marketing time.

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Table 1. Descriptive statistics and brief definitions of variable used in the study

Variable	Definition	Min	Max	Mean	Std Dev
modalp	Nominal Price in Rupees	38	19878	6059.8700	3258.1500
Arrivals	Quantity of Chillies arriving at Market in quintals	0	63000	325.7615	1552.4600
byadgi	Dummy variable. Value =1 if Variety is Byadgi, else 0	0	1	0.2567	0.4368
guntur	Dummy variable. Value =1 if Variety is Guntur, else 0	0	1	0.1909	0.3930
local	Dummy variable. Value =1 if Variety is Local, else 0	0	1	0.2511	0.4337
avg	Dummy variable. Value =1 if Grade is Average, else 0	0	1	0.5946	0.4910
medium	Dummy variable. Value =1 if Grade is Medium, else 0	0	1	0.0868	0.2816
small	Dummy variable. Value =1 if Grade is Small, else 0	0	1	0.0021	0.0460
large	Dummy variable. Value =1 if Grade is Large, else 0	0	1	0.0029	0.0541
mblr	Dummy variable. Value =1 if Market is Bangalore, else 0	0	1	0.3457	0.4756
mbdg	Dummy variable. Value =1 if Market is Byadgi, else 0	0	1	0.1637	0.3700
nov	Dummy variable. Value =1 if Month is November, else 0	0	1	0.0802	0.2716
dec	Dummy variable. Value =1 if Month is December, else 0	0	1	0.0955	0.2939
jan	Dummy variable. Value =1 if Month is January else 0	0	1	0.0949	0.2930
feb	Dummy variable. Value =1 if Month is February, else 0	0	1	0.0945	0.2926
mar	Dummy variable. Value =1 if Month is March, else 0	0	1	0.0975	0.2967
apr	Dummy variable. Value =1 if Month is April, else 0	0	1	0.0769	0.2664
sep	Dummy variable. Value =1 if Month is September, else 0	0	1	0.0728	0.2598

Major markets for chillies in Karnataka are Byadgi with a total of 74.6%, Bangalore 9.3%, Hubbali with a market share of 8.3% and all other markets with a share of 7.6%. Size of the market can affect the price. We specify dummy variables to capture this effect. For example, dummy variable representing Byadgi market *mbdg* is defined as taking a value of 1 if the market is Byadgi or 0 other wise. Similarly, dummy variables *mblr* is defined to represent Bangalore market.

Table 2. Parameter estimates from least squares estimation on data pooled across time and space

Variable	Parameter Estimate	Pr > |t|	VIF
Intercept	8.3758	<.0001	0
Lnarrival	0.0553	<.0001	1.4196
Byadgi	-0.1090	<.0001	1.6052
Guntur	-0.2843	<.0001	1.4161
Local	-0.4971	<.0001	1.7786
Avg	0.4566	<.0001	1.3695
Medium	-0.0468	<.0001	1.4668
Small	-0.3105	<.0001	1.0078
Large	0.3738	<.0001	1.0105
Mblr	0.0820	<.0001	1.2643
Mbdg	-0.4328	<.0001	2.0054
Nov	0.0804	<.0001	1.1118
Dec	0.0503	<.0001	1.1329
Jan	0.0343	<.0001	1.1397
Feb	0.0099	0.2104	1.1430
Mar	-0.0019	0.7995	1.1466
Apr	-0.0477	<.0001	1.1125
Sep	0.0170	0.0544	1.1016
Dependent Variable	ln Price		
Adj R Square	0.4544		

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Price of chillies is also dependent on the variety. Byadgi is a popular variety, with a share of 6% of total arrivals. However, the numbers of arrivals at markets of Byadgi chillies are far more than any other variety. Kaddi variety has a share of 49.3%, Guntur variety with 24.5% of all arrivals observed in our data sample. We specify dummy variables to represent the varieties. For example, dummy variable representing Byadgi variety *byadgi* is defined as taking a value of 1 when the variety is Byadgi or 0 other wise. Similarly variables *Guntur, local* are defined. It is hypothesized that the parameter estimates are significantly different from each other.

Grade of chillies is another important factor affecting price (for definition of variables see Table 1). Chillies graded as Average account for 63% of total arrivals; Medium 24% and others remaining 11%. We specify dummy variables to represent these grades. For example, dummy variable representing Average grade –*Avg* is defined as taking a value of 1 when the grade is Average or 0 other wise. Similarly variables *Medium, small, and large* are defined. It is hypothesized that the parameter estimates are significantly different from each other.

3. Estimation

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{\varepsilon} \qquad \text{Equation 1}$$

Model given in Equation 1 is estimated with data pooled over time. Dependent Variable $\boldsymbol{y}$ is price of chillies and $\boldsymbol{X}$ is the vector of independent variables as described above. $\boldsymbol{\beta}$ is the parameter vector and $\boldsymbol{\varepsilon}$ is the error term. Given the panel nature of the data, heteroscedasticity is to be expected. Estimation is done by least squares estimator with heteroscedasticity consistent Whites estimates for co-variances. Model diagnostics such as normality tests, autocorrelation tests were calculated. Multicollinearity was diagnosed using Variance Inflation Factors (VIFs). VIF value greater than 10 is an indicator of multicollinearity. Estimation was done in *SAS* using Base *SAS* and *SAS SQL* routines. Elasticity of parameter estimates was estimated by calculating the elasticity at mean of variables.

4. Results

Parameter estimate on *arrivals* is positive and statistically significant. Elasticity of *arrivals* is 0.05538, indicating that with a 1% increase in *arrivals* the price increases by 0.05%. Parameter estimate of intercept is 8.3758, positive and statistically significant. Parameter estimate on *byadgi* is -0.1090 negative and statistically significant. Parameter estimate on *Guntur* is -0.1090 negative and statistically significant. Parameter estimate on *local* is -0.4971, negative and statistically significant. These results indicate that *byadgi* variety received a higher price than *guntur* and *local* varieties. *Guntur* variety received higher price than local variety.

Parameter estimates on quality of chilies were also statistically significant. Parameter estimate on *average* size is higher than the *medium* size. However, the parameter estimate of the variable *large* size is lesser than the estimate on the variable *average*. These results indicate that price differs significantly with size of chilies.

Parameter estimates on market location were also significant, indicating that prices were significantly different in different markets even after controlling for quality characteristics. *Mblr* is positive and significant indicating that higher prices were received at Bangalore market compared to Byadgi market or any other market in the study region. Price received at Byadgi market is less compared to that at Bangalore market.

Parameter estimates on month of sale were also statistically significant. Magnitude of the parameter estimates consistently decrease from November to April. Parameter estimate on *Nov* is highest and the estimate on *Apr* is smallest among all the months. Parameter estimate on *Sep* is higher than most months.

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5. Conclusion

Price of Chillies depends on its quality characteristics. This study developed a model to explain the impacts of quality differences on price. The model is estimated using Least Squares estimates with Whites estimates for standard errors. The results from our model indicate that prices differ significantly across markets even after controlling for quality characteristics. Bangalore market received higher prices than Byadgi market or any other market in the study area. Prices at Byadgi market are higher compared to all other markets. Quantity of arrivals had a positive impact on prices. Our model indicates that for every 1% increase in arrivals, the prices increased by 0.05%. The positive relation between price and quantity is consistent with economic theory as the arrivals from the supply side of the market. Prices of different varieties are significantly different from each other. Byadgi variety received a higher price compared to Guntur variety or local variety. Guntur variety received higher price compared to local variety. Price differences reflect the preferences of consumers and/or producers for these varieties. Chillies of average size received highest price compared to large, medium, or any other size. Prices of small size chillies received less price as expected.

Seasonality is also a significant determinant of price. Price received declined consistently across the months from November to April. This period is the peak arrival period of the year. Month of September also received a significantly higher price than the rest of the year, but less than that of November, December and January months, though it is the period of least arrivals. The results from the model could be of use in designing optimum marketing policies. Further research in this area could explore the regional impacts of price formation.

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