**Abstract**:

Supply demand imbalance, natural calamities etc. may not always be the reason behind the rise in the price of a commodity. It may be a consequence of artificial supply deficit planned intelligently by traders’ nexus for profiteering through manipulation of supply of commodity and hence indirectly controlling their prices. Our attempt is to locate such hikes in prices which seem suspicious (we call them anomalies).

Here, we try to find characteristics of these anomalous situations using retail, wholesale and arrival information of onion.

**Introduction:**

Onion is a staple ingredient for almost every Indian kitchen and hence its demand is almost constant throughout the year but not the supply. In order to supply onions throughout the year, they are stored during harvest and released into markets in lean seasons.

Its importance can be well estimated by the fact that it is one among few essential commodities and often rise in its price has resulted into downfall of state and central government.

Because of its utter importance, traders often find option of making big profits by creating artificial shortage attractive. Traders often indulge in excessive hoarding practice and faking crisis situation, resulting hike in demand and so in their price.

Under APMC act, mandis were established at different places across country so that farmers can sell their produce directly in mandi and get good returns (wholesale price). There are around 1500 mandis located in different places across country which log their daily arrival of onion, minimum, maximum, modal selling price per quintal of onion data to AGMARKNET. Retailers purchase from these mandis and sell to end customers at retail price. There are around 70 centres across country which maintains retail price of onion on Ministry of consumer affairs website.

**Data and Methodology:**

We have following data:

1. Daily wholesale price of onion for 1514 mandis
2. Daily arrival of onion information for 1514 mandis
3. Daily retail price of onion for 76 centres
4. Dates and location for hoarding reports from news articles

Analysis of news articles indicated following to be the parameters which give hints about possibility of hoarding:

* Difference between wholesale and retail price goes above 100% with respect to the wholesale price
* There is more than 100% hike in the retail prices since past 2 weeks
* Arrival of current year is more compared to last year, but still wholesale rates are higher this year than the previous year

Following on the grounds of news articles, comparison of wholesale and retail price; wholesale and arrival of a location was needed. But the set of mandis and set of centre locations were disjoint. So, the task was to map every mandi to nearest possible centre location assuming retail price at a centre are dependent on the arrival and wholesale price of nearby mandis and also has no effect of the other mandis as well. Also, we have assumed that mandis falling into the region of a centre do not transact among themselves.

Task1:

Voronoi Diagram is used to map every mandi to nearest possible centre. The centres with retail data were considered fixed points and country was divided into 76 regions. All the mandis falling in that region are mapped to the respective centre.

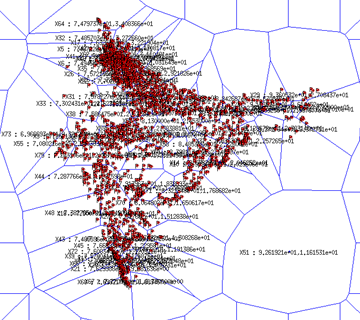


Figure 1 Voronoi Diagram

After all the mandis are mapped to their nearest centre, wholesale and arrival at every centre is computed. Wholesale price at centre is average of modal price of all mandis in its region and arrival was computed as the sum of the arrival at the mandis in its region. While calculating the wholesale price, the distance between centre and the mandi was not considered.

Task2:

Corresponding to every date and location of hoarding news report, values like current year arrival, last year arrival, Percentage difference in wholesale- retail etc. were computed. Following table resulted from these computations.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **News Date** | **Place** | **RP** | **WP** | **Arrival**  **This**  **Year** | **Arrival**  **of Last**  **Year** | **Average**  **Arrival**  **of all previous non-hoarding**  **years**  **Over Same**  **time per day** | **Wholesale**  **Last Year** | **Average**  **Wholesale**  **Of the**  **Previous**  **non-hoarding Years** | **Retail**  **Last**  **Year** | **Average**  **Retail of**  **Previous**  **non-hoarding Years** | **Average**  **Arrival**  **This year per day** | **Retail**  **Price**  **Before**  **1 week** | **Retail**  **Price**  **Before**  **2 weeks** |
| 22/12/2010 | Nashik - MH | 72 | 36 | 51661.4 | 96398.8 | 5044.35 | 14 | 9 | 22 | 11.75 | 3700.93 | 44 | 40 |
| 23/12/2010 | Delhi | 60 | 29 | 14712.73 | 18496.6 | 741.26 | 13 | 8.29 | 22 | 12.21 | 1050.9 | 30 | 31 |
| 12/01/2011 | Mumbai | 63 | 28 | 48185.9 | 96734.4 | 5213.54 | 11 | 11 | 21 | 11.01 | 4015.49 | 52 | 53 |
| 23/07/2013 | Mumbai | 37 | 22 | 91808.3 | 107240.2 | 4661.95 | 6.45 | 6.46 | 15.18 | 9.31 | 6120.55 | 32 | 32 |
| 14/08/2013 | Banglore | 60 | 45 | 4990 | 18894 | 1027.92 | 8 | 8 | 11 | 11.36 | 998 | 25 | 25 |
| 17/08/2013 | Delhi | 70 | 43.36 | 26142.83 | 18648.61 | 890.8 | 7.3 | 7.45 | 17 | 11.85 | 1867.345 | 45 | 38 |
| 18/08/2013 | Gandhinagar | 50 | 42 | 6269.6 | 10575.48 | 424.42 | 6.91 | 7.03 | 15 | 8.02 | 447.82 | 40 | 32 |
| 18/09/2013 | Delhi | 70 | 51.1 | 24091.6 | 15380.55 | 957.98 | 7.3 | 8.46 | 15 | 11.968 | 1720.82 | 58 | 53 |
| 23/10/2013 | Delhi | 78 | 44.18 | 24764.55 | 14601.75 | 839.09 | 8.23 | 10.03 | 18 | 16.65 | 1768.89 | 63 | 59 |
| 20/06/2014 | Mumbai | 29 | 14.13 | 75106.2 | 86044 | 4394.729 | 14.79 | 5.64 | 26 | 8.28 | 4694.13 | 29 | 27 |
| 08/07/2014 | Kerala | 32 | 30.46 | 1133.9 | 849.45 | 26.3 | 28.25 | 17.78 | 65 | 34.36 | 11.44 | 30 | 30 |
| 20/07/2014 | Hydrabad | 28 | 19 | 206.3 | 840.2 | 10.85 | 18.78 | 9 | 26 | 8.6 | 10.85 | 26 | 26 |
| 05/06/2015 | Bhubaneshwar | 28 | 23 | 849.6 | 905.5 | 302.26 | 16.8 | 8.99 | 17 | 11.06 | 60.68 | 20 | 20 |

**Table 1: News Analysis – Part I**

\*RP-retail Price,\*WP-Wholesale Price

Following table highlights the values from above computed values for every news report which were marked as characteristic of anomaly.

**Table 1: News Analysis – Part II**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| News Date | Place | (Retail - wholesale)% diff wrt wholesale | Spike Compared to last week | Spike Compared to before 2 week | % Diff insum of arrival compared to last year | % Diff in wholesale price compared to last year | % Diff in  avg arrivals compared to previous non-hoarding years |
| 22/12/2010 | Nashik - MH | **100** | 63.63636364 | 80 | -46.40866899 | 157.1428571 | -26.63217263 |
| 23/12/2010 | Delhi | **106.8965517** | 100 | 93.5483871 | -20.45711104 | 123.0769231 | 41.77211775 |
| 12/01/2011 | Mumbai | **125** | 21.15384615 | 18.86792453 | -50.1874204 | 154.5454545 | -22.97958777 |
| 23/07/2013 | Mumbai | 68.18181818 | 15.625 | 15.625 | -14.39003284 | **241.0852713** | 31.28733684 |
| 14/08/2013 | Banglore | 33.33333333 | **140** | **140** | -73.58949931 | 462.5 | -2.910732353 |
| 17/08/2013 | Delhi | 61.43911439 | 55.55555556 | **84.21052632** | **40.18648039** | **493.9726027** | 109.6256174 |
| 18/08/2013 | Gandhinagar | 19.04761905 | **25** | **56.25** | -40.71569328 | 507.8147612 | 5.513406531 |
| 18/09/2013 | Delhi | 36.98630137 | 20.68965517 | 32.0754717 | **56.63679127** | **600** | 79.63005491 |
| 23/10/2013 | Delhi | **76.55047533** | **23.80952381** | **32.20338983** | 69.59987673 | 436.8165249 | 110.8105209 |
| 20/06/2014 | Mumbai | **105.2370842** | 0 | 7.407407407 | -12.71186835 | -4.462474645 | 6.812729522 |
| 08/07/2014 | Kerala | 5.0558109 | **6.666666667** | **6.666666667** | 33.48637354 | 7.82300885 | -56.50190114 |
| 20/07/2014 | Hydrabad | **47.36842105** | 7.692307692 | 7.692307692 | -75.4463223 | 1.171458999 | 0 |
| 05/06/2015 | Bhubaneshwar | 21.73913043 | **40** | **40** | -6.17338487 | 36.9047619 | -79.92456825 |

Retail Price and wholesale price are of the day when news was reported. For calculating the arrival, since arrival of one day cannot reflect the prices much on the same day, we have taken the sum of the arrival over past 2 weeks. So here we have assumed, looking over the news articles, that to see any effect of something, it takes the time span of 2 weeks.

Note that, the retail prices reported by the Government officers are the minimum retail price. So there are cases where retail price reported by news and the one in our database do not match (in those cases the dates are underlined). For e.g. retail price of Gandhinagar on 18/8/2013. News reported 70 Rs./Kg, but we found 50 Rs./Kg. This also states the limitation of data we have.

Digging more into data, we found following:

* **More than 100% difference in wholesale and retail price is not always necessary condition to claim for hoarding:**

We ran a script to find all the dates and location where Percentage difference in retail and wholesale wrt wholesale is more than 100%. Let us take case for Mumbai (As Mumbai is major centre of the Maharashtra, which is the largest producer state in India).

**Year 2006:** We had dates from each month. Out of 365 days of the year, 120 days were reported by query.

**Year 2007:** This query gave quite reasonable output. The range was 26-2-2007 to 1-3-2007, 24-4-2007, 12-11-2007 to 3-12-2007 and 10-12-2007 to 18-12-2007 and 28-12-2007,31-12-2007. Total 26 days were reported.

**Year 2008:** Total 93 days were reported. 70 days were from Jan-May. Only 23 days were from June-December. No day from November and one from December.

**Year 2009:** Total 59 days were reported. Majority of them was March, April and May. Rest months had no or very few dates reported.

**Year 2010:** Total 72 days were reported. Out of which majorly were from Feb to May and then December.

**Year 2011:** Apart from August, considerable dates were reported from all the rest of the months. Total 177 days were reported.

**Year 2012:** Total 188 days were reported from all the months across whole year. November had 4 days and 1 day from December.

**Year 2013:** Total 91 days were reported. Months reported were Feb-May and Sept - December.

**Year 2014:** Total 151 days were reported. Months reported were Jan-June and Sept-Dec.

**Year 2015:** Total 75 days reported. (Data is till June). And dates from all the months were reported.

**Finding:**

1. We cannot always consider 100% as the threshold to claim anomaly. As news itself showed variation in it. Also, when we ran scripts for threshold 100 many rows were reported which were not there in news.
2. At some place like Ahmedabad there were no news reports for values even more than 125.

* **More than 100% difference in retail price since 2 week may not always indicate for hoarding:**

Considering the same place as Mumbai, we found out the following:

Considering the difference between retail prices, taking gap of 7 days we found that there was no case in which difference of retail price today and 7 days before has gone up by more than 100%.

Now, we also tried looking the data by making the gap of 14 days instead of 7 days. We just found 2 days as follows:

3rd and 4th July of 2006.

We have no news of hoarding from 2006 and also no days were reported corresponding to news.

* **Arrival of current year is more compared to last year, but still wholesale rates are higher this year than the previous year- May not always give true result:**

While checking data for Mumbai:

**2007:** Mostly 2 dates from each Month. Interesting fact is that dates are mostly 1st of the month and 15th of the month.

**2008:** Just 3 dates. 2008-11-15, 2008-12-01, 2008-12-15

**2009:** 1-2 dates from each Month. Interesting fact is that dates are mostly 1st of the month and 15th of the month.

**2010:** Just 2 dates: 2010-02-01 and 2010-08-01

**2011:** Just 2 dates: 2011-02-15 and 2011-06-15

**2012:** Just 3 dates: 2012-10-15, 2012-12-01, 2012-12-15

**2013:** 1 date from 1-4 and 12 months

**2014:** Just 2 dates 2014-06-15 and 2014-12-15

**2015:** Day 1 and 15 from each month i.e. 1-6

Clearly, the data reported was more than we found in news articles.

**Challenges:**

1. Setting threshold for parameters:

From the table 2, we could see that there is no particular pattern which is followed by any of parameter. Like consider % difference between retail and wholesale price. It is not like that for each news date, it is greater than 100%. For many news articles, this parameter has value less than 100%. So, if we consider only this parameter than it will not report the news where value of this parameter is less than 100%. Similar case is followed by the other parameters as well. So, we could not reach to setting up threshold value for any parameter.

1. Completeness of news reports:

As we could see that even keeping threshold value for any particular parameter as given in the news article, the results of the database is large. That’s the number of days are reported are too high. The articles we found are very much less in number. Also, in the query to our database, we have found the results from the year, which were not hoarding years as per the news. Since, the results from database are very large and there are no news articles corresponding to them, we have no way to detect the false positives.