1 Results and Findings

The analysis was performed for differnet timeseries of two centers- Delhi and Mumbai.

Following analysis is for Mumbai. In case of Mumbai, there are total of 66 distinct days for which news articles exist. Here, articles not matched represents unique dates for which articles were present but system failed to report anomaly against that date.

	Anomalies Reported	Anomalies Matched	Articles Not Matched	Articles Not Matched which stated traders nexus as reason
Retail Vs Average Retail	125	64	49	12 (24.49%)
Retail Vs Arrival	323	153	33	9 (27.27%)
Retail Vs Wholesale	160	52	52	14 (26.92%)
Wholesale Vs Arrival	332	168	29	7 (24.13%)

Table 1: System Result for Mumbai

Following are the inferences from the above table:

- Analysis involving arrival timeseries tends to produce better matches. This could be because arrival is one of the determining factor for the price of commodity. Also, news often compare arrival data to explain the suspicous scenarios.

- Retail vs Average Retail does not produce good matches which shows that the prices at differnet centers tend to go in tendum which might be because of strong traders nexus.

- Retail vs Wholesale is not performing good results which gives a clear indication that usually retail prices align with the wholesale prices. So, retailers don't tend to get involved in the fixing of prices because they are forced to align the price of commodity with the wholesale prices.

- This also indirectly indicates that the most of the problem exists at the wholesale level where traders operate who are usually accused by the news reports for manipulating the price of commodity.

As shown in the above table 1, from the number of news articles which are missed by system, almost 25% of them are of traders nexus. Rest 75% are because of low production, unseasonal rainfall, low supply, etc. Now, one of the reason why these articles were missed may be because of arrival will be low during this tenure and it is normal to have price hike. So, that might be reason that system might have considered them as normal that prices are high. Usually news sources report in article whenever prices goes high, but system only detects anomalous cases.

Dates with article trader nexus missed by system
2012-12-27
2013-01-22
2013-01-30
2013-07-03
2014-06-20
2014-06-30
2014-07-01

Table 2: Common 7 Dates with article trader nexus missed by system

Now, the one which are stating traders nexus as reason, and are missed by system were studied. There are 7 cases which are common to all four type of analysis. These 7 dates are shown in table 2. Note that there exist 24 unique dates for which trader nexus articles are present. So 71% of traders nexus

article were reported by system overall. So, we tried to dig up why system missed them. On studying those cases, we found following:

- When we looked for Retail vs Average Retail series, we found that all centers were behaving similar. Where as this analysis detects when one center deviates from other. That's why system might have missed them. One more point to note is that these articles are for traders nexus and it is quite common that traders will be communicating among themselves and controlling the prices and that is the reason why we observed that centers are behaving similar.

- For Retail vs Arrival analysis, Hypothesis 1 reported some of the anomalies, but Hypothesis 3 did not. Hypothesis reports anomalies date-wise and Hypothesis 1 reports anomalies window-wise. So, we found that while taking intersection these anomalies got removed. Note that in Hypothsis 3 not exact date, but nearby dates were reported.

- When we studied Retail vs Wholesale Analysis, we found that in all cases, both prices were moving hand in hand. So, this analysis could not capture these anomalies. **Note that this might be the reason, why Retail vs Average Retail and Retail vs Wholesale are not producing promising results because they usually go hand in hand. But when arrival comes into picture, then we can have better estimate of prices. So analysis which is which arrival are performing better as compared to others**

- For Wholesale vs Arrival, 3 of the anomalies were reported by Hypothesis 1. But as stated above for Retail vs Arrival, here too Hypothesis 3 results could not report exact date and we missed them. For the remaining cases in this analysis, we could not find particular reason why they are not reported.

Following figures are the pictorical representation of the above (Table 1) results on timeline.

Note: In following figures, Yellow highlighted regions are system reported anomalies for which no corresponding news article was present, Violet highlighted region represents news article for which our system did not report any anomaly and Red highlighted region represents anomalies reported by system for which news articles were present.

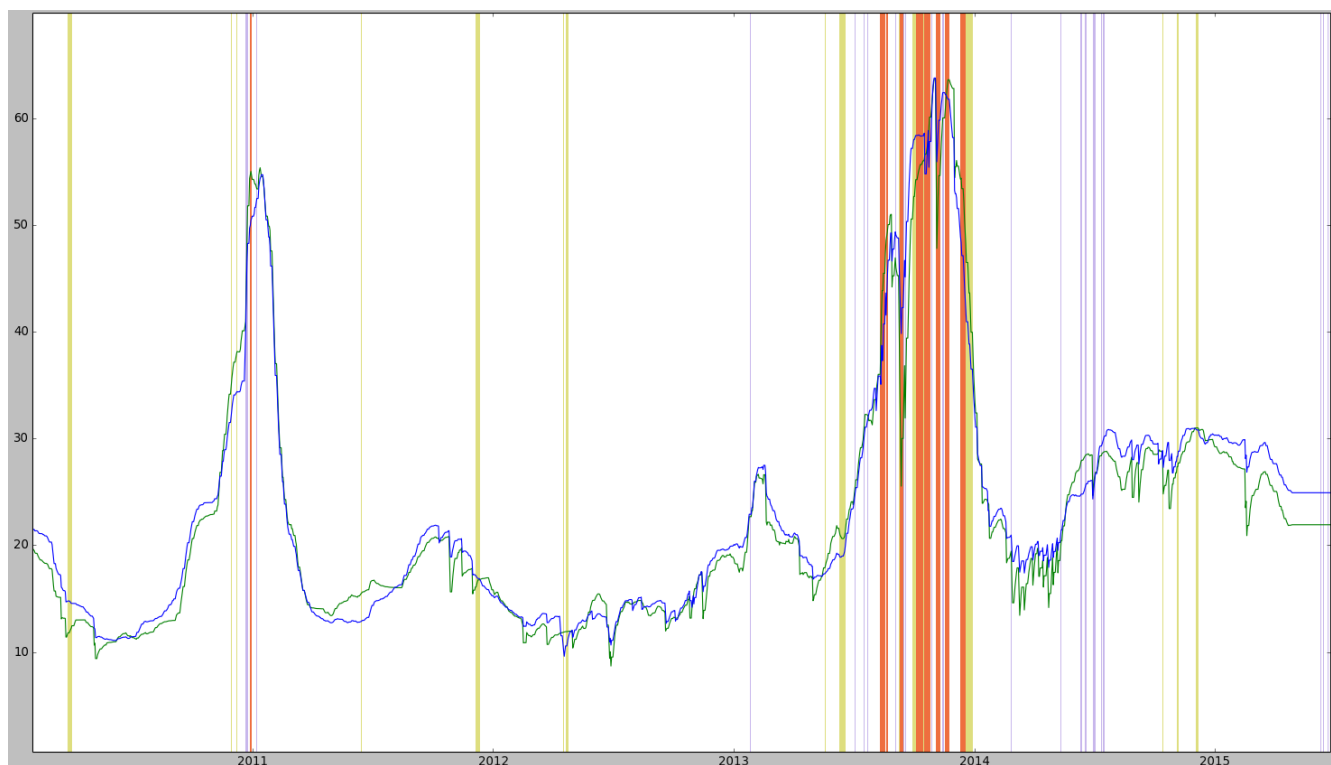- Retail Price vs Average Retail Price

Figure 1: System Result (Green line - Centre Retail Price, Blue Line - Average Retail Price)
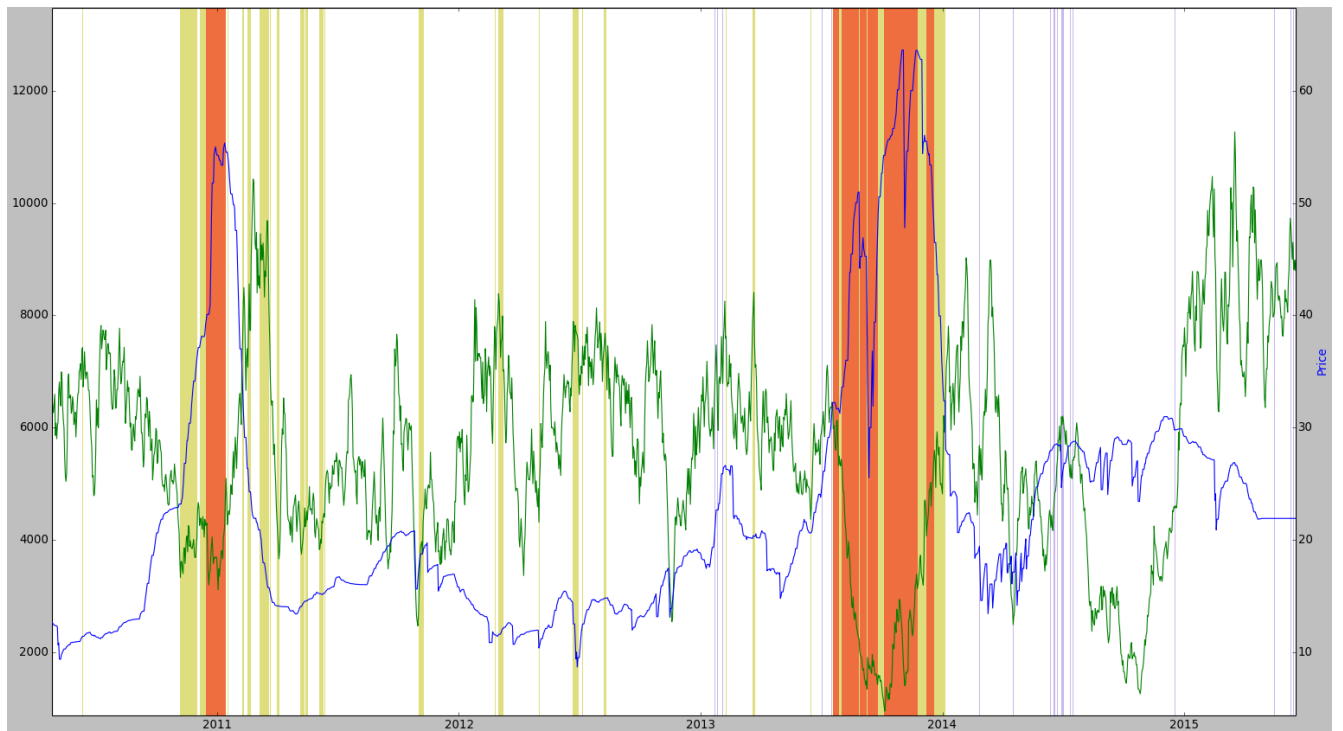
- Retail Price vs Arrival Data

Figure 2: System Result (Green line - Arrival Data of Onion, Blue Line - Retail Price)
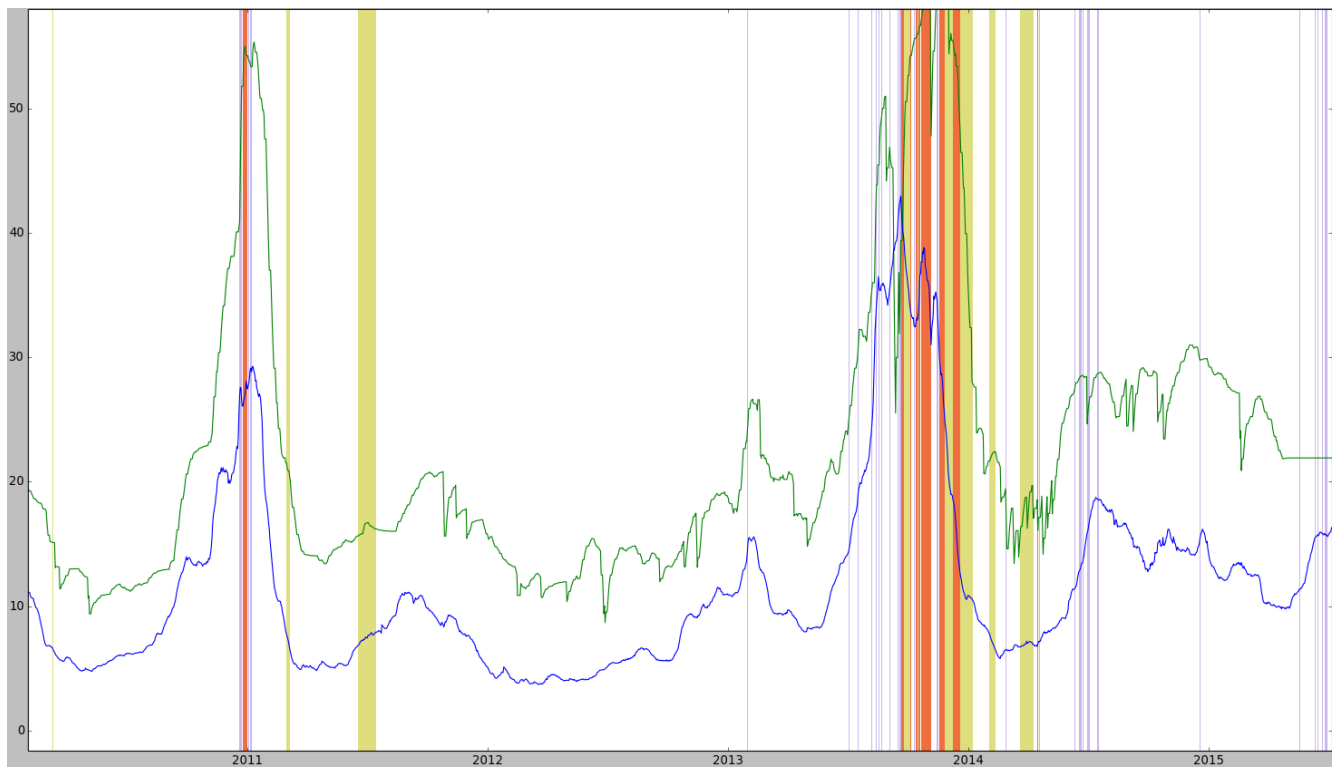
- Retail Price vs Wholesale Price

Figure 3: System Result (Green line - Retail Price, Blue Line - Wholesale Price)
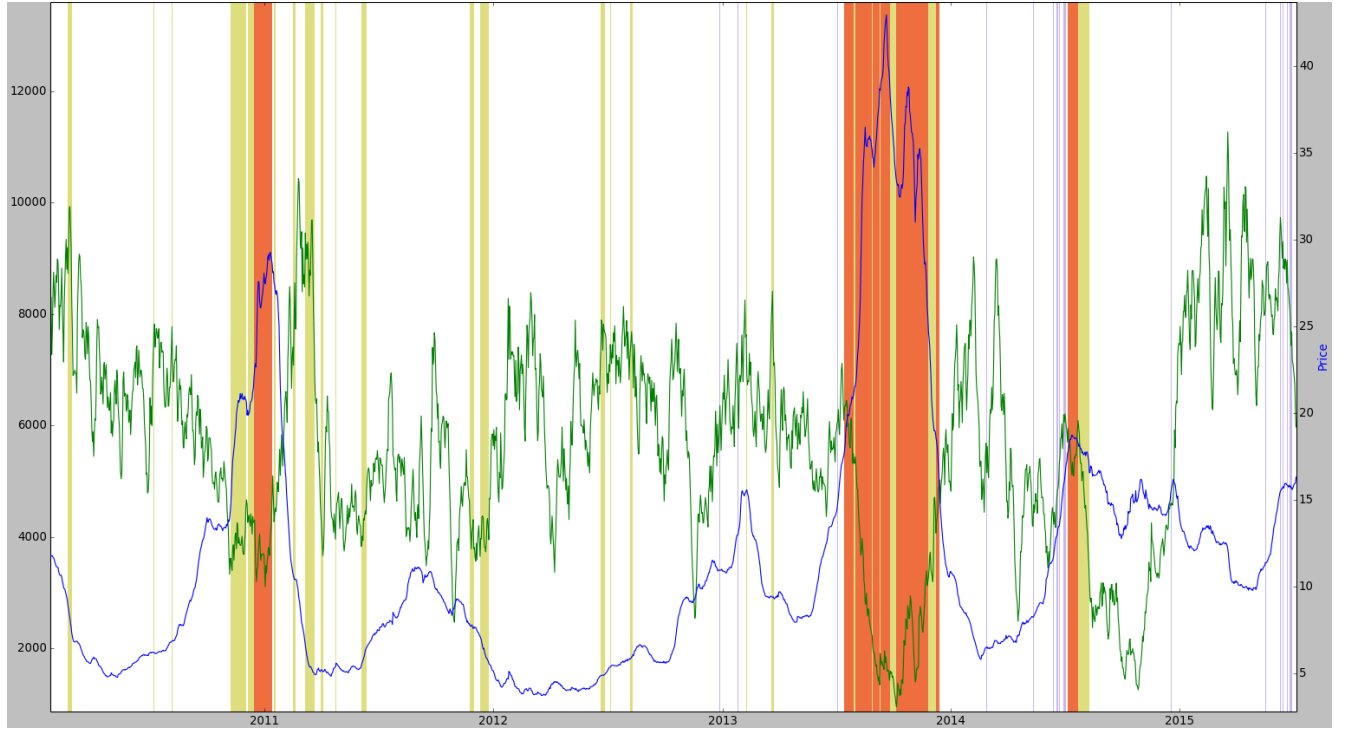
- Wholesale Price vs Arrival Data

Figure 4: System Result (Green line - Arrival Data of Onion, Blue Line - Wholesale Price)

Following table has few examples showing system reported anomalies and an article supporting it.

System Reported Tenure	News Articles Link	Analysis Type	Location
27-Dec-2010 to 29-Dec-2010	http://timesofindia.indiatimes.com/city/pune/Onion-prices-still-leave-consumers-teary-eyed/articleshow/7147525.cms	Retail vs Average	Mumbai
17-Oct-2013 to 27-Oct-2013	http://www.thehindu.com/business/Industry/monopoly-of-wholesale-trade-causing-onion-price-hike/article5264512.ece	Retail vs Average	Mumbai
15-Dec-2010 to 13-Jan-2011	http://articles.economictimes.indiatimes.com/2010-12-21/news/27586208_1_minimum-export-price-onion-prices-mep	Retail vs Arrival	Mumbai
17-Oct—2013 to 25-Nov-2013	http://www.dnaindia.com/mumbai/report-dna-exclusive-traders-not-farmers-making-the-most-of-soaring-onion-price-1909850	Retail vs Arrival	Mumbai
29-Jun-2014 to 06-July-2014	http://timesofindia.indiatimes.com/india/Retail-onion-prices-soar-to-double-of-wholesale-rates/articleshow/37490678.cms	Retail vs Arrival	Delhi
18-Nov-2013 to 24-Nov-2013	http://www.firstpost.com/politics/onion-tomato-price-hoardings-to-malign-party-cong-writes-to-ec-1238589.html	Retail vs Wholesale	Mumbai
21-Oct-2013 to 04-Nov-2013	http://www.dnaindia.com/mumbai/report-dna-exclusive-traders-not-farmers-making-the-most-of-soaring-onion-price-1909850	Retail vs Wholesale	Mumbai
27-Oct-2013 to 03-Nov-2013	http://www.thehindu.com/news/national/karnataka/are-farmers-benefiting-from-soaring-onion-prices/article5269250.ece	Retail vs Wholesale	Delhi
17-Oct-2013 to 24-Nov-2013	http://www.moneycontrol.com/news/economy/onion-prices-remain-high-at-rs-100kg-crisis-to-continue_976318.html	Wholesale vs Arrival	Mumbai
15-Dec-2010 to 12-Jan-2011	http://articles.economictimes.indiatimes.com/2010-12-21/news/27586208_1_minimum-export-price-onion-prices-mep	Wholesale vs Arrival	Mumbai
29-Jun-2014 to 05-July-2014	http://timesofindia.indiatimes.com/india/Retail-onion-prices-soar-to-double-of-wholesale-rates/articleshow/37490678.cms	Wholesale vs Arrival	Delhi

Table 3: Few Examples

Explaination of all the cases listed in table are as following:

- 27-Dec-2010 to 29-Dec-2010 : According to our hypothesis 4, price trends at differnet centers should behave similar. But, here retail price of onion in mumbai took a sharp rise then faced a downfall which was not seen being followed by Delhi. Instead retail prices at Delhi continued to grow. There were multiple news articles for the same tenure which claimed traders nexus as reason for anomaly. One of the article link is given in table. (See Figure 5)
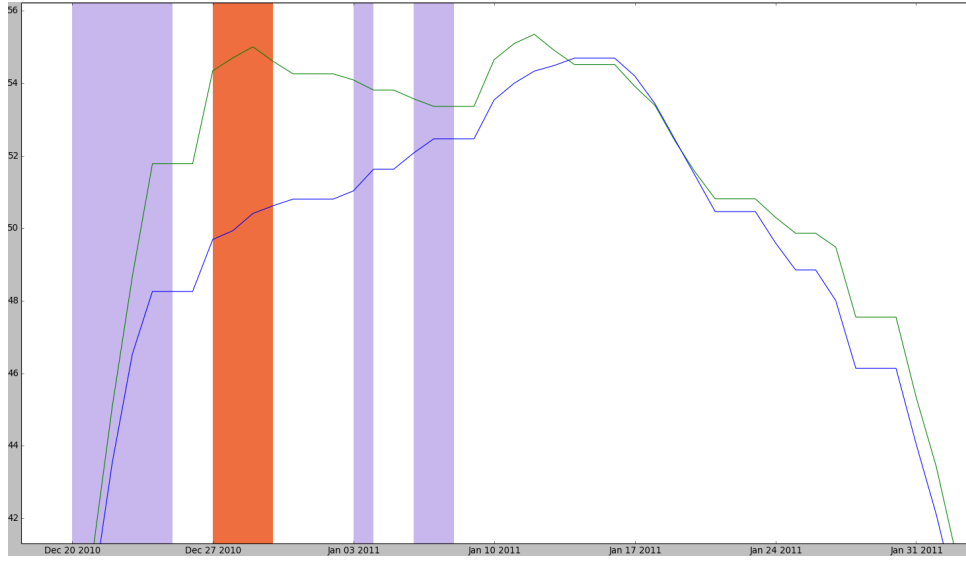
Figure 5: Case: 27-Dec-2010 to 29-Dec-2010 (Green line - Centre Retail Price, Blue Line - Average Retail Price)

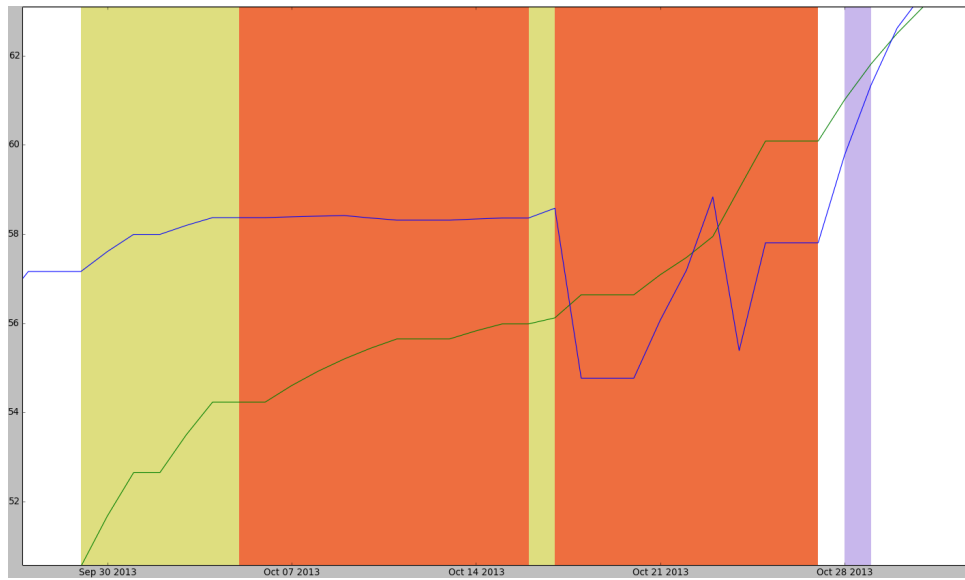Similar is observed for 17-Oct-2013 to 27-Oct-2013. (See Figure 6)

Figure 6: Case: 17-Oct-2013 to 27-Oct-2013 (Green line - Centre Retail Price, Blue Line - Average Retail Price)

- 15-Dec-2010 to 13-Jan-2011 : There was a decrease in the arrival of onion at the start of December which resulted in the increase of retail price. Later arrival seemed nearly constant or increasing but prices continued to grow high. The arrival also increased when the prices were very high which could be the arrival of hoarded stock in market for profiteering.
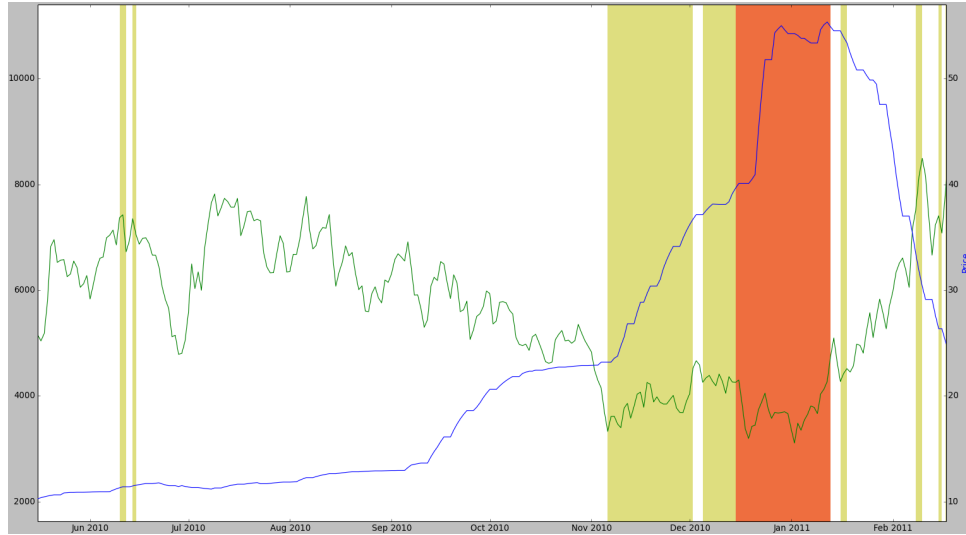
Figure 7: Case: 15-Dec-2010 to 13-Jan-2011 (Green line - Arrival Data of Onion, Blue Line - Retail Price)

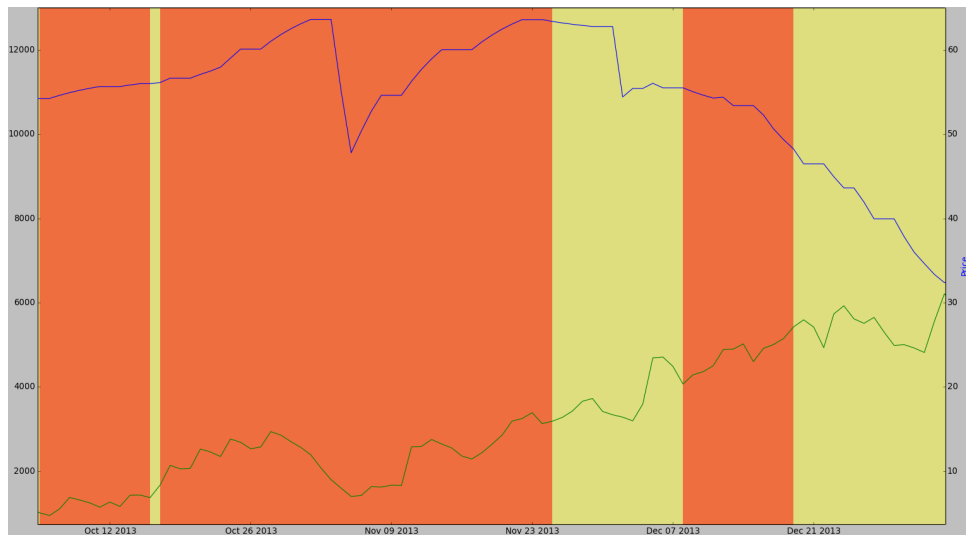Similar is observed for 17-Oct-2013 to 25-Nov-2013. (See Figure 8)

Figure 8: Case: 17-Oct-2013 to 25-Nov-2013 (Green line - Arrival Data of Onion, Blue Line - Retail Price)

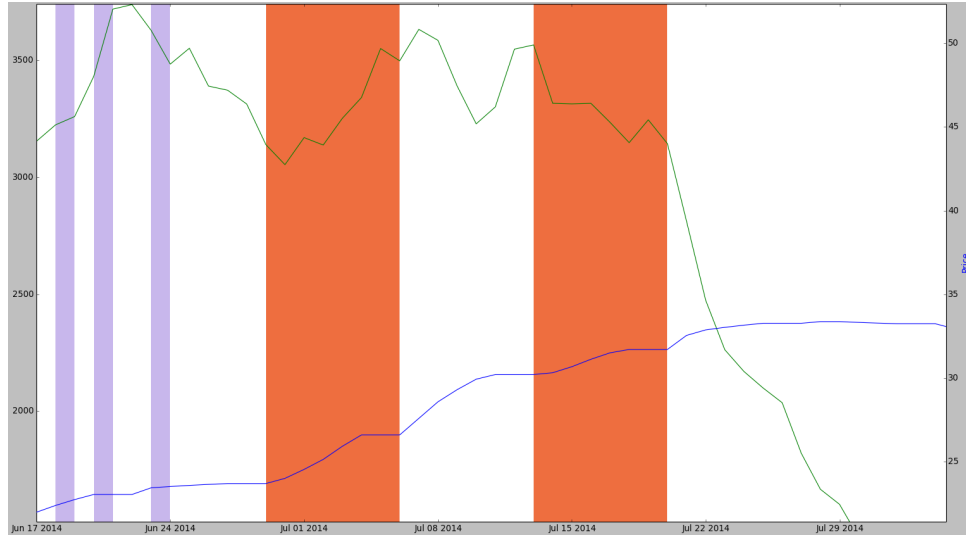Similar is observed for 29-Jun-2014 to 06-July-2014 in Delhi. (See Figure 9)

Figure 9: Case: 29-Jun-2014 to 06-July-2014 (Green line - Arrival Data of Onion, Blue Line - Retail Price)

- 18-Nov-2013 to 24-Nov-2013 : Retail prices are decided by wholesale price. But here, retail price continued to remain high despite of decrease in the wholesale price. (See Figure 10)
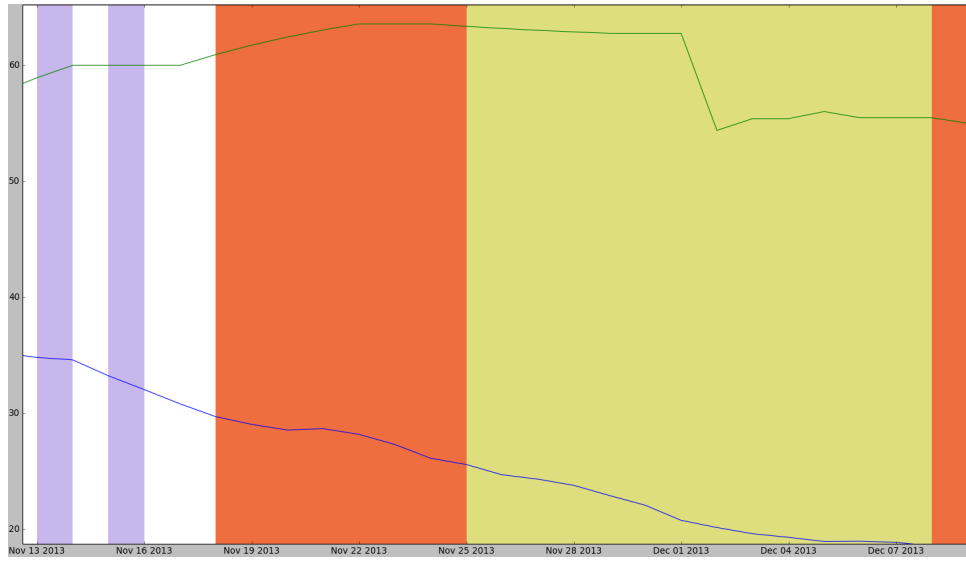

Figure 10: Case: 18-Nov-2013 to 24-Nov-2013 (Green line - Retail Price, Blue Line - Wholesale Price)

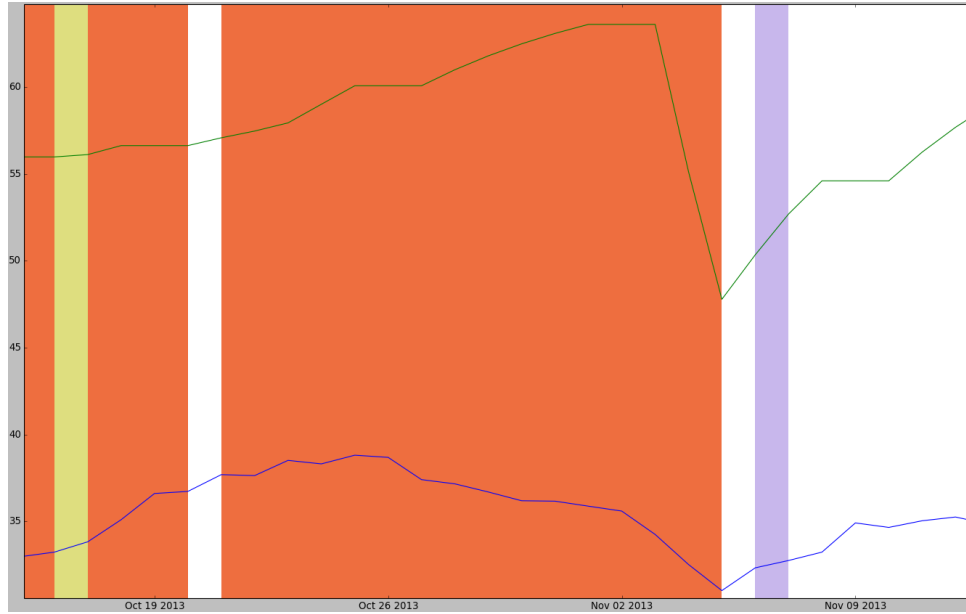Similar is observed for 21-Oct-2013 to 04-Nov-2013. (See Figure 11)

Figure 11: Case: 21-Oct-2013 to 04-Nov-2013 (Green line - Retail Price, Blue Line - Wholesale Price)

Similar is observed for 27-Oct-2013 to 03-Nov-2013 in Delhi. (See Figure 12)
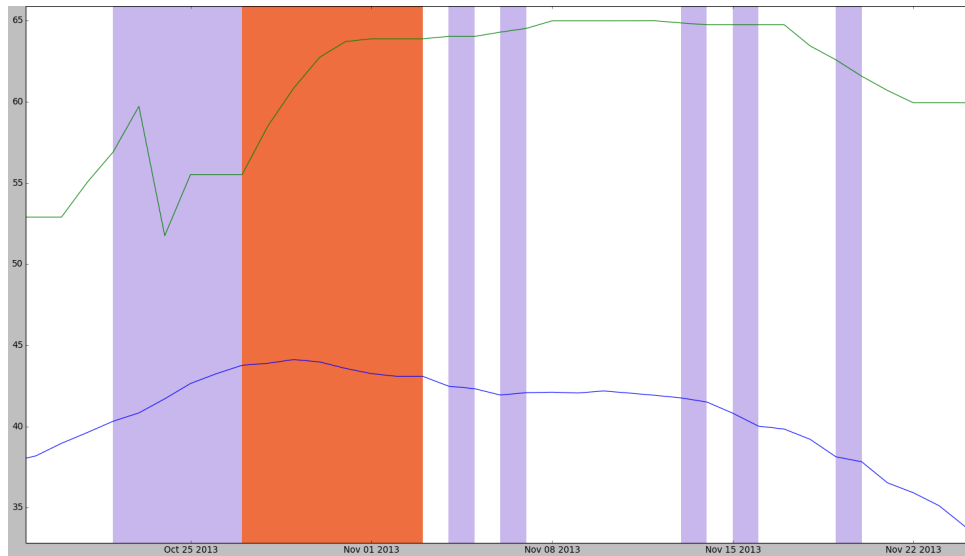

Figure 12: Case: 27-Oct-2013 to 03-Nov-2013 (Green line - Retail Price, Blue Line - Wholesale Price)

- 17-Oct-2013 to 24-Nov-2013 : Market observed increase in the arrival on increase of wholesale. The supply crunch could be man-made which resulted in increase in wholesale price and then to take advantage of increased prices, stocks were released in market. (See Figure 13)
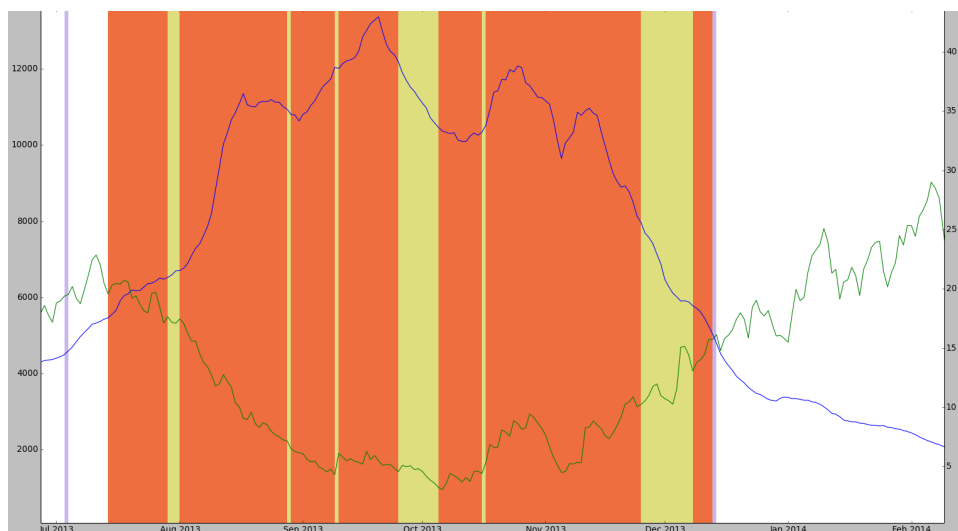
Figure 13: Case : 17-Oct-2013 to 24-Nov-2013 (Green line - Arrival Data of Onion, Blue Line - Wholesale Price)

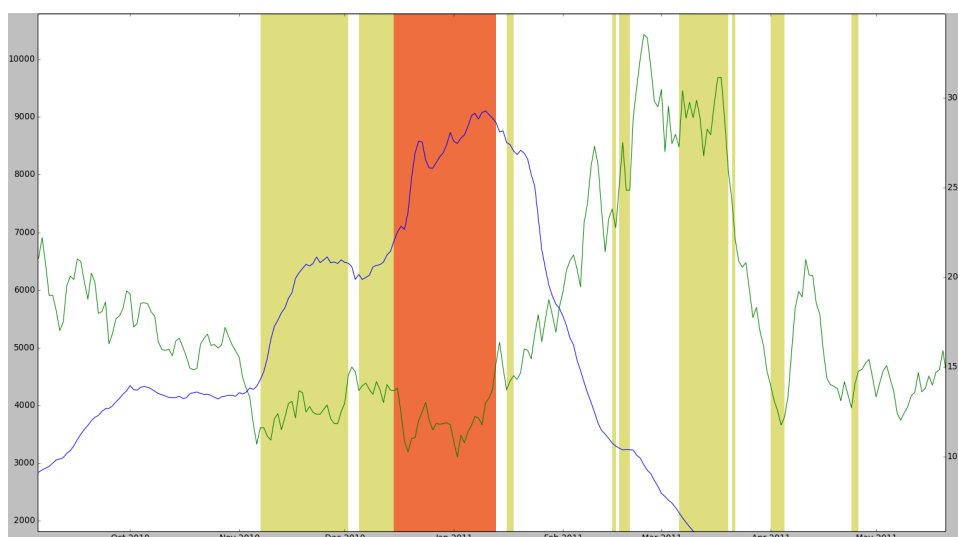Similar is observed for 15-Dec-2010 to 12-Jan-2011. (See Figure 14)

Figure 14: Case : 15-Dec-2010 to 12-Jan-2011 (Green line - Arrival Data of Onion, Blue Line - Wholesale Price)

Similar is observed for 29-Jun-2014 to 05-July-2014 in Delhi. (See Figure 15)
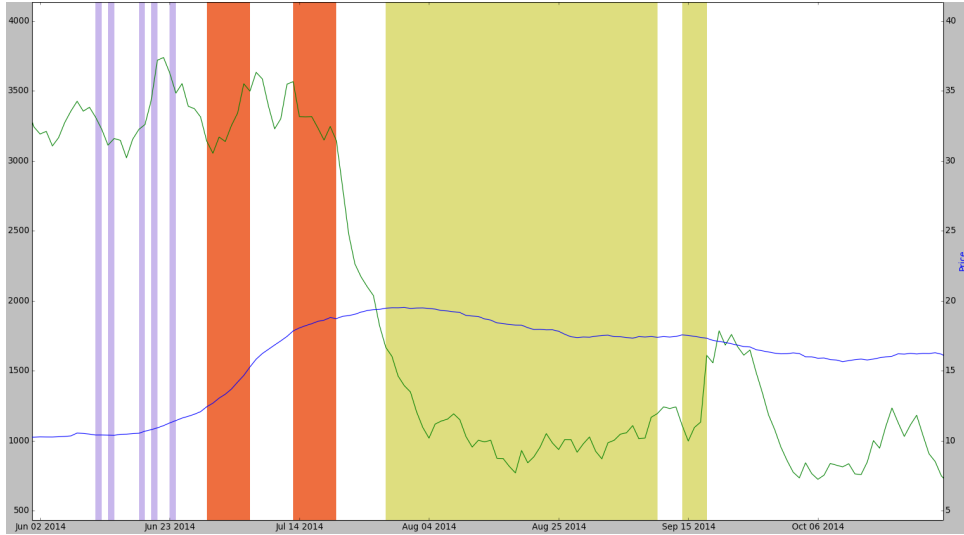
Figure 15: Case : 29-Jun-2014 to 05-July-2014 (Green line - Arrival Data of Onion, Blue Line - Wholesale Price)

Few of the analysis which were local to center could not be matched with national news articles, but on digging more in regional news article, we could justify the anomaly. One of such case is the anomaly reported on 7th and 8th January 2013, in Delhi, for which news was reported in Jagran local news paper on 28th December 2012 which says due to fog there was disruption in the supply of onions. Despite of the speculation on low arrival of onion we observed considerable hike in arrival (which could be hoarded onion stocks brought into market) to earn better profits to take advantage of increased price of onion. Also, we have observed 2 news articles suspecting traders' nexus as the reason for the increased onion prices.
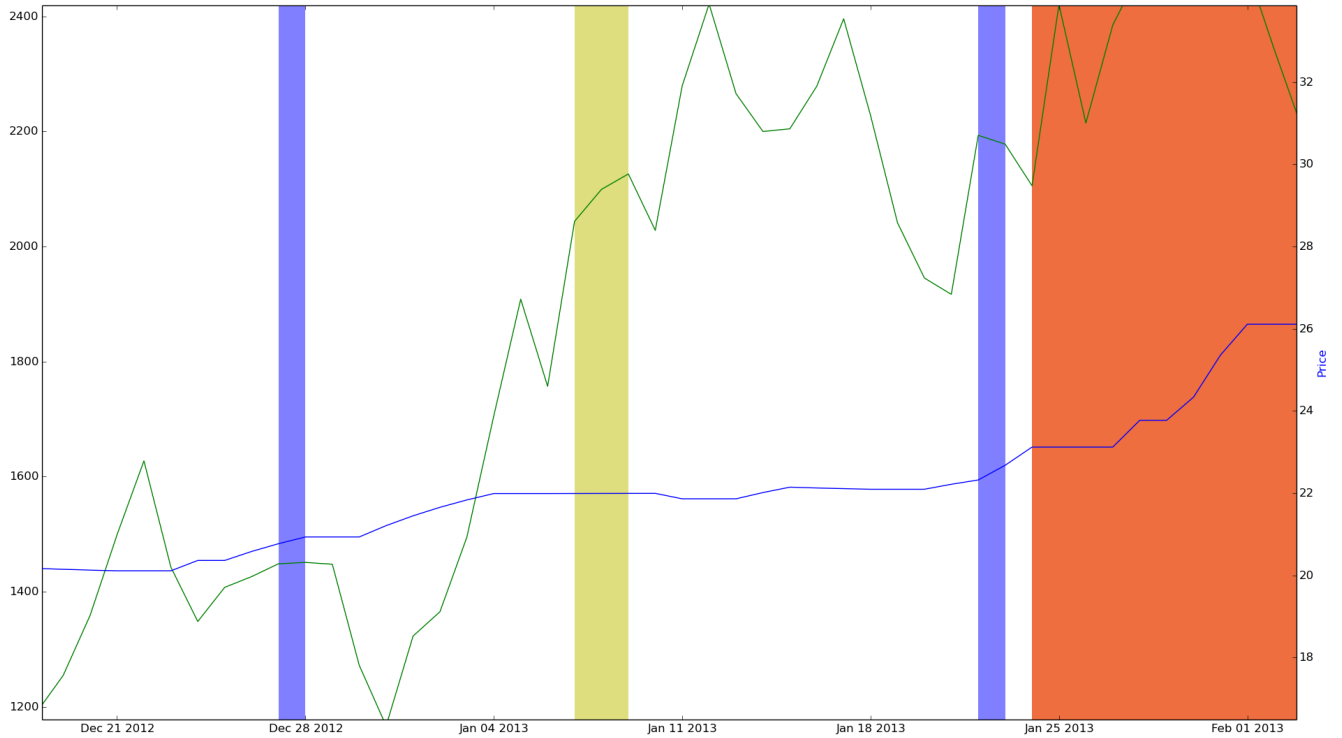

Figure 16: System Result (Green line - Arrival Data of Onion, Blue Line - Retail Price)

News Article stated the following,

10

नई दिल्ली [सुरेंद्र प्रसाद सिंह] प्याज एक बार फिर आंसू निकालने को तैयार है। ठंड बढ़ने से जहां प्याज की मांग बढ़ी है, वहीं आपूर्ति कम होने से प्याज की कीमतें साल के उच्चतम स्तर पर पहुंच गई हैं। उत्पादक और उपभोक्ता मंडियों के मूल्य में भारी अंतर तो है ही, थोक और खुदरा कीमतों की खाई भी बढ़ गई है। कोहरे की वजह से महाराष्ट्र की प्याज की सप्लाई लाइन टूट गई है।

Figure 17: Jagran News paper article

We also tried to run system by changing window size. We got the following results:
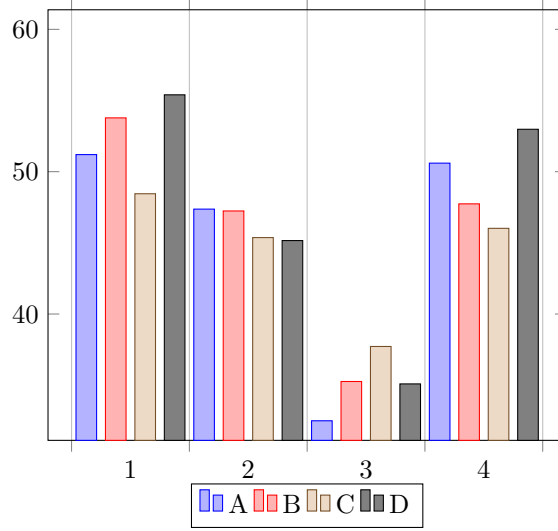

Figure 18: Anomaly Reported, (1-Retail vs Average Retail, 2-Retail vs Arrival, 3-Retail vs Wholesale, 4-Wholesale vs Arrival)

Where,

- A - System result when Correlation Window: 15 and Slope Based Window: 7

- B - System result when Correlation Window: 10 and Slope Based Window: 4

- C - System result when Correlation Window: 20 and Slope Based Window: 4

- D - System result when Correlation Window: 7 and Slope Based Window: 4

Figure 18 shows comparison of system result taking different window size for correlation and slope based anomaly detection mathod. Note that for all of these methods, default threshold value was considered, user did not provided threshold value in any. From this figure 18, we can see that analysis where both series are inversely proportional to each other, A is performing better. Where both series are directly proportional to each other reducing window size for correlation method does help as we can see by comparing A, B and D.