A CLUSTER ANALYSIS OF PETROL PROFIT MARGINS ACROSS VARIOUS REGIONAL AND URBAN LOCATIONS IN AUSTRALIA

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ABSTRACT: Rising fuel prices can hamper economic activities in urban and regional areas. Despite following a mean reverting pattern over time, the spread between retail and wholesale prices of petrol exhibits significant differences across various geographical locations in Australia. Using a hierarchical cluster analysis, this paper classifies 109 retail locations into six heterogeneous groups with homogeneous contents. By identifying the whereabouts of those petrol stations that set relatively high gross profit margins within each comparable cluster, this study can provide important policy implications for both consumers and regulators. Contrary to popular belief, we found that excessively high margins are not necessarily observed only in remote and rural areas.

KEY WORDS: Regional clusters; Profit margins; Australia.

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1. INTRODUCTION

The present study is one of the few attempts to examine the spread between the retail and wholesale prices using disaggregate data as most of the previous empirical studies on petrol prices in Australia utilised mainly national and/or state level data (see inter alia Donnelly, 1982; Newman and Kenworthy, 1989; Samimi, 1995; Fatai *et al.*, 2004; Dodson and Sipe, 2007; Hensher and Stanley, 2009; Li *et al.*, 2010; Gargett, 2010). Using a unique database, this study provides a cross-sectional comparison of retail profit margins using a hierarchical cluster analysis to determine whether or not the observed large variations in petrol margins can be described as 'excessive'. As an example, the average difference between retail and wholesale prices of petrol varies from 24.1 cents per litre in Tennant Creek to only 2.4 cents per litre in Mackay during the period October 2007-January 2012. This paper seeks to identify whether such large profit spreads can be explained by the extent of economies of scale and scope, the market size and the associated overhead costs. In other words, is the spread between the retail and wholesale prices high mainly in rural, less-populated and remote areas or is it a ubiquitous phenomenon everywhere?

In order to examine these issues, a cluster analysis is conducted to classify all retail locations into various groups each exhibiting similar magnitudes of gross profit spread and a set of control variables. Due to the unavailability of the data for various petrol stations within each of the 109 retail locations, we use two proxy variables to capture the effects of transport cost and the extent of economies of scale and scope, namely population and the distance between retailers and wholesalers. The major objective of this paper is to identify several clusters in which gross profit margins are relatively comparable. This allows us to analyse whether large existing differences in margins across various locations can be justified against the factors associated with location, cost and the size of the market.

The findings presented here not only contribute significantly to our understanding of substantial regional differences in petrol margins, but also have direct practical implications for motorists and provide a guideline for relevant regulatory authorities across various geographical locations. Instead of the prevailing use of aggregate data, our disaggregated study can lead to an in-depth understanding of competition, or lack thereof, and the extent of profiteering in the petrol market. The location-specific results of this study make price monitoring by regulatory bodies more cost effective as they can readily identify and target price setting in those locations pursuing comparatively higher margins. Hence, this study assists both motorists and regulatory bodies to make more informed and objective assessments of retail profit margins within the identified homogeneous clusters, leading to greater efficiency and transparency of the petrol market.

The rest of the paper is structured as follows. Section 2 presents a succinct review of literature on this topic. Section 3 briefly discusses how we conduct our cluster analysis at a disaggregate level for benchmarking purposes. Section 4 describes the sources and summary statistics of the data employed. Section 5 presents the results of our cluster analysis using 109 cross-sectional observations within a trivariate system. Section 6 discusses the policy implications of the study followed by some concluding remarks in Section 7.

2. REVIEW OF LITERATURE

The fuel consumption-economic activity nexus has been examined extensively in the literature since the 1973 oil embargo. According to Hamilton (1983), fuel price hikes were responsible for the majority of post-war U.S. recessions until the mid-1970s. However, Hamilton's study only focused on periods when the economy was subject to significant upward fuel price movements and controls. Hooker (1996) pointed out that such an inverse relationship between fuel prices and economic activity was weakened after 1985 when falling fuel prices failed to stimulate the U.S. economy as anticipated, a view not shared in Hamilton's (1996) subsequent study.

Inter alia Mork (1989) and Ferderer (1996) confirmed Hamilton's initial finding after incorporating the effect of fuel price volatility on the US economy. Brown and Yucel (2002, p.194) analogously summed up this inverse relationship by suggesting that "the classic supply-side effect best explains why rising oil prices slows GDP growth and stimulates inflation." In a recent study, Ford (2011) concludes that vertically integrated oil companies' gross profit margins are actually highest during the time of moderate petrol prices. Contrary to popular belief, these companies' gross profit margins decline when petrol prices are excessively high, and even more so than when these prices are low.

The adverse effect of fuel prices on economic activity has been well documented in many countries around the world. For example, Asafu-Adjaye (2000) finds that a change in fuel consumption Granger causes changes in income in several Asian developing countries. In a follow-up study, Mahadevan and Asafu-Adjaye (2007) broaden the investigation to include a total of 20 developed and developing countries and find that fuel consumption stimulates short-run economic activity. Chontanawat *et al.* (2008) is one of the studies that provides comprehensive evidence for fuel consumption as a determinant of economic growth. They examined the effect of fuel consumption in 100 countries and concluded that rising fuel costs and reductions in fuel consumption can jeopardise economic growth in the developed countries more than that of the developing countries.

There are a number of studies in the literature which have highlighted the significance of regional differences in the context of petrol prices (see inter alia Hastings and Gilbert, 2005; Simpson and Taylor, 2008; Hosken, *et al.* 2008; Eckert, 2013; Pennerstorfer and Weiss, 2013). For example, Pennerstorfer and Weiss (2013) compiled a large database consisting of 18 quarterly observations on prices of diesel fuel (December 2000-March 2005) for an unbalanced sample of 595 to 1 370 gasoline stations in Austria. They supplemented price data with geographical/demographical data (i.e. population density, commuting behavior and importance of tourism) as well as individual characteristics of petrol stations in their comprehensive analysis. Based on a measure of spatial clustering of competitors, Pennerstorfer and Weiss (2013) substantiated the effects of local market power on petrol prices with a particular focus on the significance of coordinated pricing behaviour using the difference-in-difference approach (i.e. differentiation between the treatment and control groups). By comparing individual observations before and after the station conversion period, they concluded that spatial clustering of petrol stations lowers competition and increases prices (Pennerstorfer and Weiss, (2013).

There is also an emerging consensus in the extant literature that higher petrol prices and large retail price margins between rural and urban areas in Australia are largely attributable to the lack of competition in the market (Industry Commission, 1994; Australian Competition and Consumer Commission, 1996, 2007; Walker *et al.*, 1997; Department of Parliamentary Services, 2004; Queensland Parliament, 2006). Setting excessive profit margins for fuel prices can adversely affect economic activity, particularly in rural and regional Australia, where petrol is used as a key intermediate input in the production of goods and services. Therefore, many policymakers in Australia have been sensitive to excessive profiteering behaviour in the fuel market since such practices can undermine economic growth. The Australian Competition and

Consumer Commission (ACCC) (1996; 2007) launched several inquiries into possible price collusions in the oil industry but was unable to find any significant evidence of systematic price collusion among the major oil companies. However, a recurring theme in these inquiries was the significant difference between fuel prices in different geographical locations.

After reviewing evidence of the ACCC's inquiry in 1996, Walker *et al.* (1997) concluded that much of the urban-rural fuel price gap may be attributed to the lack of competition among oil importers coupled with limited market power of the independent discount retailers. The systematic rise in petrol prices since 2000 sparked the second wave of the fuel price debate. Eckert (2013, p.140) summarises the prominence of this issue by pointing out that: "since 2000 alone, over 75 empirical studies of gasoline retailing have been published in English language academic journals, with many more studies existing in working paper form or as reports issued by governments or other agencies or institutes."

In order to enhance competition in the petrol market, the Western Australian state government introduced the fuel price monitoring scheme 'FuelWatch' in January 2001. The FuelWatch scheme has provided a comprehensive dataset on fuel prices down to the station level. After analysing FuelWatch data, the ACCC (2008) failed to identify any attempt by the oil majors to profiteer by manipulating fuel prices. However, Davidson (2008, p.8) cast doubts over the reliability of ACCC's conclusion by pointing to the fact that the ACCC model contained no "diagnostic statistics such as standard errors or p-values that one might expected in any econometric analysis". Using input-output analysis, Valadkhani and Mitchell (2002) demonstrated that although fuel price hikes would not have harmed the Australian economy to the extent as they did in the 1970s, these price hikes would nevertheless adversely affect poorer families. As a result, schemes such as FuelWatch could be readily justified by aiming to protect the interests of lower socioeconomic groups.

It should be noted that Valadkhani (2013a) found that out of the 28 retail locations exhibiting significant petrol pricing asymmetry, none were from Western Australia, where FuelWatch is effectively monitoring petrol prices unlike the rest of the country. Valadkhani (2013b) examined the day of the week effect in retail prices of unleaded petrol across 114 retail locations in Australia during the period spanning from January 2005 to April 2012. He found that in major capital cities and urban areas prices generally peak on Thursday/Friday and then fall until they reach their cyclical trough on Tuesday. Valadkhani (2013b) also argues that petrol is more expensive in remote and small towns, where the economies of scale and scope are relatively limited and prices are less variable.

3. CLUSTER ANALYSIS OF REGIONAL LOCATIONS

For any given location, our key variable, the mean gross profit spread (margin) is the difference between retail and wholesale prices of petrol averaged over the sample period. It should be noted that there is generally more than one petrol station in each retail location and thus the retail prices in each location at any point of time are already the average of several petrol stations. In other words, the mean retail prices of petrol are averaged over time and over the retail outlets within each location. The wholesale prices are averaged over time only, as retailers purchase petrol from just one outlet which is usually the nearest outport terminal.

After computing the mean profit spread for each of the 109 retail locations, we need to obtain the data on transport costs, the number of service stations in the area (as a proxy for the extent of competition) and the extent of economies of scale and scope. Complete accurate data on the above control variables for various petrol stations within all 109 geographical locations are not available, therefore, we use the distance between retailers and their nearest wholesale distribution terminal as a proxy for transport costs. Consequently the further away each retail location is from its wholesale outport, the higher are expected transport and overhead costs. In addition, population is used as a proxy to capture the size of the market, the density of service stations within a certain geographical location and the extent of economies of scale and scope. When competition is localized in the gasoline market, the information on local differences in demand and cost and the share of informed vs. uniformed consumers are hard or impossible to obtain, thus making the assessment of the effects of coordinated behavior on prices very difficult (Pennerstorfer and Weiss, 2013).

Cluster analysis is a data-reduction technique which can be used to minimise within-group variance, while also maximising between-group variance, leading to a small number of heterogeneous groups with homogeneous contents (Hair *et al.*, 1998). We thus adopt a hierarchical cluster analysis to group the 109 retail locations into several manageable clusters according to the following three variables: mean profit spread, population of the retail location, and distance to the nearest wholesaler. Before conducting a cluster analysis, these three variables are standardised to avoid bias resulting from variables having substantially different magnitudes or being measured in different units. This paper measures the similarity (in terms of the above three variables) between two retail locations, *j* and *k*, by the following squared Euclidean distance:

$$D(j,k) = \sum_{i=1}^{3} (X_{ij} - X_{ik})^2 \quad (1)$$

where X_{ij} and X_{ik} denote the i^{th} variable of locations *j* and *k*, respectively. The smaller D(*j*, *k*) is, the more similar are locations *j* and *k* in terms of the normalised magnitude of the three control variables. In hierarchical cluster analysis, at the beginning of the procedure there are 109 clusters, each representing one retail location. Then, at each stage, the two most similar locations (clusters) are combined until, at the last stage, a single cluster of 109 locations is formed. There are several alternative methods for merging the most similar pair of clusters at each stage namely the average linkage, the nearest centroid sorting, and the complete linkage, which is a conservative decision rule (Hirschberg et al., 1991), because it uses the maximum distance between any two attributes in the two clusters. In practice, compared to the above 3 methods, the Ward method is more widely used. This paper uses Ward's (1963) method, which chooses the two clusters whose merger would result in the smallest increase to the aggregate sum of squared deviations within clusters. The sum of squared deviations within cluster *k* is defined as follows:

$$\text{ESS}(k) = \sum_{j \in k} \sum_{i=1}^{3} (X_{ij} - \bar{X}_{ik})^2 \quad (2)$$

where X_{ij} is the i^{th} variable in location *j*, and $\bar{X}_{ik}$ is the i^{th} variable averaged across all locations in cluster *k*. Given the values of ESS(*k*), the increment to the aggregate sum of squared deviations within clusters resulting from the merger of cluster *k* and cluster *K* to form cluster ($k \cup K$) is computed by:

$$d_{\text{Ward}}(k,K) = \sum_{j \in (k \cup K)} \sum_{i=1}^{3} (X_{ij} - \bar{X}_{i(k \cup K)})^2 - \text{ESS}(k) - \text{ESS}(K) \quad (3)$$

Based on the resulting grouping of homogenous locations within each cluster, cluster analysis can provide a detailed understanding of the pricing behaviour of retailers at various geographical locations and reveal any possible evidence of abnormal pricing practices as presented below.

4. DATABASE

Retail and wholesale petrol prices were obtained from *FUELtrac* (www.fueltrac.com.au) and *Informed Sources* (www.informedsources.com) using funding made available under the Australian Research Council's Discovery Projects scheme. Close scrutiny of both databases revealed that there are only 109 retail locations for which consistent and complete price data (with no gap or missing observations) were available over the period 29 October 2007 to 30 January 2012. Petrol stations in these locations purchase petrol from their nearest wholesale outport terminal. In total there are 18 wholesale distribution terminals across 7 states and territories in Australia: 2 are in the State of New South Wales (Newcastle and Sydney), 1 in the Northern Territory (Darwin), 5 in Queensland (Brisbane, Cairns, Gladstone, Mackay, Townsville), 2 in South Australia (Adelaide, Port Lincoln), 2 in Tasmania (Hobart, Devonport), 1 in Victoria (Melbourne) and 5 in Western Australia (Albany, Esperence, Geraldton, Perth, Port Hedland). Population data were obtained from the Australian Bureau of Statistics (2012), and the distance between retail locations and their nearest wholesale terminals was approximated in kilometres using Google map assuming a minimum distance of 5 km.

5. EMPIRICAL RESULTS

Table 1 shows the descriptive statistics and the unit root test results using weekly data spanning from 29 October 2007 to 30 January 2012. During this period on average ten retail locations with the highest average gross profit margin (in cents per litre) were: Tennant Creek (24.1 cents per litre), Eucla (23.9), Alice Springs (21.1), Carnarvon (19.5), Cunnamulla (16.6), Bega (15.4), Cooma (15.3), Hay (14.9), Geraldton (14.4) and Ceduna (14.0). In contrast, the lowest margins were observed at the following retail locations: Mackay (2.4 cents per litre), Townsville (2.7), Bundaberg (4.0), Dalby (4.4), Perth metropolitan (4.7), Cairns (4.7), Caloundra (4.8), Mandurah (4.9), Warwick (5.0), and Brisbane metropolitan area (5.1). Overall it appears that the average margins in urban and more populous metropolitan areas (especially those in Queensland) are conspicuously less than regional areas, where the extent of economies of scope and scale is probably far more limited.

The average gross margin in Sydney metropolitan, as the most populous city in Australia, is 6.3 cents per litre, whereas in Eucla (with a population of only 86 persons) this margin is as high as 23.9 cents. Before computing the mean margin for each of the 109 locations, it is important to ensure that all individual 109 spread series follow a mean reverting pattern during the sample period when the average series are computed. According to the Augmented Dickey-Fuller (ADF) test results in Table 1, the null of unit root is rejected at the 5 percent level of significance or better for all of the 109 spread series. Therefore, we can assert that the spread series fluctuates around their mean values without showing upward or downward trends during the sample period. These results support the view that although the margins between retail and wholesale prices of petrol exhibit significant differences across various geographical locations, they follow a mean reverting pattern over time within their individual retail locations. In the context of the Austrian gasoline market, Pennerstorfer and Weiss (2013) provide convincing evidence that large gasoline price differences can be adequately explained by analysing the link between ownership structure and spatial clustering (i.e. the sequence of stations on a road). It is highly likely that retailers, which are generally members of a network of multi-station firms, can coordinate their pricing attempts within the spatial network due to the lack of competition.

Table 1. Descriptive Statistics and the Unit Root Test Results (October 2007-January 2012).

No.	*Retailer location*	*Mean*[(a)]	*Rank*	*Standard deviation*[(a)]	*ADF t stat.*[(b) (c)]	*P-value*
1	Adelaide Metro	5.6	95	2.43	-10.96	0.00
2	Albany	9.6	47	3.67	-5.16	0.00
3	Albury	5.3	98	3.77	-6.12	0.00
4	Alice Springs	21.1	3	5.01	-5.08	0.00
5	Ararat	6.9	79	3.84	-6.38	0.00
6	Bairnsdale	7.0	77	3.64	-4.71	0.00
7	Ballarat	5.6	94	4.06	-4.82	0.00
8	Bathurst	9.6	46	3.65	-5.16	0.00
9	Bega	15.4	6	2.87	-4.74	0.00
10	Benalla	10.8	34	3.20	-5.51	0.00
11	Bendigo	6.8	80	3.50	-6.30	0.00
12	Bowen	5.8	91	5.83	-4.68	0.00
13	Brisbane Metro	5.1	100	5.40	-5.62	0.00
14	Broken Hill	11.8	27	3.70	-5.68	0.00
15	Bunbury	8.3	63	2.61	-5.16	0.00
16	Bundaberg	4.0	107	4.39	-5.64	0.00
17	Burnie	10.4	40	2.97	-5.89	0.00
18	Caboolture	5.4	97	5.57	-5.52	0.00
19	Cairns	4.7	104	5.16	-5.69	0.00
20	Caloundra	4.8	103	5.92	-5.94	0.00
21	Campbelltown	11.4	30	2.88	-5.61	0.00
22	Canberra Metro	9.2	55	3.69	-7.60	0.00
23	Carnarvon	19.5	4	5.19	-4.62	0.00
24	Casino	7.7	69	5.07	-4.70	0.00
25	Ceduna	14.0	10	3.16	-4.94	0.00
26	Charters Towers	7.6	71	5.06	-4.68	0.00
27	Coffs Harbour	10.6	36	3.05	-6.49	0.00
28	Colac	11.9	24	3.81	-5.08	0.00
29	Cooma	15.3	7	2.87	-6.01	0.00
30	Cowra	8.8	59	3.28	-5.99	0.00
31	Cunnamulla	16.6	5	6.28	-4.93	0.00
32	Dalby	4.4	106	5.20	-5.37	0.00
33	Darwin Metro	11.5	28	4.00	-4.21	0.01
34	Devonport	9.5	52	3.53	-5.06	0.00
35	Dubbo	9.6	51	3.73	-4.60	0.00
36	Echuca	11.9	23	3.81	-5.28	0.00
37	Emerald	6.6	83	4.84	-5.81	0.00
38	Eucla	23.9	2	6.74	-3.86	0.02
39	Forbes	13.3	12	2.85	-5.96	0.00
40	Forster	9.7	44	5.23	-4.01	0.01
41	Geelong	6.2	86	2.48	-7.61	0.00
42	Geraldton	14.4	9	3.90	-5.16	0.00
43	Gladstone	5.2	99	4.91	-4.07	0.01
44	Gold Coast	5.8	92	5.13	-5.77	0.00
45	Goondiwindi	7.6	70	6.42	-4.88	0.00
46	Goulburn	7.9	66	3.60	-4.79	0.00
47	Grafton	9.1	56	4.61	-4.79	0.00
48	Griffith	11.5	29	3.74	-5.02	0.00
49	Gympie	5.9	89	6.12	-4.81	0.00
50	Hervey Bay	6.9	78	5.52	-4.67	0.00
51	Hay	14.9	8	3.41	-5.59	0.00
52	Hobart Metro	8.7	61	3.88	-5.38	0.00
53	Horsham	12.3	21	2.85	-5.99	0.00
54	Inverell	10.6	35	4.18	-5.54	0.00
55	Ipswich	5.5	96	5.33	-6.45	0.00
56	Kalgoorlie	10.0	42	4.15	-5.46	0.00
57	Katherine	11.1	32	4.70	-4.54	0.00

Table 1. Descriptive Statistics and the Unit Root Test Results (October 2007-January 2012).

No.	*Retailer location*	*Mean*[(a)]	*Rank*	*Standard deviation*[(a)]	*ADF t stat.*[(b) (c)]	*P-value*
58	Kempsey	9.9	43	3.51	-5.34	0.00
59	Kingaroy	6.2	87	5.63	-5.16	0.00
60	Lakes Entrance	11.0	33	3.79	-4.15	0.01
61	Launceston	10.6	39	3.37	-5.79	0.00
62	Lismore	8.2	64	4.74	-4.77	0.00
63	Longreach	12.4	20	6.18	-4.60	0.00
64	Mackay	2.4	109	5.37	-5.76	0.00
65	Mandurah	4.9	102	3.11	-5.22	0.00
66	Mansfield	12.7	17	3.17	-4.85	0.00
67	Maryborough	5.7	93	5.32	-4.72	0.00
68	Melbourne Metro	7.3	74	2.07	-8.35	0.00
69	Mildura	12.5	19	3.47	-5.87	0.00
70	Moree	12.7	16	4.05	-6.05	0.00
71	Mt Gambier	8.7	60	3.88	-5.39	0.00
72	Murray Bridge	7.3	75	2.63	-5.30	0.00
73	New Norfolk	7.4	72	4.53	-6.26	0.00
74	Newcastle	7.8	68	2.48	-7.06	0.00
75	North Coast	6.1	88	5.32	-3.73	0.02
76	Orange	11.8	25	3.04	-5.97	0.00
77	Parkes	12.6	18	3.09	-5.54	0.00
78	Perth Metro	4.7	105	2.60	-5.74	0.00
79	Port Augusta	8.1	65	4.26	-5.45	0.00
80	Port Lincoln	9.2	53	3.60	-5.18	0.00
81	Port Macquarie	9.0	57	3.54	-4.39	0.00
82	Port Pirie	8.7	62	2.12	-5.99	0.00
83	Portland	12.8	15	3.08	-5.51	0.00
84	Renmark	5.8	90	4.94	-4.92	0.00
85	Rockhampton	6.7	82	5.35	-5.33	0.00
86	Roma	9.6	50	5.82	-4.43	0.00
87	Sale	9.2	54	3.01	-5.64	0.00
88	Shepparton	10.2	41	3.56	-4.34	0.00
89	Sunbury	7.3	73	2.15	-8.42	0.00
90	Swan Hill	13.4	11	2.40	-4.90	0.00
91	Sydney Metro	6.3	85	1.99	-8.61	0.00
92	Tamworth	11.2	31	2.76	-6.18	0.00
93	Taree	6.7	81	4.33	-5.13	0.00
94	Tennant Creek	24.1	1	5.47	-4.85	0.00
95	Townsville	2.7	108	4.62	-5.99	0.00
96	Traralgon	9.6	49	3.54	-5.75	0.00
97	Ulverstone	10.6	38	3.20	-5.47	0.00
98	Victor Harbour	7.8	67	3.70	-5.22	0.00
99	Wagga Wagga	12.3	22	3.59	-4.68	0.00
100	Wangaratta	10.6	37	2.43	-6.01	0.00
101	Warrnambool	8.8	58	3.42	-6.68	0.00
102	Warwick	5.0	101	5.68	-3.85	0.02
103	Whyalla	6.6	84	5.84	-4.52	0.00
104	Wodonga	7.1	76	3.07	-5.69	0.00
105	Wollongong	9.7	45	2.14	-7.47	0.00
106	Wonthaggi	13.2	14	2.44	-6.41	0.00
107	Wynyard	13.2	13	2.63	-5.98	0.00
108	Yarrawonga	9.6	48	4.25	-4.90	0.00
109	Yass	11.8	26	2.94	-5.93	0.00
	Average	**9.5**		**4.00**		

Note.−(a) cents per litre. (b) The Schwarz information criterion is utilised to select the optimal lag length, including both an intercept term and a time trend variable. (c) Following Hayashi (2000), given T=223 weekly observations, the upper bound in search of the optimum lag length is assumed to be 14. Source: the Authors

A hierarchical cluster analysis is performed to identify in which comparable locations the average retail gross margins can be considered as relatively too high. To this end, the 109 x 109 proximity matrix is first computed which contains the squared Euclidean distances between all pairs of retail locations. This matrix is not reported here due to its large size, but is available from the author on request.

Table 2 shows how the clusters (or geographical locations) are merged at each stage of the procedure. At Stage 0 there are 109 separate clusters with each containing a single retail location. As shown in Table 2 (columns 2 and 3) at stage 1, Forster (Cluster 40) and Traralgon (Cluster 96) are combined. The number of clusters at the end of Stage 1 is 108 (see Column 5). The clusters that are formed at Stages 2 and 3 also involve the merging of two similar single-location clusters. At Stage 2, locations 57 (Katherine) and 60 (Lakes Entrance) are merged, and at Stage 3 locations 2 (Albany) and 34 (Devonport) are clustered. In this way, the most similar locations continue to merge until stage 37, where Forster (Cluster 40) and Traralgon (Cluster 96), as one cluster, are combined with location 88 (Shepparton). The individual locations, or cluster groupings will continue to merge in the same manner until stage 108, where there will be just one cluster containing all 109 locations.

The agglomeration schedule in Table 2 shows that retail location 4 (Alice Springs), as the most dissimilar location compared to the rest, does not join any cluster until the last stage (see stage 108) and, in so doing, increases the agglomeration coefficient markedly from 223 to 324. Figure 1 shows how clusters (or locations) are formed in a hierarchical clustering by using a dendrogram.

Table 2. Agglomeration Schedule.

Stage	Cluster Combined		Agglomeration Coefficients	No. of clusters
	Cluster 1[(a)]	Cluster 2[(a)]		
1	40	96	.000	108
2	57	60	.001	107
3	2	34	.001	106
4	67	84	.003	105
5	18	55	.004	104
6	73	89	.006	103
7	77	83	.009	102
8	30	47	.012	101
9	46	62	.016	100
10	58	108	.021	99
11	6	50	.025	98
12	11	93	.030	97
13	76	109	.035	96
14	81	101	.040	95
15	2	80	.046	94
16	57	92	.051	93
17	35	56	.058	92
18	8	87	.065	91
19	53	70	.073	90
20	20	65	.081	89
21	29	51	.089	88
22	17	97	.097	87
23	9	29	.105	86
24	12	59	.114	85
25	72	98	.124	84
26	39	90	.135	83
27	64	95	.147	82
28	21	28	.160	81
29	6	103	.173	80
30	15	46	.186	79
31	16	32	.201	78
32	81	82	.216	77
33	45	104	.233	76
34	10	100	.250	75
35	19	43	.269	74
36	48	99	.290	73
37	40	88	.312	72
38	39	77	.336	71
39	5	24	.359	70
40	14	69	.383	69
41	30	79	.412	68
42	12	49	.441	67
43	36	66	.470	66
44	27	35	.502	65
45	41	85	.534	64
46	72	73	.572	63
47	7	102	.610	62
48	71	86	.650	61
49	37	45	.693	60
50	8	40	.736	59
51	11	26	.780	58
52	106	107	.828	57
53	53	76	.890	56
54	18	19	.954	55
55	7	20	1.022	54

Table 2. Agglomeration Schedule.

Stage	Cluster Combined		Agglomeration Coefficients	No. of clusters
	Cluster 1[(a)]	Cluster 2[(a)]		
56	17	61	1.092	53
57	41	75	1.166	52
58	9	25	1.242	51
59	5	15	1.319	50
60	12	67	1.399	49
61	38	94	1.487	48
62	2	52	1.581	47
63	14	48	1.678	46
64	10	58	1.778	45
65	17	33	1.889	44
66	21	36	2.004	43
67	30	81	2.130	42
68	6	37	2.263	41
69	13	78	2.402	40
70	5	11	2.555	39
71	53	57	2.709	38
72	27	71	2.874	37
73	3	6	3.054	36
74	14	54	3.238	35
75	17	105	3.431	34
76	44	74	3.625	33
77	42	106	3.820	32
78	8	10	4.076	31
79	7	41	4.337	30
80	12	16	4.613	29
81	68	91	4.931	28
82	22	30	5.261	27
83	7	18	5.598	26
84	2	17	5.956	25
85	39	53	6.417	24
86	31	63	6.988	23
87	8	22	7.617	22
88	21	42	8.305	21
89	1	44	9.037	20
90	5	72	9.825	19
91	14	27	10.915	18
92	3	12	12.008	17
93	7	64	13.118	16
94	9	23	14.294	15
95	2	21	17.019	14
96	3	5	19.806	13
97	14	39	22.604	12
98	1	7	25.517	11
99	9	31	29.443	10
100	4	38	33.786	9
101	3	8	38.826	8
102	9	14	46.269	7
103	1	13	58.055	6
104	2	3	71.928	5
105	1	2	92.378	4
106	4	9	138.109	3
107	1	68	223.185	2
108	1	4	324.000	1

Note.− (a) See the first and second columns in Table 1 to identify the retail location. Source: the Authors

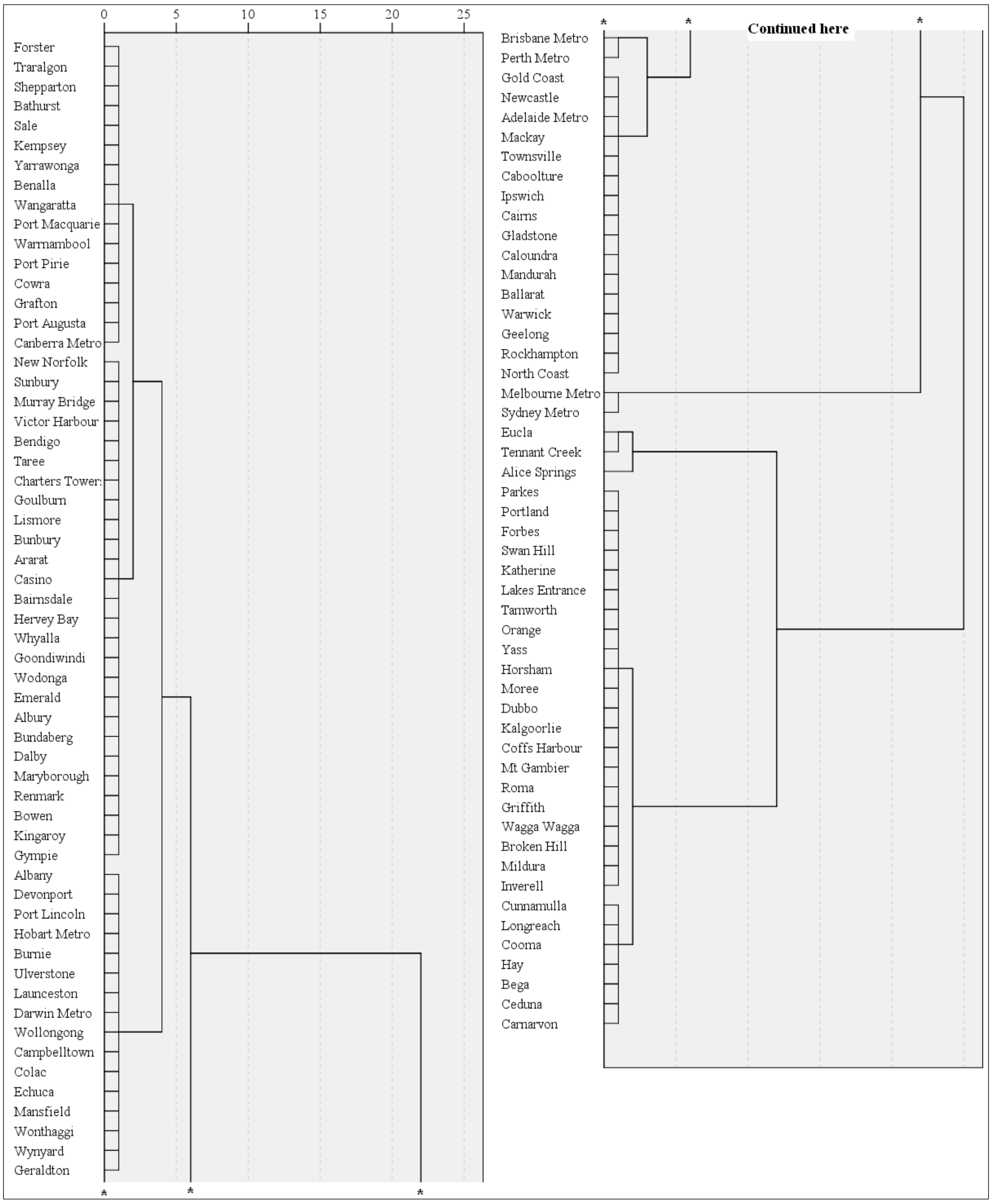

Figure 1. Dendrogram using the Euclidean distance.
Note: the vertical axis shows the rescaled distance cluster combine. Source: the Authors

The maximum change in the agglomeration coefficient is used by some practitioners as a guide to determine the optimum number of clusters. This coefficient denotes the within-cluster sum of squares, aggregated across all clusters that are formed by a given stage of the procedure. Small increments in the agglomeration coefficient mean that relatively homogeneous clusters are being combined at the corresponding stage. Conversely, large increments in the agglomeration coefficient indicate that relatively more heterogeneous clusters are being grouped. The use of maximum change in the agglomeration coefficient as a stopping rule usually suggests too few clusters (Hair *et al.*, 1998). The cubic clustering criterion is another alternative stopping rule that has the tendency to identify too many clusters. In order to overcome the shortcoming associated with adopting too few or too many cluster solutions, we report a range of solutions, varying from two to six. This approach offers a better understanding of the how different retail locations are clustered. However, our preferred final grouping is based on the six-cluster solution because the corresponding change in the agglomeration coefficient rises from one to two digits.

Table 3 reports the cluster analysis results using Ward's method and the normalised values of our three control variables. All five different cluster solutions are reported in columns 2–6 of Table 3. A cursory look at Table 3 reveals that, irrespective of the number of clusters, Melbourne and Sydney (both with large population and minimum distance to their supplying wholesale distributors) appear as separate clusters in all of the cluster solutions. Similarly, Tennant Creek, Eucla and Alice Springs are always grouped together, regardless of the number of clusters. In this cluster, while the mean gross profit margin is higher than that of the other clusters, their populations are relatively lower and at the same time the distances to their corresponding wholesale distributors are also further than others. These groupings can also be seen in the dendrogram presented in Figure 1.

Table 3. Gross profitability index using a six-cluster solution. (Cont.)

Retailer Location	Cluster Membership Codes					AGM	REPI (%)	Population (Persons)	Distance to Wholesaler Km	Wholesale Distributor	Wholesaler state
	6	5	4	3	2						
Newcastle	**C6.1**	C5.1	C4.1	C3.1	C2.1	7.8	50	552776	5	Newcastle	NSWACT
Rockhampton	**C6.1**	C5.1	C4.1	C3.1	C2.1	6.7	29	78643	109	Gladstone	QLD
Geelong	**C6.1**	C5.1	C4.1	C3.1	C2.1	6.2	19	180805	75	Melbourne	VIC
North Coast	**C6.1**	C5.1	C4.1	C3.1	C2.1	6.1	17	335273	95	Brisbane	QLD
Gold Coast	**C6.1**	C5.1	C4.1	C3.1	C2.1	5.8	12	600475	80	Brisbane	QLD
Ballarat	**C6.1**	C5.1	C4.1	C3.1	C2.1	5.6	8	97810	115	Melbourne	VIC
Adelaide Metro	**C6.1**	C5.1	C4.1	C3.1	C2.1	5.6	8	1212982	5	Adelaide	SA
Ipswich	**C6.1**	C5.1	C4.1	C3.1	C2.1	5.5	6	172738	40	Brisbane	QLD
Caboolture	**C6.1**	C5.1	C4.1	C3.1	C2.1	5.4	4	158988	50	Brisbane	QLD
Gladstone	**C6.1**	C5.1	C4.1	C3.1	C2.1	5.2	0	52949	5	Gladstone	QLD
Brisbane Metro	**C6.1**	C5.1	C4.1	C3.1	C2.1	5.1	-2	2074222	5	Brisbane	QLD
Warwick	**C6.1**	C5.1	C4.1	C3.1	C2.1	5.0	-4	12659	156	Brisbane	QLD
Mandurah	**C6.1**	C5.1	C4.1	C3.1	C2.1	4.9	-6	89559	70	Perth	WA
Caloundra	**C6.1**	C5.1	C4.1	C3.1	C2.1	4.8	-8	51991	94	Brisbane	QLD
Cairns	**C6.1**	C5.1	C4.1	C3.1	C2.1	4.7	-10	153075	5	Cairns	QLD
Perth Metro	**C6.1**	C5.1	C4.1	C3.1	C2.1	4.7	-10	1738807	5	Perth	WA
Townsville	**C6.1**	C5.1	C4.1	C3.1	C2.1	2.7	-48	176347	5	Townsville	QLD
Mackay	**C6.1**	C5.1	C4.1	C3.1	C2.1	2.4	-54	87324	5	Mackay	QLD
Cluster average	**C6.1**					**5.2**	**0**	**434857**	**49**		
Melbourne Metro	**C6.2**	C5.2	C4.2	C3.2	C2.1	7.3	7	4137432	5	Melbourne	VIC
Sydney Metro	**C6.2**	C5.2	C4.2	C3.2	C2.1	6.3	-7	4627345	5	Sydney	NSWACT
Cluster average	**C6.2**					**6.8**	**0**	**4382389**	**5**		
Benalla	**C6.3**	C5.3	C4.1	C3.1	C2.1	10.8	38	9129	212	Melbourne	VIC
Wangaratta	**C6.3**	C5.3	C4.1	C3.1	C2.1	10.6	36	29018	252	Melbourne	VIC
Shepparton	**C6.3**	C5.3	C4.1	C3.1	C2.1	10.2	31	50373	190	Melbourne	VIC
Kempsey	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.9	27	29581	280	Newcastle	NSWACT
Forster	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.7	24	18372	164	Newcastle	NSWACT
Bathurst	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.6	23	34561	203	Sydney	NSWACT
Yarrawonga	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.6	23	5727	282	Melbourne	VIC
Traralgon	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.6	23	31105	164	Melbourne	VIC
Sale	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.2	18	14782	214	Melbourne	VIC
Canberra Metro	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.2	18	417860	287	Sydney	NSWACT
Grafton	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.1	17	24798	315	Brisbane	NSWACT
Port Macquarie	**C6.3**	C5.3	C4.1	C3.1	C2.1	9.0	15	44793	245	Newcastle	NSWACT
Warrnambool	**C6.3**	C5.3	C4.1	C3.1	C2.1	8.8	13	34193	265	Melbourne	VIC
Cowra	**C6.3**	C5.3	C4.1	C3.1	C2.1	8.8	13	12940	309	Sydney	NSWACT
Port Pirie	**C6.3**	C5.3	C4.1	C3.1	C2.1	8.7	12	18169	224	Adelaide	SA
Bunbury	**C6.3**	C5.3	C4.1	C3.1	C2.1	8.3	6	70037	172	Perth	WA
Lismore	**C6.3**	C5.3	C4.1	C3.1	C2.1	8.2	5	32617	198	Brisbane	NSWACT
Port Augusta	**C6.3**	C5.3	C4.1	C3.1	C2.1	8.1	4	14725	306	Adelaide	SA
Goulburn	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.9	1	22225	197	Sydney	NSWACT
Victor Harbour	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.8	0	14219	83	Adelaide	SA
Casino	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.7	-1	11414	229	Brisbane	NSWACT
Goondiwindi	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.6	-3	11437	348	Brisbane	QLD
Charters Towers	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.6	-3	12978	136	Townsville	QLD
New Norfolk	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.4	-5	5230	35	Hobart	TAS
Sunbury	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.3	-6	36658	40	Melbourne	VIC
Murray Bridge	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.3	-6	19724	78	Adelaide	SA
Wodonga	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.1	-9	51899	322	Melbourne	VIC
Bairnsdale	**C6.3**	C5.3	C4.1	C3.1	C2.1	7.0	-10	11282	282	Melbourne	VIC
Hervey Bay	**C6.3**	C5.3	C4.1	C3.1	C2.1	6.9	-12	61691	294	Brisbane	QLD
Ararat	**C6.3**	C5.3	C4.1	C3.1	C2.1	6.9	-12	8215	205	Melbourne	VIC
Bendigo	**C6.3**	C5.3	C4.1	C3.1	C2.1	6.8	-13	92934	154	Melbourne	VIC
Taree	**C6.3**	C5.3	C4.1	C3.1	C2.1	6.7	-14	49453	169	Newcastle	NSWACT
Emerald	**C6.3**	C5.3	C4.1	C3.1	C2.1	6.6	-15	18410	370	Gladstone	QLD
Whyalla	**C6.3**	C5.3	C4.1	C3.1	C2.1	6.6	-15	23430	267	Port Lincoln	SA
Kingaroy	**C6.3**	C5.3	C4.1	C3.1	C2.1	6.2	-21	14601	225	Brisbane	QLD
Gympie	**C6.3**	C5.3	C4.1	C3.1	C2.1	5.9	-24	50011	169	Brisbane	QLD
Renmark	**C6.3**	C5.3	C4.1	C3.1	C2.1	5.8	-26	9834	257	Adelaide	SA

Table 3. (Cont.) Gross profitability index using a six-cluster solution.

Retailer Location	Cluster Membership Codes					AGM	REPI (%)	Population (Persons)	Distance to Wholesaler Km	Wholesale Distributor	Wholesaler state
	6	5	4	3	2						
Bowen	**C6.3**	C5.3	C4.1	C3.1	C2.1	5.8	-26	14515	203	Townsville	QLD
Maryborough	**C6.3**	C5.3	C4.1	C3.1	C2.1	5.7	-27	28520	256	Brisbane	QLD
Albury	**C6.3**	C5.3	C4.1	C3.1	C2.1	5.3	-32	107086	327	Melbourne	NSWACT
Dalby	**C6.3**	C5.3	C4.1	C3.1	C2.1	4.4	-44	11419	208	Brisbane	QLD
Bundaberg	**C6.3**	C5.3	C4.1	C3.1	C2.1	4.0	-49	69500	185	Gladstone	QLD
Cluster average	**C6.3**					**7.8**	**0**	**39273**	**222**		
Geraldton	**C6.4**	C5.3	C4.1	C3.1	C2.1	14.4	29	37842	5	Geraldton	WA
Wynyard	**C6.4**	C5.3	C4.1	C3.1	C2.1	13.2	18	11530	66	Devonport	TAS
Wonthaggi	**C6.4**	C5.3	C4.1	C3.1	C2.1	13.2	18	6529	136	Melbourne	VIC
Mansfield	**C6.4**	C5.3	C4.1	C3.1	C2.1	12.7	13	7998	192	Melbourne	VIC
Echuca	**C6.4**	C5.3	C4.1	C3.1	C2.1	11.9	6	2261	221	Melbourne	VIC
Colac	**C6.4**	C5.3	C4.1	C3.1	C2.1	11.9	6	10857	152	Melbourne	VIC
Darwin Metro	**C6.4**	C5.3	C4.1	C3.1	C2.1	11.5	3	128073	5	Darwin	NT
Campbelltown	**C6.4**	C5.3	C4.1	C3.1	C2.1	11.4	2	772	130	Hobart	TAS
Ulverstone	**C6.4**	C5.3	C4.1	C3.1	C2.1	10.6	-5	9760	21	Devonport	TAS
Launceston	**C6.4**	C5.3	C4.1	C3.1	C2.1	10.6	-5	106655	100	Devonport	TAS
Burnie	**C6.4**	C5.3	C4.1	C3.1	C2.1	10.4	-7	17729	48	Devonport	TAS
Wollongong	**C6.4**	C5.3	C4.1	C3.1	C2.1	9.7	-13	293503	85	Sydney	NSWACT
Albany	**C6.4**	C5.3	C4.1	C3.1	C2.1	9.6	-14	36551	5	Albany	WA
Devonport	**C6.4**	C5.3	C4.1	C3.1	C2.1	9.5	-15	25639	5	Devonport	TAS
Port Lincoln	**C6.4**	C5.3	C4.1	C3.1	C2.1	9.2	-18	14739	5	Port Lincoln	SA
Hobart Metro	**C6.4**	C5.3	C4.1	C3.1	C2.1	8.7	-22	216656	5	Hobart	TAS
Cluster average	**C6.4**					**11.2**	**0**	**57943**	**72**		
Carnarvon	**C6.5**	C5.4	C4.3	C3.3	C2.2	19.5	56	6333	480	Geraldton	WA
Cunnamulla	**C6.5**	C5.4	C4.3	C3.3	C2.2	16.6	33	1217	804	Brisbane	QLD
Bega	**C6.5**	C5.4	C4.3	C3.3	C2.2	15.4	23	34035	425	Sydney	NSWACT
Cooma	**C6.5**	C5.4	C4.3	C3.3	C2.2	15.3	22	10524	399	Sydney	NSWACT
Hay	**C6.5**	C5.4	C4.3	C3.3	C2.2	14.9	19	3315	421	Melbourne	NSWACT
Ceduna	**C6.5**	C5.4	C4.3	C3.3	C2.2	14.0	12	3828	403	Port Lincoln	SA
Swan Hill	**C6.5**	C5.4	C4.3	C3.3	C2.2	13.4	7	22275	343	Melbourne	VIC
Forbes	**C6.5**	C5.4	C4.3	C3.3	C2.2	13.3	6	9818	375	Sydney	NSWACT
Portland	**C6.5**	C5.4	C4.3	C3.3	C2.2	12.8	2	11531	363	Melbourne	VIC
Moree	**C6.5**	C5.4	C4.3	C3.3	C2.2	12.7	2	14465	315	Brisbane	NSWACT
Parkes	**C6.5**	C5.4	C4.3	C3.3	C2.2	12.6	1	15267	358	Sydney	NSWACT
Mildura	**C6.5**	C5.4	C4.3	C3.3	C2.2	12.5	0	50909	542	Melbourne	VIC
Longreach	**C6.5**	C5.4	C4.3	C3.3	C2.2	12.4	-1	4384	786	Gladstone	QLD
Horsham	**C6.5**	C5.4	C4.3	C3.3	C2.2	12.3	-2	14125	300	Melbourne	VIC
Wagga Wagga	**C6.5**	C5.4	C4.3	C3.3	C2.2	12.3	-2	59005	458	Sydney	NSWACT
Orange	**C6.5**	C5.4	C4.3	C3.3	C2.2	11.8	-6	40062	258	Sydney	NSWACT
Yass	**C6.5**	C5.4	C4.3	C3.3	C2.2	11.8	-6	15450	279	Sydney	NSWACT
Broken Hill	**C6.5**	C5.4	C4.3	C3.3	C2.2	11.8	-6	19703	516	Adelaide	NSWACT
Griffith	**C6.5**	C5.4	C4.3	C3.3	C2.2	11.5	-8	26001	461	Melbourne	NSWACT
Tamworth	**C6.5**	C5.4	C4.3	C3.3	C2.2	11.2	-10	48262	306	Newcastle	NSWACT
Katherine	**C6.5**	C5.4	C4.3	C3.3	C2.2	11.1	-11	9967	317	Darwin	NT
Lakes Entrance	**C6.5**	C5.4	C4.3	C3.3	C2.2	11	-12	12070	318	Melbourne	VIC
Inverell	**C6.5**	C5.4	C4.3	C3.3	C2.2	10.6	-15	5013	569	Sydney	NSWACT
Coffs Harbour	**C6.5**	C5.4	C4.3	C3.3	C2.2	10.6	-15	53798	390	Brisbane	NSWACT
Kalgoorlie	**C6.5**	C5.4	C4.3	C3.3	C2.2	10	-20	32841	390	Esperance	WA
Roma	**C6.5**	C5.4	C4.3	C3.3	C2.2	9.6	-23	7191	476	Brisbane	QLD
Dubbo	**C6.5**	C5.4	C4.3	C3.3	C2.2	9.6	-23	38383	394	Sydney	NSWACT
Mt Gambier	**C6.5**	C5.4	C4.3	C3.3	C2.2	8.7	-30	26206	436	Adelaide	SA
Cluster average	**C6.5**					**12.5**	**0**	**21285**	**424**		
Tennant Creek	**C6.6**	C5.5	C4.4	C3.3	C2.2	24.1	5	3555	989	Darwin	NT
Eucla	**C6.6**	C5.5	C4.4	C3.3	C2.2	23.9	4	86	894	Port Lincoln	WA
Alice Springs	**C6.6**	C5.5	C4.4	C3.3	C2.2	21.1	-8	27589	1498	Darwin	NT
Cluster average	**C6.6**					**23.0**	0	**10410**	**1127**		

Notes: This Table is first sorted in terms of the ascending magnitudes of the corresponding cluster averages, whereby the cluster average for C6.1, C6.2, C6.3, C6.4, C6.5 and C6.6 are 5.2, 6.8, 7.8, 11.2 , 12.5 and 23.0 (cents per litre), respectively. Then, the retail locations within each cluster are sorted in terms of the descending values of their gross margins. AGM=Average Gross Margin (Cents Per Litre). REPI=Relative excess (gross) profitability index measures how much the gross profit margin in a given location is above or below the corresponding cluster's average. Source: the Authors

A systematic notation is used to identify each location with a cluster membership code. For example, C6.1 denotes the first cluster within a six-cluster solution, C5.3 indicates the third cluster within a five-cluster solution and so forth. In the six-cluster solution the following 16 locations are separated from cluster 3 in the five-cluster solution (C5.3) and form a more homogeneous group (that is, C6.4): Geraldton, Wynyard, Wonthaggi, Mansfield, Echuca, Colac, Darwin metropolitan, Campbelltown, Ulverstone, Launceston, Burnie, Wollongong, Albany, Devonport, Port Lincoln and Hobart metropolitan.

All clusters in Table 3 are first sorted in terms of the ascending magnitude of the cluster average, using a six-cluster solution, and then within each cluster the corresponding members are further sorted in terms of individual average gross margins (in descending order). In this way, the sixth cluster appears right at the end of Table 3 as it has the highest average margin (that is, 23 cents per litre). Within the sixth cluster solution, the three locations are sorted in descending order, with Tennant Creek (24.1) appearing first and Alice Springs (21.1) last.

6. POLICY IMPLICATIONS OF THE STUDY

By comparing 'apples with apples' in Table 3, one can identify which retail locations charge relatively higher or lower gross margins than their comparable counterparts. In order to facilitate the comparison, all of the retail locations are sorted within a six-cluster solution in terms of a measure of the excess gross profitability index. This index quantifies how much the average gross profitability in a given location is above or below the corresponding cluster's average. For instance, within C6.1, the gross margin for Newcastle is on average 50 percent higher than the average margin for other comparable locations. It is interesting that within this same cluster there are other comparable locations in which the actual average gross margin is well below 7.8 cents per litre (see Table 3).

Another example of excessive margin is Carnarvon (19.5 cents per litre) in Western Australia within cluster C6.5 with a population of 6 333 and an approximate distance of 480 km to its wholesale outport terminal in Geraldton. For comparison purposes, it is interesting to note that the relevant margin in Longreach (12.4 cents per litre) in Queensland is well below that of Carnarvon, where the former has both a smaller population (4 384) and a longer distance to its wholesale outport terminal (786 km). Similarly, both Geraldton and Albany (two Western Australian country towns) in C6.4 are located only 5 kilometres away from their wholesaler, however, the excess profitability index in Geraldton is 29 percent above the cluster average, but 14 percent below the cluster average in Albany. This finding is compounded by the fact that Geraldton and Albany have similar population sizes.

A cursory look at the retail locations appearing at the top of clusters C6.1, C6.3, C6.4 and C6.5 provides convincing evidence that high profit margins are not observed only in remote rural and less populated regional areas. For example, although Rockhampton and Caloundra in C6.1 share similar attributes in terms of population size and the distance to the wholesaler, the excess profitability index is 29 percent above the cluster average in Rockhampton, compared to 8 percent below the cluster average in Caloundra. We also observe the same phenomenon in C6.3 when comparing two similar Victorian country towns, namely Benalla and Ararat, where the excess profitability indices are respectively 38 percent above and 12 percent below the cluster average. These results show that there may be other forces at work in determining gross profit margins.

It is important to explain why there are large profit margins in both rural and urban areas. Foss and Lien (2010) and Dayanandan and Donker (2011) have highlighted the importance of changes in ownership structures in revealing the competitive dynamics and thus profitability of oil and gas firms. It is very useful to explore whether excessive margins can be explained by the extent of competition, ownership structure, local market conditions and its individual characteristics. At this stage, we have not been able to obtain such data for all 109 locations from the ACCC, Fuelwatch or other sources. However, there is widespread view in the literature that large regional price variations are driven by the lack of competition and the number of independent suppliers. For example a similar comprehensive study of the Austrian gasoline market by Pennerstorfer and Weiss (2013) provides convincing evidence that large gasoline price differences can be adequately explained by analysing the link between ownership structure and spatial clustering (i.e. the sequence of stations on a road). An increase in the extent of spatial clustering can lower the degree of competition and hence raise equilibrium prices. It is highly likely that retailers, which are generally members of a network of multi-station firms, can coordinate their pricing attempts within the spatial network due to the lack of competition.

The Australian Institute of Petroleum (2012) report notes that the aggregate retail net profit margin should be in the vicinity of 6 cents per litre. However, this net profit margin appears to be well below the retail gross profit margin of 11 cents per litre identified in this study, even after deducting several cents per litre for overhead costs other than transport. We argue that if gross profit margins in a particular retail location are regarded as relatively excessive, then further careful examination of other factors should also be taken into account as these differences may be reasonably justifiable on other location specific factors.

Of key importance to this study is that it clearly highlights important geographical pricing differences at a disaggregate level. By identifying various urban and regional areas in which profit margins appear to be excessive, the results of this paper provide more transparency in the petrol market particularly for consumers and industries for which petrol is an essential intermediate input. Given the critical role of fuel prices in both regional and urban economies, consumers and regulatory bodies can directly benefit from greater efficiency and transparency of the petrol market. In light of recent debates surrounding suspected profiteering in the petrol industry, our results are both timely and relevant for consumers as well as government regulatory agencies.

7. CONCLUSION

Changes in petrol prices attract a great deal of attention from consumers since they spend a significant share of their income on this commodity. This paper examines the extent to which the average spread between retail and wholesale prices of petrol across 109 rural, urban geographical locations in Australia are relatively excessive. For this purpose, we conduct a hierarchical cluster analysis using a disaggregated database (during the period 29 October 2007-30 January 2012) not freely available to the public. We postulate that population (as a proxy for the market size, competition and the extent of economies of scale and scope) and the distance between retailers and wholesalers (as a proxy for transport costs) are the major determinants of the observed sizable differences in the gross margins across various geographical locations. The results indicate that retailers have enough market power to determine their margins, particularly when the local market is subject to less competition, potentially causing substantial cost inefficiencies for consumers and industries with high reliance on petrol for transportation and production.

Our cluster analysis classifies all of the 109 retail locations into six heterogeneous groups with each group containing homogenous and comparable contents in terms of the standardised magnitudes of the following control variables: the averaged spread between retail and wholesale prices of petrol, population, and the distance between the retailers and wholesalers. Within the six-cluster solution, we have ranked all of the 109 retail locations in terms of the excess-gross profitability index, quantifying the extent to which the average gross profitability in a particular retail location is above or below the corresponding cluster average.

Contrary to popular belief, our results provide compelling new evidence that excessively high profit margins are not necessarily observed only in remote and isolated rural areas. In other words, large gross profit margins do also exist in major urban areas such as Newcastle, Rockhampton, Geelong, North Coast, Wangaratta, Shepparton, Geraldton and Bega (see the top of each of the 6 clusters in Table 3). Despite petrol retailers being exposed to high levels of competition and the economies of scale and scope in these locations, they continue to charge relatively higher profit margins from motorists than their counterparts in other similar locations. Therefore, this study can provide important policy implications for consumers and regulators given the recent debates in relation to the whereabouts of suspected profiteering in the petrol market, which can equally affect both urban and regional economies.

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