Technical attachment – Analysis of impact of new unstaffed retail petrol stations on fuel prices

This attachment provides the technical detail on the empirical analysis we undertook to examine the competitive effects of unstaffed site entry on local fuel prices. The attachment begins with an executive summary of our analysis and findings.

Sections 1 and 2 describe the background, preliminary analysis, and precedents.

Section 3 presents data, econometric strategies, and results.

Section 4 discusses limitations of the analysis.

Executive Summary

The Commerce Commission's (Commission's) monitoring work under the Fuel Industry Act 2020 has observed significant variation in retail prices of fuel within and between cities in New Zealand. The Commission has been exploring the likely reasons for such variations, including differences in costs and differences in competitive conditions. It appears that differences in competition can be an important source of retail price variation. The effect of independent distributor sites on regional prices has also previously been explored in the 2019 Market study into the retail fuel sector.[1]

This report extends our analysis of differences in competition as a driver of price variations and documents our empirical analysis of the competitive impact of unstaffed site entry on prices of Regular 91 fuel at incumbent sites. Our data sources include Gaspy and information available publicly from the websites of fuel retailers and the Ministry of Business, Innovation and Employment (MBIE). The work complements the analysis of data that we receive from fuel sector participants under the Fuel Industry Act. We utilise the broader coverage of fuel sites in Gaspy data to obtain a comprehensive view of the industry.

The econometric framework employs two separate methods to examine the impact of entry:

1. a panel event study comparing the incumbent sites' pricing trends pre- and post-entry of an unstaffed site; and
2. a cross-sectional analysis comparing price outcomes at a point in time between local markets with and without unstaffed sites.

The results of the panel event study show a statistically significant effect of entry on incumbent sites' prices for Regular 91. On average, incumbents' prices are 3.1 cents per litre (cpl) lower two weeks after entry, compared to the week immediately prior to entry. Price reductions of between 2-3.1 cpl are observed for at least eight weeks post-entry. We also found that existing unstaffed sites responded more aggressively to new entry than existing staffed sites did.

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1   https://comcom.govt.nz/__data/assets/pdf_file/0028/193915/Retail-fuel-market-study-Final-report-5-December-2019.PDF, Market study into retail fuel sector pg. 132-134 (3.124 – 3.128)

The results of the cross-sectional analysis indicate that statistically significant differences exist in price outcomes between local markets that have at least one unstaffed site within a 0-5 minute drive time, and those with staffed sites only. On average, Regular 91 prices are 6.1 cpl lower in local markets where at least one non-supermarket unstaffed site is present, compared to those with staffed sites only.

Overall, the results offer empirical insights into the competitive effects of unstaffed site entry on retail fuel prices in New Zealand. There is strong evidence that incumbent sites exposed to the entry of an unstaffed site in their local market respond by lowering prices at the time of entry. We observe statistically significant differences between prices in local markets where an unstaffed site is present and those in markets with only staffed sites, suggesting a long-lasting price effect of entry on local markets.

1. Background

The retail fuel industry is characterised by localised markets, where motorists tend to drive short distances to purchase fuel. An increase in localised competition through entry is expected to improve competitive outcomes for consumers, including retail prices.

An example of this has been referred to as the "Gull effect" in the Commerce Commission's 2019 retail fuel market study, where it was observed that retail outcomes tended to diverge across areas, depending in part on whether a Gull site is present or not.[2]

As noted in the fuel market study, improvements in electronic payment technology and the lower investment requirements have led to the continuing expansion of unstaffed sites. We continue to see new entry occurring in the form of new low-cost unstaffed fuel sites. According to Gaspy data, the number of retail sites of the three major importer brands (BP, Mobil and Z Energy) declined over the last five years, from 729 (in 2018) to 722 (2023); over the same period, the number of non-major branded sites increased by 137.[3] This is summarised in Table 1.

Table 1: Number of retail fuel sites (2018-2023)

	2018	2019	2020	2021	2022	2023	Change
Major brands	729	735	733	732	729	722	-7
Non-major brands	596	636	664	706	731	733	+137

Source: internal analysis based on Gaspy data

Many of the new sites opened by the non-major brands have been unstaffed sites, with NPD, Gull, and Waitomo opening the most new sites over the period.

More recently, the Commission's monitoring work has observed wide price variations within and between cities, beyond the differences in costs of supplying fuel at retail sites. In

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[2]   See for example, paragraph 3.126. The market study further considered the impact of new entry in Attachment H of the final report.

[3]   Unpublished work, Commerce Commission.

September 2023, the Commerce Commission issued a letter to the major fuel companies in New Zealand seeking to better understand the price outcomes.

Against this backdrop, this report analyses the competitive impact of entry of unstaffed sites on price outcomes in local markets. By examining the impact of changes in fuel sites' local competitive environment on price, the analysis contributes to the Commission's understanding of why retail fuel prices differ across local markets throughout New Zealand and underscores the benefits of increased competition through entry.

2. Preliminary analysis and precedents

2.1. Initial exploratory analysis

We have conducted an initial exploratory analysis of the effect of unstaffed site entry in regions by visually comparing the differences in the Gaspy time-series data on retail prices for Regular 91. Specifically, we compared the following city/town pairs:

- Taumarunui and Te Kuiti;

- Kilbirnie/Miramar and Petone;

- Waiouru and Taihape;

- Whangārei and Gisborne;

- Whanganui and Bulls/Sanson; and

- Oamaru and Timaru.

This initial analysis indicated that the presence of unstaffed sites, or the greater number of unstaffed sites, appears to be correlated to lower retail prices. Moreover, we observed the differences in the pricing behaviour of supermarket unstaffed sites, depending on the presence of an unstaffed site nearby.

2.2. Previous findings from 2019 Market study[4]

The 2019 Market study investigated the impact of entry by new fuel retailers (Allied, Challenge, GAS, Gull, McFall, McKeown, NPD, RD, Southfuels and Waitomo) on prices and volumes of existing retail fuel sites in local markets. The objective of the analysis was to determine how far the benefits of entry extended to consumers. The results found that new retail sites tend to locate close to, within 2km of, the major brand retail sites (BP, Mobil, Z). New unstaffed sites were less likely to be located close to existing unstaffed sites. The study observed that, in general, new entry did not have a material impact on board prices of the major brands' existing sites. Where a material effect was observed, it was often in response to NPD opening a new staffed site.

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[4]   2019 Market study, Appendix H, pg. 563-579.

The current analysis builds on these findings by incorporating *drive time* as a measure of exposure to competitive effect from entry and identifies a geographical boundary for localised competition, considering the effect of entry on both staffed and unstaffed sites in a local market.

3. Analytical framework

3.1. Data sources

The analysis utilises three data sources.

The first dataset is from Gaspy, used to identify entrants, incumbents, and prices for Regular 91, excluding truck stops and marinas. Using price observations between 2019 and 2023, the identification strategy for entrant and incumbent site involves checking whether a fuel site of the same name is consistently observed across the years. A minimum of 30 observations is required for a retail site to be included as being observed in a year. We focus on new entrants only and exclude instances of rebranding or renaming.

The daily price data covers the period between *1 August 2021 and 31 December 2023*. The start date for the price data reflects when the majority of the provisions of the Fuel Industry Act came into force (11 August 2021). We adjust the board prices for fuel sites located in the Auckland territorial authority area by 11.5 cpl to remove the Auckland regional fuel tax and aggregate the daily data to weekly average prices.

The second dataset includes information on the type of service offerings at each fuel site, collected from the internet through web scraping and manual searches. We apply brand-specific keyword rules to identify whether a site is staffed or unstaffed.

The final data source is the importer cost data from the Ministry of Business, Innovation and Employment (MBIE), available publicly from the MBIE website. We use the importer cost data to control for the time trend in costs that commonly affects all retail fuel sites.

We employ two approaches to examine the impact of entry by unstaffed sites:

- 'before and after' analysis: we use a 'panel event study' to compare incumbent sites' retail prices before a new unstaffed site opens in their local competitive area, with their prices after the unstaffed site opens;
- 'with and without' analysis: we undertake a cross-sectional analysis to compare retail prices in local areas where unstaffed sites are present with retail prices in areas where there are no unstaffed sites.

In the next subsections, we detail each method and discuss the results.

3.2. Panel event study

3.2.1. Pre- and post-entry pricing trends

We design a panel event study to compare the pricing trends pre- and post-entry, using a difference-in-difference modelling approach. An event refers to an unstaffed site entry by

Allied, Gull, NPD or Waitomo. We specify a window of eight weeks pre- and post-entry to construct a panel of incumbents' prices at weekly time intervals. In other words, we are interested in differences in the pricing trends across the 8-week period before and after the week of entry, equating to a total time-period of 17 weeks.

Our pricing dataset provides variations in both the *entry timings* and *incumbent stations* experiencing entry. We identify the 'treated' incumbent fuel sites as those experiencing an entry within a 0-5 minute and 5-10 minute drive time bands. We then construct a control group of fuel sites located in treated fuel sites' bordering suburbs, but *never* experiencing entry within a 0-5 minute or 5-10 minute drive time during the period covered. We use Stats NZ's Statistical Area 3 (SA3) to identify each fuel site's suburb. The use of 'treated' and 'control' groups aims to identify comparable sites within a local area and is designed to isolate the effect of new entry on retail prices from other factors that influence retail prices.[5]

Figure 1 A hypothetical example of an entrant site, treated incumbent site, and control incumbent site.
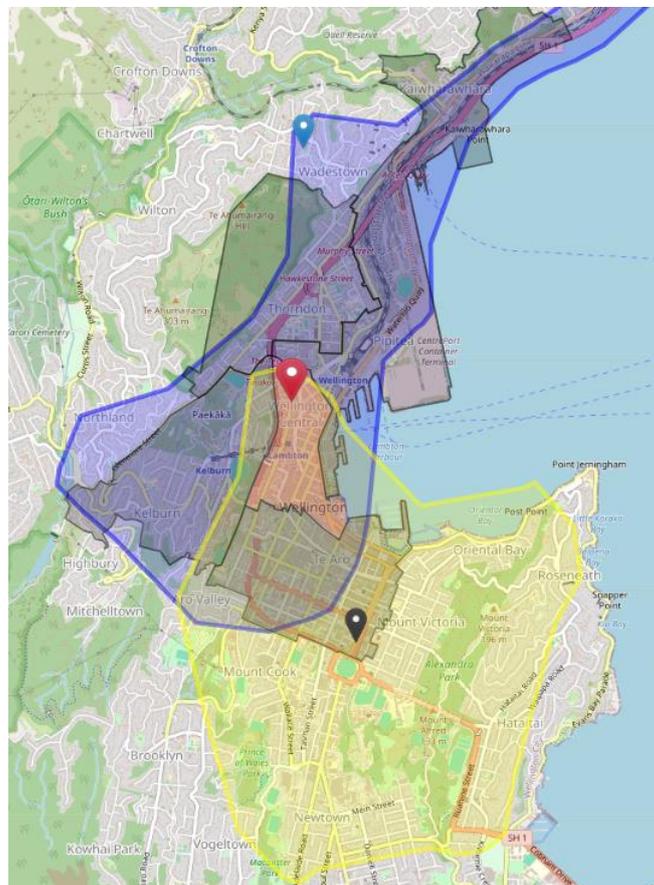

Figure 1 illustrates how we identify the treatment and control groups for an entry. The red marker indicates a hypothetical incumbent site, and its SA3 (Wellington Central) is indicated by the red shaded area. The blue shaded area is within a 5 minute drive from the red marker. The blue marker indicates a hypothetical new unstaffed entrant. Since this blue marker is within a 5 minute drive from the red marker, the red marker is identified as a 'treated' incumbent site. To find a 'control' site (ie, an existing site that is not affected by entry), we

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5   For example, changes in international oil prices are an important driver of retail prices, but oil prices should affect both the treated and control groups the same. Furthermore, other variable factors such as trucking costs would be similar for neighbouring fuel sites.

identify the SA3s bordering the treated incumbent station's SA3. These consist of Kelburn, Pipitea-Kaiwharawhara, and Te Aro, and are indicated in the figure by the grey shaded areas. The black marker indicates a hypothetical incumbent station in a bordering SA3 (Te Aro), and the yellow shaded area indicates the area within a 5 minute drive from the black marker. The black marker is identified as a 'control' incumbent site as the entrant is located further than 5 minute drive from the black marker. As noted in the description, the locations of these fuel sites are illustrative only and the markers do not point to any actual fuel sites.

Table 2 Summary of entry events by drive time band and average site counts by service offering type.

| | | Average number of incumbents per entry | | | |
| | **# of entry events** | Treated | | Control | |
Model		staffed	unstaffed	staffed	unstaffed
0-5 minute drive time	27	4.2	2	8.3	3.2
5-10 minute drive time	27	8.1	3.2	14.2	4
0-10 minute drive time	28	11.6	4.1	12.1	4.3

Table 2 presents a summary of entry events by drive time and average site counts by service offering. On average, there are four staffed and two unstaffed sites impacted by an entry within a 0-5 minute drive time. This number increases to eight staffed and three unstaffed sites when considering entries in further distance of within a 5-10 minute drive time. For the overall dataset that contains incumbents experiencing entries within a 0-10 minute drive time, on average, an entry impacts twelve staffed sites and four unstaffed sites.

3.2.2. Model

We run a two-way fixed effects difference-in-difference regression on weekly average board prices (cpl) at time t for fuel site i, denoted by p_{it}. We specify the treated group indicator variable, $treat_{ij}$, to interact with the weeks to entry and estimate the below equation:

$$p_{it} = \beta_1 W_{jt} + \beta_2 treat_{ij} + \beta_3 W_{jt} \times treat_{ij} + \beta_4 D_{ij} + c_t + \pi_i + \lambda_t + u_{it}$$

where W_{jt} denotes the variable with 17 levels, from 8 weeks before entrant j's entry at time t, to 8 weeks after entry. D_{ij} denotes the incumbent i's drive time from entrant j, and takes one of three values: 0-5 minutes, 5-10 minutes, or ≥ 10 minutes. c_t, π_i, λ_t denote importer costs, site specific fixed effect and time fixed effect, respectively, and u_{it} represents an error term.

The event study model assumes that entry timings are random. Therefore, observing a common pattern in the treated group after an exogenous event takes place highlights the causal effect of the treatment. While an entry itself may not be random and incumbents influence entry decisions, it is reasonable to assume that the exact timing of an entry is exogenous. To validate the assumption, we evaluate for common price trends between the

treated and control groups prior to entry. If we observe similar pre-entry price trends, we infer that a divergence in the trends between the treated and control groups post-entry is attributed to the entry event. The reference period to compare the pricing trends is one week prior to entry.

3.2.3. Results

**Figure 2 Pricing trends of incumbents experiencing entry within 0-5 minute drive time.**
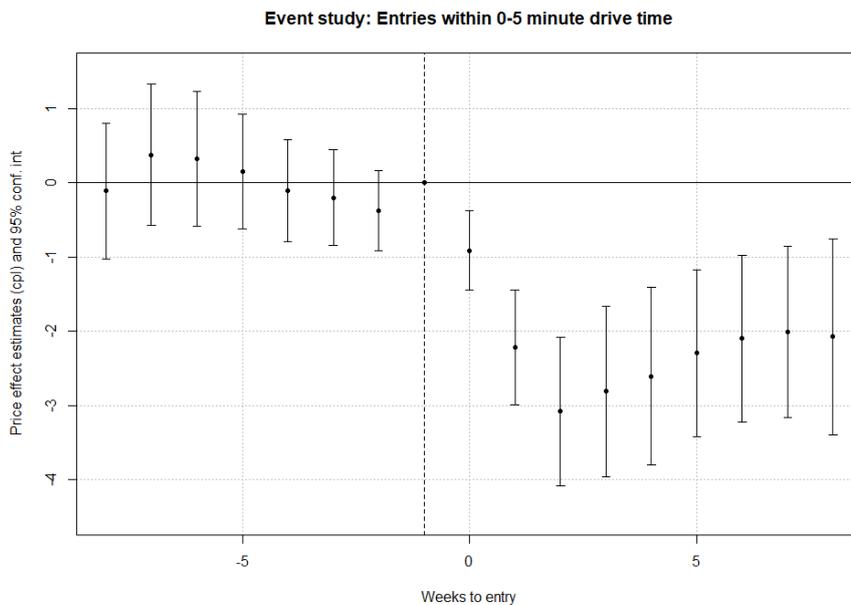
First, we report the results of estimating the equation for incumbents experiencing entry within a five-minute drive time. The data includes a total of 152 treated incumbents. Full results of the regression specifications are presented in Appendix A.

Figure 2 shows the trends in the price effect of unstaffed site entry on the treated incumbents. The graph plots the point estimates of the coefficients associated with the event time (β_k) and 95 per cent confidence intervals. The confidence intervals that span a zero price effect indicate that we do not observe any statistically significant price differences from the week immediately prior to entry. As shown in Figure 2, this indicates that prior to entry, prices of the treated and control group incumbents do not trend differently. In contrast, starting from the week of entry, the prices of incumbent retail fuel sites within a 0-5 minute drive time start to drop lower than the prices in the week prior to entry.

On average, the treated group's prices are 3.1cpl lower two weeks after entry, compared to the week just before entry. We note that promotional prices often accompany new site openings, creating a degree of immediate competitive pressure on the incumbents. The lower prices persist across the entire post-entry period (8 weeks) considered in the study, remaining 2cpl lower by the end of the period.

We are also interested in whether staffed and unstaffed incumbents respond differently. We run the 0-5 minute drive time model specification separately by the incumbent site type. Figure 3 displays the results of the two specifications side-by-side.

Figure 3 Comparison of price effect estimates for staffed and unstaffed incumbent sites.
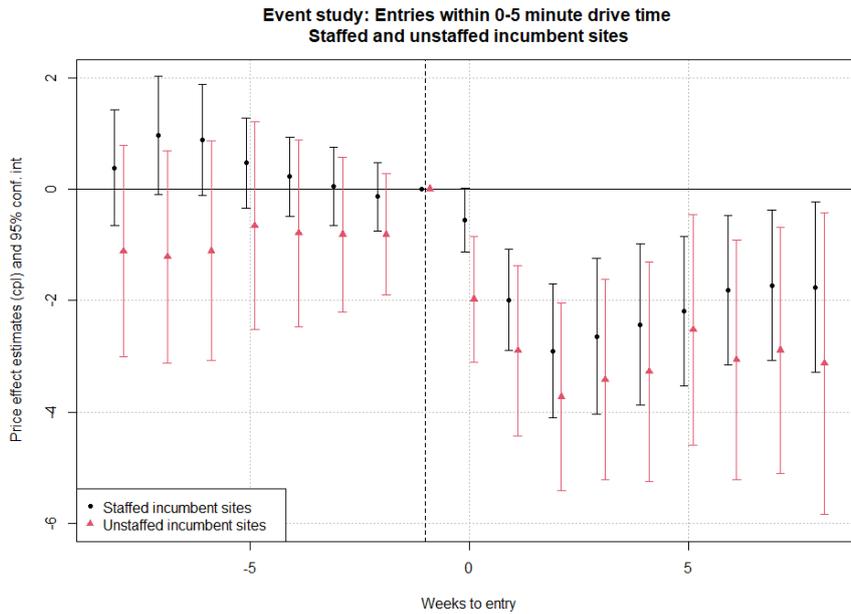
For both staffed and unstaffed incumbents, the prices prior to entry for the treated group do not trend differently to the control group and are not significantly different to the prices in the week immediately before entry. However, we observe differences in the magnitude of the post-entry price effect. Unstaffed sites' prices at two weeks post-entry are, on average, 3.8cpl lower compared to the week prior to entry. In contrast, staffed sites' prices at two weeks post-entry are 2.9cpl lower than the prices in the week just prior to entry. We note the large standard errors for the unstaffed sites due to the smaller sample size, however, the estimates are statistically significant.

Figure 4 Pricing trends of incumbents experiencing entry within 0-10 minute drive time.
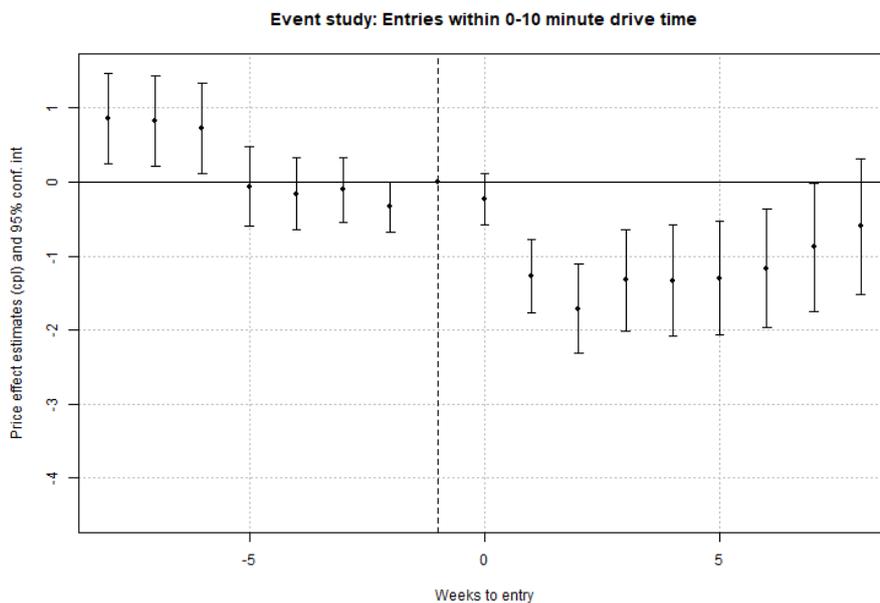
Next, we test whether the price effect changes with distance. Specifically, we consider the price effect on incumbents experiencing entry within 0-10 minute drive time band. There are 398 treated incumbents from a total of 28 entry events.

Figure 4 depicts the estimates of the price effect on the treated group. We observe that differences in prices at eight to six weeks prior to entry compared to the week just prior to entry are statistically significant and are higher, which may suggest an anticipatory effect of entry on prices. Prices across five weeks prior to entry until the week of entry show no statistically significant differences to prices at one week prior to entry. From a week post-entry, however, we observe significant price differences compared to the week before entry. The average price effect two weeks after entry is 1.7cpl. Price effects on the treated group taper off towards 7 weeks post-entry. As can be seen by comparing Figures 2 and 4, the average price effect is reduced as distance increases.

We consider an alternative way to look at the effect of distance by estimating the model on incumbents experiencing entry within a 5-10 minute drive time band. The data includes 264 incumbents from 27 entries. Figure 5 compares the results of the specification with the estimates for entries within 0-5 minute drive time in Figure 2.

Overall, differences in the pre- and post-entry pricing trends between the treated and control groups are, in general, statistically insignificant for the 5-10 minute drive time. The magnitude of the estimated price effect within a 5-10 minute drive time is also weaker compared to the results for entries within 0-5 minute drive time. These results suggest that incumbents respond more aggressively to changes in competitive pressure within a 0-5 minute drive time and may not consider fuel sites that are 5-10 minute drive away from them as direct competition. This is sensible given the localised nature of the retail fuel market, and consumer search behaviours. Fewer consumers would be willing to pay the higher search costs associated with driving further to access lower prices.

Figure 5 Comparison of pricing trends between incumbents experiencing entry within 0-5 minute versus 5-10 minute drive time bands.
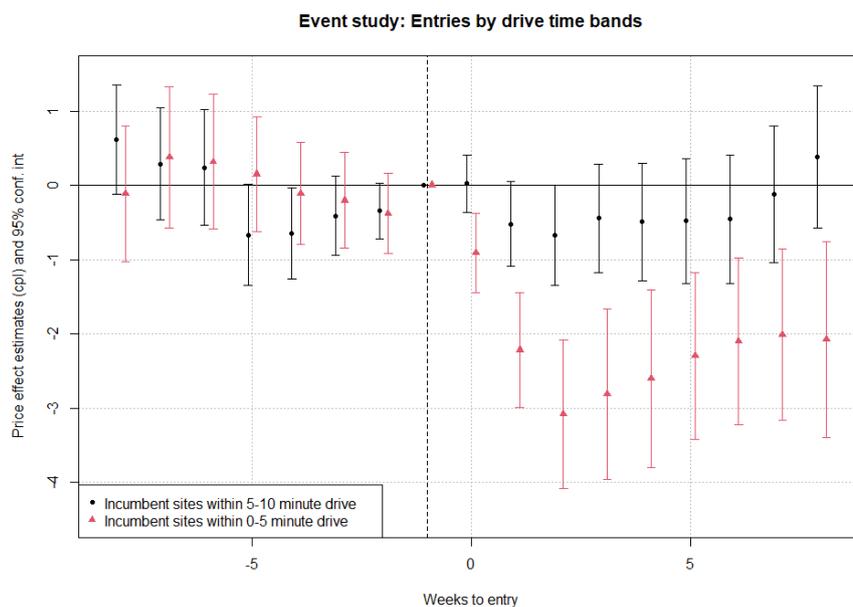
Figure 6 Pricing trends of incumbents located in Auckland experiencing entry within 0-10 minute drive time.

Event study: Entries within 0-10 minute drive time bands for incumbents located in Auckland
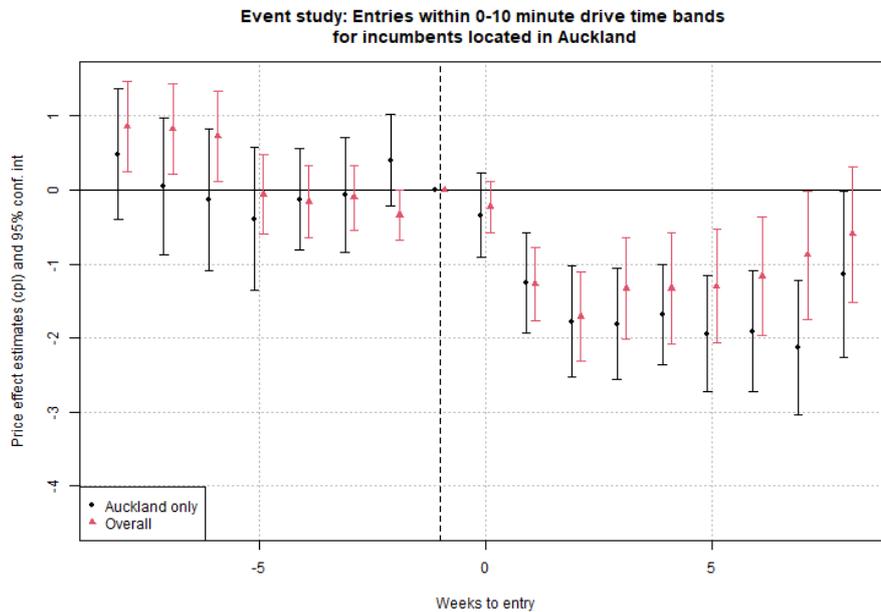
In the final specification, we separate out incumbent stations located in the Auckland territorial region. The data includes a total of 128 treated incumbents from 6 entry events during the period in our data. Figure 6 plots the price effect estimates for Auckland and for New Zealand as a whole.

We do not observe statistically significant differences in pre-entry pricing trends between the treated and control groups. The treated incumbents' prices at two weeks after entry are, on average, 1.8cpl lower compared to the week immediately prior to entry, both for Auckland and for New Zealand. A price effect of similar magnitude (1.7-2.1cpl) continues until 7 weeks after entry on the treated group. The magnitude of the price effect of entry is greater and longer lasting in the Auckland area compared to the overall model that covers across New Zealand. While beyond the scope of the current analysis, the observation raises a question on the relationship between local market characteristics (such as population density) and the competitive effect of entry.

Overall, in the panel event study, we see statistically strong evidence for price effects of entry on incumbents exposed to entries within a 0-5 minute drive. We also find that existing unstaffed sites respond more aggressively in terms of price to new entry than existing staffed sites.

3.3. Cross-sectional analysis

3.3.1. *Local markets with and without unstaffed sites*

Building on the insights from the panel event study, we define a *local market* as the area within a 0-5 minute drive time of each station.[6] In other words, each station serves its own local catchment area within a 0-5 minute drive time. We specify a local market for each of the stations in our dataset, identifying other fuel sites included in the local market.

We take a random snapshot of the prices for the cross-sectional study. We report the results for a selected date of the week ending Friday 10 November 2023. Each station's prices are averaged across a seven-day period between 4 and 10 November 2023.[7]

We define three local market, or local catchment, types:

1. '*Staffed'* local market, which includes staffed sites only;

2. '*Unstaffed'* local market, which includes at least one or more non-supermarket unstaffed sites; and

3. '*Supermarket unstaffed'* local market, which includes one or more supermarket-run unstaffed sites but no other branded unstaffed sites.

The results presented below focus on staffed and unstaffed local markets, and exclude the supermarket unstaffed local markets, based on our understanding of supermarkets' pricing behaviour depending on the presence of another unstaffed site nearby.[8]

We then match each unstaffed local market with staffed local markets in a neighbouring suburb (SA3). We exclude a local market if there are no matches. The matched dataset includes a total of 863 local markets, out of 1452 local markets.

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[6] We note that 'local markets' as defined here are not equivalent to local markets as would be defined for competition purposes, but are instead site-specific catchment areas. For more information regarding defining local geographic markets for competition purposes, see the Commerce Commission's Merger and acquisition guidelines at [3.28] – [3.34].

[7] For robustness, we repeat the analysis 10 times, using different dates. We obtain comparable results across the additional dates analysed.

[8] In Appendix A 2.1, we test whether average prices differ between staffed and supermarket unstaffed local markets.

Figure 7 Illustration of local markets defined by five-minute drive time.
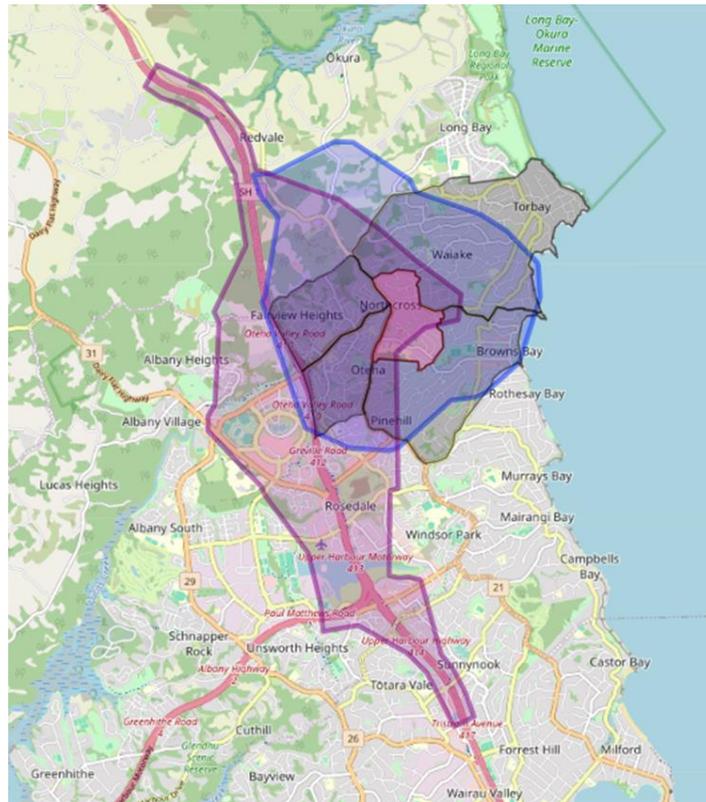
Figure 7 illustrates two local markets/catchments in North Shore, Auckland. The blue-outlined area indicates a local market/catchment for a fuel site within the red-shaded SA3, Northcross. The grey shaded areas indicate the SA3s that share a border with Northcross. The purple outlined area indicates a local market/catchment for a fuel site within a bordering SA3, Fairview Heights. This highlights that for fuel sites in close vicinity, our definition of a local market for the purposes of this report often implies an overlap of catchment areas from two or more sites.

Figure 8 below indicates that most local markets in the dataset consist of five or fewer sites. On average, a local market has four fuel sites with three staffed and one unstaffed sites. Out of the 863 local markets, 364 markets are 'staffed' local markets, while 499 markets include at least one unstaffed site.

Figure 8 Histogram of local markets by total number of stations.
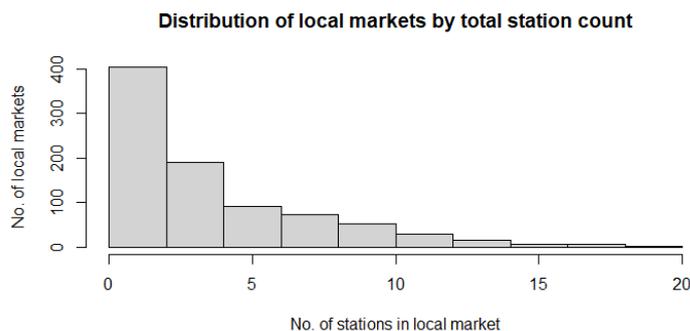
3.3.2. Model

For each price outcome y for a local market i, we estimate the following ordinary least squares (OLS) regression:

$$y_i = \beta_0 + \beta_1 m_i + \beta_2 s_i + \epsilon_i$$

where m_i denotes the unstaffed local market type indicator, which takes a value of 1 if the fuel sites in the catchment area includes at least one unstaffed (non-supermarket) fuel site.[9] Variables s_i and ϵ_i denote the total number of stations in local market i and the error term, respectively. Inclusion of the total number of stations controls for correlation between the overall market structure and prices across local markets. We consider four price outcomes at the local market level, including the mean price, coefficient of variation of price, maximum and minimum prices.

3.3.3. Results

We report our findings from estimating the above OLS equation. We find that on average, the presence of a non-supermarket unstaffed site in a local market is associated with a lower average price of 6.1cpl. The coefficient of variation of price, which measures the extent of price dispersion in relation to the average price in a local market, is greater in markets with non-supermarket unstaffed site(s). This implies that in markets with at least one non-supermarket unstaffed site, consumers have access to a wider range of prices, whereas in markets with staffed sites only, fuel prices are more aligned to each other. Both maximum and minimum prices are lower in markets with unstaffed sites, by 4.1cpl and 9.4cpl, respectively.

We see no statistically significant differences in prices in local markets with supermarket unstaffed sites (but no other unstaffed sites) and those in markets that only include staffed sites, ie, supermarket sites do not influence market prices to the same extent as other unstaffed sites.

4. Risks and limitations

The entries in the panel event study included new fuel sites from independent distributors. We have not explored competitive effect of entry on local markets of unstaffed sites from major brands in this analysis.

The analysis explores neighbouring suburbs to identify comparable local markets that differ by the presence of unstaffed sites. We note that there are a variety of factors that contribute to price heterogeneity across fuel sites that we have not explored. For example, two neighbouring sites will face varying degrees of demand elasticity depending on their location

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[9]   Recall, we exclude local markets where the only unstaffed petrol stations are those operated by, and co-located with, supermarkets in this analysis. Therefore, the market type can be either 'staffed' or 'unstaffed', each aligning with the first two definitions previously outlined in subsection 3.3.1.

and local market characteristics, such as proximity to the main road and traffic flow.[10] Thus, exploring the location choice of entrants can shed further light into effect of entry.

We also note that the pre- and post-entry windows can be adjusted to cover a longer time horizon to effectively examine the persistence of price effect. The trade-off would be the number of entries covered in the pricing data.

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[10]   The 2019 market study referred to other ways in which retail sites differentiate themselves. See 2019 Market study, paragraphs X13, 6.176.

Appendix A

1. Panel event study regression results

Table A.1 Price effect on incumbents experiencing entries within 0-5 minute drive time.

	(1)	(2)	(3)
8 weeks before entry	-0.112	0.383	-1.114
	(0.464)	(0.528)	(0.958)
7 weeks before entry	0.373	0.965	-1.219
	(0.485)	(0.539)	(0.962)
6 weeks before entry	0.318	0.884	-1.108
	(0.461)	(0.509)	(0.994)
5 weeks before entry	0.150	0.469	-0.655
	(0.392)	(0.410)	(0.939)
4 weeks before entry	-0.113	0.225	-0.793
	(0.349)	(0.362)	(0.847)
3 weeks before entry	-0.204	0.056	-0.813
	(0.329)	(0.358)	(0.699)
2 weeks before entry	-0.382	-0.131	-0.815
	(0.275)	(0.311)	(0.548)
1 week before entry		base category	
Week of entry	-0.914***	-0.551	-1.974***
	(0.272)	(0.292)	(0.568)
1 week after entry	-2.216***	-1.986***	-2.897***
	(0.394)	(0.460)	(0.772)
2 weeks after entry	-3.082***	-2.907***	-3.728***
	(0.508)	(0.612)	(0.852)
3 weeks after entry	-2.811***	-2.642***	-3.419***
	(0.584)	(0.709)	(0.906)
4 weeks after entry	-2.606***	-2.427**	-3.276**
	(0.607)	(0.735)	(0.994)
5 weeks after entry	-2.298***	-2.192**	-2.520*
	(0.571)	(0.679)	(1.044)
6 weeks after entry	-2.097***	-1.810**	-3.066**
	(0.571)	(0.683)	(1.082)
7 weeks after entry	-2.014***	-1.724*	-2.893*
	(0.587)	(0.688)	(1.116)
8 weeks after entry	-2.076**	-1.763*	-3.128*
	(0.672)	(0.777)	(1.364)
Fixed Effects: Station ID	Yes	Yes	Yes
Fixed Effects: Week ending date	Yes	Yes	Yes
Weekly average importer cost	Yes	Yes	Yes
Number of observations	7174	5474	1700
R^2	0.974	0.975	0.975
R^2 Within	0.024	0.029	0.021

Notes: Results of regressing incumbents' prices on exposure to new unstaffed site and time before and after entry. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors clustered by station ID in parentheses. Treatment group includes incumbents within 0-5 minute drive from new sites. The reference period is 1 week before entry. Column (1) shows results for all station types. Columns (2) and (3) present separate results for staffed and unstaffed sites, respectively.

Table A.2 Price effect on incumbents experiencing entries within 0-10 minute drive time.

	(1)	(2)	(3)
8 weeks before entry	0.852**	0.616	-0.112
	(0.313)	(0.376)	(0.464)
7 weeks before entry	0.823**	0.286	0.373
	(0.313)	(0.383)	(0.485)
6 weeks before entry	0.728*	0.239	0.318
	(0.313)	(0.396)	(0.461)
5 weeks before entry	-0.060	-0.670	0.150
	(0.273)	(0.347)	(0.392)
4 weeks before entry	-0.160	-0.647*	-0.113
	(0.249)	(0.314)	(0.349)
3 weeks before entry	-0.104	-0.411	-0.204
	(0.225)	(0.270)	(0.329)
2 weeks before entry	-0.338*	-0.346	-0.382
	(0.170)	(0.191)	(0.275)
1 week before entry	base category		
Week of entry	-0.225	0.020	-0.914***
	(0.177)	(0.199)	(0.272)
1 week after entry	-1.272***	-0.524	-2.216***
	(0.251)	(0.290)	(0.394)
2 weeks after entry	-1.710***	-0.675*	-3.082***
	(0.304)	(0.342)	(0.508)
3 weeks after entry	-1.329***	-0.443	-2.811***
	(0.349)	(0.370)	(0.584)
4 weeks after entry	-1.332***	-0.495	-2.606***
	(0.380)	(0.402)	(0.607)
5 weeks after entry	-1.301***	-0.480	-2.298***
	(0.390)	(0.427)	(0.571)
6 weeks after entry	-1.168**	-0.458	-2.097***
	(0.406)	(0.441)	(0.571)
7 weeks after entry	-0.880*	-0.121	-2.014***
	(0.442)	(0.471)	(0.587)
8 weeks after entry	-0.598	0.381	-2.076**
	(0.466)	(0.488)	(0.672)
Fixed Effects: Station ID	Yes	Yes	Yes
Fixed Effects: Week ending date	Yes	Yes	Yes
Weekly average importer cost	Yes	Yes	Yes
Drive time	Yes	No	No
Number of observations	14162	12853	7174
R^2	0.969	0.971	0.974
R^2 Within	0.014	0.003	0.024

Notes: Results of regressing incumbents' prices on exposure to new unstaffed site and time before and after entry. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors clustered by station ID in parentheses. The reference period is 1 week before entry. Treated group in Column (1) includes incumbents within 0-10 minute drive from new sites. Treated group in Column (2) includes incumbents within 5-10 minute drive from new sites. Column (3) replicates the results in Column (1), Table A.1, and is included for comparison between model specifications.

Table A.3 Price effect on incumbents located in Auckland experiencing entry within 0-5 minute and 5-10 minute drive time bands.

	(1)	(2)
8 weeks before entry	0.484	0.852**
	(0.448)	(0.313)
7 weeks before entry	0.053	0.823**
	(0.470)	(0.313)
6 weeks before entry	-0.137	0.728*
	(0.487)	(0.313)
5 weeks before entry	-0.392	-0.060
	(0.489)	(0.273)
4 weeks before entry	-0.129	-0.160
	(0.349)	(0.249)
3 weeks before entry	-0.067	-0.104
	(0.395)	(0.225)
2 weeks before entry	0.401	-0.338*
	(0.316)	(0.170)
1 week before entry	base category	
Week of entry	-0.343	-0.225
	(0.289)	(0.177)
1 week after entry	-1.256***	-1.272***
	(0.347)	(0.251)
2 weeks after entry	-1.778***	-1.710***
	(0.381)	(0.304)
3 weeks after entry	-1.814***	-1.329***
	(0.380)	(0.349)
4 weeks after entry	-1.683***	-1.332***
	(0.344)	(0.380)
5 weeks after entry	-1.941***	-1.301***
	(0.398)	(0.390)
6 weeks after entry	-1.915***	-1.168**
	(0.415)	(0.406)
7 weeks after entry	-2.133***	-0.880*
	(0.461)	(0.442)
8 weeks after entry	-1.144*	-0.598
	(0.570)	(0.466)
Fixed Effects: Station ID	Yes	Yes
Fixed Effects: Week ending date	Yes	Yes
Weekly average importer cost	No	Yes
Drive time	Yes	Yes
Number of observations	4998	14162
R^2	0.971	0.969
R^2 Within	0.029	0.014

Notes: Results of regressing existing sites' prices on exposure to new unstaffed site and time before and after entry. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors clustered by station ID in parentheses. The reference period is 1 week before entry. Treated group in Column (1) includes incumbents located in Auckland territorial authority that are within 0-5 minute and 5-10 drivetime of new sites. Column (2) replicates the results in Column (1), Table A.2, and is included for comparison between model specifications.

2. Cross-sectional regression results

Table A.4 Regression results for price outcomes

Dependent variable:	(1) Average price	(2) Coefficient of variation	(3) Minimum price	(4) Maximum price
Unstaffed market type	-6.143***	1.055***	-4.101***	-9.433***
	(0.693)	(0.103)	(0.691)	(0.756)
Station count	-0.592***	0.037**	0.002	-1.322***
	(0.097)	(0.013)	(0.097)	(0.106)
(Intercept)	295.300***	0.687***	294.960***	295.985***
	(0.525)	(0.097)	(0.523)	(0.572)
Number of observations	863	596	863	863
R^2	0.187	0.191	0.048	0.387

Notes: Results of regressing each type of price outcome on the market type indicator and number of stations in the local market. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors in parentheses. The reference market type is staffed market.

2.1. Supermarket unstaffed sites

We ran a regression to test whether the average prices in staffed type and supermarket unstaffed type local markets are different. Recall the definition of supermarket unstaffed local market refers to markets that include supermarket-run unstaffed sites and no other unstaffed sites. This implies that a supermarket unstaffed local market may also include staffed sites. The regression results displayed in Table A.5 shows that there are no statistically significant differences between prices in local markets that include supermarket unstaffed sites (but no other unstaffed sites) and those in markets that include only staffed sites.

Table A.5 Regression results for average price

	(1)
Staffed market type	0.996
	(1.690)
Station count	-1.024***
	(0.247)
(Intercept)	295.940***
	(2.017)
Number of observations	522
R^2	0.059

Notes: Results from regressing average price on market type indicator and number of stations in the local market. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Standard errors in parentheses. The reference market type is supermarket unstaffed market.