NSOU-OPEN JOURNAL **ISSN: 2581-5415**
Vol.4 No.1 (January 2021)
A multidisciplinary Online Journal of Netaji Subhas Open University, INDIA

Seasonal Variations in Market Arrivals and Retail Price Inflation of Onions An Analysis

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Abstract

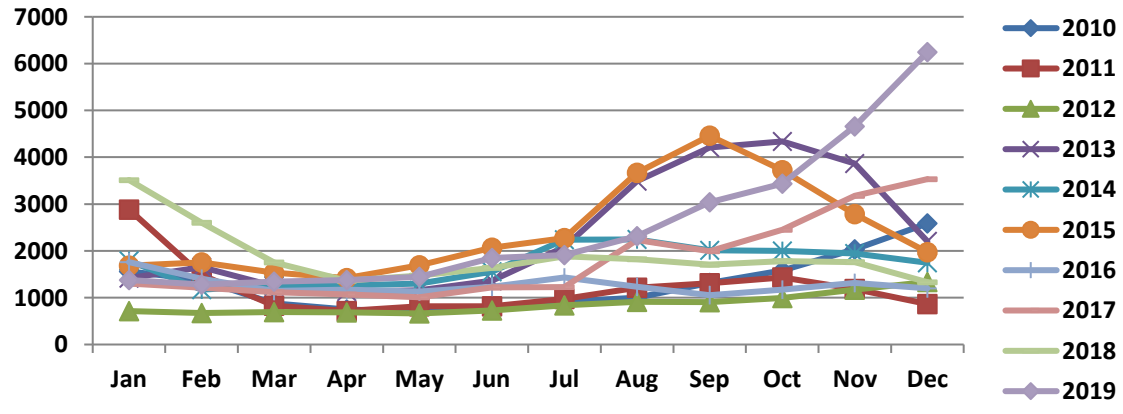
This paper examines variations in monthly arrival patterns of onions during the ten year period of 2010 to 2019.The objective is to assess why market arrival of onions have varied during different months of these years. The paper's other important aim to compare instabilities in onion arrivals with its price fluctuations and understand how strongly these are interrelated. Data for analysis was collected from the websites of AGMARKNET and National Horticultural Board. Statistical tools like Coefficient of Variation, Ray Instability Index, Pearson's Correlation coefficient, Seasonal Indices, Intra-Year Price Rise and Average Seasonal Price Variation have been used for the analysis . The paper found that prices have tended to inflate during the second half of these years when onions from the Rabi season start depleting and the Kharif harvest has not entered the market. The other important finding is that onion arrivals are very weakly correlated with its price. The more than proportional increase in prices raises doubts of hoarding and price manipulations by market intermediaries. The paper suggests improving onion storage infrastructure, improving weather forecasting, encouraging the use of dehydrated onions and acting strongly against hoarding and collusion among traders as a remedy for the situation.

Keywords: Agro marketing, Collusion, Hoarding, Market arrivals, Onions, Seasonal Index

Introduction

Among the food crops, onions have the highest price volatility (Setiya and Muthuselvan (2018)). During the ten year period: 2010 to 2019, retail prices of onions varied widely in different months of the year. Every year onion prices have increased exorbitantly particularly in the second half of the year. The price rise has been more pronounced in the years 2013, 2015, 2017 and 2019 (Figure1).

Figure1: All India monthly average wholesale prices (Rs per quintal)



Source: *http://agmarknet.gov.in/PriceTrends/SA_TotalArrival.aspx*

Spike in wholesale prices is often transmitted to its retail prices. In most major Indian cities, there has been a wide variation between highest and lowest retail prices of onions. In India there are three

seasons for growing onions: Rabi, Kharif and Late Kharif. The three crop seasons differ in terms of their time of harvesting (PIB (2019)):

- Rabi: March to June
- Kharif : October to December
- Late Kharif: January to March

Although demand for onion prevails throughout the year, new onions are available only in the months when crops are harvested after a cropping season. Hence, yearly fluctuations in onion prices may be deemed to be as a result of instabilities in its supply. Supply of onions is represented by its market arrivals. Market arrival of onions varies between different months of a year. Onion arrivals in the first half of the year are comparatively higher than the second half when arrivals plunge significantly. Since onion demand persists year long but harvesting takes place only in certain months of the year, market arrivals are weak in the months before harvesting but gains strength as harvesting begins.

A sharp increase in onion prices between September and December has become a regular occurrence in the last decade (Figure1). The price fluctuation is almost always blamed on crop destruction by unseasonal rains leading to restricted onion supplies to the markets. Months of the first half of the year are characterised by high arrivals and low prices. Onwards of September, arrivals tend to slow down and prices escalate dramatically. This paper analyses variability trends of market arrivals of onions for each month of the years between 2010 and 2019. The objective is to compare variations in onion arrival patterns in these years during periods of high and low onion prices.

Objectives

The paper's objectives may be summarized as under:

i. To understand how onion arrival patterns vary in different months of the year
ii. To explore causes that bring about variations in market arrivals of onions
iii. To compare and analyse fluctuations in wholesale onion prices with respect to variations in market arrivals of onions.

Data and Methods

Data sources

The paper uses secondary data from the following sources:

- Monthly time-series data on all India arrivals and average wholesale prices of onions (2010to2019) from the website of AGMARKNET (https://agmarknet.gov.in/)
- Monthly time-series data on arrivals and average prices (wholesale and retail) of onions in fourteen metropolitan cities of India for the years 2010 to 2019 was downloaded from the website of the National Horticultural Board (NHB).

Seasonal Indices

For analysing seasonal influences on onion arrivals and prices, seasonal indices were constructed by applying the "ratio of moving averages" method on monthly time series data. As per the multiplicative model of time series:

$$\mathbf{Y_t = Trend_t \times Seasonal_t \times Irregular_t} \ldots\ldots\ldots\ldots \mathbf{(1)}$$

Where,

- Y_t=Actual value of the time series at time 't'
- $Trend_t$=Trend value at time 't'
- $Seasonal_t$=Seasonal index at time 't'
- $Irregular_t$=Irregular index at time 't'

To identify the "trend" component, 12-month moving averages were first calculated from the monthly time series data. Thereafter, "centred moving averages" were calculated from the moving averages. Dividing both sides of equation (1) by the "trend" component gives the combined "seasonal-irregular" effect in the time series:

$$\frac{\text{Y}}{\text{Trend}} = \frac{\text{Trend} \times \text{Seasonal} \times \text{Irregular}}{\text{Trend}} = \text{Seasonal} \times \text{Irregular}$$

Seasonal-irregular values greater than 100 indicate "above the trend" effects, while values lower than 1 indicates "below the trend" effects. The "irregular" or "random" component in the seasonal-irregular values is eliminated by computing their medians. This gives the "unadjusted seasonal indices". Where the sum of these indices is not equal to1200, each index is multiplied by a "correction factor":

$$\text{Correction factor} = \frac{1200}{\text{Sum of unadjusted seasonal indiices}}$$

Coefficient of Variation (CV)

Coefficient of Variation (CV) measures how large a data set's standard deviation (SD) is relative to its mean and is expressed as a percentage.

$$\textbf{Coefficient of Variation}(\textbf{CV}) = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100$$

CV has been used as one of the means of estimating volatility in onion production, yield, cultivation area, market arrivals and prices.

Instability Index

In addition to CV, several authors have also used instability indices to analyse instability in agricultural time series data. Commonly used instability indices are Cuddy Della-Velle Index (Cuddy and Della-Velle(1978)), Coppock's Index and the Ray Instability Index (Ray(1983)). This paper has used the Ray Instability Index:

$$\textbf{Ray Instability Index}(\textbf{RII}) = \text{Standard Deviation}[\log\left(\frac{\text{Yt}+1}{\text{Yt}}\right)]$$

Where**,**

- Y_t = Time series data for the current year
- Y_{t+1} = Time series data for the next year

RII is unit free and robust. If there is no deviation from the underlying trend, $\frac{\text{Yt+1}}{\text{Yt}}$ will be constant and its standard deviation will be zero. Where the time series has greater instability, $\frac{\text{Yt+1}}{\text{Yt}}$ fluctuates more and its standard deviation will also be more (Chand and Raju(2009)). Hence, low RII indicates less instability and vice versa.

Intra-Year Price Rise (IPR) and Average Seasonal Price Variation (ASPV)

To assess intra-year fluctuations in onion prices in the major cities and on an all India basis, the following two measures were used:

$$\textbf{IntraYear Price Rise } (\textbf{IPR}) = \frac{\text{HSPI} - \text{LSPI}}{\text{LSPI}} \times 100$$

$$\textbf{Average Seasonal Price Variation } (\textbf{ASPV}) = \frac{\text{HSPI} - \text{LSPI}}{\frac{\text{HSPI} + \text{LSPI}}{2}} \times 100$$

Where:

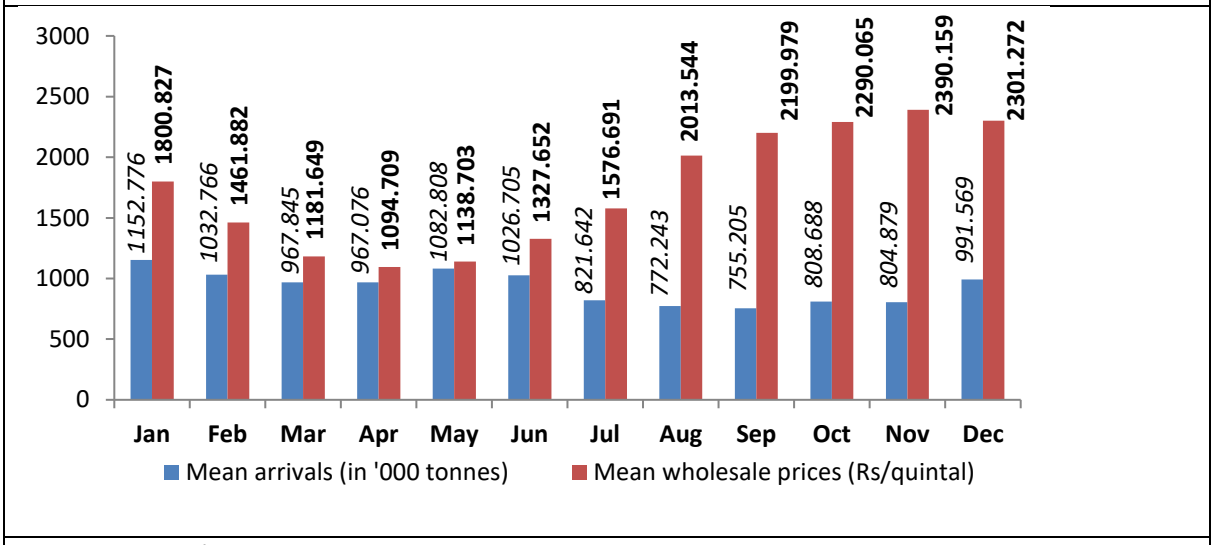
- HSPI=Highest Seasonal Price Index
- LSPI=Lowest Seasonal Price Index

Results and Discussions

Analysis of monthly onion arrival patterns

To get an estimate of onion supplies and prevailing prices during the study period (2010 to 2019), average of monthly arrivals and wholesale prices are computed (Figure2). Here, the average of onion arrivals for a particular month was calculated by taking that month's data from each of the years from 2010 to 2019. For example, average onion arrivals for January (1152776 tonnes) was calculated using monthly arrival data of January 2010, January 2011 … January 2019. Averages of the other months were calculated similarly.

Figure2: Average monthly arrivals (in '000 tonnes) and wholesale prices (Rs/quintal)

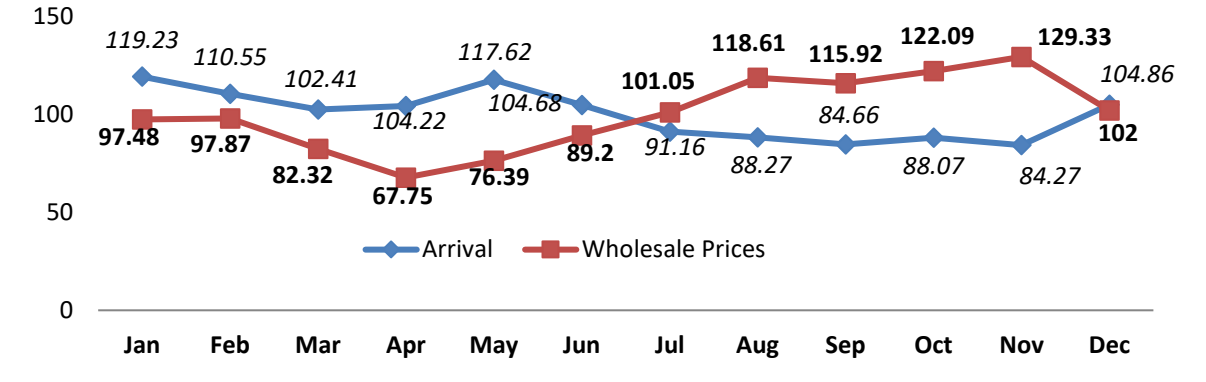


Source: *Author's computation*

Based on levels of onion prices, the months of the year can be divided into two phases. In the consecutive months of the first half of the year (January to May), average prices have shown a falling trend. In the months of second half of the year, a rising trend in wholesale prices is seen from June to November before decreasing slightly in December.

Similar to onion prices, average arrivals too have demonstrated differing trends in the two halves of the year. Months in the first half of the year (January to June) have had higher levels of average onion arrivals than in the months of the second half (July to November). Average arrivals in December have been comparatively higher. Seasonal Indices (SI) of monthly onion arrivals and prices (Figure3) also indicates that onion arrival rates have been higher in the first half of the year but tends to decline in the second half. SI of arrivals are above average (>100) from January to June and below average (<100) from July to November. It again rose above the average (100) in December. The months of January to May had the highest levels of SI for arrivals. The highest SI for arrivals was in January (119.23) followed by May (117.62).

Figure3: Seasonal indices of monthly arrivals and wholesale prices



Source: *Author's computation*

The harvesting pattern of onions is the primary reason for its high arrival rates in the first six months of the year. Between January and June, crops of the late Kharif and Rabi harvests from a number of Indian states enter the market. These happen to be the months when the late Kharif and Rabi harvest of Maharashtra, Karnataka and Andhra Pradesh - India's largest onion producing state- as well as several other secondary producers enters the market (Table1). 60% of India's onion supplies are produced in the Rabi season. Together with the late Kharif harvest, this brings an abundant supply of onions in the markets.

Table1: Months of onion availability

States	**Cropping season**	**Months of onion availability**
Maharashtra, Gujarat	Late Kharif	January – March
	Rabi	April – June
	Kharif	October – December
Tamil Nadu, Karnataka, Andhra Pradesh	Rabi	March – April
	Early Kharif	August
	Kharif	October – November
Rajasthan, Bihar, Uttar Pradesh, Haryana, Punjab, West Bengal, Orissa	Rabi	May – June
	Kharif	November – December

Source: *http://apeda.in/agriexchange/Market%20Profile/one/ONION.aspx*

Higher market arrivals of onions also are a consequence of its perishable nature. Onions are semi-perishable in nature and storage losses may range from 30% to 40%. During natural calamities it may even exceed 40% (ICAR). Due to financial reasons, onion storage facilities are concentrated in the hands of the traders and not the farmers (Chengappa et al(2012)Pg40). Most onion growers are small and marginal farmers (Chengappa et al(2012)Pg74). Post harvest, they are compelled to sell their produce immediately at various Agricultural Produce Marketing Committee (APMC) markets. One of the primary reasons behind this is the lack of adequate facilities for safely storing onions and preventing these from decaying. Other compulsions are financial in nature. These include immediate need for cash to pay off earlier loans, meeting domestic expenses or commitment to money lenders and for buying farm inputs for the next crop season etc (Chengappa et al(2012)Pg22). Thus, the farmer's need for avoiding post harvest losses and their financial compulsions come together to raise inflows of onions in the markets.

Falling arrival patterns in the months from July to November can be partly attributed to the harvesting patterns of onions. Unlike in the first six months of the year, the months of July to September does not have any major harvesting season that can bring significant onion supplies to the market (Table1). This depletes market supplies in comparison to the first half of the year.

Lack of supply of fresh onions after July makes it imperative to depend on stored onions. Onion demand between July and October is chiefly met by onions stored from the Rabi season till the Kharif harvest starts arriving in the market (PIB(2019)). India is deficient in modern facilities and infrastructure for onion storage, making onions more vulnerable to post harvest and storage losses. Although cold storage of onions can improve their shelf life, it is not considered viable in India due to its exorbitantly high costs. Sophisticated infrastructure for onion storage (like ultra-low oxygen controlled atmosphere) is technically viable but not financially due to high costs and power shortages (Setiya and Muthuselvan(2018)). The Kharif harvest arrives in the market in the last quarter of the year- October to December (Table1). Kharif onions have poor storability (Gopal(2014)) and show the highest incidence of sprouting and rotting. Both of these are lower for Late Kharif onions. Rabi onions are better in terms of storage as compared to Kharif and late Kharif onions (Tripathi and Lawande

(2019), Setiya and Muthuselvan(2018)) and can be stored safely for 5 to 6 months (Gopal(2014)). Although Rabi onions are better suited for storage, inadequate storage facilities sometimes make it difficult to store these for the full duration of their storage potential. In that case, it may not be possible to fully support onion demand from stored Rabi onions, causing scarcity in the months immediately before the arrival of the Kharif harvest.

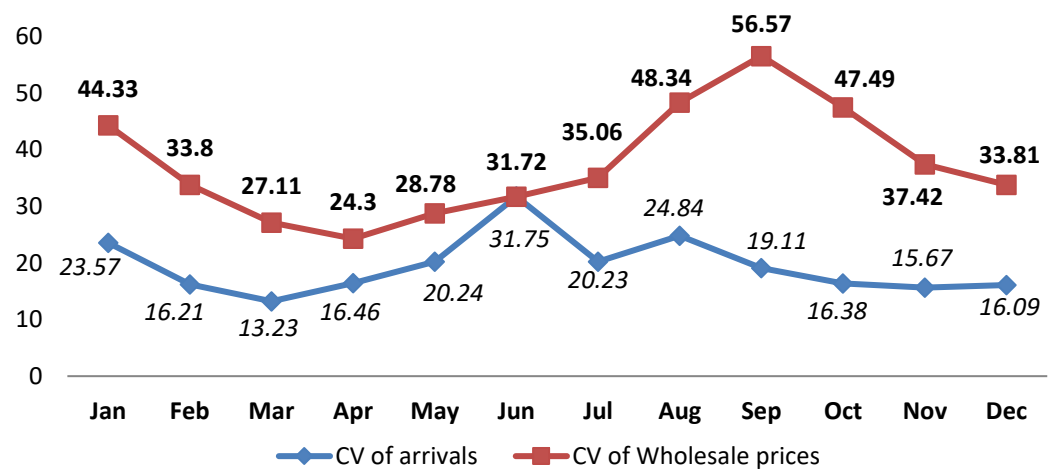
In recent years, onion growing areas of Maharashtra, Karnataka and Telengana have witnessed heavy rains between September and November. This coincides with the period when the stock of stored Rabi onions starts depleting and the Kharif crop is yet to be harvested. Unseasonal rains cause un-harvested onions to soak in water thus becoming more susceptible to rotting (DNA(2015)). Where storage infrastructure is inadequate, such untimely rains even cause storage losses in the already diminishing stock of Rabi onions. The years in which un-harvested (Kharif) and stored (Rabi) onions are damaged by rains, market arrivals are severely strained in the latter half of the year.

Intermediaries in the onion supply chain such as commission agents; wholesalers etc have firm control over onion trade and prices. Utilizing their power over the markets, intermediaries get involved in intentional hoarding of onions. After sourcing the onions from the farmers, the traders stored the onions instead of releasing the stocks to the retail markets (Chengappa et al(2012)). The objective is to create an artificial scarcity in the market in order to raise market prices.

Comparing onion arrival instabilities and its price fluctuations

In Figure4, Coefficient of Variation (CV) of onion arrivals and prices are computed. Here CV for a particular month was calculated by taking that month's data from each of the years from 2010 to 2019. For example, the CV of onion arrivals for January (23.57%) was calculated using monthly arrival data of January 2010, January 2011 … January 2019. CVs of the other months were calculated similarly.

Figure4: CV of monthly arrivals and wholesale prices (in %)



Source: *Author's computation*

Instability in monthly arrivals shows a falling trend between (i) January and March, (ii) June and July and (iii) August and November. Rising instability trends were noted between (i) March and June, (ii) July and August and (iii) November and December.

Rise and fall in instability trends follows the times of onion harvest and the volumes of market arrivals from a cropping season. The falling arrival instability between January and March coincides with the late Kharif cropping season. Instabilities are at their peak at the start of the cropping season, i.e. in January (23.57%). Market arrivals from this season are also at their highest in January (Figure2). Instabilities start decreasing as the season progresses and market arrivals gradually deplete (Figure2). The rising trend between March and June follows the Rabi season. Unlike the late Kharif season, the Rabi season shows a rising trend of instabilities as the season progresses. That happens because, the

arrivals from the Rabi season follows different timelines in different states. As arrivals from one set of states starts decreasing, arrivals start picking up from other states (Table1). June has the highest arrival instability when the Rabi season is at its peak. CVs of arrivals decline in July and again climb in August. It may again be noted that in August the early Kharif harvest arrives from Tamil Nadu, Karnataka and Andhra Pradesh. Declining arrival instabilities from August onwards coincides with the period of falling onion arrivals. CV of arrivals again rises slightly in December when Kharif harvests arrive. However Kharif is a secondary cropping season and crops are often hit by unseasonal rains hindering market arrivals. So supplies from the Kharif season are normally lower than the Rabi season. Instabilities in wholesale prices have shown rising trend from April to September. Falling trends are noticed during January to April and from September to December. Rising price instabilities have followed the trends of rising wholesale prices (Figure2). The months with highest and lowest price instability was September and April respectively (Figure4). This corresponds to the Late Kharif (January to March) and Kharif (October to December) harvest with a lag of one month.

Instability trends of both arrivals and wholesale prices have followed the same general trend. However prices have shown much higher fluctuations than arrivals. This is supported by the findings of the Ray Instability Indices for monthly arrivals and wholesale prices:

Table2: Results of Ray Instability Indices for monthly arrivals and wholesale prices	
Monthly arrivals	**Monthly wholesale prices**
0.1833438	0.2100486
Source: *Author's computation*	

Instability in monthly arrivals of onions was 0.1833438 (i.e. 18.33%) compared to 0.2100486 (i.e. 21%) for monthly wholesale prices. All India Intra-Year Price Rise (IPR) and Average Seasonal Price Variation (ASPV) during the study period (2010-2019) was 90.89% and 62.49% respectively. In many of India's major cities, both IPR and ASPV are much higher.

This indicates high rate of price rise during the year and seasonal variation of prices.

Table3: Intra-Year Price Rise (IPR) and Average Seasonal Price Variation (ASPV)				
	IPR (%)		**ASPV (%)**	
	Wholesale Prices	**Retail Prices**	**Wholesale Prices**	**Retail Prices**
Ahmadabad	134.37	75.73	80.37	54.93
Bangalore	140.14	98.28	82.40	65.90
Bhubaneshwar	103.54	75.22	68.22	54.66
Chandigarh	106.11	86.05	69.33	60.16
Chennai	104.97	82.45	68.84	58.38
Delhi	118.70	72.03	74.49	52.96
Hyderabad	75.38	78.82	54.75	56.54
Jaipur	113.77	99.26	72.52	66.34
Kolkata	127.24	82.09	77.76	58.20
Lucknow	79.37	88.56	56.82	61.38
Mumbai	132.14	118.45	79.57	74.39
Bhopal	123.77	111.97	76.46	71.78
Patna	105.18	72.33	68.93	53.12
Ranchi	163.55	107.23	89.97	69.81
All India	90.89	-	62.49	-
Source: *Author's computation*				

The severity of the intra-year price fluctuations in India's large cities is borne out by the fact that twelve out of fourteen cities included in this study had wholesale price IPR greater than 100%. Retail price IPRs in five cities was greater than 95%. It's worth noting that despite being the capital of a major onion producing state – Karnataka, Bangalore has one of the highest wholesale IPR: 140.14%. The retail price IPR: 98.28% too is extremely high.

During most years of the study period, arrivals and prices have had negative correlation.

Table4:Pearson's correlation coefficients (r)			
Year	**R**	**Year**	**R**
2010	-0.30978675	2015	-0.673647826*
2011	-0.115097732	2016	0.412317531
2012	-0.583283984*	2017	-0.680811329*
2013	-0.568693044**	2018	-0.062313777
2014	-0.65962719*	2019	-0.826145509*
Source: *Author's computation*			

* Significant at 5% ** Significant at 10%

The findings of this paper regarding the relationship between onion arrival rates and its prices are in line with the observations of Chengappa *et al*(2012) and several media reports. The outcomes obtained in the present paper lend support to the claims of the possibility of hoarding by powerful market intermediaries to create artificial shortages in the market and inflating prices. Market intermediaries in the onion value chain have considerable control over the onion trade and often leverage it to manipulate prices to their advantage Chengappa *et al*(2012).

Conclusion

Onion prices show a marked escalation in the latter half of the year. The critical time period is when Rabi onions in store are depleting and Kharif crop is in the fields, yet to be harvested. Adequate steps should be taken to improve conditions for onion storage so as to avoid storage losses to the Rabi harvest. Also measures should be taken to better predict untimely rains. Another possible measure may be to encourage the use of dehydrated onions so that storage complexities can be avoided. Equally important is to take steps to prevent collusion among market intermediaries to check arbitrary price fixation and hoarding.

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