Understanding fluctuations in Brisbane fuel prices

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Introduction

Fuel prices move up and down in cycles, which results from pricing strategies of petrol retailers, who tend to adjust their prices according to their rivals' behaviours.

We exploit a dataset that contains station-level prices of unleaded fuel prices in Brisbane. Furthermore, we explored their price cycles. as well as price leadership in terms of brand and location, which uncovered a transition of leadership from a location cluster to others.

Data

We have daily fuel prices (price may be updated more than once in a day) for stations in Queensland, and our study focuses on unleaded fuel prices in Brisbane. Prices are in terms of cents per litre (cpl). The data is available from 3rd Dec 2018 to 30th Nov 2020, and there are 1445 stations in total.

There are 427 stations in Brisbane, and the brands with leading numbers of stations are 7 Eleven(90), Caltex(63), BP(63), Coles Express(61), Caltex/Woolworths(42), and Puma Energy(33).

Price Cycles

Figure 1 shows the mean daily price of unleaded gasoline throughout 2019. It has a generally upward trend, but the most striking thing is that the prices are cyclic. Indeed there were 13 cycles in 2019, and the length of a cycle was four weeks on average.

Figure 2 shows the mean daily price of unleaded gasoline from Jan 2020 to Nov 2020. Coronavirus and the plummeting of US dollar affected the fuel market, which is associated with a downward trend from January to April (the first three cycles). It was followed by a relatively stable phase, where the length of a cycle was around four to five weeks. The longest cycle lasted from 23rd Mar to 9th May, and it roughly coincided with the plummeting in the value of US dollar.

It is also worth mentioning that even though big brands often increased their prices first, their cycles tend to last longer, that means they started to lower their price almost the same day as the other brands.
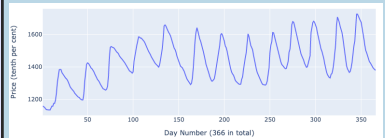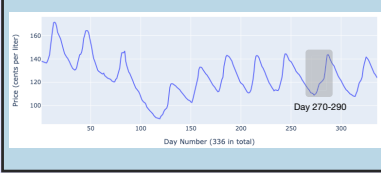
Figure 1: Mean price for unleaded fuel in 2019

Figure 2: Mean price for unleaded fuel in 2020

Price leadership

1 Brand

1.1 Definitions

Bryne and De Roos's paper (in Reference) looked at a different market (the Perth Market between 2001 and 2015), which had weekly cycles. It mentioned Wednesday price leadership by BP before 2013, while it slowly transitioned to Thursday jumps together with its rivals by communicating with prices.

Station-level Price Jump: it occurs at station **i** on day **t** if $\Delta p_{i,t} \geq 6$ cpl (cents per liter), where $p_{i,t}$ is the retail price at station **i** on day **t** and $\Delta p_{i,t} = p_{i,t} - p_{i,t-1}$.

1.2 Comments

Figure 3 is a representative example of price jumps in one cycle (from day 270 to 290 in 2020), which is the shaded area in Figure 2: there is a minor peak in the number of jumps among leading brands before other brands receive the signal and more stations begin to raise their prices.

Some brands could be eliminated from potential price leaders. They are Caltex/Woolworths, Puma Energy, Freedom Fuels, and Others. Because they are often absent from the minor peak and then join the major peak 3 to 4 days later. Although there are no brands which consistently play a leading role in the beginning phase of the cycle, brands that often have their stations raise their prices earlier are Coles Express, 7 Eleven, Caltex and BP. However, there is no substantial evidence to distinguish these brands as price leaders from others.

Figure 3: Number of price jumps, example
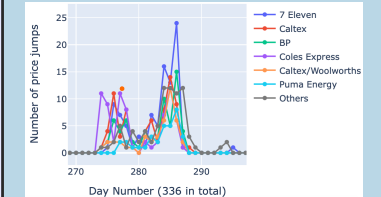
2 Location

Figure 4: Heat map for Unleaded fuel price
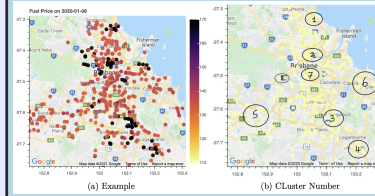

(a) Example   (b) CLuster Number

Figure 4(a) shows an example of a heat map of unleaded fuel prices at stations in Brisbane on a day(8th Jan 2020), and 4(b) indicates the index of clusters of stations from ① to ⑧.

2.1 Definitions

Table 1 and 2 show the summary of cluster jump levels (defined below) for clusters during each cycle in 2019 and 2020, where each row represents each cycle, and each column represent the index assigned to each cluster. We will be focusing on the highlighted columns below.

Table 1: Culster Jump Levels for each Cycle in 2019

Cycle/Index	①	②	③	④	⑤	⑥	⑦	⑧
1	-	0	0	-	-	-	-	0
2	1	0.5	-	-	-	0	0	-
3	1	0	-	-	-	0	0	-
4	0	1	0	-	-	-	-	1
5	0	0.5	1	0	-	-	0	1
6	1	-	-	1	-	1	-	-
7	0	1	2	1	-	-	-	2
8	0	2	0	0	-	-	-	-
9	0	1	0	-	-	-	-	1
10	0	1	0	1	-	-	-	-
11	0	1	1	-	-	-	-	-
12	0	0	0	0	-	-	-	-
13	0	2	1	-	-	1	1	-

Table 2: Culster Jump Levels for each Cycle in 2020

Cycle/Index	①	②	③	④	⑤	⑥	⑦	⑧
1	0	1	0	1	-	-	-	-
2	0	0	0	0	-	-	-	1
3	-	0	0	0	-	-	-	-
4	0	-	-	-	-	2	-	-
5	-	0	0	-	-	0	-	-
6	-	0	0	0	0	0	-	-
7	-	0	-	-	-	-	-	0
8	-	2	-	-	0	0	-	-
9	-	2	-	2	-	-	-	0
10	-	0	-	0	1	2	-	-

Cluster jump: occurs when the first time a cluster has more than five stations with a price jump recently (usually within three days). A cluster jump is usually shown by darker clusters of points in the heatmap (Figure 4(a) is an example).
Cluster jump levels: 0 means that there is a cluster jump exactly when the upward phase of a cycle begins, and 1, 2 mean it has a cluster jump 1 and 2 days later respectively, and '-' means the cluster jump occurs more than two days later. Moreover, 0.5 means that the cycle is not long enough for this cluster to drop the prices, and its average price is higher than in other places.
Cluster jump leader: a cluster with cluster jump level less or equal to 1.

2.2 Comments

Interestingly, in 2019 cluster ① was highly involved in the initial stage of upward trending of a cycle, and is a cluster jump leader in 12 out of 13 cycles, followed by cluster ② (10/13) and ③ (9/13). In 2020 cluster ② started to overtake (7/10), together with cluster ⑥ (5/10), while cluster ① (4/10) was a cluster jump leader on fewer occasions. Therefore, leadership in terms of location is likely to exist, and the cluster jump leadership evolved during the time: cluster ① become less critical while cluster ② and ⑥ become more active in 2020 than 2019.

Summary

We are looking for cluster leadership in terms of brand or location. Likely, leadership is there in terms of location, while it is still not easy to recognise the leaders from the visualisation.

Additionally, the global economic environment, as well as travel restrictions due to Covid-19, adds uncertainties to the fuel market, making patterns of prices less regular with more noises.

Acknowledgements

References

[1] Byrne, David P. and de Roos, Nicolas, Learning to Coordinate: A Study in Retail Gasoline (July 23, 2018). Available at SSRN: https://ssrn.com/abstract=2570637 or http://dx.doi.org/10.2139/ssrn.2570637
[2] The data is provided by the Queensland Government Open Data Portal (https://www.data.qld.gov.au/dataset/fuel-price-reporting).