Second Biannual Update – February 2020

DNRME 03/07/3795

An Assessment of the Queensland Fuel Price Reporting Trial

For the Department of Natural Resources, Mines and Energy

Griffith UNIVERSITY

Know more. Do more.

Nathan campus Griffith University
170 Kessels Road
Nathan

QLD 4111

Contents

Executive Summary

- This report examines how the Queensland Fuel Price Reporting Trial (QFPRT) has impacted retail fuel prices across Queensland since the commencement of the trial in December 2018. It specifically considers whether the Trial has put upwards or downwards pressure on average fuel prices in Queensland.
- The report examines the impact of the Trial on retail fuel prices by considering trends in i) the level of average retail fuel prices and ii) the spread of fuel prices within regions.
- In terms of the impact on average fuel retail prices, results show that the trial generated a small but statistically significant decline in the average daily retail prices of regular unleaded (ULP91), premium unleaded (PULP) and ethanol (E10) petrol fuels in most regions in Southeast Queensland. No statistically significant declines in average retail fuel prices were found in regions outside of Southeast Queensland. In addition, no significant declines were observed in average diesel fuel prices.
- For regular unleaded users in Southeast Queensland (including Brisbane), this represents an average savings of $7.86 per annum per passenger vehicle. For PULP, the annualised savings per passenger vehicle is estimated to be $9.10 in Brisbane and $9.21 in Southeast Queensland whereas for E10 the savings are $9.21 in Brisbane and $8.43 in Southeast Queensland.
- The total estimated gain in consumer surplus associated with the trial is $10,099,991 per annum in Brisbane and $14,267,471 per annum in the greater Southeast Queensland region.
- Concerning the impact on ii) the spread of fuel prices within regions, this report finds evidence for statistically significant increase in the spread of prices (price dispersion) in several regions including: Brisbane, Ipswich, Logan, Townsville, Rockhampton, Bundaberg and Cairns. An increase in the spread of prices could be interpreted as an increase in the potential savings generated for motorists actively seeking the lowest prices.
- Examining differences between minimum and average 2019 ULP91 fortnightly prices, this report finds that in Brisbane, motorists filling up at the minimum can save up to $179.30 per annum relative to filling up at the mean. In Rockhampton motorists could save up to $81.10 per annum, while in Cairns motorists could save up to $53.80 per annum
- These empirical findings should be treated as preliminary. A more comprehensive picture of the long run effect should emerge in the next 6 to 12 months when more data becomes available.

1. Introduction

The Queensland Fuel Price Reporting Trial commenced on 3 December 2018, with full legal and enforceable compliance commencing on 15 April 2019 (DNRME, 2018). This trial mandates that retail fuel stations report fuel price changes within 30 minutes. An aggregation system collates this information, which is then made accessible to the public via third party fuel apps.

This second biannual update provides a detailed empirical assessment of the impact the Queensland Fuel Price Reporting Trial has had on average daily retail fuel prices across Queensland over a twelve-month period (December 2018 to December 2019). The impact of this trial is assessed empirically by comparing fuel prices pre- and post-trial. This assessment takes into account a number of other factors that also impact retail prices, such as international oil prices, exchange rates and changes in excise tax.

In order for the trial to generate declines in average retail fuel prices, a number of conditions need to be fulfilled. First, fuel prices would have to be disseminated to the public in a timely and accurate manner. Second, a substantial proportion of consumers would need to utilise this information to identify which fuel stations offered the cheapest fuel in the region. Third, a sufficient level of competition would need to exist amongst retail petrol stations within the region to make it possible for motorists to identify cheaper petrol prices amongst local competitors. The trial may result in no statistically significant changes in regions where levels of competition among retail fuel stations are low, or may even increase in cases of very low competition, as discussed in the previous report (Griffith University, 2019).

2. Update on the Queensland Fuel Market

The first biannual update in July 2019 (Griffith University, 2019) provided an overview of the key factors influencing retail fuel prices in Queensland. In the following we provide a brief update on new relevant information and trends that have since emerged:

- **Retail competition levels:** There has been an increase in the number of fuel stations participating in the trial. As of December 2019, there are approximately 1,575 retail fuel site reporting prices according to the trial data. Of these, approximately half are in metropolitan locations, with 500 in regional areas and a further 200 in remote localities. It is notable that in the Brisbane area, the ACCC (2019) reported a 12% rise in retail sites between 1 January 2017 and 30 September 2019, which they note has likely increased competition and lowered prices. Given the overlap with the current trial, they also note the potential impact of the trial (on top of likely greater competition due to the rise in retail sites) to the lowering of fuel prices in Brisbane. This meshes in well with the rise in users of fuel price apps, which could have raised greater awareness of the competitive pricing strategies of independent fuel retailers.

- **International oil prices:** Since the last report, international oil prices were relatively steady during the second half of 2019, ranging from US$62.72 on 2 July 2019 to US$66.44 on 9 December 2019, trading within a band of US$55.03 (7 August 2019) to US$68.42 (16 September 2019). This is in contrast to the greater price dispersion (volatility) witnessed in 2018 and early 2019. Issues related to geo-political uncertainty in the Middle East, particularly US sanctions on Iranian oil exports has not however led to greater price dispersion, partially due to an increase in Iraqi oil production making up for shortfalls in production (and subsequent exports) in Iran and also Venezuela. Nevertheless, production (supply) did not match demand in 2019, though this shortfall was made up by the utilisation of reserves, thus dampening price rises. As well, falls in production from OPEC member states were partially offset by increased production from non-member states (IEA, 2020). In terms of currency fluctuations, the Australian dollar has been relatively stable over the past 12 months. Figure 1 below highlights the fluctuations in the Brent crude oil price from August 2016 to the start of December 2019. The national daily average Terminal Gate Price (TGP) from 17 July 2019 to 23 December 2019 was also stable.[1]

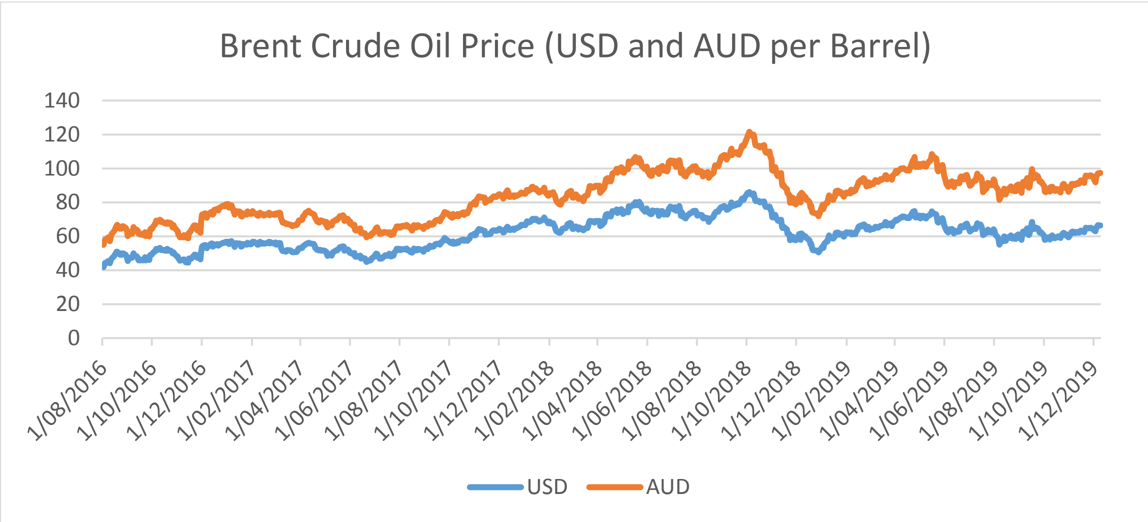

Figure 1: Brent crude oil prices in both USD and AUD from 1 August 2016 to 9 December 2019. AUD figures imputed from the daily USD-AUD exchange rate (source: Macrotrends.net).

- **Refined Fuel Costs** have remained relatively stable since the last report, and indeed have remained so for a sustained period of time (see Figure 3). As noted in the last report, these account for a large share of retail fuel prices (AIP, 2018, 2019a).[2] Figure 3 highlights how wholesale fuel

[1] Both the ACCC and the AIP have stated consistently over time that domestic fuel prices are strongly influenced by international benchmarks (with a 1 to 2 week lag, hence the slightly different dates for TGPs reported above), and TGPs are set based on the Asia-Pacific refined fuel benchmarks (MOGAS95 for petrol and Gasoil 10 ppm sulfur for diesel).

[2] These vary over time. They are partially accounted for by fluctuations in both international prices and exchange rates (which as previously noted have both been relatively stable in

prices (TGPs) move consistently with international refined fuel prices in the Asia-Pacific region, albeit with a short time lag. It also highlights how regulatory charges such as excise tax make up a substantial portion of wholesale prices and that refiner mark-ups appear to be relatively small.

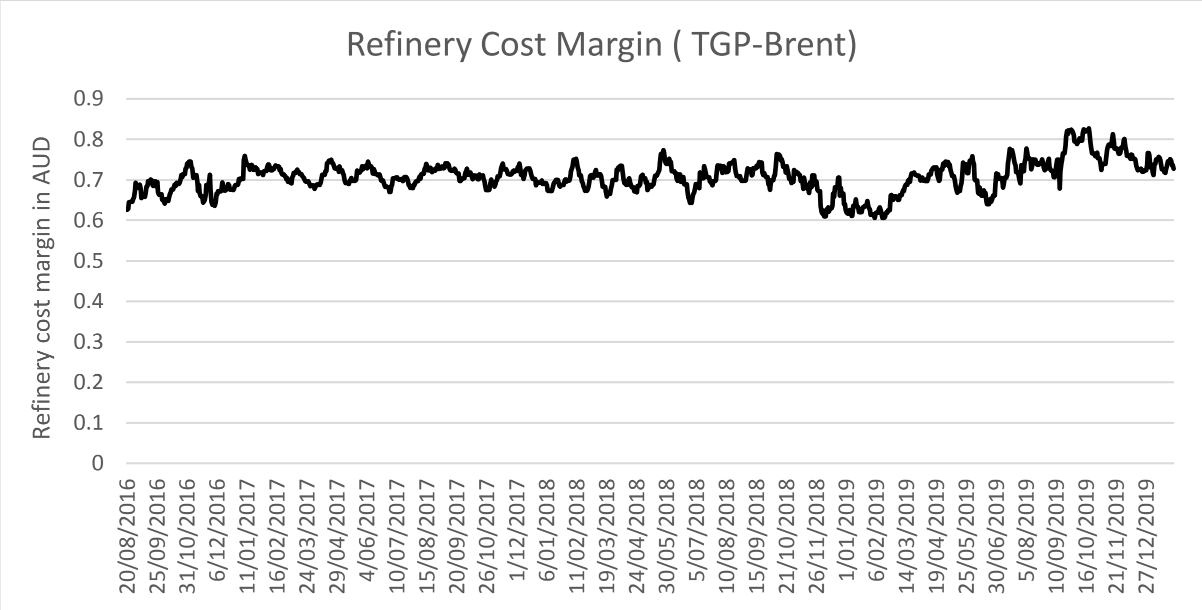

Figure 2: Refinery cost margins, August 2016 – January 2020.

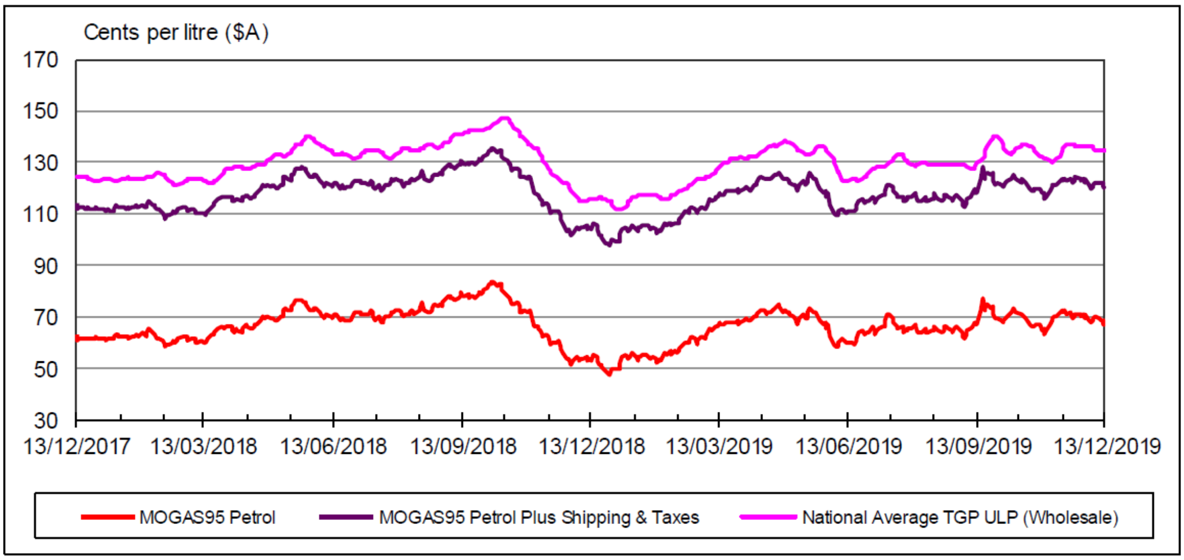

Figure 3: Comparison of Singapore Fuel Prices (MOPS95 Fuel) with Australian fuel TGP (source: AIP, 2019b).

- **Retail Gross Margins** have remained stable over the past decade (at around 1.35 cpl). It has been noted that margins can vary substantially both across price cycles and between retailers, with market leaders being more likely to charge higher peak prices at the bowser relative to retail discounters (ACCC, 2019; RACQ, 2019a, 2019b). Figure 4 below

recent months), but have been estimated to average around 57% (AIP, 2018) of the final retail price.

highlights a rough approximation of retail gross margins in Brisbane by comparing the difference between ULP91 retail prices and the reported TGP.

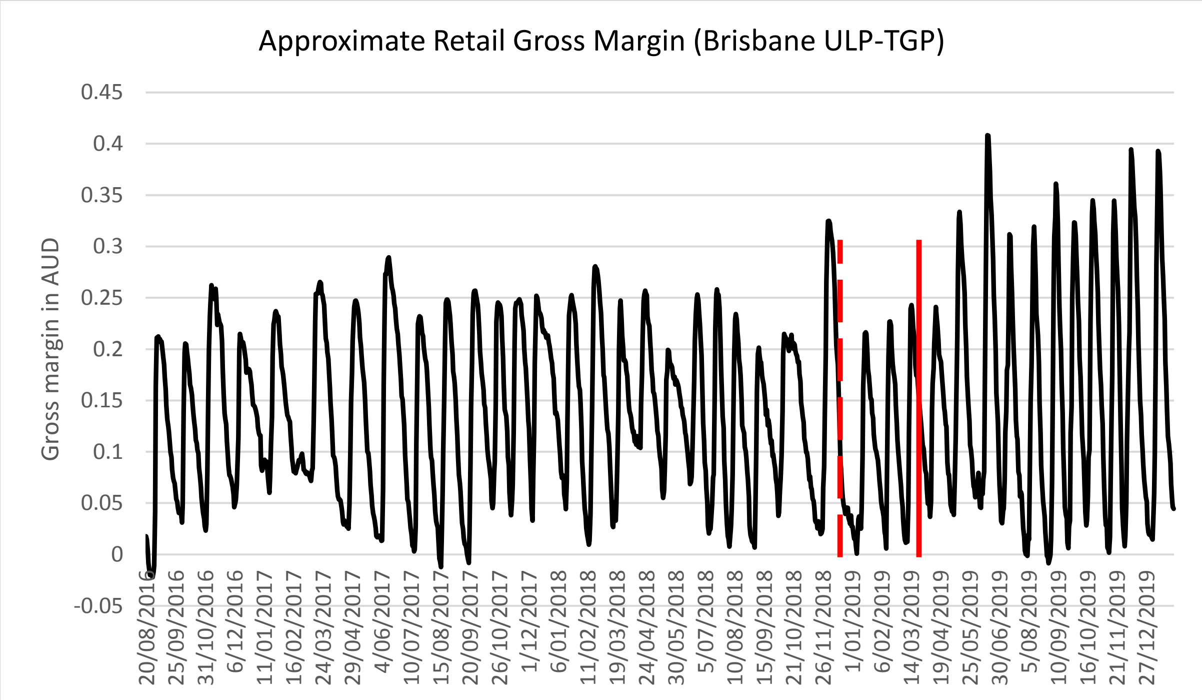

Figure 4: Approximate retail gross margins for ULP91 in Brisbane. The red dashed vertical line represents the trial commencement date on 20/12/2018 and the solid red vertical line represents the compliance date 01/04/2019.

- **New evidence on consumer use of retail apps.** The RACQ conducted a survey on fuel price app usage (RACQ, 2019c), and reported new evidence on the utilisation of apps and websites that can help contribute to consumers saving money at the bowser (RACQ, 2019a, 2019b, 2019c). Their analysis of the survey notes that usage of such apps in Queensland increased markedly (by around 250%) between 2017 and 2019. It should be noted that this increase in usage cannot be attributed solely to the commencement of the trial, given the big spikes in prices that have periodically occurred, which would also have contributed to interest in using apps that display current fuel price information. At the same time, it is reasonable to conclude that one potential factor explaining this increase in usage is the widespread belief among users that the data contained within these apps is highly accurate, and this rise has coincided with the implementation of the scheme, with reported perceived accuracy jumping from 73.5% in 2017 to 93.5% in 2019.

  From these RACQ reports, it is worth noting that app usage is not widespread across all regions and is largely centred in urban areas and are predominantly used by younger consumers. This would suggest that the impact of the trial may be limited to urban regions, such as Southeast Queensland. The use of these apps in urban areas is linked to competition, and its lack of use in regional areas is also linked to a lack of belief that the apps will help to find lower prices (i.e. perception that competitive levels are low and thus the apps will not assist in lowering prices). Overall, users are more likely to use such apps when they believe there is enough price dispersion to make their usage worthwhile, and this is more likely to occur in urban areas that possess more retail stations. Thus, while the apps are available throughout Queensland, the main beneficiaries are far more likely to reside in urban centres as opposed to regional centres.

3. Data and Methodology

3.1 The Dataset

To study retail fuel price trends before and after the introduction of the Queensland Fuel Price Reporting Trial, three different data sources have been integrated:

- Baseline legacy data supplied by Informed Sources that reported fuel prices across all major grades of fuel from December 2017 to December 2018. This consisted of 398,531 observations across 857 fuel stations.
- Baseline data sourced from point of sale data provider Oil Pricing Information Service (OPIS). This data also reported fuel prices across all major grades of fuel from December 2016 to December 2019 and consisted of 3,470,641 observations across 1,544 fuel stations.[3]
- API Data from the Queensland Fuel Price Reporting Trial (www.fuelpricesqld.com.au) that covers the period of December 2018 to the end December 2019. This covers 1,575 stations; this number increased over the period of the trial.

In terms of the regional distribution of fuel stations, these remain highly concentrated in the Southeast Queensland regions as approximate half of all fuel stations in Queensland are in this region. 26.98% of retail stations are in the Brisbane and Gold Coast LGAs, while LGAs close to Brisbane, such as Ipswich, Logan, Moreton Bay, Redland and the Sunshine Coast account for a further 23.98% of retail stations. 25 of the 57 LGAs (43.98%) have (individually) between 1 and 8 retail stations.[4]

[3] This figures was 1,481 participating fuel stations in the July report.

[4] There are 77 LGAs in Queensland, but fuel data is only available for 57 LGAs. The LGAs with missing data are Aurukun Shire, Barcoo Shire, Boulia Shire, Burke Shire, Cherbourg Aboriginal Shire, Croydon Shire, Doomadgee Aboriginal Shire, Hope Vale Aboriginal Shire, Kowanyama Aboriginal Shire, Lockhart River Aboriginal Shire, Mapoon Aboriginal Shire, Mornington Shire, Pormpuraaw Aboriginal Shire, Richmond Shire, Torres Strait Island Regional, Weipa Town, Woorabinda Aboriginal Shire, Wuial Wuial Aboriginal Shire and Yarrabah Aboriginal Shire.

3.2 Basic Trends

We begin by highlighting some basic features of the data and its trends that can be observed on the most disaggregated fuel station level. Figure 5 provides a typical overview of fuel station level fuel price trends observable in Southeast Queensland between the second half of 2016 and late 2019. Appendix A reports more aggregated LGA level price trends for several LGAs. First, note that there is a high degree of consistency and overlap across the data sources (Legacy, Informed Sources and API) noted in Section 3.1.

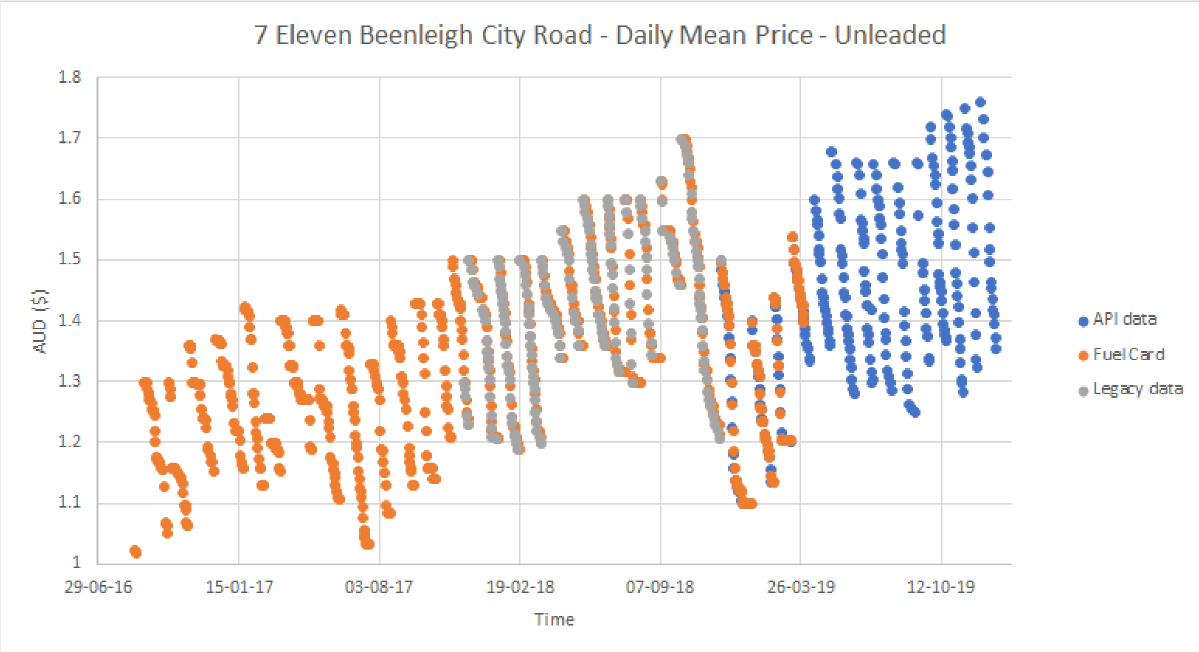

Figure 5: Average daily ULP 91 fuel price (cents per litre) points over time for one fuel station in Southeast Queensland.

In general, the figure highlights how retail petrol prices can exhibit price cycles: sudden, sharp increases in the price of petrol, followed by a gradual decline. These are a prominent, and longstanding, feature of retail petrol prices in urban areas across the country (ACCC, 2018). These cycles occur due to competitive pressures, which is why they are often observed in urban areas where retail competition is more pronounced. These competitive pressures encompass the need to capture market share whilst at the same time maintain retail margins as well. Indeed, negative retail margins at some point of the cycle is also a known feature of the cycle, suggesting that the trade-off between market share and retail margins are a live feature of these cycles.

Of interest to this report are the data from the full enforcement period (15 April 2019) onwards. A visual inspection of this figure indicates a small rise in the difference between the peak and trough of price cycles since December 2018. This is also found in figures 6 and 6a (selected Brisbane fuel stations) and figures 7 and 7a (selected Ipswich fuel stations). The fuel stations in these figures were selected to compare price cycles across independent retailers and larger brands. However, it is not clear to what extent these changes are statistically significant. As such, the trends in price dispersion are empirically examined and discussed in Section 4. A set of visuals (figures 8 - 11 below for the Brisbane LGA and surrounding LGAs[5]) also suggest an uptick in price dispersion post-trial implementation.

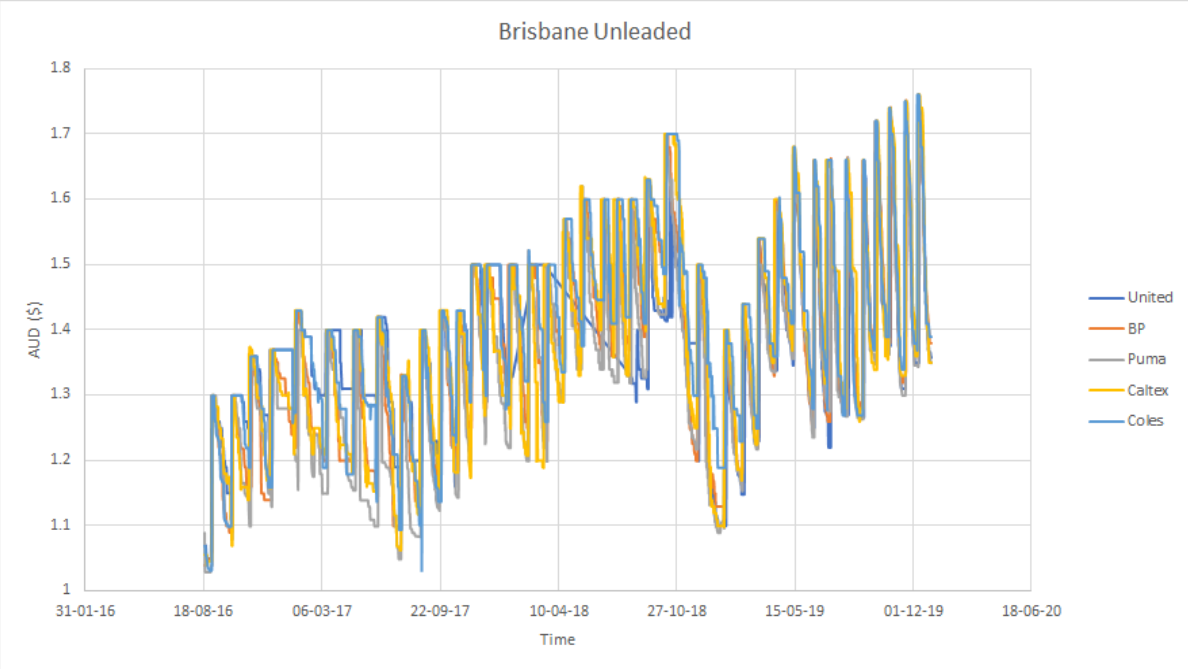

Figure 6: Average daily fuel price (cents per litre) over time (i.e. price cycles) for selected fuel stations per selected brand in Brisbane, August 2016 – December 2019.

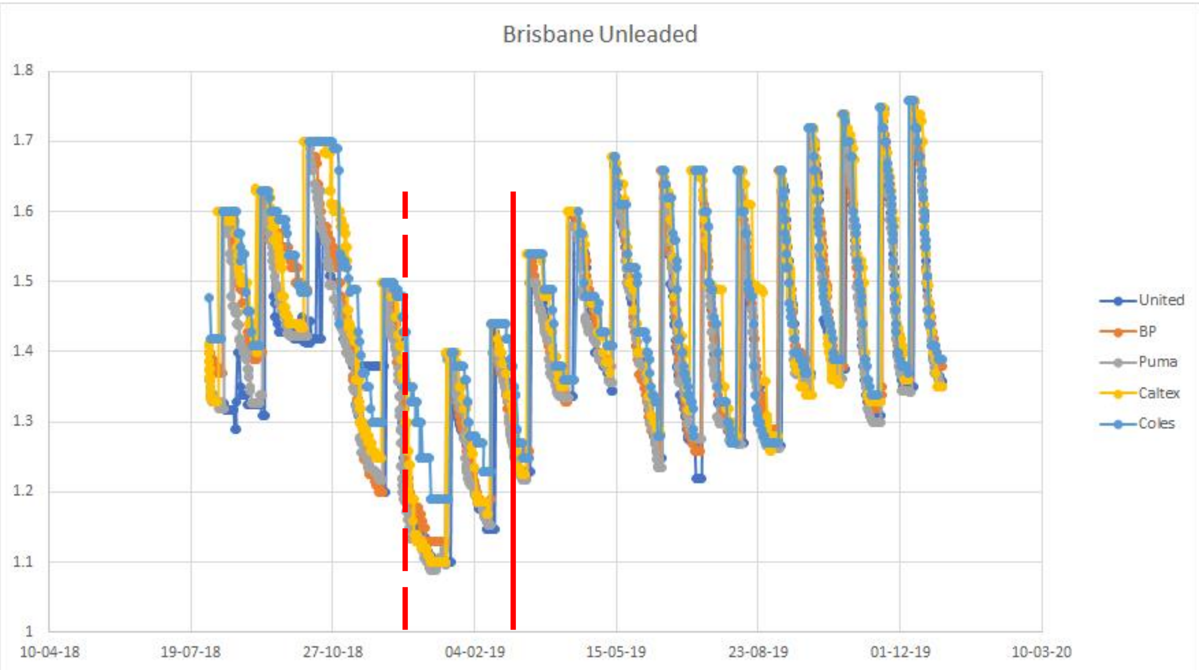

Figure 6a: Average daily fuel price (cents per litre) over time (i.e. price cycles) for selected fuel stations per selected brand in Brisbane for a more concentrated timeframe: August 2018 -

[5] See Appendix B for a fuller set of LGAs.

December 2019. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

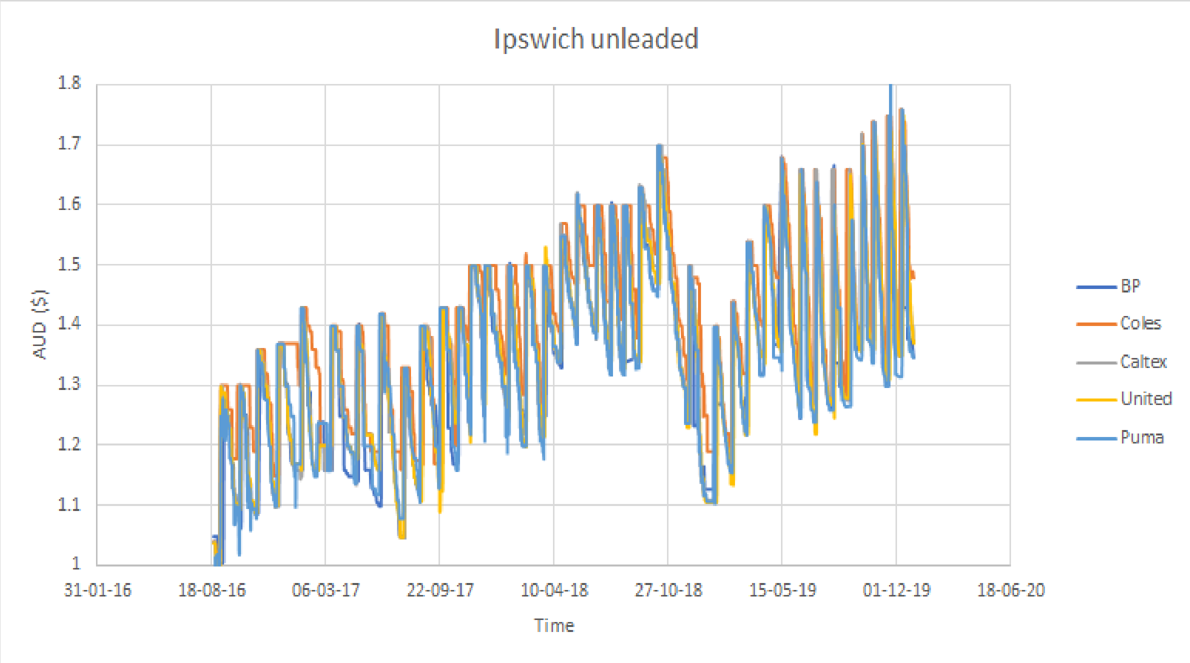

Figure 7: Average daily fuel price (cents per litre) over time (i.e. price cycles) for selected fuel stations in Ipswich, August 2016 – December 2019.

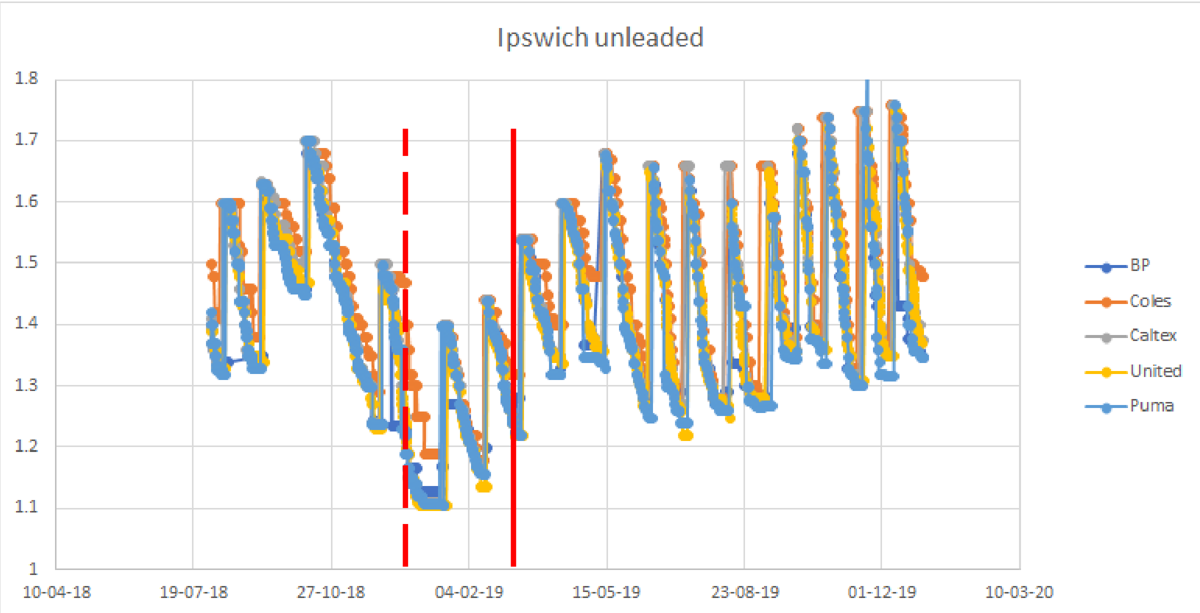

Figure 7a: Average daily fuel price (cents per litre) over time (i.e. price cycles) for selected fuel stations per selected brand in Ipswich for a more concentrated timeframe: August 2018 - December 2019. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

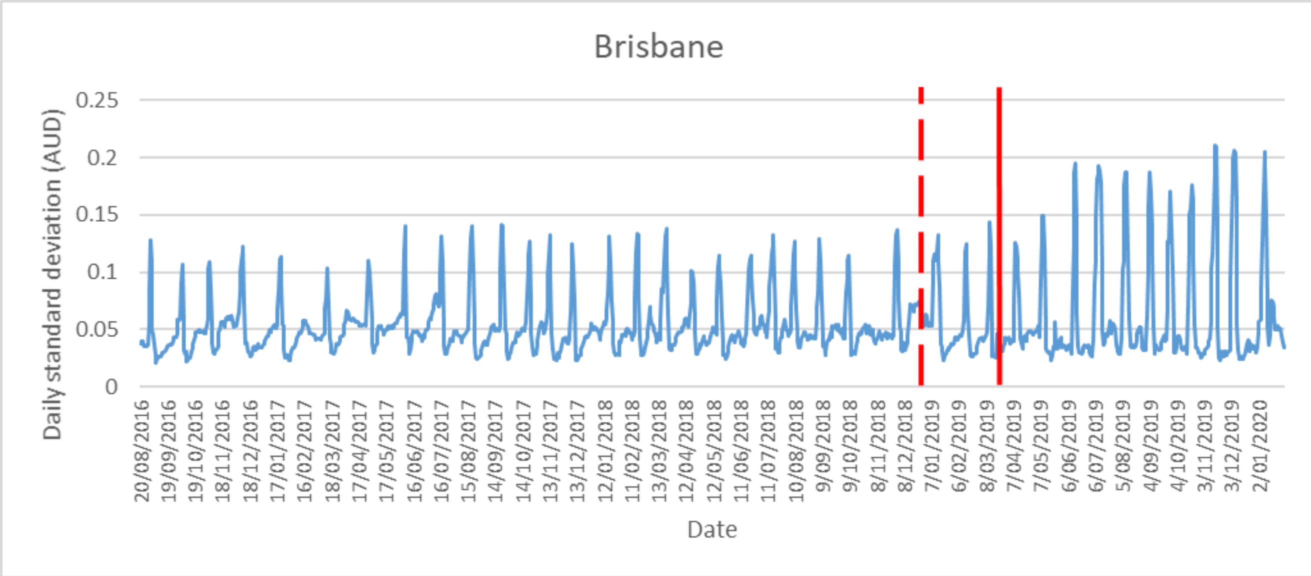

Figure 8: Daily standard deviation in ULP91 prices for Brisbane LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

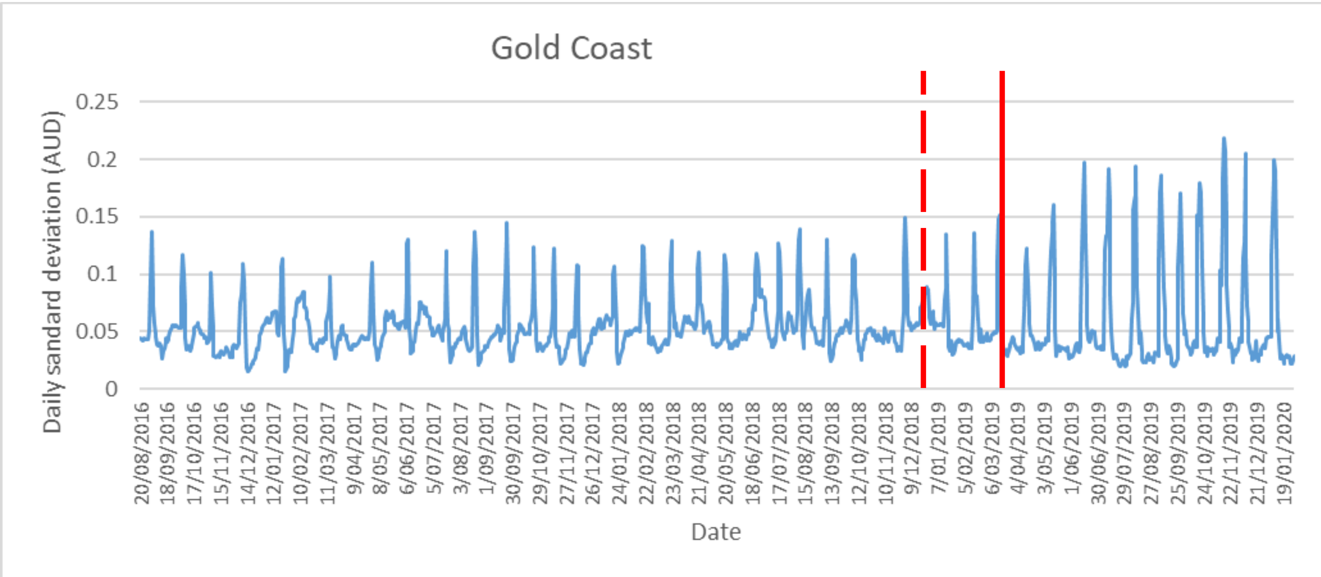

Figure 9: Daily standard deviation in ULP91 prices for Gold Coast LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

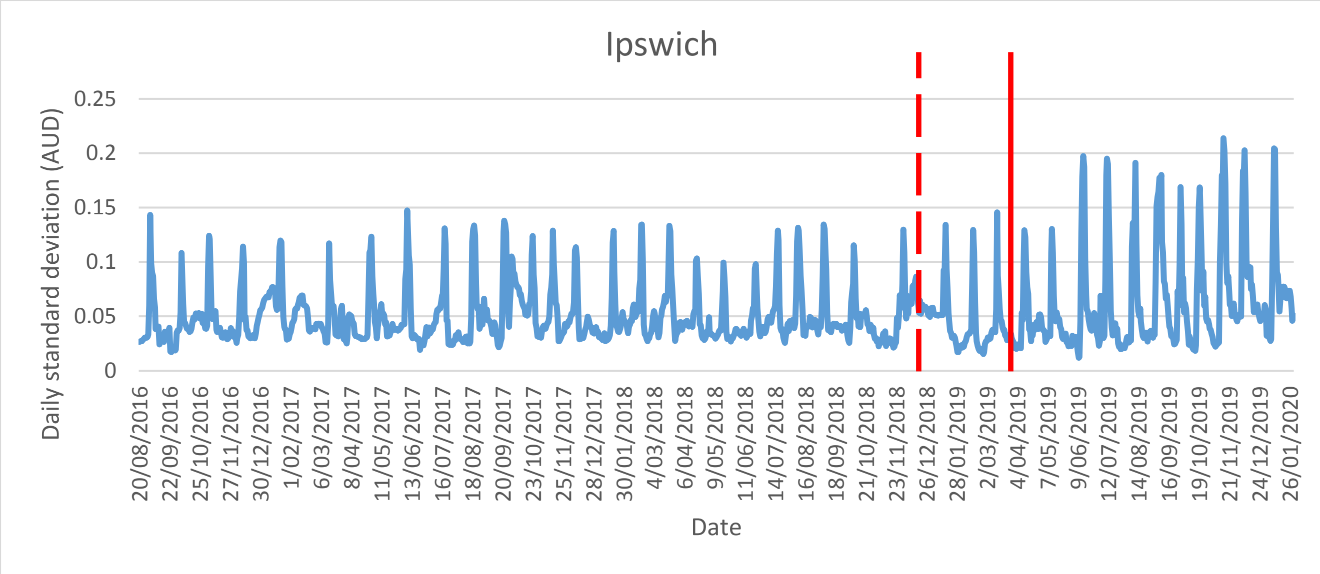

Figure 10: Daily standard deviation in ULP91 prices for Ipswich LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

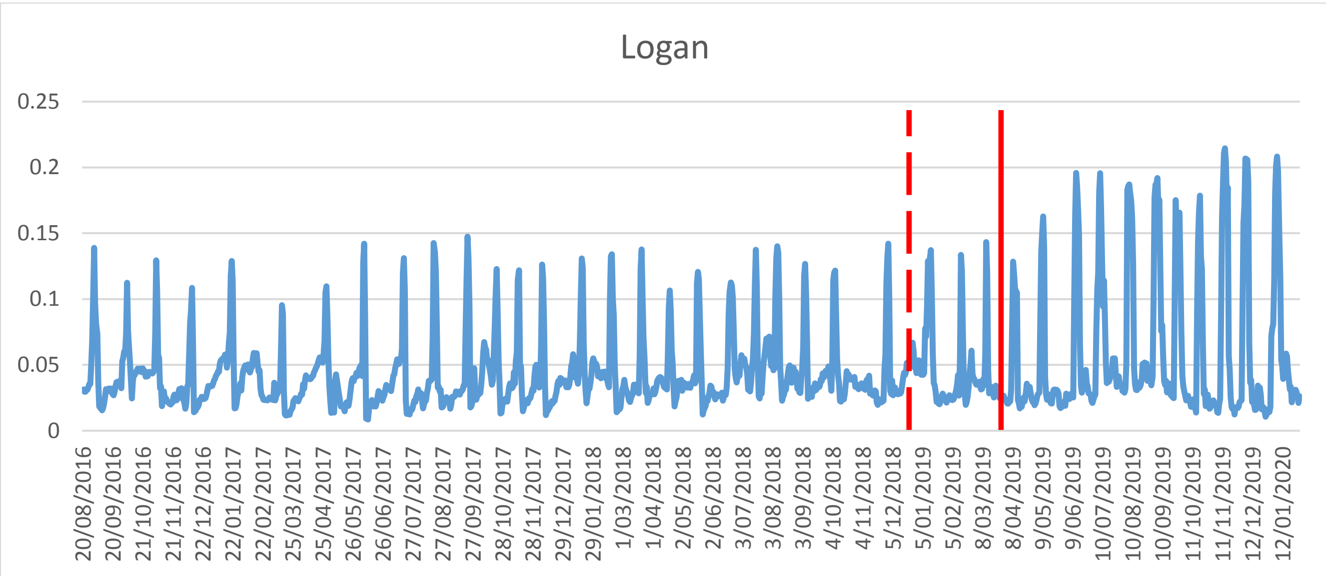

Figure 11: Daily standard deviation in ULP91 prices for Logan LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

The RACQ (2019a, 2019b) also observed changes in the Brisbane fuel price cycle. In 2019, retailers appeared to maintain cheaper prices for longer. When prices did rise, the rise also appeared to be more gradual. The RACQ reported an increase in the number of days when cheaper fuel was available in the Greater Brisbane RULP (i.e. ULP91) market. This is potentially due to smaller and/or independent retailers not imitating the higher prices set by major retailers (RACQ, 2019c), thus indicating a rise in competitive pressures, not otherwise observed in less urban centres.[6] It is worth noting here that without

[6] The econometric results justifying this assertion are shown and discussed in Section 4.

taking into account daily volume consumption, there is no clear empirical direct relationship between realised consumer savings and the number of days on which relatively cheap petrol was available.

Beyond the Brisbane LGA, figures 12 and 12a provide a snapshot of the observed regular unleaded fuel price (i.e. ULP91) across Queensland[7] during the pre- and post-policy implementation periods. These run from 1 December 2017 to 31 December 2019. The first set of numbers for each LGA show the minimum price observed during each period, followed by the maximum price and then the average (mean) price of the period. The colours denote average prices (e.g. blue denotes average prices are around the $1.40-$1.60 litre mark).

While these show that average prices have generally declined, it is worth noting that the declining trend in international oil prices have been a contributing factor as well, though there is also some evidence of the trial leading to more competitive pressures in the Southeast Queensland region (see Section 4.1 for a detailed exposition on this). As well, there has been a fall in minimum prices alongside a rise in maximum prices post-implementation, which is consistent with the finding of the RACQ discussed above. Section 4.2 also tests for price dispersion across the state. For example, looking at Ipswich LGA, the minimum price reported fell from $1.23 in the pre-trial period to $1.14 post-implementation, and the maximum price was higher post-implementation ($1.71 as opposed to $1.67 pre-trial). These greater dispersions then allow for fuel price app users to make savings at the bowser.

[7] The LGAs without data are denoted in white in the maps.

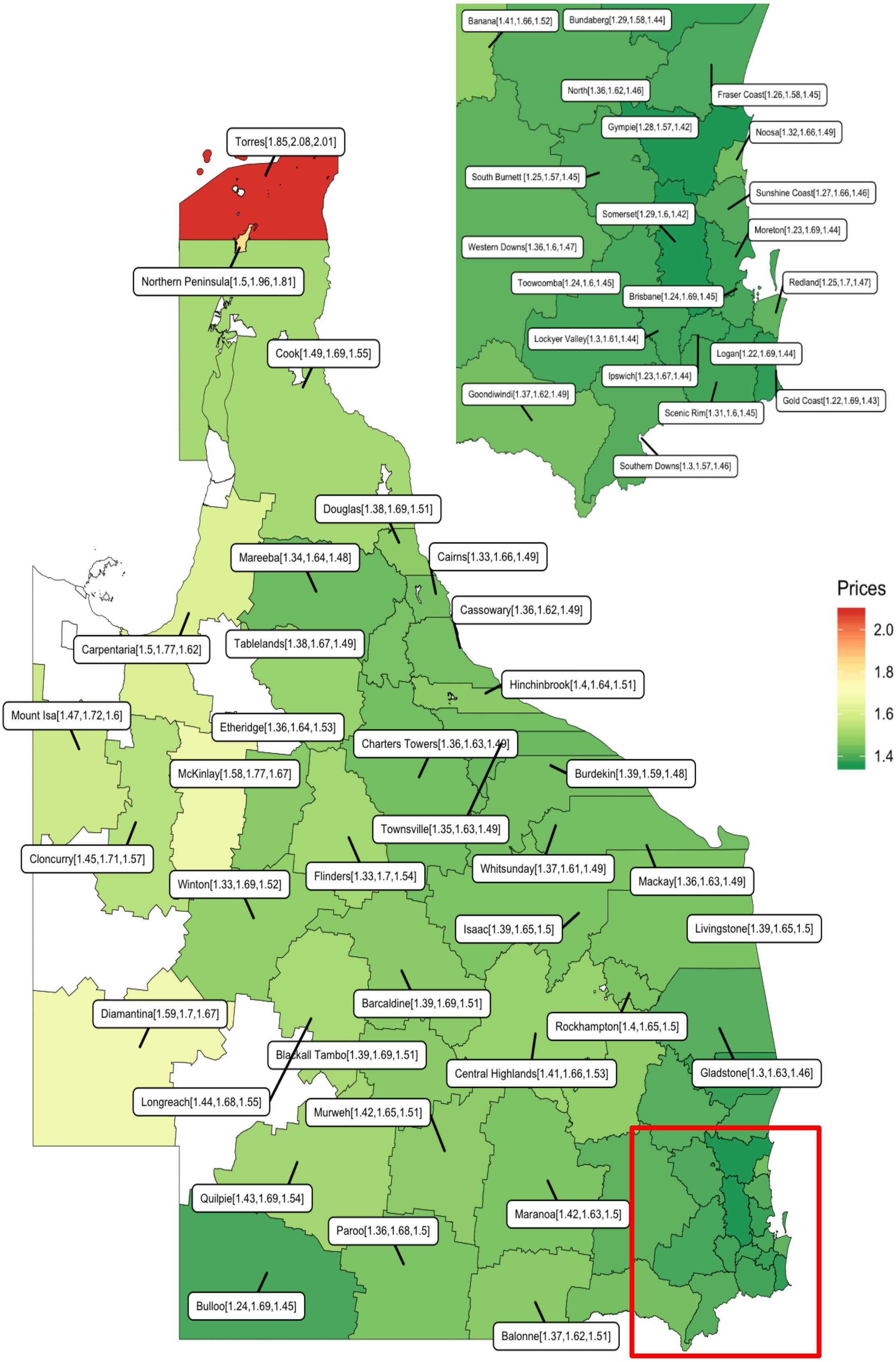

Figure 12: A snapshot of the observed regular unleaded fuel price across Queensland in the pre policy implementation periods (December 2017 to December 2018) The first set of numbers for each LGA show the minimum price observed during each period, followed by the maximum price and then the average (mean) price of the period. The colours denote average prices (green indicates a low price, yellow medium, red high)

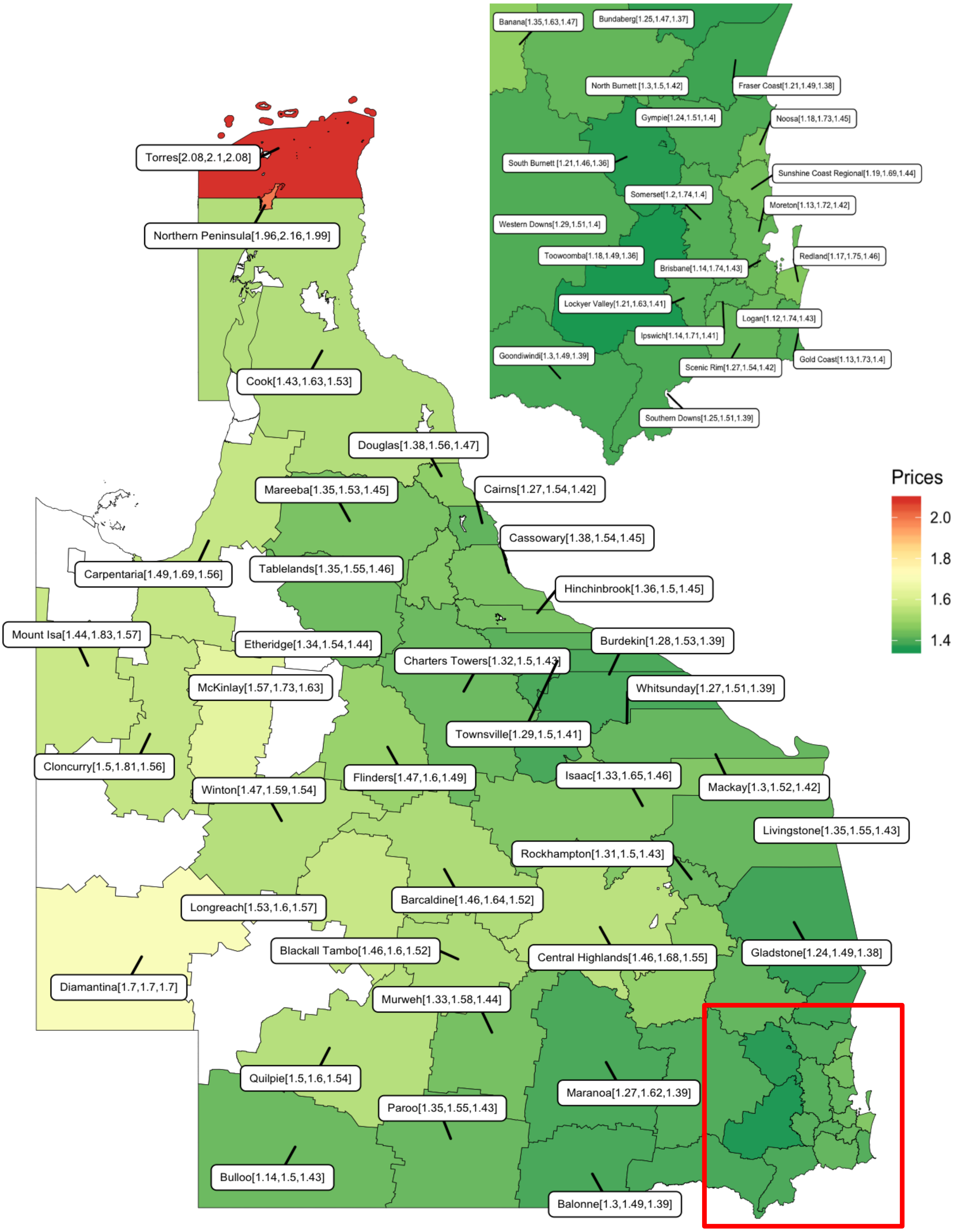

Figure 12a: A snapshot of the observed regular unleaded fuel price across Queensland in the post policy period(December 2018 to December 2019). The first set of numbers for each LGA show the minimum price observed during each period, followed by the maximum price and then the average (mean) price of the period. The colours denote average prices (green indicates a low price, yellow medium, red high).

4. Model and Results

A model of the log average daily retail price[8] by LGA and petrol type is constructed in order to empirically verify the impact of the trial on retail fuel prices. This is done using tests for structural breaks that coincide with the commencement of the trial (December 2018). This model will incorporate the main drivers of price fluctuations, including international oil prices, retail margins, demand conditions, changes in excise tax and exchange rates. The average daily petrol price for each fuel type and LGA is converted into natural-logged variables. The results cover four broad fuel types: (regular) unleaded (ULP91), ethanol blended fuel (E10), premium unleaded (PULP95 and PULP98 combined) as well as diesel.

As this analysis uses time series data, it is vital to investigate the presence of unit roots and/or co-integration relationships among variables. In other words, we are interested in identifying whether the time series variables in the model are non-stationary or stationary as well as whether there are long run equilibrium relationships among variables. The preliminary analysis suggests that price variables in some LGAs are stationary, whereas the Australian dollar value of the international oil price is non-stationary (integrated of order 1). Stationarity means that the statistical properties of a process generating a time series do not change over time. A stationary time series tends to revert to a long run mean and has constant variance. When there is a mix of stationary and non-stationary variables as well as co-integration association among variables, the well-known Auto Regressive Distributed Lag (ARDL) model becomes a suitable modelling framework for the analysis.

In the ARDL model, the dependent variable (retail fuel price) is regressed over its own past values (lagged values) as well as current and lagged values of other independent variables (in this case, the domestic currency value of international oil prices). The model is augmented via the incorporation of a further set of dummy variables that control and account for excise taxes imposed by the government that occur on a biannual basis. Given that we have a large sample in this analysis, there are sufficient degrees of freedom to include these additional dummy variables.

To check the robustness of our results, we use both Brent oil prices and TGPs as proxies for international oil prices. In terms of TGPs, these typically are closer to

[8] Transforming variables into natural logs helps to handle non-linear relationships within linear models. Similarly, logarithmic transformations help to convert highly skewed variables into more approximately normal variables.

the actual wholesale prices paid by retailers. Specifically, we use Brisbane TGPs as published by the AIP (2019b). However, we cannot exclude the possibility that there could be an endogenous impact of the trial on TGPs. If so, then TGPs may be impacted by the fuel price reporting trial. If retail margins in Queensland decline due to the trial, this may trigger petrol retailers in Queensland to re-negotiate their wholesale price agreements with petrol wholesalers. Most of these negotiated prices are not publicly available; nevertheless, a decline in these negotiated prices could be reflected in the reported Brisbane TGP. As a result, TGPs are potentially influenced by the decline in petrol retail prices caused by the trial.

In such circumstances, using a model that relies on TGPs is not advisable in terms of best practice econometric modelling procedures. More specifically, this is as reverse causality could occur between retail prices and TGPs while the model formally assumes a one-way causal relationship between the dependent variable (retail petrol prices) and the independent (oil prices). In the scenario where the trial triggers declines in retail oil prices that could also trigger reductions in TGPs, this would violate assumptions made in the ARDL model about the independent variable (in this case TGPs) being exogenous to the dependent variable (retail petrol prices). As a result, the focus of the discussion in this report will be on the model results using Brent oil prices.[9] International Brent oil prices are far less likely to be affected by retail fuel prices in Queensland. For the sake of transparency, this report will still present results for TGPs as well.

4.1 Results – Retail Fuel Price Changes

Table 1 below summarises the impact of the implementation of the fuel price reporting trial on 3 December 2018 using the ARDL model. The model covers logged average daily prices per LGA and petrol type. Appendix C provides detailed modelling results by region and fuel type (Tables C1–C4). The negative (minus) sign indicate that the model has detected a decline in retail fuel prices since the introduction of the trial, with a positive (plus) sign indicate the reverse scenario.

[9] It should be noted that the same issues come into play when considering the use of the Singaporean MOGAS95 oil prices instead of the more international Brent oil price. If the trial significantly depresses retail fuel prices in Queensland, there is a theoretical possibility that this could impact regional oil prices. For this reason, to safeguard the exogeneity assumptions of the model, Brent oil price is used.

	Independent variable: Terminal Gate Price				**Independent variable: Brent Price**			
	ULP 91	PULP	E10	Diesel	ULP 91	PULP	E10	Diesel
South East Qld LGAs								
Brisbane					-**	-**	-**	
Gold Coast					-*	-**	-**	
Ipswich	-*	-*	-*		-**	-**	-**	+*
Logan					-**	-**	-**	
Moreton Bay					-**	-**	-**	
Lockyer Valley	-**	-**	-**		-**	-**	-**	
Noosa	-*	-**	-*		-**	-**	-**	
Scenic Rim			-**					
Sunshine Coast			-*		-**	-**	-*	
Redland					-**	-**	-**	
Average					-**	-**	-**	
Other LGAs								
Townsville								
Rockhampton								
Bundaberg								+*
Cairns	+**	+**	+**					
Cairns Urban	+**	+**	+**					

Table 1 Impact of the trial on retail fuel prices.
Note: ** refers to policy effect at 5% level of significance and * refers to policy effect at 10% level of significance. Levels of significance indicate the level of confidence in the accuracy of the result, with 5% indicating strong confidence and 10% weaker confidence.

Results on Brent pricing analysis reported on the right-hand side of the table indicates that retail fuel prices across UL91, PULP and E10 have declined in a statistically significant manner since the introduction the trial across most of Southeast Queensland. However, the impact of the trial seems to be relatively confined to this region only, as the other selected LGAs indicate no statistically significant decline in retail prices. This evidence suggests that the more competitive nature of the retail fuel market in the southeast relative to other Queensland regions, and the higher utilisation of fuel price apps (RACQ, 2019c) has enabled the implementation of the trial to generate consumer savings in Southeast Queensland.

The estimated magnitude of the impact of the trial on retail fuel prices is relatively small. The estimated fall in the ULP91 price due to the implementation of the trial in the Brisbane LGA is approximately 0.51% (less than one per centage point). The impact is only marginally higher for the Southeast Queensland average (0.52%).[10] The greatest observed fall in average daily ULP91 price was in Ipswich, where the estimated impact of the trial on regular unleaded fuel prices was almost one percent (0.95%). Percentage falls were also sizeably greater than Brisbane's on the Gold Coast (0.74%), Logan (0.727%), Moreton Bay (0.78%), Lockyer Valley (0.67%), Noosa (0.84%) and Redland (0.76%), with the Sunshine Coast's fall (0.50%) approximating that of

[10] Note that the average results for Southeast Queensland are weighted to account for the number of retail fuel stations in each LGA. Therefore, the Brisbane LGA results have a higher weighting than other LGAs, as Brisbane is part of Southeast Queensland.

Brisbane's. In dollar terms, relative to the pre-trial average ULP 91 price, this equates to a fall of 0.70 cpl in both Brisbane and the Southeast Queensland average.

We observe that both the TGP and Brent model results indicate that the effect of the trial on diesel pricing is minimal or non-existent. This outcome is expected, given that only approximately one quarter of diesel consumed is sold through retail outlets. As well, across different non-diesel fuel variants (ULP91, PULP and E10) the trial seems have a consistent impact of reducing fuel prices across several Southeast Queensland regions including Ipswich, Lockyer Valley and Noosa LGAs. Finally, it is worth noting that of these fuel types, both the TGP and Brent results show that E10 pricing has declined across a greater number of Southeast Queensland regions. This is consistent with reports that E10 fuel consumers are relatively price sensitive, compared to consumers using PULP and ULP 91 (RACQ 2019c).

Concerning the results for Cairns, it is worth noting that the region was defined at the LGA level in this report. Other studies (ACCC, 2019) report a decline in average retail prices in Cairns. However, these studies use a different geographical definition of Cairns.[11] These geographical differences explain why the results are different from those reported in the ACCC study. Nevertheless, in the interest of transparency this report shows the results for both Cairns LGA and a more concentrated geographical area denoted as 'Cairns Urban' that more closely approximate the ACCC study.

4.2 Estimated Potential Savings

Beyond changes in average retail prices, Section 3 noted visible increases in price dispersion (the spread of retail petrol prices) in some regions. Increases in the spread of prices suggests that informed consumers have a greater potential to save if they are able to locate the cheapest available prices in their area for a given fuel cycle. To find evidence for statistically significant changes in price dispersion, Table 2 summarises results of an ANOVA test[12] with unequal sample sizes that check whether price dispersions (for ULP91) between daily minima and maxima have increased in a statistically significant fashion over time. Three time periods are identified. The pre-trial period (Segment 1, $\bar{\sigma}_{s1}$) from 20 August 2016 to early December 2018, the trial commencement period prior to full enforcement (Segment 2, $\bar{\sigma}_{s2}$) (early December 2018 to April 2019) and the full enforcement period thereafter (Segment 3, $\bar{\sigma}_{s3}$).

[11] For its study the ACCC defined Cairns as the area in a 15-kilometre radius from the post office at 38 Sheridan Street, Cairns (ACCC, 2017).

[12] Analysis of variance (*ANOVA*) is a collection of statistical models and their associated estimation procedures (such as the "variation" among and between groups) used to analyze the differences among group means in a sample.

	ANOVA pair-wise comparison		
Periods	S1 and S2	S1 and S3	S2 and S3
Southeast Queensland LGAs			
Brisbane		Higher (S3>S1)	Higher (S3>S2)
Gold Coast		Higher (S3>S1)	
Ipswich		Higher (S3>S1)	Higher (S3>S2)
Logan		Higher (S3>S1)	Higher (S3>S2)
Moreton Bay		Higher (S3>S1)	Higher (S3>S2)
Lockyer Valley	Higher (S2>S1)	Higher (S3>S1)	
Noosa	Higher (S2>S1)	Higher (S3>S1)	
Scenic Rim		Higher (S3>S1)	Higher (S3>S2)
Sunshine Coast		Higher (S3>S1)	Higher (S3>S2)
Redland		Higher (S3>S1)	
Other LGAs			
Townsville	Higher (S2>S1)	Higher (S1>S3)	Higher (S2>S3)
Rockhampton	Higher (S2>S1)	Higher (S3>S1)	Higher (S2>S3)
Bundaberg		Higher (S3>S1)	Higher (S3>S2)
Cairns	Higher (S2>S1)	Higher (S1>S3)	Higher (S2>S3)

Table 2: ANOVA results for price dispersion. The 'different' notation refers to a statistically significant change in daily minima and maxima price dispersions between selected periods. An empty cell refers to the fact that there was no statistically significant change in daily minima and maxima price dispersions between selected periods.

The main periods of interest would be between the pre-trial and full enforcement period (S1 vs S3 as shown in the middle column). Table 2 indicates that when comparing these two time periods, there has been a significant increase in the spread of prices (price dispersion) across all fourteen LGAs. In all ten Southeast Queensland LGAs and half of the four non-Southeast Queensland LGAs, price dispersion increased, indicating increased potential for savings at the bowser. This is also consistent with the evidence that regions with more competition could benefit from a greater spread of fuel pricing information. However, for Cairns and Townsville, we find falling dispersion instead. Nevertheless, it is important to note that this does not necessarily mean that they are savings (or otherwise) to be had as the ANOVA test does not account for any other factors or determinants that may influence price dispersion such as retail competition, transport costs and regulatory charges.

There is also some evidence that price dispersion changed between the intermediate (S2) and full enforcement (S3) periods. This occurred in a slim majority (six of ten) of Southeast Queensland LGAs and all four non-Southeast Queensland LGAs. However, while price dispersion increased in the six Southeast Queensland LGAs, this occurred for only one of the four non-Southeast Queensland LGAs. While further study is required to better understand these regional differences, we note at this stage that regional areas typically have smaller numbers of retail outlets and thus price changes at any given station could wield a greater effect on overall price trends relative to LGAs with larger number of retail stations. Changes in prices pre- and early-implementation periods (S1 and S2) are, as expected, less apparent given the trial was being bedded in.

Brisbane LGA Analysis: The analysis of price dispersion of the Brisbane LGA shows that the standard deviation between daily minima and maxima prices is not statistically different between the pre-trial (S1) and intermediate (S2) periods, suggesting that if the trial has had any impact on pricing, it was either not showing up through price cycles, or was only marginally altering pricing behaviour, such that the impact could not be econometrically stated to have significantly altered pricing behaviour. However, the standard deviation between daily minima and maxima prices is statistically significant and rising between the pre-trial (S1) and full enforcement (S3) periods, as well as between the early implementation (S2) and full enforcement (S3) periods. We interpret this to mean that from mid-April 2019 onwards, the Brisbane ULP price dispersion changed in a manner that led to a concrete alteration between daily minima and maxima prices. Graphically (see Figure 7), this can be seen as an increase in price dispersion in the later months of the trial relative to earlier periods.

Potential to save: An increase in the spread of fuel prices can grow the potential savings that can be made by motorists using fuel price apps to identify cheaper prices available in their local area. A rough indication of the annual potential savings can be derived from measuring the difference between the minimum fortnightly petrol price the mean petrol price observed in the same period. Using Brisbane LGA and Ipswich LGA ULP91 fuel price cycles in 2019, we estimate annualised savings based at comparing minimum and mean prices at $179.30 for Brisbane and $139.30 for Ipswich. Table 3 Below reports the result for other LGAs. Appendix D discusses the method in greater detail.[13]

[13] This effectively assumes a positive relationship between price dispersion and competition. This is in line with recent studies that show when competition is low, greater competition leads to greater price dispersion (Dai et al 2014).

LGA	Potential Savings
Brisbane	179.3
Ipswich	139.3
Lockyer Valley	95.2
Rockhampton	81.1
Gold Coast	139.1
Cairns	53.8
Mt. Isa	65.8

Table 3: Estimated potential Savings accrued to motorists in 2019 derived from refuelling at the minimum fortnightly observed ULP91 prices in their region, relative to refuelling at the mean fortnightly observed ULP91 price in their region.

4.3 Estimated consumer savings

Consumer surplus arising out of the fall in prices since the implementation of the trial was calculated using both information derived from this study and that provided by the Australian Bureau of Statistics (ABS) 2019 Cat. No. 9208.0 (Survey of Motor Vehicle Use, Australia, 12 months ended 30 June 2018). This is relatively consistent with previous reports that assessed the performance of similar schemes in both NSW (Griffith University, 2018a) and the Northern Territory (Griffith University, 2018b). The difference with these reports is that the fuel types reported on now go beyond using only ULP91 and include PULP and E10 as well. Analysis is conducted on the use of passenger vehicles.[14]

Using information from appendix tables C1-C3, we estimate that the savings at the bowser since the introduction of the trial to be $0.0070 per litre for ULP91 in both Brisbane and Southeast Queensland, $0.0081 per litre for PULP in Brisbane and $0.0082 pe litre for Southeast Queensland, and $0.0082 per litre for E10 in Brisbane and $0.0075 per litre for Southeast Queensland.

Brisbane LGA: ABS data reports that the average rate of petrol consumption in Queensland is 10.7 litres per 100 kilometres (or 0.107 litres per kilometre), and this data is assumed to also represent that of the Brisbane LGA, though the rather more urban setting of Brisbane LGA may lead to this average rate of petrol consumption to be a more conservative estimate. The average kilometres travelled within Brisbane for passenger vehicles is 10,500 kilometres

[14] ABS data is also available on the following motorised vehicles: motorcycles, light commercial vehicles, rigid trucks, articulated trucks, non-freight carrying trucks and buses.

per year. Over this distance, the amount of petrol consumed would be 1,123.5 litres (10,500 x 0.107).

Given an estimated savings of $00.70 per litre using ULP91 in Brisbane, users of this fuel would save $7.86 a year per passenger vehicle from the implementation of the trial.[15] For PULP users, this would be $9.10 and for E10 users, $9.21. Using Southeast Queensland average petrol volume data between January 2017 and December 2019 provided by DNRME, we estimate that 52.13% of these petrol based passenger vehicles would utilise ULP91, 27.98% PULP and 19.89% E10. Across all the petrol using motorists in Brisbane, this amounts to a total consumer surplus of $10,099,991.33 resulting from the introduction of the trial.[16]

Variations to Consumer Surplus: Changes in the figure for total kilometres travelled will impact consumer surplus, and there is no *a priori* reasoning to use only the 'within Brisbane' average annual kilometre estimate of 10,500 kilometres per annum. Going back to Table 27 of Cat. No. 9208.0, if we include trips not just within Brisbane but also those between Brisbane and other parts of Queensland as well as between Brisbane and other capital cities (as calculated by the ABS), then 15,692,955,000 kilometres are covered. This yields a total consumer surplus of $12,771,805.17.[17] Nevertheless this report opines that the 'within Brisbane' definition is a more accurate depiction of the use of passenger vehicles within the Brisbane LGA, and the presentation of a broader measure is used to indicate that aggregated savings can expand if we also incorporate a wider driving range that will better represent a minority of drivers.

Southeast Queensland LGAs Weighted Average: With some variation, the same methodology is used to calculate consumer savings for Southeast Queensland (note that this includes Brisbane).[18] Given an estimated savings of $00.70 per litre using ULP91 in Southeast Queensland, users of this fuel would save $7.86 a year per passenger vehicle from the implementation of the trial. For PULP users, this would be $9.21 and for E10 users, $8.43. Across all the petrol using motorists in Southeast Queensland, this amounts to a total consumer surplus of $14,267,470.64.[19]

5. Conclusion and Discussion

This report empirically examines how the Queensland Fuel Price Reporting Trial has impacted daily retail fuel prices across Queensland since the

---

[15] 1,123.5 litres*$0.0070 and the same amount of litres is utilised is every case (e.g. region and fuel type).
[16] See Explanation 1 in Appendix E.
[17] See Explanation 2 in Appendix E.
[18] See Explanation 3 in Appendix E.
[19] See Explanation 4 in Appendix E.

commencement of the trial in December 2018. The results show that the trial generated a small but statistically significant decline in the average daily retail prices of ULP91, PULP and E10 petrol in most regions of Southeast Queensland. No statistically significant declines in petrol prices were observed in regions outside of Southeast Queensland. As well, no statistically significant changes were detected for diesel fuel prices.

The results of the report highlight that the scope for consumer savings is not uniform across the state and is concentrated in more urban settings. A key condition to ensure the trial works effectively to lower retail fuel prices is to increase the uptake of consumer utilisation of fuel price information via fuel price apps. Policymakers may wish to consider what steps can be undertaken to assist app developers heighten consumer awareness of the information provided by the trial such that it can be utilised in a timely and efficient manner. This could include developing LGA-specific forecasts of petrol prices so consumers are more aware not only of which fuel prices are cheap within their local regions, but also whether they are forecast to change over the next few days. Some websites and apps already provide some of this information (including the ACCC and the RACQ). The results of this report suggest that such detailed information would be useful across many regions. Such steps could potentially help ensure the trial has a more effective impact on lowering retail fuel prices across a greater number of regions.

Finally, in order to better understand the impact of the trial on consumer savings, more research is needed on how the trial influences the timing of fuel purchases and the volumes of petrol purchased, and this can also encompass qualitative as well as the more apparent quantitative studies (such as the ones conducted in this report). It is feasible that consumers could delay or move forward their refuelling decisions or reduce/increase the volume of petrol consumed given the rich set of information made available from the trial. Such information may highlight how the scheme could have a deeper impact on consumer savings than is currently estimated in this report.

In terms of the quantum of savings, the decline in ULP91, PULP and E10 fuel prices attributed to the trial represent varying degrees of savings. These savings (annualised) are $7.86 per passenger vehicle in both Brisbane and the southeast Queensland region for ULP91, $9.10 in Brisbane and $9.21 in Southeast Queensland for PULP and $9.21 in Brisbane and $8.43 in Southeast Queensland for E10. This yields a per annum gain in consumer surplus of $10,099,991.33 in Brisbane and $14,267,470.64 in Southeast Queensland.

6. References

ABS (2019) Survey of motor vehicle use, Australia, 12 months ended 30 June 2018, Cat. No. 9208.0.

ACCC (2017) Report on the Brisbane fuel market, October. Available at: https://www.accc.gov.au/publications/petrol-industry-reports

ACCC (2018) Fuel price cycles in Australia, December. Available at: https://www.accc.gov.au/publications/petrol-industry-reports

ACCC (2019) Report on the Australian petroleum market. September quarter 2019, November. Available at: https://www.accc.gov.au/publications/petrol-industry-reports

AIP (2018) Facts about fuel prices & the Australian fuel market. Available at: https://www.aip.com.au/index.php/resources

AIP (2019a) Facts about fuel prices & the Australian fuel market. 16 December. Available at: https://www.aip.com.au/index.php/resources

AIP (2019b) Terminal Gate Prices (TGPs) Historical Averages for Petrol and Diesel. Available at: https://www.aip.com.au/pricing/terminal-gate-prices

DNRME (2018) Fuel Price Reporting Decision Regulatory Impact Statement. Available at: https://www.dnrme.qld.gov.au/energy/initiatives/fuel-price-reporting-trial/about

Dai, M, Q. Liu, K. Serfes (2014) Is the effect of competition on price dispersion nonmonotonic? Evidence from the US Airline Industry. The Review of Economics and Statistics 96(1): 161-170.

Griffith University (2018a) DNRME 18018, the impact of FuelCheck on retail fuel prices in New South Wales, final report.

Griffith University (2018b) DNRME 18018, variation 1, the impact of MyFuelNT on retail fuel prices in the Northern Territory.

Griffith University (2019) DNRME 03/07/3795, a preliminary assessment of the Queensland fuel price reporting trial.

IEA (2020) Oil market report - January 2020, IEA, Paris. Available at: https://www.iea.org/reports/oil-market-report-january-2020

RACQ (2019a) Monthly fuel price report – October 2019. Available at: https://www.racq.com.au/cars-and-driving/cars/owning-and-maintaining-a-car/fuel-prices

RACQ (2019b) Monthly fuel price report – November 2019. Available at: https://www.racq.com.au/cars-and-driving/cars/owning-and-maintaining-a-car/fuel-prices

RACQ (2019c) Perception and use of fuel-price apps. Post-trial survey. 20 December.

APPENDIX A: Average daily ULP prices for selected LGA regions

Note: Vertical axis refers to the petrol price in Australian Dollars

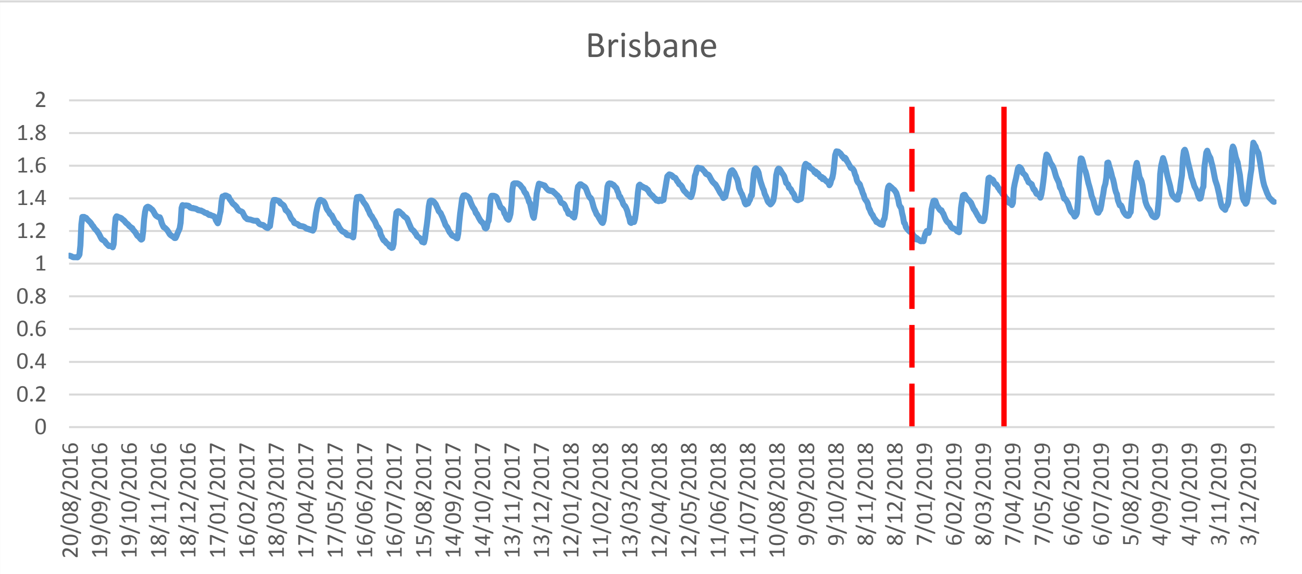

Figure A1: ULP 91 prices for Brisbane LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

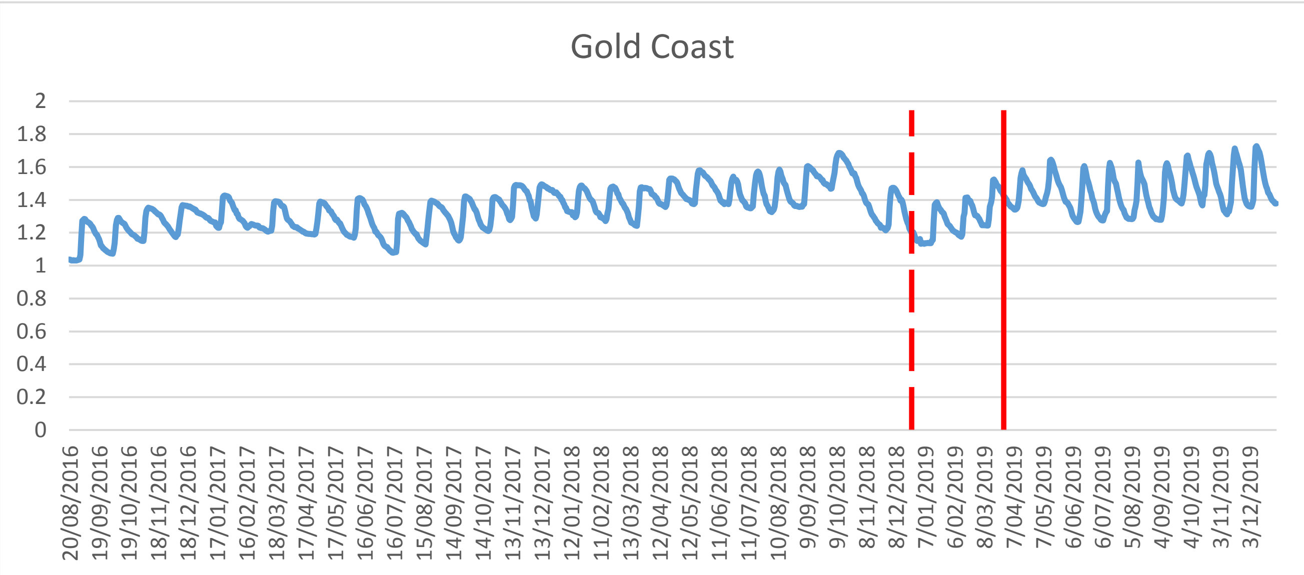

Figure A2: ULP 91 prices for Gold Coast LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

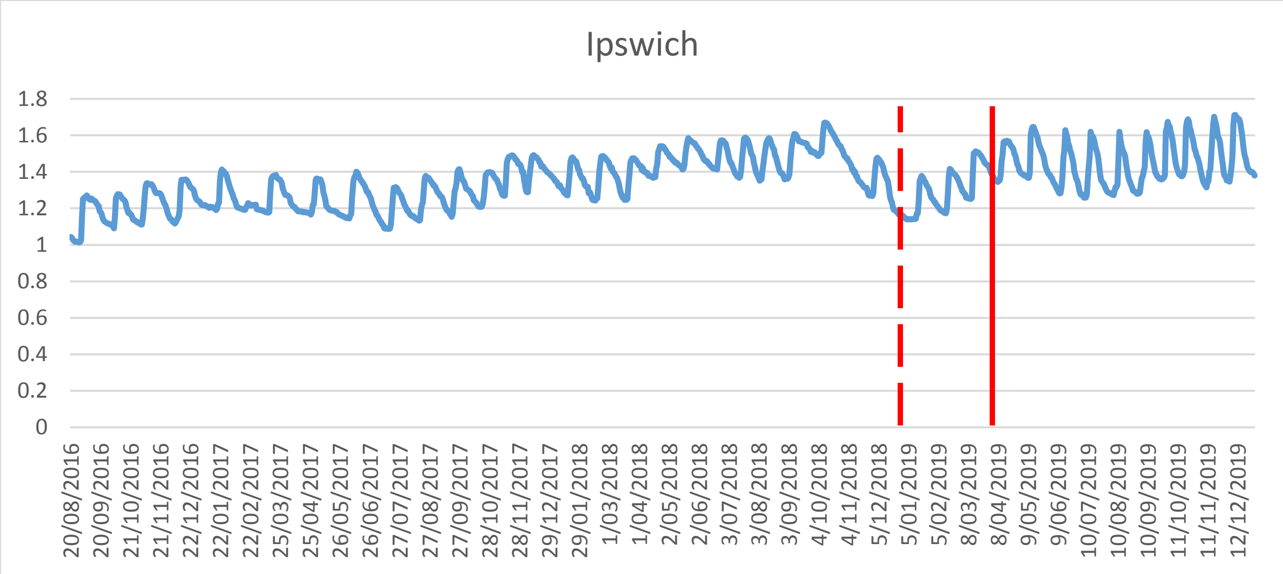

Figure A3: ULP 91 prices for Ipswich LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

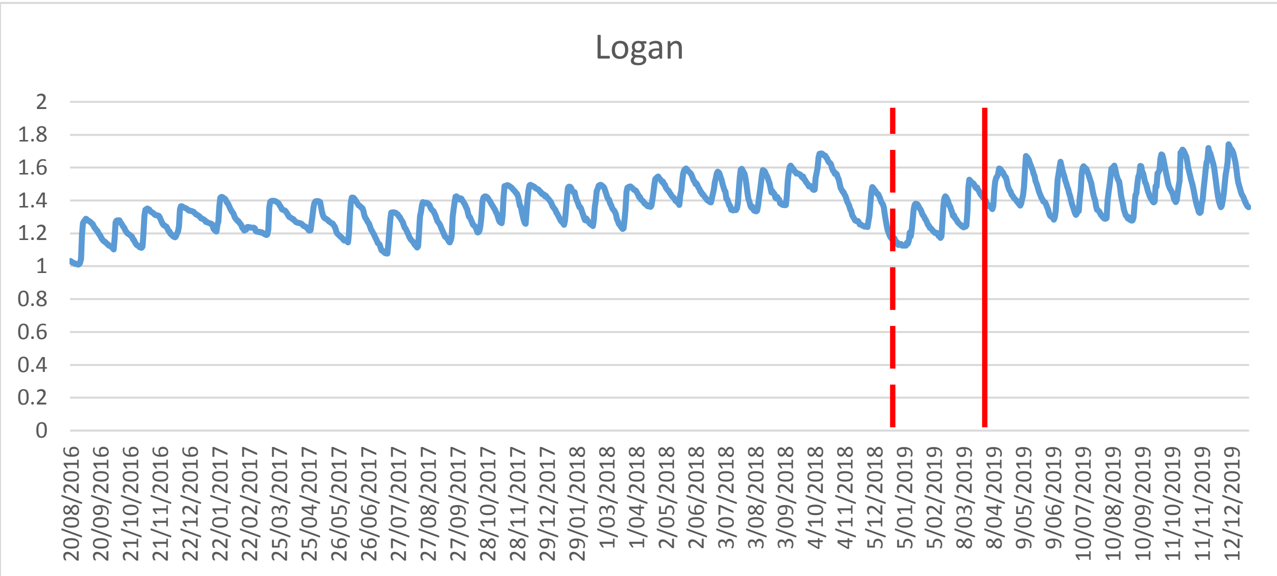

Figure A4: ULP 91 prices for Logan LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

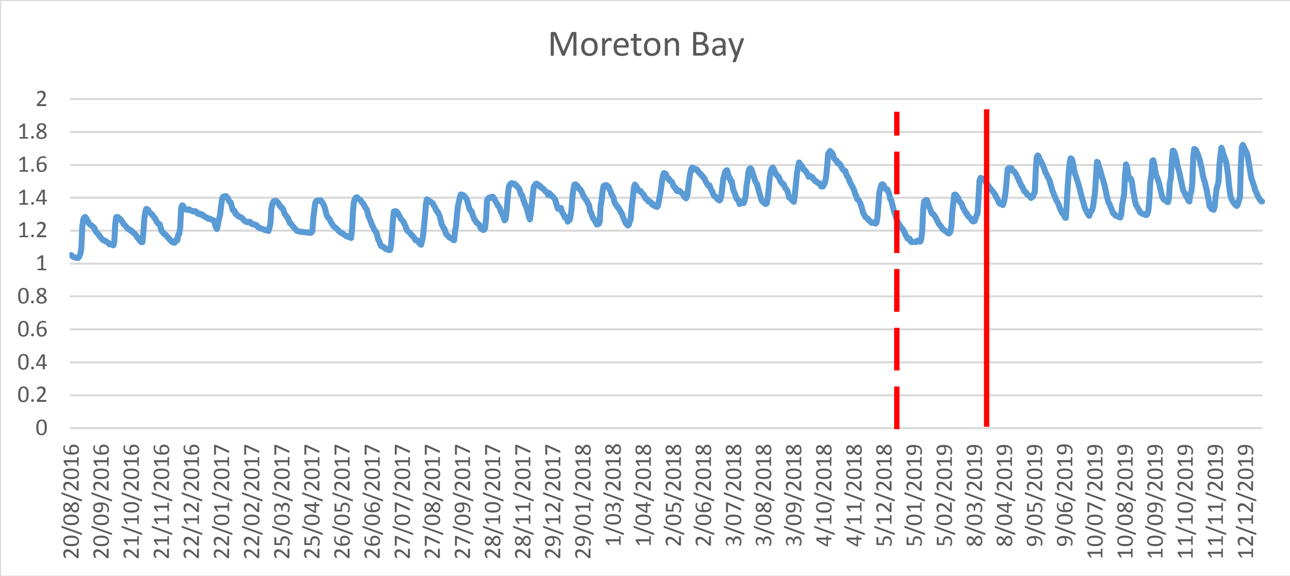

Figure A5: ULP 91 prices for Moreton Bay LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

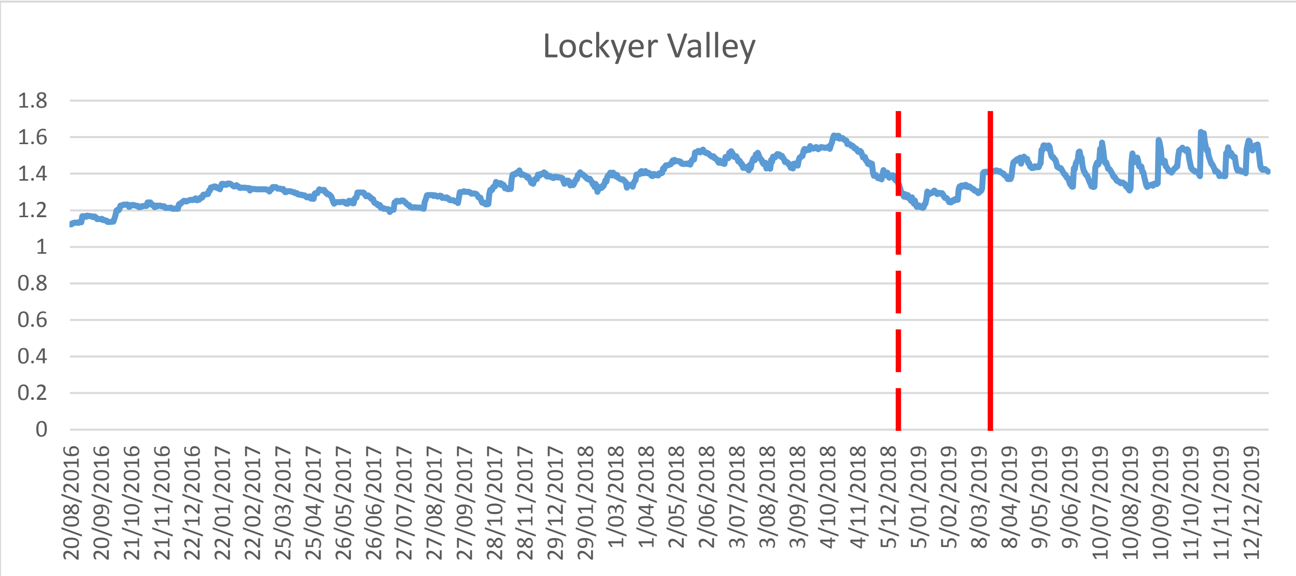

Figure A6: ULP 91 prices for Lockyer Valley LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

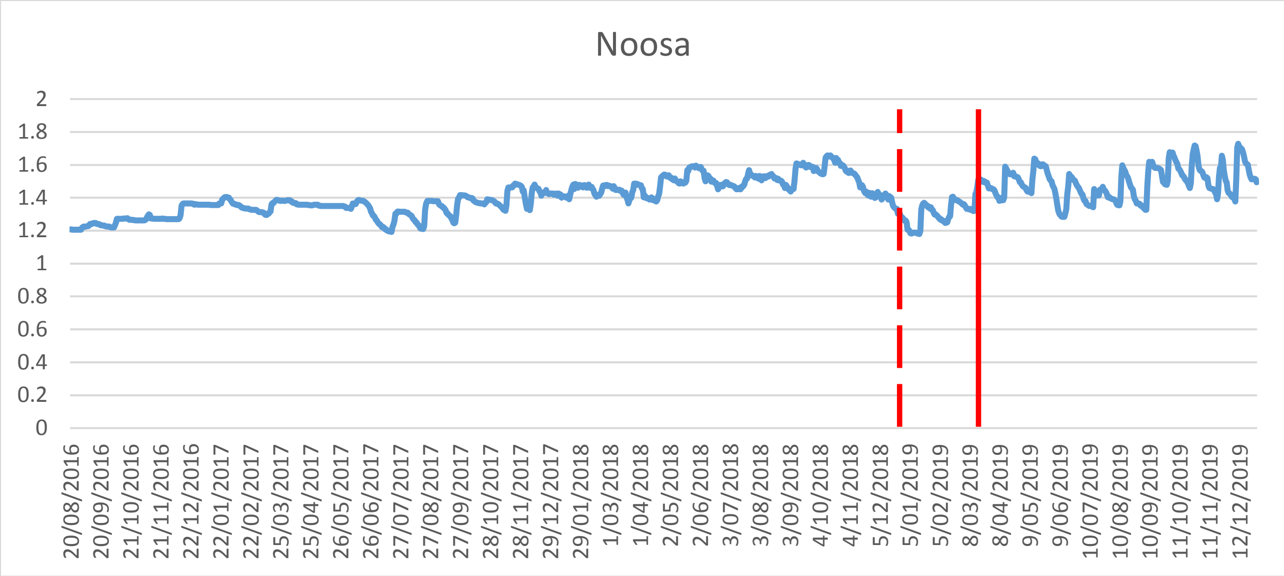

Figure A7: ULP 91 prices for Noosa LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

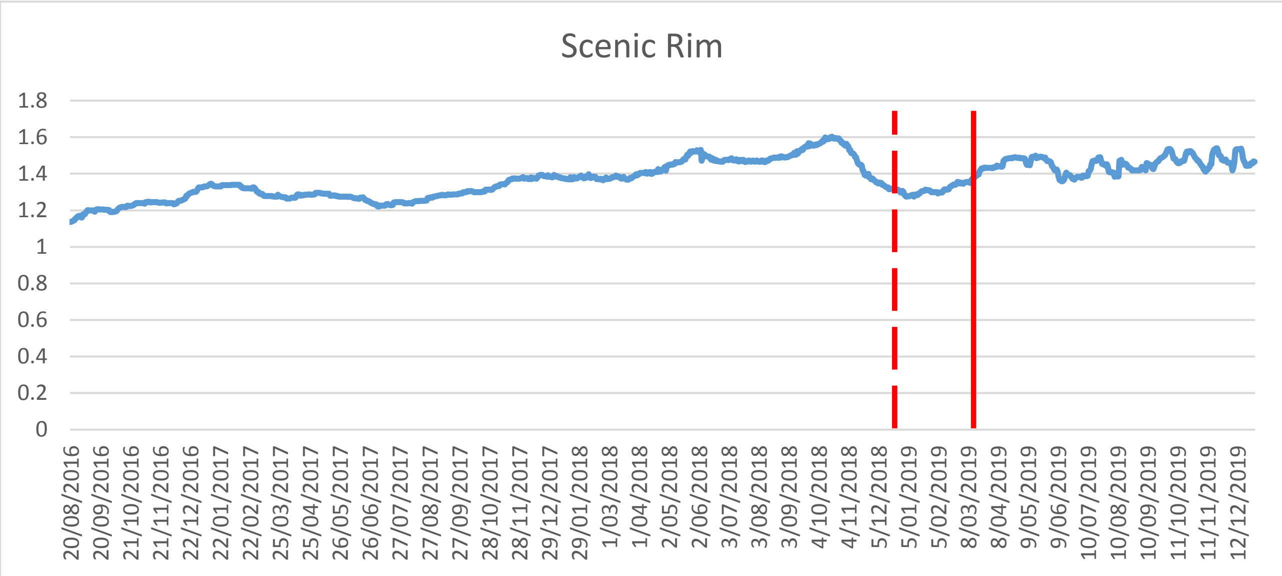

Figure A8: ULP 91 prices for Scenic Rim LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

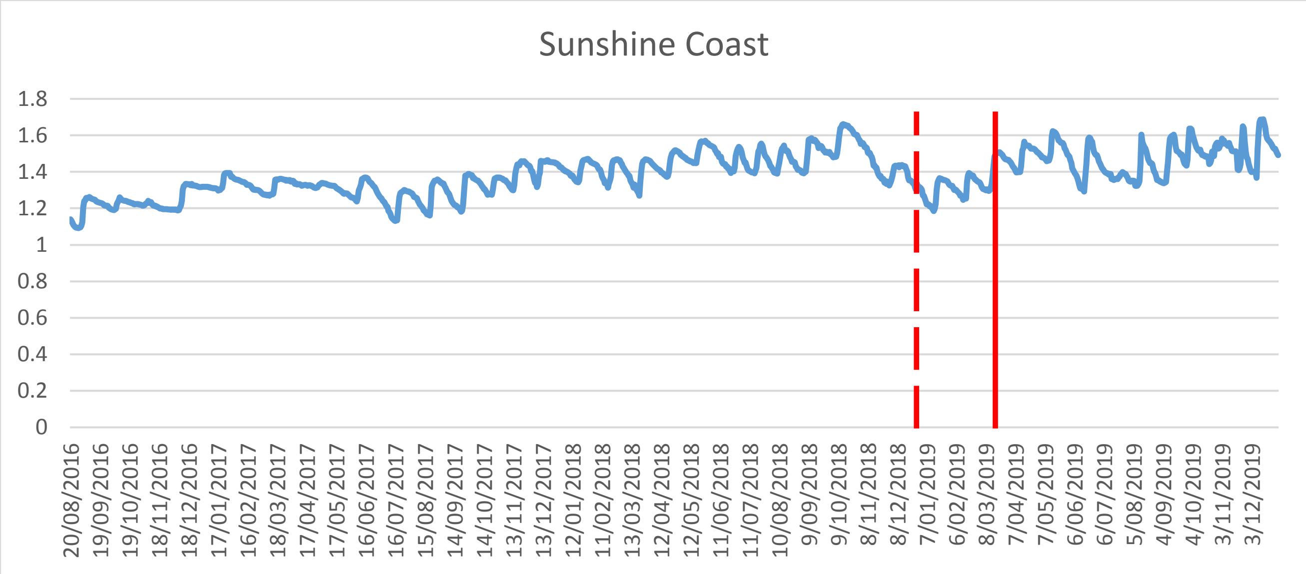

Figure A9: ULP 91 prices for Sunshine Coast LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

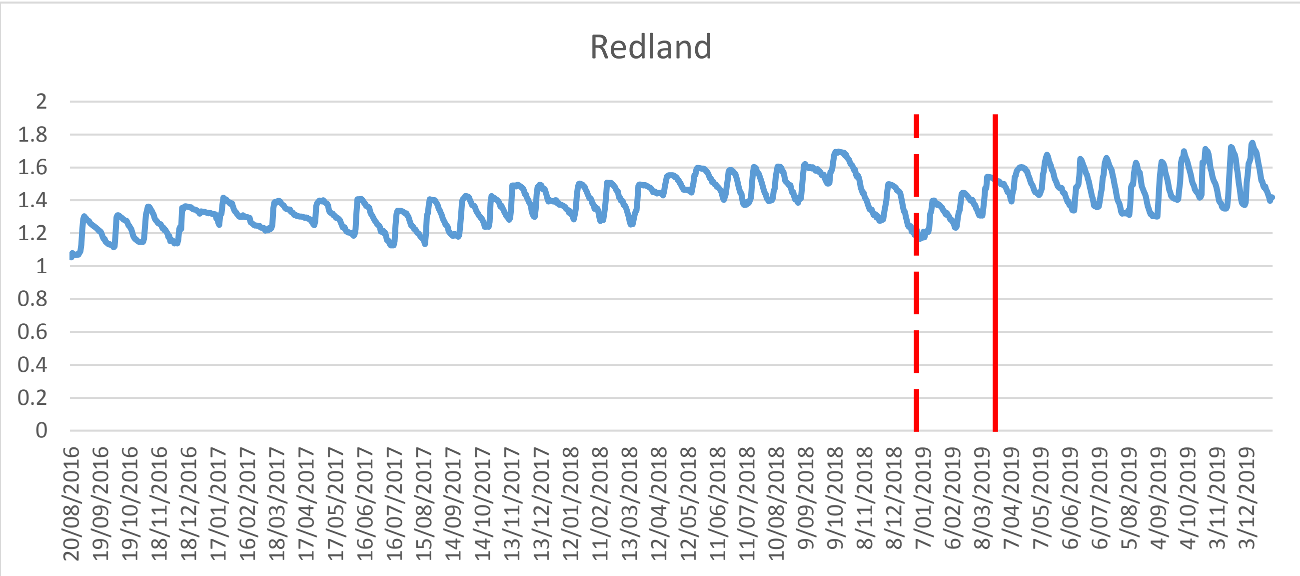

Figure A10: ULP 91 prices for Redland LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

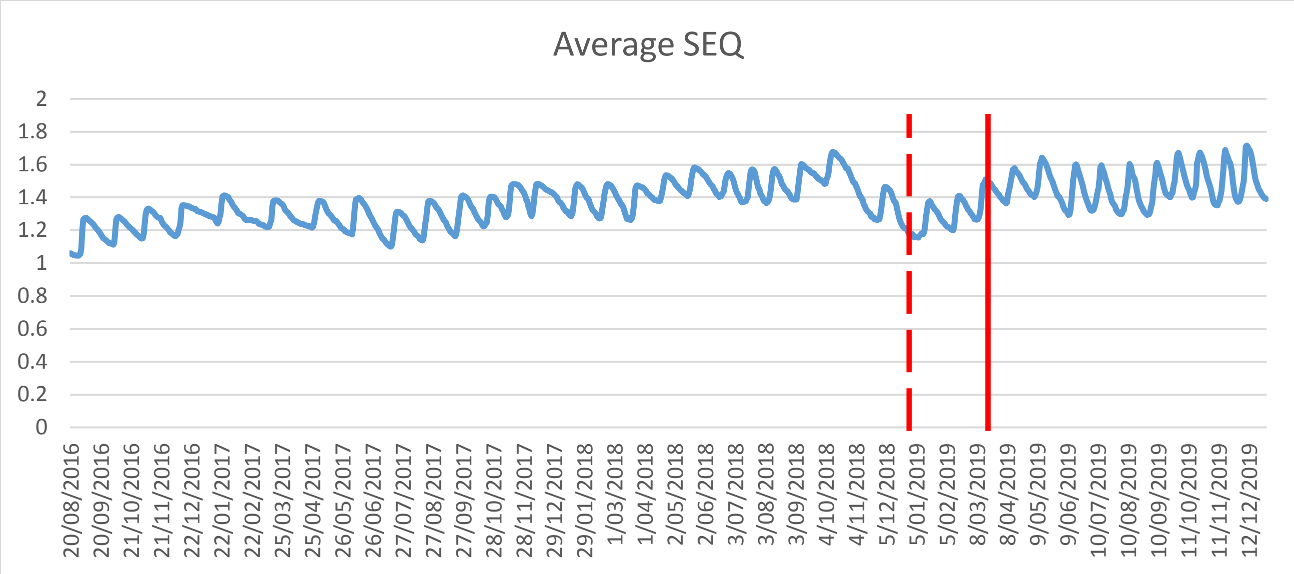

Figure A11: ULP 91 prices for Southeast Queensland LGAs (weighted average). Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

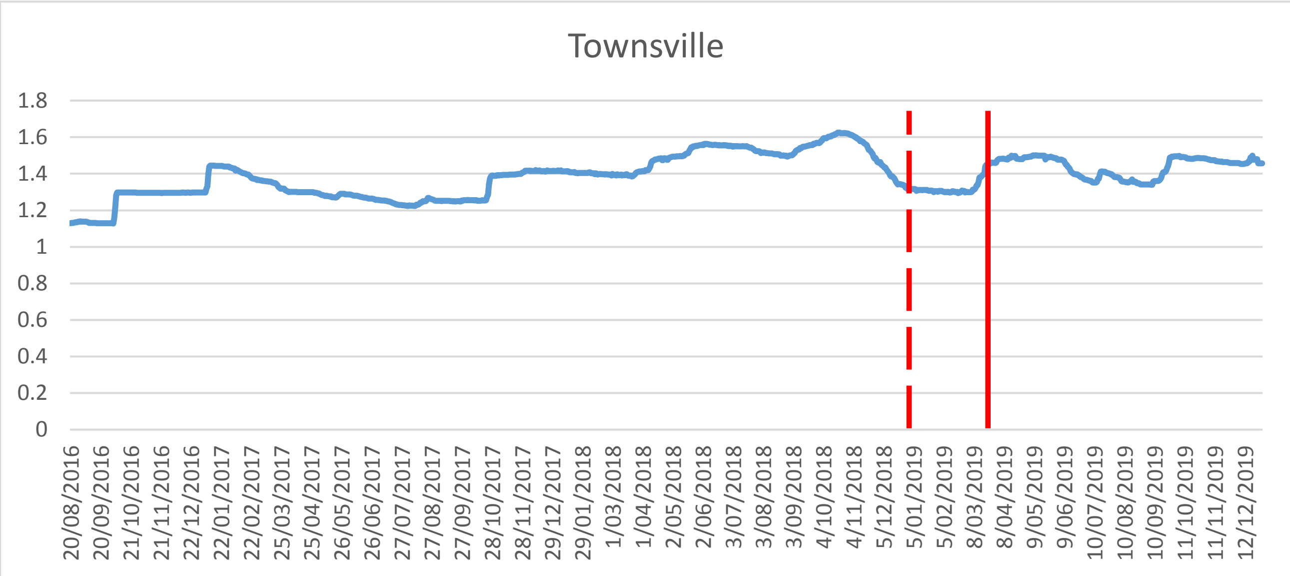

Figure A12: ULP 91 prices for Townsville LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

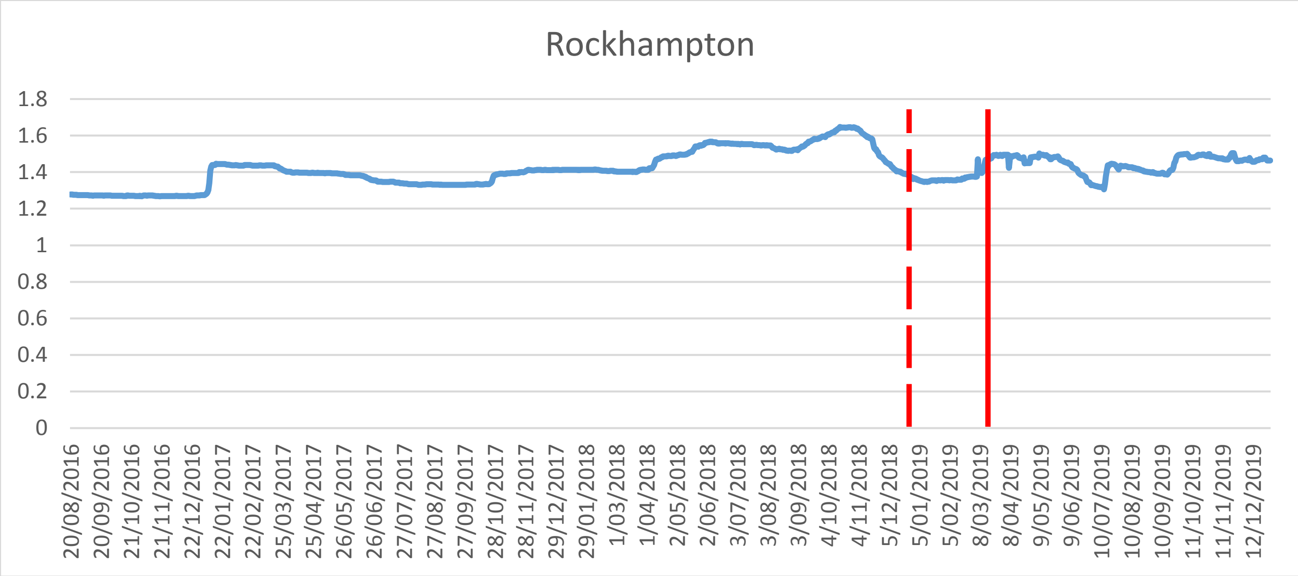

Figure A13: ULP 91 prices for Rockhampton LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

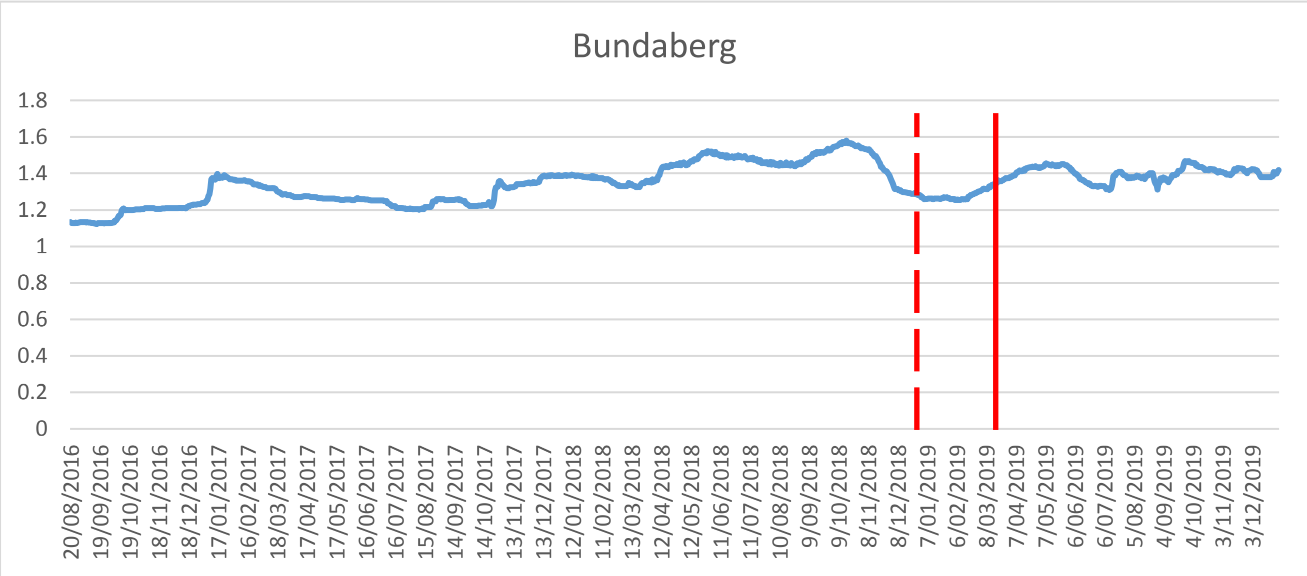

Figure A14: ULP 91 prices for Bundaberg LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

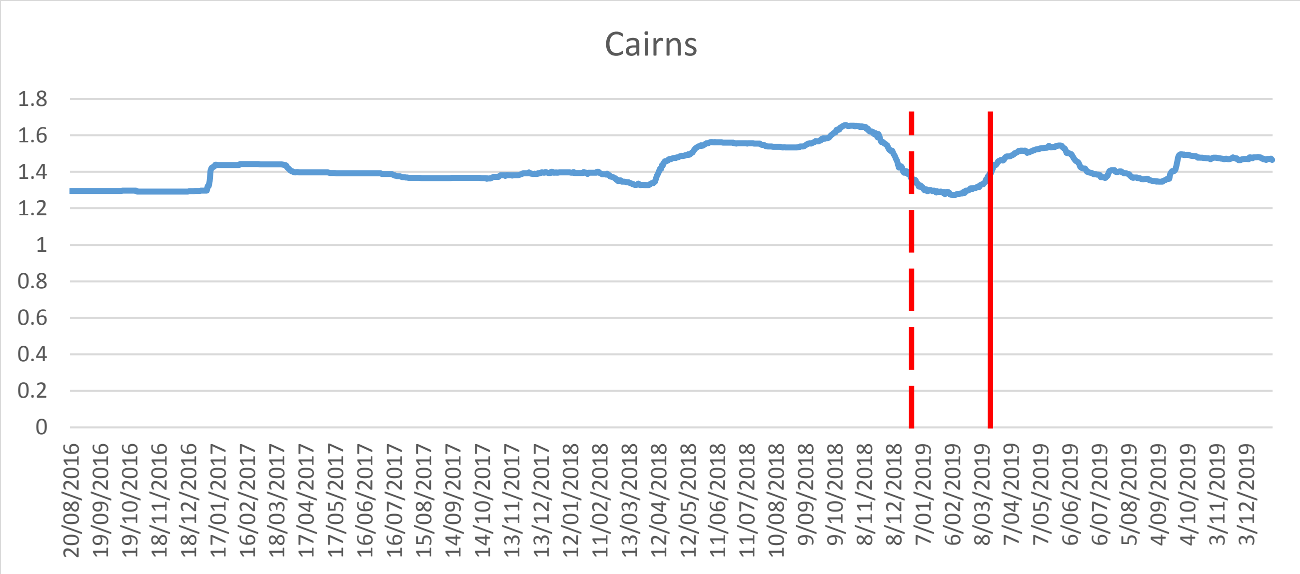

Figure A15: ULP 91 prices for Cairns LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

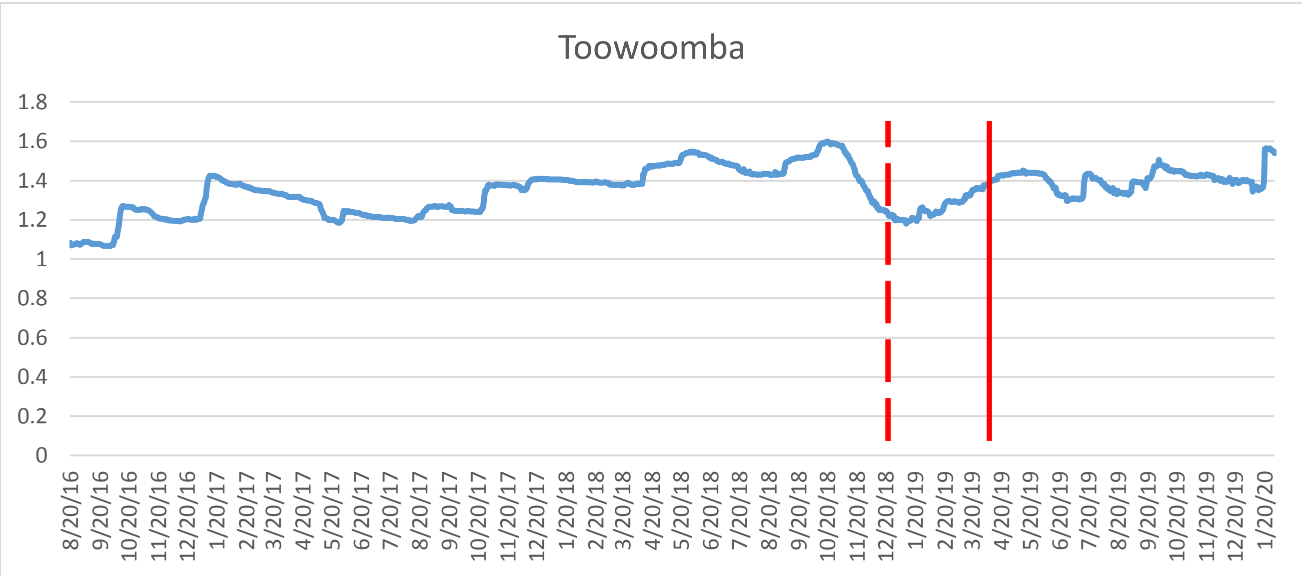

Figure A16: ULP 91 prices for Toowoomba LGA. Red dashed vertical line represents the trial commencement on 20/12/2018 and the other red vertical line represents the compliance date 01/04/2019.

APPENDIX B: Trends in Price Dispersion

LGA level figures for ULP 91. Vertical (Y) axis refers to daily standard deviation in ULP 91 prices per region.

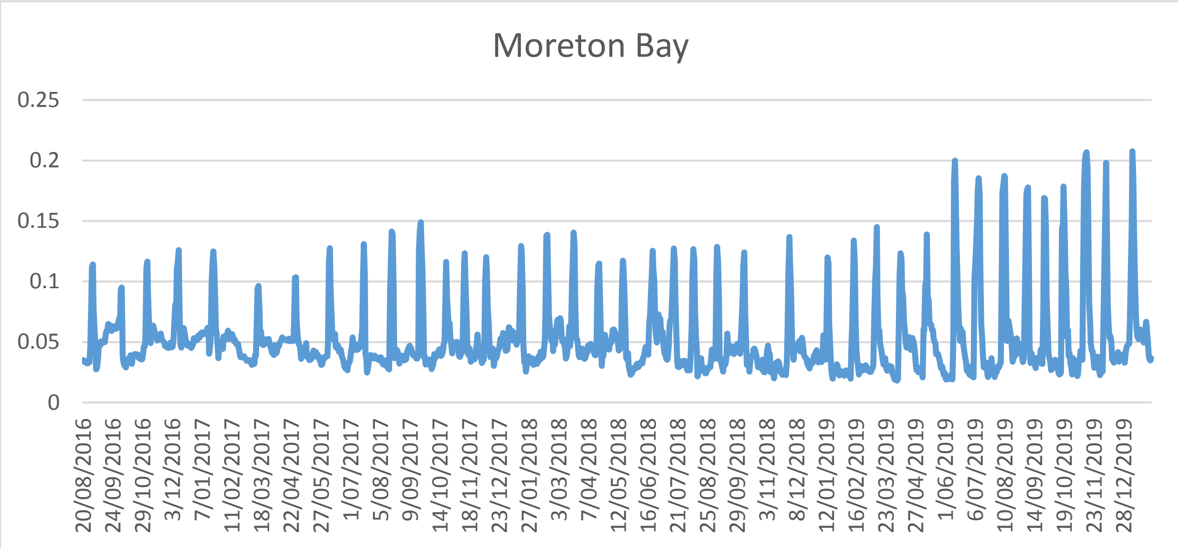

Figure B1: Standard deviation of daily prices for Moreton Bay LGA

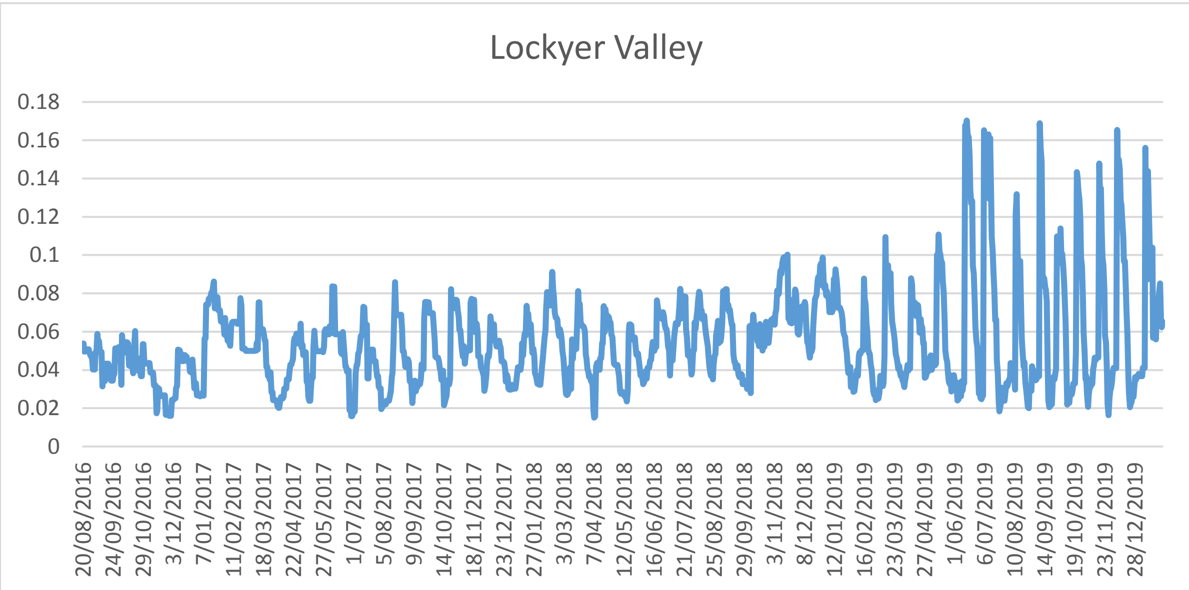

Figure B2: Standard deviation of daily prices for Lockyer Valley LGA

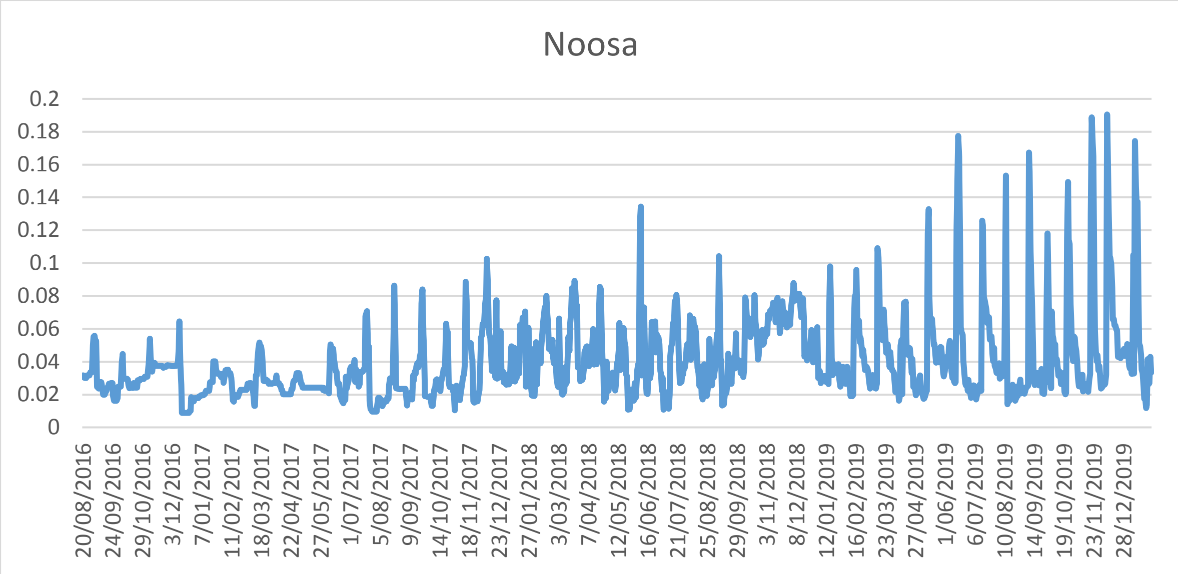

Figure B3: Standard deviation of daily prices for Noosa LGA

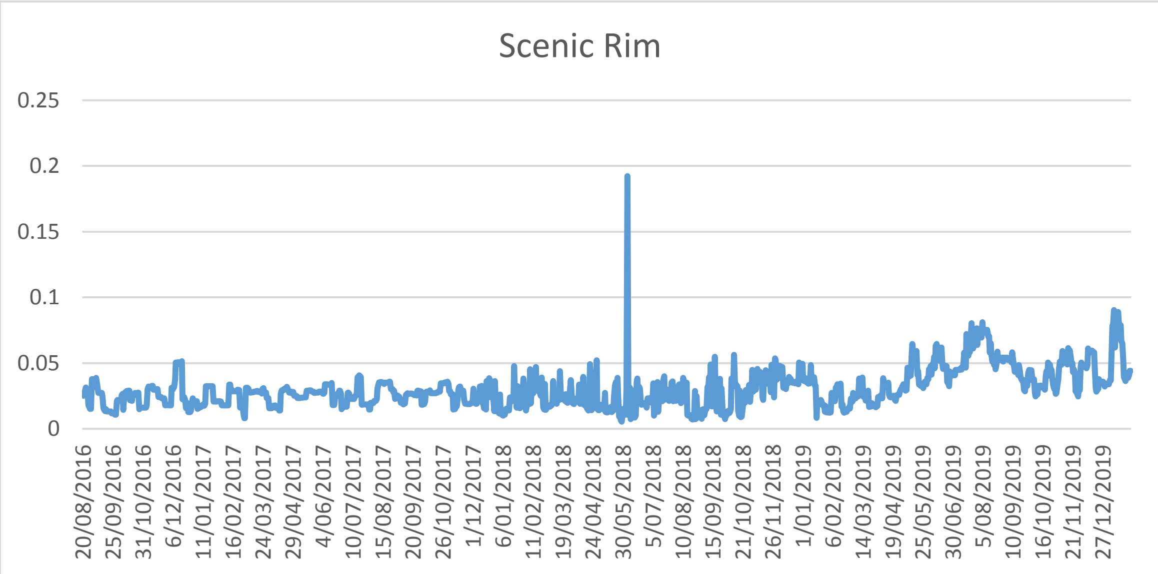

Figure B4: Standard deviation of daily prices for Scenic Rim LGA

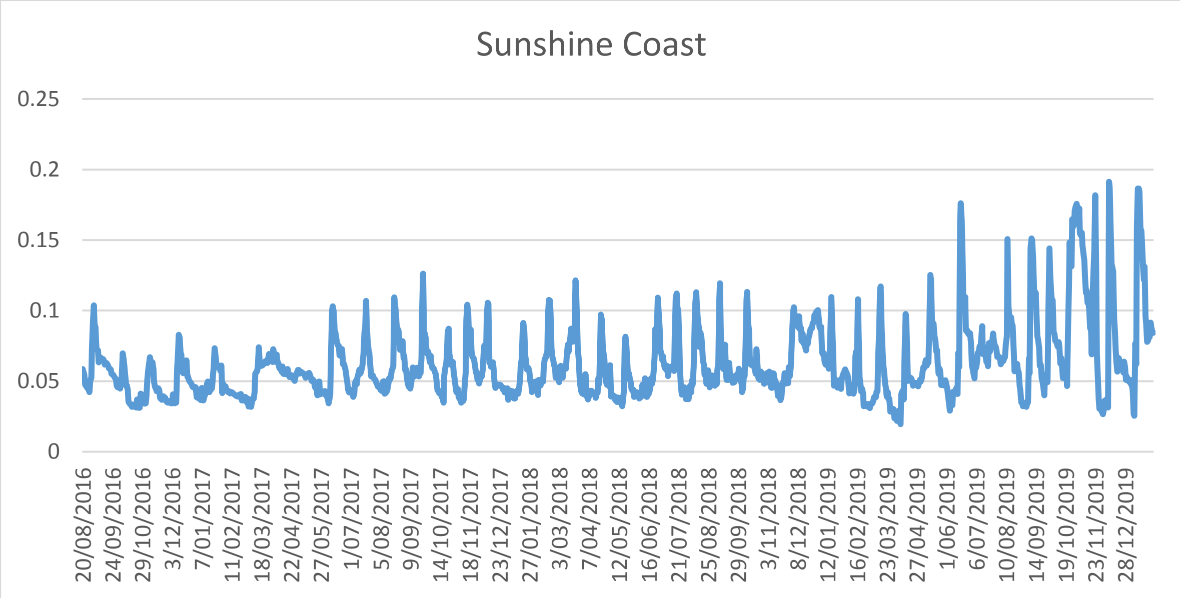

Figure B5: Standard deviation of daily prices for Sunshine Coast LGA

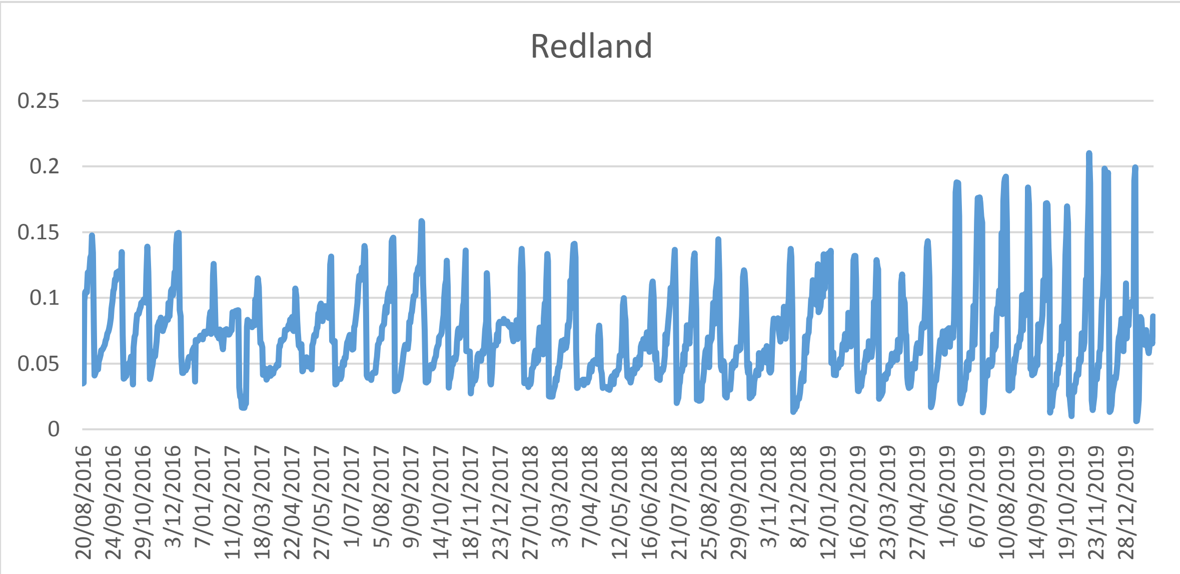

Figure B6: Standard deviation of daily prices for Redland LGA

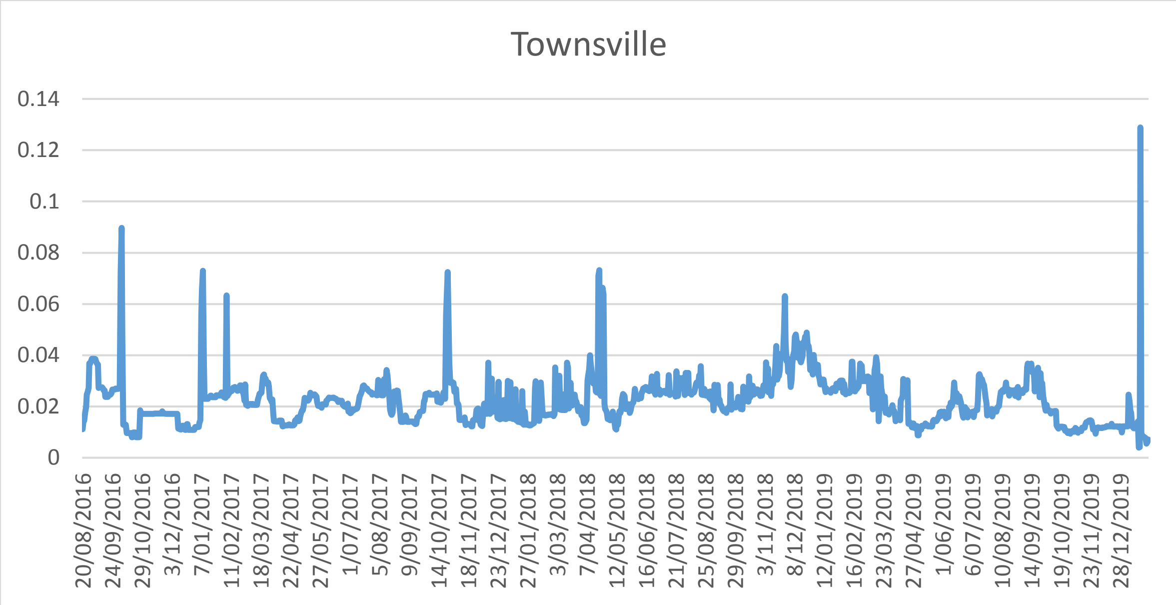

Figure B7: Standard deviation of daily prices for Townsville LGA

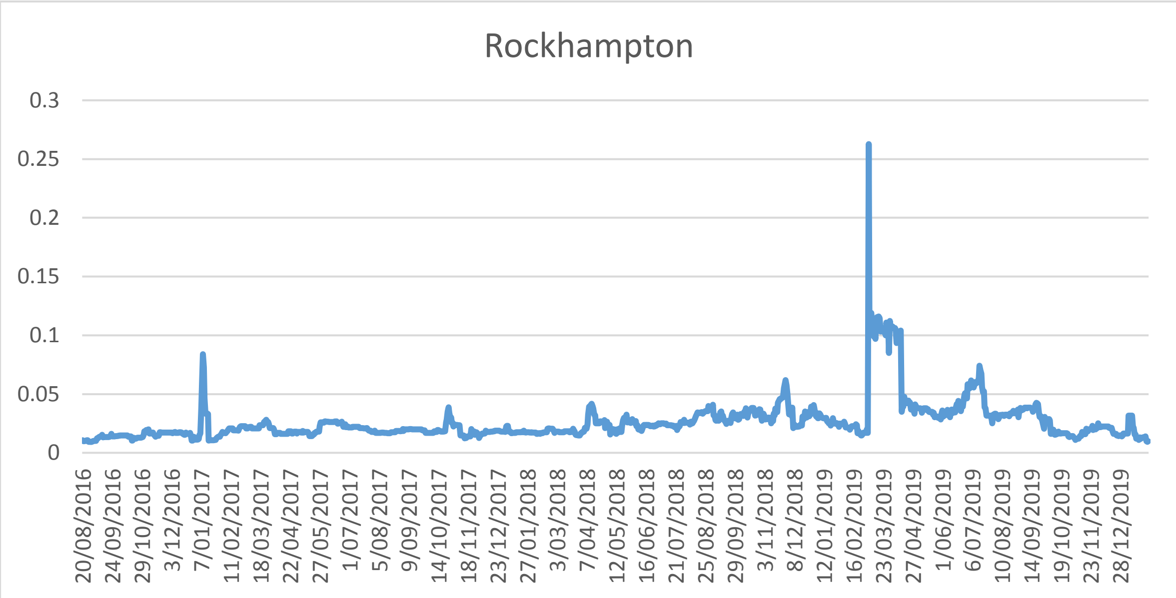

Figure B8: Standard deviation of daily prices for Rockhampton LGA

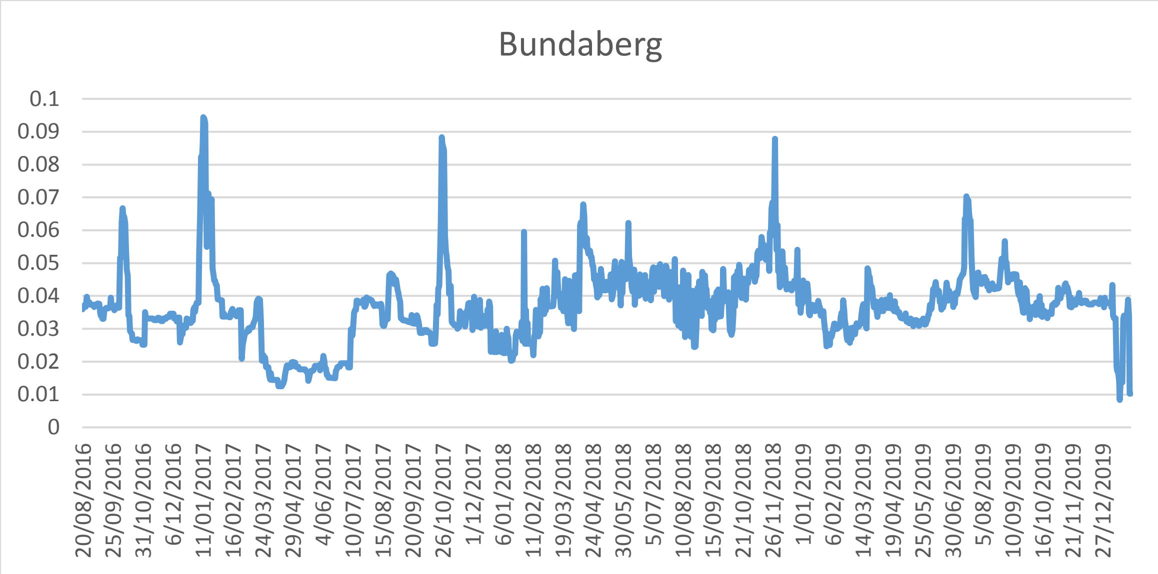

Figure B9: Standard deviation of daily prices for Bundaberg LGA

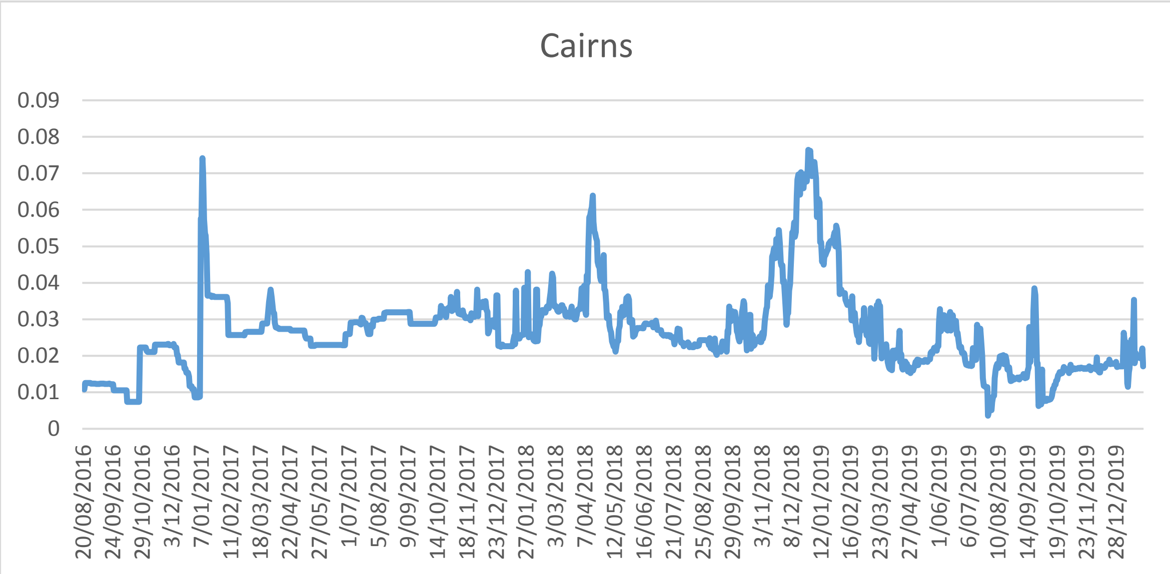

Figure B10: Standard deviation of daily prices for Cairns LGA

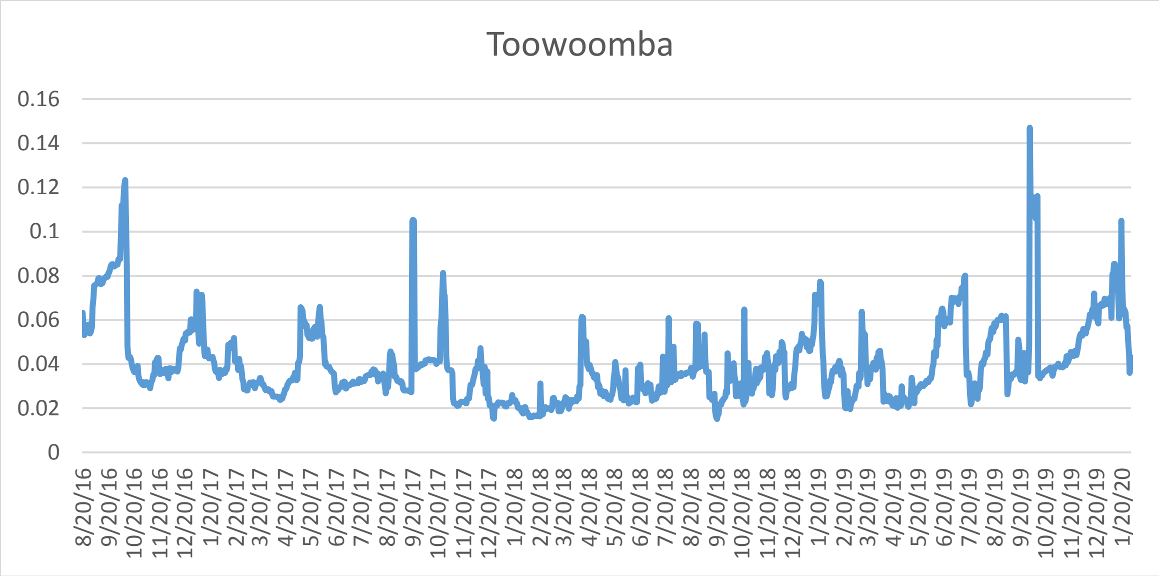

Figure B11: Standard deviation of daily prices for Toowoomba LGA

APPENDIX C: Detailed Results

Table C1: ULP 91 Results. Note: ** refers to α=5% level of significance,*refers to α=10% level of significance.

LGA	Independent variable: Terminal Gate Price				Independent variable: Brent Price (with dummies)			
	Selected ARDL model using BIC	Existence of co-integration F statistic [95% interval]	Coefficient of dummy variable [P-value]	Policy effect	Selected ARDL model using BIC	Existence of co-integration F statistic [95% interval]	Coefficient of dummy variable [P-value]	Policy effect
Southeast Qld LGAs								
Brisbane	ARDL(2,0)	83.3719 [7.6889, 8.2723]	-.2601E-3 [0.848]		ARDL(2,0)	73.7309 [13.6245, 14.2505]	-.0051519** [.026]	Significant reduction in prices at 5% l.o.s
Gold Coast	ARDL(3,0)	72.0826 [7.6889, 8.2723]	-.0015029 [0.392]		ARDL(3,0)	66.4134 [13.6245, 14.2505]	-.0073813** [0.013]	Significant reduction in prices at 5% l.o.s
Ipswich	ARDL(3,0)	68.0393 [7.6889, 8.2723]	-.0034410* [.081]	Significant reduction in prices at 10 % l.o.s	ARDL(3,0)	62.3104 [13.6245, 14.2505]	- .00957**[0 .004]	Significant reduction in prices at 5% l.o.s
Logan	ARDL(3,0)	69.7116 [7.6889, 8.2723]	-.5196E-3 [0.772]		ARDL(3,0)	64.1343 [13.6245, 14.2505]	-.0072503** [0.017]	Significant reduction in prices at 5% l.o.s
Moreton Bay	ARDL(3,0)	77.3423 [7.6889, 8.2723]	-.0012831 [0.455]		ARDL(3,0)	68.4648 [13.6245, 14.2505]	-.0078367** [0.007]	Significant reduction in prices at 5% l.o.s
Lockyer Valley	ARDL(3,0)	48.2575 [7.6889, 8.2723]	-.0040682** [0.007]	Significant reduction in prices at 5% l.o.s.	ARDL(3,0)	34.8221 [13.6245, 14.2505]	-.0067416** [0.007]	Significant reduction in prices at 5% l.o.s
Noosa	ARDL(3,0)	51.5743 [7.6889, 8.2723]	-.0035555** [0.028]	Significant reduction in prices at 5% l.o.s.	ARDL(3,0)	49.1948 [13.6245, 14.2505]	-.0084123** [0.002]	Significant reduction in prices at 5% l.o.s
Scenic Rim	ARDL(2,0)	109.2202 [7.6889, 8.2723]	-.7087E-3 [0.216]		ARDL(3,0)	27.4468 [13.6245, 14.2505]	-.1551E-3 [.875]	
Sunshine Coast	ARDL(3,1)	54.2451 [7.6889, 8.2723]	-.0020715 [0.172]		ARDL(3,0)	52.3042 [13.6245, 14.2505]	-.0050102** [.045]	Significant reduction in prices at 5% l.o.s
Redland	ARDL(3,0)	61.3798 [7.6889, 8.2723]	-.0011431 [0.562]		ARDL(3,0)	55.3195 [13.6245, 14.2505]	-.0076461 ** [0.023]	Significant reduction in prices at 5% l.o.s
Average	*ARDL(2,0)*	88.9338 [7.6889, 8.2723]	-.9222E-3 *[0.420]*		*ARDL(2,0)*	78.2703 [13.6245, 14.2505]	-.0051768** *[0.008]*	Significant reduction in prices at 5% l.o.s
Other LGAs								
Townsville	ARDL(3,0)	30.3519 [7.6889, 8.2723]	.2546E-3 [0.620]		ARDL(3,0)	20.6113 [13.6245, 14.2505]	.2602E-5 [0.998]	
Rockhampton	ARDL(3,0)	41.2765 [7.6889, 8.2723]	.4468E-3 [0.393]		ARDL(3,0)	19.2683 [13.6245, 14.2505]	.2262E-3 [0.787]	
Bundaberg	ARDL(3,1)	40.8338 [7.6889, 8.2723]	.2275E-3 [0.686]		ARDL(3,0)	26.4755 [13.6245, 14.2505]	.6228E-3 [0.483]	
Cairns	ARDL(3,0)	50.2536 [7.6889, 8.2723]	.0010617** [0.007]	Significant increase in prices at 5% l.o.s	ARDL(3,2)	25.4217 [13.6245, 14.2505]	.2332E-3 [0.731]	
Cairns Urban	ARDL(3,0)	46.9588 [7.6889, 8.2723]	.0011861** [0.011]	Significant increase in prices at 5% l.o.s	ARDL(3,2)	24.3214 [13.6245, 14.2505]	-.1394E-3 [.862]	

Table C2: PULP Results. Note: ** refers to α=5% level of significance, *refers to α=10% level of significance.

LGA	**Independent variable: Terminal Gate Price**				**Independent variable: Brent Price (with dummies)**			
	Selected ARDL model using BIC	Existence of co-integration F statistic [95% interval]	Coefficient of dummy variable [P-value]	Policy effect	Selected ARDL model using BIC	Existence of co-integration F statistic [95% interval]	Coefficient of dummy variable [P-value]	Policy effect
Southeast Qld LGAs								
Brisbane	ARDL(3,0)	84.9909 [7.6889, 8.2723]	-.3365E-3 [0.797]		ARDL(3,0)	74.3789 [13.6245,14.2505]	-.0053457** [0.017]	Significant reduction in prices at 5% l.o.s
Gold Coast	ARDL(3,0)	72.9193 [7.6889, 8.2723]	-.0013045 [0.429]		ARDL(3,0)	67.1582 [13.6245,14.2505]	-.0069015** [0.013]	Significant reduction in prices at 5% l.o.s
Ipswich	ARDL(3,0)	67.9297 [7.6889, 8.2723]	-.0033827* [0.077]	Significant reduction in prices at 10% l.o.s.	ARDL(3,0)	62.9036 [13.6245,14.2505]	-.0096948 ** [0.003]	Significant reduction in prices at 5% l.o.s
Logan	ARDL(3,0)	68.4895 [7.6889, 8.2723]	-.4359E-3 [0.800]		ARDL(3,0)	63.3885 [13.6245,14.2505]	-.0068388** [0.019]	Significant reduction in prices at 5% l.o.s
Moreton Bay	ARDL(3,0)	75.5972 [7.6889, 8.2723]	-.9937E-3 [0.545]		ARDL(3,0)	67.0270 [13.6245,14.2505]	-.0075421** [0.007]	Significant reduction in prices at 5% l.o.s
Lockyer Valley	ARDL(3,0)	46.0567 [7.6889, 8.2723]	-.0044450** [0.017]	Significant reduction in prices at 5% l.o.s.	ARDL(3,0)	38.8454 [13.6245,14.2505]	-.0087049 ** [0.006]	Significant reduction in prices at 5% l.o.s
Noosa	ARDL(3,0)	49.3385 [7.6889, 8.2723]	-.0032890** [0.021]	Significant reduction in prices at 5% l.o.s.	ARDL(3,0)	48.0896 [13.6245,14.2505]	-.0077736 ** [0.001]	Significant reduction in prices at 5% l.o.s
Scenic Rim	ARDL(2,0)	103.1379 [7.6889, 8.2723]	-.9231E-3 [0.147]		ARDL(2,0)	28.9031 [13.6245,14.2505]	.4290E-5 [0.997]	
Sunshine Coast	ARDL(3,0)	50.9707 [7.6889, 8.2723]	-.0023658 [0.111]		ARDL(3,0)	50.7928 [13.6245,14.2505]	-.0052037** [0.035]	Significant reduction in prices at 10% l.o.s.
Redland	ARDL(3,0)	61.3187 [7.6889, 8.2723]	-.5444E-3 [0. 768]		ARDL(3,0)	54.6652 [13.6245,14.2505]	-.0065611 ** [0.036]	Significant reduction in prices at 10% l.o.s.
Average	*ARDL(3,0)*	89.5122 [7.6889, 8.2723]	-.9194E-3 [0.412]		*ARDL(3,0)*	78.2145 [13.6245,14.2505]	-.0054213** *[0.005]*	Significant reduction in prices at 5% l.o.s
Other LGAs								
Townsville	ARDL(3,0)	31.9326 [7.6889, 8.2723]	.1701E-3 [0.744]		ARDL(3,0)	20.5403 [13.6245,14.2505]	.3298E-4 [0.968]	
Rockhampton	ARDL(1,0)	54.2980 [7.6889, 8.2723]	.8244E-3 [0.104]		ARDL(3,0)	18.3836 [13.6245,14.2505]	.4215E-3 [0.606]	
Bundaberg	ARDL(3,1)	34.5416 [7.6889, 8.2723]	.4514E-4 [0.939]		ARDL(3,0)	22.2843 [13.6245,14.2505]	.2732E-3 [0.774]	
Cairns	ARDL(3,0)	57.3215 [7.6889, 8.2723]	.0015286** [0.005]	Significant increase in prices at 5% l.o.s.	ARDL(3,0)	25.0715 [13.6245,14.2505]	.1978E-3 [0.835]	
Cairns Urban	ARDL(2,0)	56.8027 [7.6889, 8.2723]	.0019274** [0.002]	Significant increase in prices at 5% l.o.s.	ARDL(3,0)	20.4805 [13.6245,14.2505]	-.2928E-4 [0.979]	

Table C3: E10 Results. Note: ** refers to α=5% level of significance, *refers to 10% level of significance.

LGA	**Independent variable: Terminal Gate Price**				**Independent variable: Brent Price (with dummies)**			
	Selected ARDL model using BIC	Existence of co-integration F statistic [95% interval]	Coefficient of dummy variable [P-value]	Policy effect	Selected ARDL model using BIC	Existence of co-integration F statistic [95% interval]	Coefficient of dummy variable [P-value]	Policy effect
Southeast Qld LGAs								
Brisbane	ARDL(3,0)	82.6884 [7.6889, 8.2723]	-.5212E-3 [0.725]		ARDL(2,0)	69.6411 [13.6245,14.2505]	-.0061769 ** [0.015]	Significant reduction in prices at 5% l.o.s
Gold Coast	ARDL(3,0)	69.0437 [7.6889, 8.2723]	-.0020329 [0.279]		ARDL(2,0)	62.7238 [13.6245,14.2505]	-.0078101** [.014]	Significant reduction in prices at 5% l.o.s
Ipswich	ARDL(3,0)	66.1810 [7.6889, 8.2723]	-.0039943 * [0.062]	Significant reduction in prices at 10% l.o.s	ARDL(3,0)	58.8576 [13.6245,14.2505]	-.010043** [0.005]	Significant reduction in prices at 5% l.o.s
Logan	ARDL(3,0)	69.482 [7.6889, 8.2723]	-.9024E-3 [0.638]		ARDL(3,0)	63.7665 [13.6245,14.2505]	-.0080684 ** [0.013]	Significant reduction in prices at 5% l.o.s
Moreton Bay	ARDL(3,0)	74.9771 [7.6889, 8.2723]	-.0013873 [0.452]		ARDL(3,0)	65.9882 [13.6245,14.2505]	-.0085217** [0.007]	Significant reduction in prices at 5% l.o.s
Lockyer Valley	ARDL(3,0)	50.0785 [7.6889, 8.2723]	-.0067449** [0.002]	Significant reduction in prices at5% l.o.s	ARDL(3,0)	41.9487 [13.6245,14.2505]	-.010509 ** [0.003]	Significant reduction in prices at 5% l.o.s
Noosa	ARDL(2,0)	45.6451 [7.6889, 8.2723]	-.0041227* [0.062]	Significant reduction in prices at 10% l.o.s.	ARDL(2,0)	44.8112 [13.6245,14.2505]	-.010482** [0.004]	Significant reduction in prices at 5% l.o.s
Scenic Rim	ARDL(1,0)	62.9062 [7.6889, 8.2723]	-.0035647** [.003]	Significant reduction in prices at5% l.o.s	ARDL(2,0)	24.1461 [13.6245,14.2505]	-.0022418 [0.258]	
Sunshine Coast	ARDL(3,0)	52.3908 [7.6889, 8.2723]	-.0032089* [0.059]	Significant reduction in prices at 10% l.o.s	ARDL(2,0)	50.3391 [13.6245,14.2505]	-.0051362* [0.066]	Significant reduction in prices at 10% l.o.s.
Redland	ARDL(3,0)	67.1114 [7.6889, 8.2723]	-.0018953 [0.353]		ARDL(3,0)	60.7029 [13.6245,14.2505]	-.0086645** [0.012]	Significant reduction in prices at 5% l.o.s
Average	ARDL(2,0)	85.4033 [7.6889, 8.2723]	-.0011548 [0.357]		ARDL(2,0)	75.3577 [13.6245,14.2505]	-.0056453** [0.008]	Significant reduction in prices at 5% l.o.s
Other LGAs								
Townsville	ARDL(3,0)	31.6851 [7.6889, 8.2723]	.6042E-3 [0.418]		ARDL(3,0)	17.1688 [13.6245,14.2505]	.1703E-3 [0.888]	
Rockhampton	ARDL(3,0)	39.8321 [7.6889, 8.2723]	.3446E-4 [0.947]		ARDL(3,0)	18.6712 [13.6245,14.2505]	-.7567E-4 [0.926]	
Bundaberg	ARDL(1,0)	44.6084 [7.6889, 8.2723]	.2079E-3 [0.789]		ARDL(1,0)	24.7111 [13.6245,14.2505]	.6695E-3 [0.579]	
Cairns	ARDL(1,0)	52.7601 [7.6889, 8.2723]	.0016453** [0.013]	Significant increase in prices at 5% l.o.s.	ARDL(1,0)	20.6727 [13.6245,14.2505]	-.1573E-3 [0.891]	
Cairns Urban	ARDL(1,0)	48.6804 [7.6924, 8.3695]	.0015962 ** [0.020]	Significant increase in prices at 5% l.o.s.	ARDL(1,0)	19.7246 [13.6245,14.2505]	-.4963E-3 [0.680]	

Table C4: Diesel Results. Note: ** refers to α=5% level of significance, *refers to α=10% level of significance.

LGA	**Independent variable: Terminal Gate Price**				**Independent variable: Brent Price (with dummies)**			
	Selected ARDL model using BIC	Existence of co-integration F statistic [95% interval]	Coefficient of dummy variable [P-value]	Policy effect	Selected ARDL model using BIC	Existence of co-integration F statistic [95% interval]	Coefficient of dummy variable [P-value]	Policy effect
Southeast Qld LGAs								
Brisbane	ARDL(3,1)	59.3595 [7.6889, 8.2723]	-.1362E-3 [.633]		ARDL(3,0)	47.3366 [13.8025, 14.2505]	.4040E-3 [.391]	
Gold Coast	ARDL(1,1)	66.5668 [7.6889, 8.2723]	-.2853E-4 [.931]		ARDL(1,0)	55.0892 [13.6245, 14.2505]	.9023E-3 [0.100]	
Ipswich	ARDL(3,1)	52.2765 [7.6889, 8.2723]	.2979E-3 [.390]		ARDL(3,0)	40.1934 [13.6245, 14.2505]	.0010607* [.074]	Significant increase in prices at 10% l.o.s.
Logan	ARDL(3,1)	40.5399 [7.6889, 8.2723]	-.5272E-4 [.870]		ARDL(3,0)	41.5519 [13.6245, 14.2505]	.1787E-3 [0.739]	
Moreton Bay	ARDL(3,1)	50.3024 [7.6889, 8.2723]	-.1649E-3 [.617]		ARDL(3,0)	39.0208 [13.6245, 14.2505]	.5425E-3 [0.315]	
Lockyer Valley	ARDL(3,0)	96.0779 [7.6889, 8.2723]	-.2645E-3 [.529]		ARDL(3,0)	59.2300 [13.6245, 14.2505]	.3725E-3 [0.589]	
Noosa	ARDL(21)	67.1865 [7.6889, 8.2723]	-.3111E-3 [.458]		ARDL(2,2)	70.9467 [13.6245, 14.2505]	-.6663E-3 [0.360]	
Scenic Rim	ARDL(2,2)	73.3030 [7.6889, 8.2723]	-.6140E-3 [.147]		ARDL(2,2)	84.2814 [13.6245, 14.2505]	-.2349E-3 [.737]	
Sunshine Coast	ARDL(1,1)	83.2224 [7.6889, 8.2723]	-.4893E-3 [0.107]		ARDL(3,0)	57.993 [13.6245, 14.2505]	-.3042E-4 [.949]	
Redland	ARDL(2,0)	64.7654 [7.6889, 8.2723]	.3252E-3 [0.408]		ARDL(2,0)	49.6284 [13.6245, 14.2505]	.2824E-3 [0.671]	
Average	*ARDL(3,1)*	53.8995 [7.6889, 8.2723]	-.7149E-4 *[0.769]*		*ARDL(3,0)*	46.4275 [13.6245, 14.2505]	.4074E-3 *[0.315]*	
Other LGAs								
Townsville	ARDL(3,2)	23.4288 [7.6889, 8.2723]	.1610E-3 [0.733]		ARDL(3,0)	26.4256 [13.6245, 14.2505]	.4827E-3 [0.516]	
Rockhampton	ARDL(2,0)	68.4418 [7.6889, 8.2723]	.3146E-3 [0.458]		ARDL(2,0)	47.5978 [13.6245, 14.2505]	.0011818 [0.106]	
Bundaberg	ARDL(1,1)	63.4013 [7.6889, 8.2723]	.5542E-4 [0.887]		ARDL(1,0)	46.5329 [13.6245, 14.2505]	.0011876* [0.058]	Significant increase in prices at 10% l.o.s.
Cairns	ARDL(3,0)	63.9478 [7.6889, 8.2723]	.3851E-3 [0.203]		ARDL(3,0)	36.6275 [13.6245, 14.2505]	-.6162E-3 [0.225]	
Cairns Urban	ARDL(2,0)	65.9801 [7.6924, 8.3695]	.4964E-3 [0.165]		ARDL(3,0)	33.7290 [13.6245, 14.2505]	-.6613E-3 [0.271]	

APPENDIX D: Savings from Greater Price Dispersion: Method

Daily price minima and maxima per area of interest was identified and the mean was subsequently estimated. A visual inspection of minimum and maximum curves allowed for the removal of unrealistic low and high price points (outliers) that could have arisen out of input errors. In the case of missing observations, an assumption was made that in time periods where no price changes were reported, the price remained unchanged from the last reported price change. These removals were validated by investigating the length of time these prices remained unchanged, and in all cases they occurred within a 2-hour window. This resulted in the removal of 5 price points for Brisbane and 1 for Ipswich.

An average unleaded petrol passenger vehicle in Southeast Queensland uses 1123.5 litres per annum (see Section 4.2 on the sourcing of this figure). We estimated 26 annual fuel stops (i.e. fortnightly fill-ups) resulting in 43.21 litres being pumped every fortnight. Daily simulations were executed using this amount of fuel at minimal, mean and maximal price point.

14 series were created, each containing 26 petrol station visits. Series 1 starts with fuel purchase being undertaken fuel on day 1, followed by day 15, day 29 and so forth. Series 2 started with day 2, then day 16 and so forth. This resulted in 14 set of 26 simulated petrol purchases at daily minimum, maximum and mean prices.

These simulated purchases were summed to create 14 minima, maxima and mean yearly fuel expenditures. These prices were averaged across the 14 sets to create average minima yearly fuel expenditure, average maxima yearly fuel expenditure and average mean yearly fuel expenditure.

Realistic savings was calculated by subtracting this average mean yearly fuel expenditure with average minima yearly fuel expenditure.

APPENDIX E: Consumer Surplus Calculations and Explanations

Explanation 1

ABS reports that total distance travelled within Brisbane using passenger vehicles is 15,490,000,000 kilometres. Approximately 80.75% of passenger vehicles in Queensland use petrol as opposed to diesel, LNG and hybrid fuels, and this information is obtained from Table 5 of Cat. No. 9208.0.

We assume the same proportion for Brisbane. Thus, we estimate total kilometres for petrol driven passenger vehicles in Brisbane to be 15,490,000,000*0.8075 = 12,508,175,000 kilometres.

Given this information and the volume breakdown provided by the DNRME we estimate total kilometres travelled for ULP users to be 12,508,175,000*0.5213 = 6,520,511,627.5. For PULP, this would be 3,499,787,365 kilometres and 2,487,876,007.5 for E10 users.

This would yield a total consumer surplus of 6,520,511,627.5*0.107*0.0070 =$4,883,863.21 for ULP users, 3,499,787,365*0.107*0.0081 = $3,033,265.71 for PULP users and 2,487,876,007.5*0.107*0.0082 = $2,182,862.41for E10 users.

Explanation 2

19,434,000,000*0.8075 = 15,692,955,000 kilometres for petrol. Delineated by petrol type, this is 8,180,737,441.50 kilometres for ULP, 4,390,888,809 kilometres for PULP users and 3,121,328,749.50 kilometres for E10 users.

The consumer surplus figure is aggregated from the following:

ULP: 8,180,737,441.50*0.107*0.0070 = $6,127,372.34

PULP: 4,390,888,809*0.107*0.0081 = $3,805,583.33

E10: 3,121,328,749.50*0.107*0.0082 = $2,838,848.50

Explanation 3

To get total consumer surplus we need to estimate the average per annum kilometres covered by passenger vehicles in Southeast Queensland in this time. However, only information for Brisbane is available from Table 27 of Cat. No. 9208.0 (12,508,175,000). While not ideal, this report also incorporates total kilometres travelled outside the capital city (within a 100 kilometres of base) using passenger vehicles (11,388,000,000 kilometres*0.8075 = 9,195,810,000).

Using ABS population data from Table 3 of Cat. No. 3218.0 (ABS, 2019a), we weight this latter figure to encapsulate the share of the non-Brisbane Southeast Queensland population relative to the rest of Queensland.

Given our non-Brisbane Southeast Queensland population is 2,222,360 and the rest of Queensland is 1,557,251, this gives non-Brisbane Southeast Queensland a weighting of 0.59.

Multiplying this by 11,388,000,000 yields 5,425,527,900 kilometres. Thus the total kilometres travelled in Southeast Queensland (including Brisbane) is estimated at 17,933,702,900 kilometres.

<u>Explanation 4</u>

We estimate total kilometres travelled for ULP users to be 17,933,702,900*0.5213 = 9,348,839,321.77.

For PULP, this would be 5,017,850,071.42 kilometres and 3,567,013,506.81 for E10 users.

This would yield a total consumer surplus of 9,348,839,321.77*0.107*0.0070 =$7,002,280.65 for ULP users, 5,017,850,071.42*0.107*0.0082 = $4,402,661.65 for PULP users and 3,567,013,506.81*0.107*0.0075 = $2,862,528.34.