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Price effect of a Gasoline Cartel: An Ontario Case Study

ECON 699 - Advanced Competition Policy

1 Introduction

In 2012, 3 independent[A] gasoline brands, Pioneer Energy, Canadian Tire, and Mr. Gas, plead guilty to participating in a cartel from May to November 2007.[1,2] The cartel took place in Kingston and Brockville, Ontario, but the analysis will focus on Kingston, as data availability is poor for Brockville. In particular, the Bureau found explicit collusion, through phone calls, that retailers communicated to coordinate their response to pricing changes initiated by brands.[B]

In this paper, I attempt to determine how this cartel impacted prices. Economic theory suggests that strong and coordinated cartels can sustainably raise prices by acting as one firm, following a unified strategy. Therefore, you traditionally expect the presence of a cartel to raise prices and adversely hurt consumers. To assess fines and restitution to consumers, I attempt to find the magnitude of this price effect in this paper.

I start by presenting data for the collusive market, Kingston, and a non-collusive analogy market, Peterborough, which I use for comparisons. Kingston and Peterborough are geographically close[C] and similar in population. Next, I search for the cartel period as robustness to the Bureau's definition. Once the cartel period is determined, I present two econometric methods to assess the effect on prices. Finally, I use Kingston's limited sample of daily, firm-specific data to examine the market in finer detail.

[A] Independents are gasoline stations without their own refineries.

[B] Brands are gasoline stations with their own refineries, such as Esso

[C] Therefore sharing economic characteristics of the region, as well as other factors like weather

2 Data

The primary data source for this paper comes from Kalibrate (formerly Kent marketing).[3] I utilize their weekly series of regular retail gasoline as well as wholesale (rack) prices. I utilize data for Kingston and Peterborough, both beginning in March 2006 and ending in December 2008. As a secondary source, I use daily, firm-specific data employed by Eckert et al. (2014).[4] This data is not used for the primary analysis, as it is a subsample of my weekly data. For now, I use the daily data to determine where Kingston and Peterborough stations obtain their wholesale. Maitland provides wholesale to Kingston and Toronto to Peterborough. Table 1 and figure 1 provide overviews of the weekly data from Kalibrate.

City	Series	Minimum	Median	Mean	Standard Deviation	Maximum
Kingston	Retail	63.7	98.1	98.1	14.1	135.1
	No Tax Retail	35.9	67.5	68.0	13.5	104.0
	Rack	33.8	65.6	65.9	13.4	97.2
Peterborough	Retail	70.0	99.5	100.4	15.1	136.3
	No Tax Retail	42.0	69.5	70.3	14.6	105.1
	Rack	34.9	66.0	66.2	13.6	98.3

Table 1: Summary stats for Kingston and Peterborough. Series run weekly from March 2006 to December 2008. Prices are in Canadian cents per litre, and not in real terms. Wholesale for Kingston and Peterborough are Maitland and Toronto, respectively.

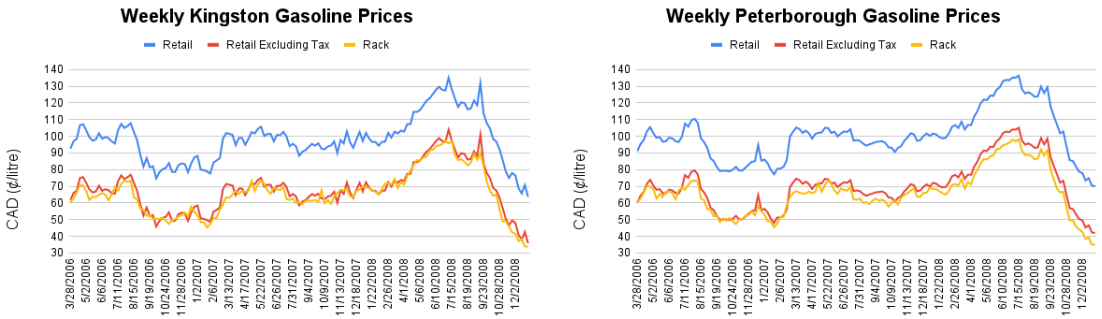

Figure 1: Plot of weekly prices in Kingston and Peterborough. Series run from March 2006 to December 2008. Prices are in Canadian cents per litre, and not in real terms. Wholesale for Kingston and Peterborough are Maitland and Toronto, respectively.

3 Determining Cartel Period

3.1 Introduction

In their backgrounder, the Bureau states the collusive period was between May and November 2007. While you may take November 2007 as the ending period (when the Bureau executed search warrants) a bit more confidently, determining the start of the cartel is more complicated. Therefore, we utilize the Quandt likelihood ratio (QLR)[5] test to determine structural breaks.

3.2 QLR Testing For Structural Breaks

The QLR test is a modified Chow test employed to find structural breaks with an unknown date. Houde and Clark used this test (2014),[6] precisely as in our case, to determine locations of structural breaks in gasoline margins. Following their guidelines, I consider the regression,

$$M_{jw} = \alpha_j + \gamma_j D_w(\tau) + u_{jw}$$

Where M is the mark-up, D is a dummy variable, equalling zero before break date τ, and one after, and subscripts j and w indicate city and weeks. A Chow test is employed, testing that the break occurs at τ and returns an F statistic. QLR selects the most significant F statistic as the location of the structural break. Figure 2 plots the break-in Kingston's margins and 12-week averages to better observe trends. The identified break-date of July 2008 occurs approximately 7-8 months after the end date of the cartel as defined by the Bureau, November 2007.

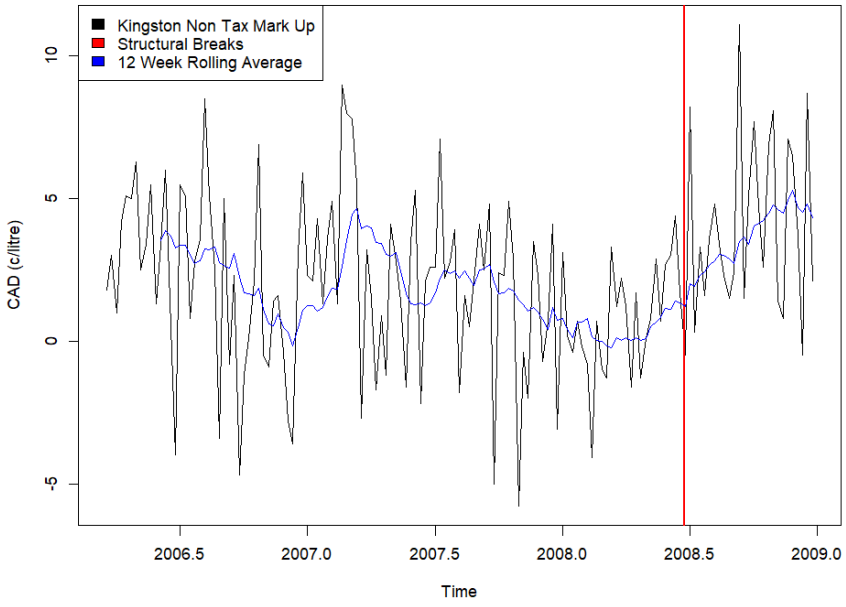

Figure 2: Location of structural breaks in Kingston's non-tax mark-up using. Break date was determined using QLR testing. Rolling averages presented to smooth the data and present easier to visualize trends.

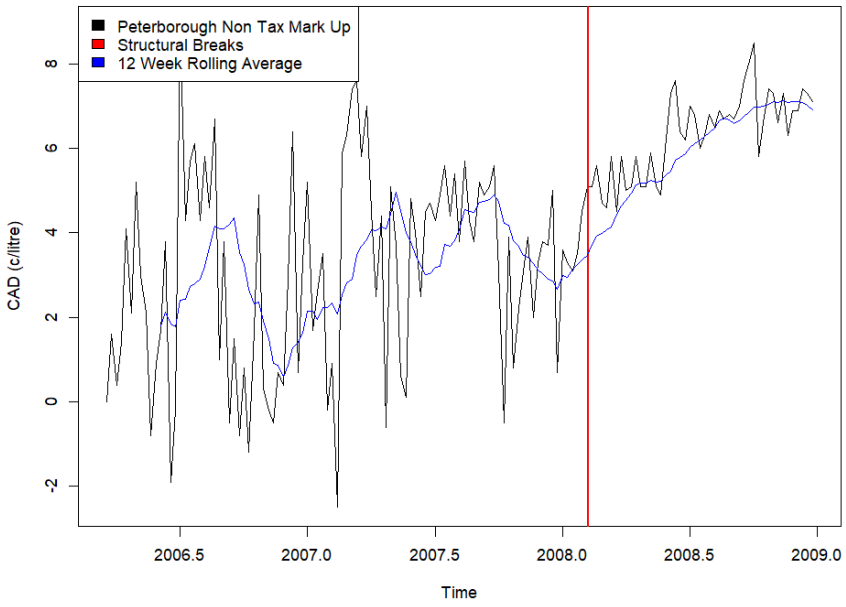

Figure 3: Location of structural breaks in Peterborough's non-tax mark-up using. Break date was determined using QLR testing. Rolling averages presented to smooth the data and present easier to visualize trends.

Figure 3 presents similar results for Peterborough and is used as a robustness check to see if there are similar changes between the two cities. Finally, figure 4 illustrates the F statistics for each city for breaks at time τ. While the QLR statistic attempts to find a particular break date (the highest F stat), one can use figure 4 to identify multiple break dates. However, no critical F statistics occurred before 2008 (when the cartel might have started) with Kingston. For Peterborough, there may be a second structural break around 2007, but since nearly every single time is above the critical value, these tests for Peterborough carry little weight.

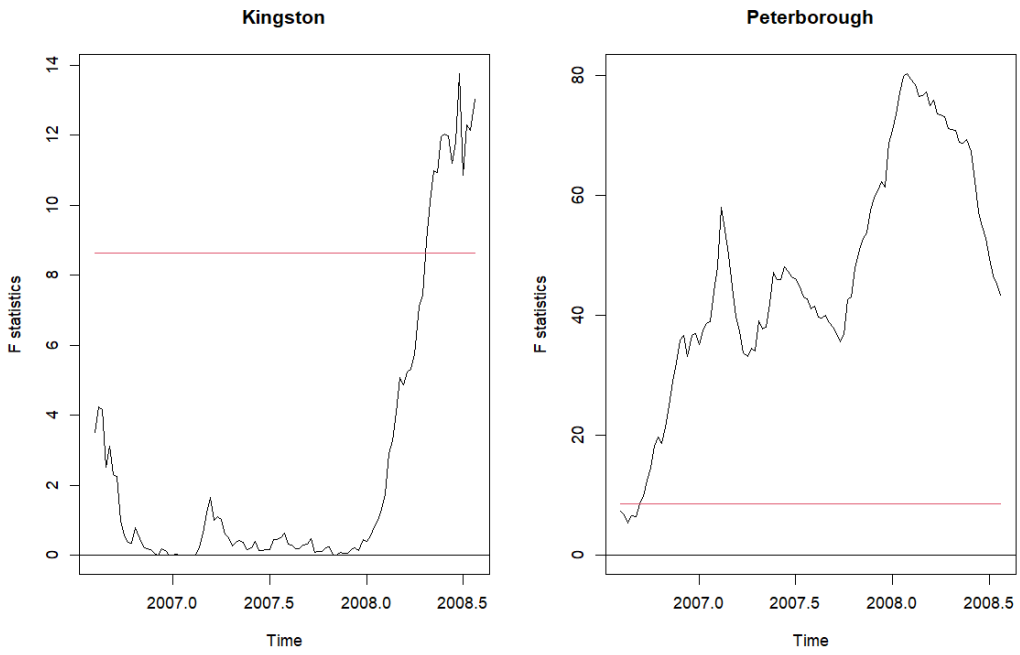

Figure 4: F statics for a Chow test at each date, for a regression of city mark-up on a constant. Red is the critical value. Max F statistics from this graph are the QLR statistics.

3.3 Summary

In summary, QLR testing identified July 2008 as the most significant break date in Kingston and February 2008 in Peterborough. There was no evidence of earlier breaks in Kingston, and the data for Peterborough contains too many significant breaks. The 2008 break signals an upward trend in mark-ups in both cities, suggesting a common factor to both markets raised mark-ups. Overall, QLR testing provides little help in identifying the cartel period within my sample.

As the Bureau's backgrounder notes, cartel members primarily communicated to coordinate responses to pricing changes initiated by brands. Therefore, two issues present themselves. First,

since our data is not retailer-specific, it will be biased as it contains both colluding and non-colluding firms. Secondly, the cartel likely did not or could not permanently increase prices over the period. As demonstrated by Byrne et al. (2015),[7] many cities such as Kingston exhibit price cycles that average around a week. If they coordinated to respond to price changes, weekly data might miss these finer price shifts.

4 Determining the Price Effect

4.1 Introduction

Since I could not definitively identify the beginning of the cartel, I will operate under two definitions. In one case, I will assume the cartel began, as stated by the Bureau, in May of 2007. Next, I will assume that my testing is roughly accurate in its inability to find no breaks before the data start and assume that the cartel was active at the beginning of our data, March 2006.

4.2 Reduced Form Econometrics

I begin by estimating the model,

$$P_t = \alpha + \beta X_t + \gamma C_t + u_t$$

Where P are the non-tax prices in Kingston, C is a cartel indicator dummy[D], and X contains other factors influencing prices. In this case, to control for demand and supply, I use seasonal dummies and rack prices, respectively. I specify four cartel periods, and table 2 presents the results.

[D]Equal to 1 during the cartel period, and 0 otherwise

	Kingston Retail Price (No Tax)			
	(1)	(2)	(3)	(4)
Trend	0.020*** (0.0003)	0.015*** (0.0001)	−0.012*** (0.0001)	0.021*** (0.00004)
Constant	4.190 (9.012)	5.890** (2.314)	9.662*** (2.447)	4.741*** (1.457)
Maitland Rack	0.939*** (0.001)	0.924*** (0.0004)	0.958*** (0.0004)	0.951*** (0.0004)
Q2	0.765 (1.900)	1.186 (1.841)	0.336 (1.103)	0.938 (0.963)
Q3	1.127 (1.823)	1.658 (1.737)	−0.109 (1.204)	0.857 (0.992)
Q4	−1.188 (1.401)	−1.163 (1.458)	−1.875* (1.028)	−1.413 (0.959)
Cartel: 3/2006-11/2007	0.695 (2.337)			
Cartel: 5/2007-11/2007		−0.868** (0.431)		
Cartel: 3/2006-7/2008			−4.010*** (0.703)	
Cartel: 5/2007-7/2008				−2.094*** (0.315)
Observations	145	145	145	145
R^2	0.952	0.952	0.957	0.956
F Statistic (df = 6; 138)	451.935***	456.013***	513.529***	501.201***
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 2: Reduced form results for Kingston, for various cartel specifications. Data is weekly running from March 2006 to December 2008.

	Peterborough Retail Price (No Tax)			
	(1)	(2)	(3)	(4)
Trend	0.039*** (0.0001)	0.042*** (0.00003)	0.033*** (0.0001)	0.044*** (0.00003)
Constant	2.116 (5.547)	2.383* (1.372)	3.138* (1.841)	1.599 (1.435)
Toronto Rack	0.987*** (0.001)	0.978*** (0.0004)	0.995*** (0.0004)	0.995*** (0.0004)
Q2	0.293 (0.915)	0.653 (0.814)	0.123 (0.803)	0.331 (0.663)
Q3	1.305 (1.223)	1.709* (0.978)	0.853 (0.903)	1.060 (0.753)
Q4	−0.948* (0.489)	−0.917 (0.567)	−1.160* (0.623)	−1.078* (0.610)
Cartel: 3/2006-11/2007	−0.180 (1.283)			
Cartel: 5/2007-11/2007		−1.081*** (0.154)		
Cartel: 3/2006-7/2008			−1.193*** (0.334)	
Cartel: 5/2007-7/2008				−1.050*** (0.150)
Observations	145	145	145	145
R^2	0.984	0.985	0.984	0.985
F Statistic (df = 6; 138)	1,397.092***	1,461.468***	1,436.614***	1,493.556***
Note:				*p<0.1; **p<0.05; ***p<0.01

Table 3: Reduced form results for Peterborough, for various cartel specifications. Data is weekly running from March 2006 to December 2008.

Since the data is time series, I utilize Newey-West errors, which are heteroskedasticity and autocorrelation robust.[8] I notice that all cartel periods are significant at the 99% level, except for definition 1, and they all provide a negative effect on price.

To determine if this effect is Kingston-specific, I run the same models on Peterborough, presented in table 3. As in table 2, three cartel specifications are significant and negative. However, the magnitudes are larger in Kingston. Since these indicators are significant in both markets, a joint movement may have been common to both cities. More analogy cities should be employed to determine if this event is widespread or localized.

4.3 Analogy Method

Erutku and Hildebrand (2010),[9] estimate a model focused on the price effect after the cartel ends. I estimate their model below on Kingston and Peterborough data.

$$P_{it} = \beta_0 + \beta_1 \text{Kingston} + \beta_2 \text{Post}_t + \delta_1 \text{Post}_t \times \text{Kingston} + \beta_3 X_t$$

Where P are non-tax prices, Kingston is a Kingston indicator, post is a post-cartel indicator variable[E], and X_t contains wholesale prices and quarterly dummies. I specify two versions of the model. Cartel end (2007) is the end date specified by the Bureau, of November 2007. Cartel end (2008) is the end date specified by the QLR test, July 2008. Table 4 presents the results.

[E] Equal to 0 before the end of the cartel, and 1 after

	Retail Gasoline Price (No Tax)	
	(1)	(2)
Kingston	-0.722^{**} (0.290)	-1.721^{***} (0.223)
Cartel End (2007)	3.349^{***} (0.505)	
Cartel End (2008)		3.822^{***} (0.328)
Q2	0.586 (0.735)	-0.029 (0.616)
Q3	1.655^{**} (0.710)	0.063 (0.528)
Q4	-0.802 (0.577)	-1.475^{***} (0.514)
Rack Price	0.958^{***} (0.001)	0.991^{***} (0.0003)
Cartel End (2007) $\times$ Kingston	-2.843^{***} (0.975)	
Cartel End (2008) $\times$ Kingston		-1.048 (0.730)
Constant	5.104^{***} (1.586)	4.466^{***} (1.442)
Observations	290	290
R^2	0.967	0.968
F Statistic	$1{,}167.839^{***}$	$1{,}225.355^{***}$
Note:		*p<0.1; **p<0.05; ***p<0.01

Table 4: Results of the Erutku and Hildebrand specification. Standard errors are in parenthesis and are Newey-West heteroskedasticity and autocorrelation robust standard errors. Cartel end (2007) specifies November 2007 as the cartel end date, and cartel end (2008) specifies July 2008 as the end date.

According to this specification, after the cartel ended, prices in Peterborough increased by 3.35 cents per litre, while prices in Kingston increased by only 0.51 cents per litre.[F] As a reference, Erutku and Hildebrand found a magnitude of -1.75 on their post-cartel interaction term, whereas I found a more substantial effect of -2.84.

Figure 5 graphs the difference in non-tax retail prices between Kingston and Peterborough. After the cartel end date in 2007,[G] the difference decreases, until approximately July 2008, then begins increasing afterwards, with a slight net negative trend post-cartel. This trend validates the Erutku model, as the figure says that Peterborough prices post-cartel increased by more than Kingston, leading to a decrease in the difference.

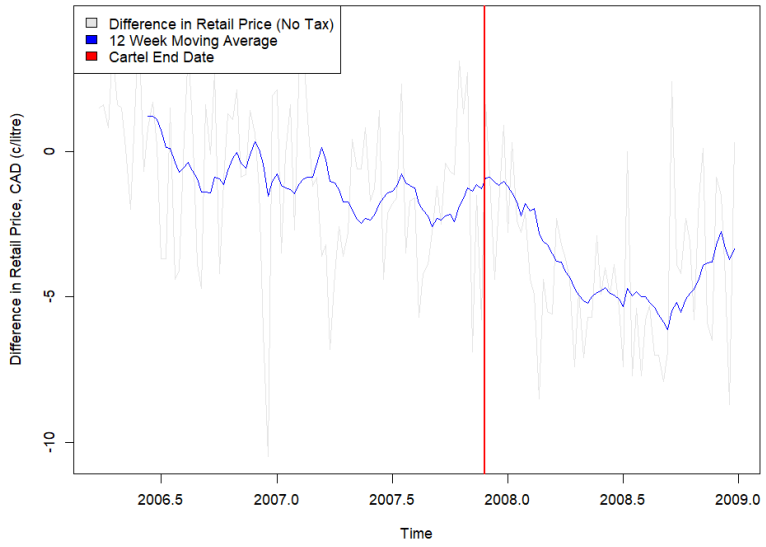

Figure 5: Kingston non-tax retail price minus Peterborough non-tax retail price. Series are weekly running from March 2006 to December 2008. Cartel end date is November 2007.

[F] Post cartel (3.35) plus interaction term (-2.84) for Kingston gives an overall increase of 0.51 cents per litre.

[G] As specified by both the Bureau and the Erutku method

4.4 Summary

Section 4.2 indicated that the cartel had a negative effect on prices and that several cartel specifications were significant in both Kingston and Peterborough. Section 4.3 suggests that after the cartel ended in 2007, prices decreased by 2.84 cents per litre relative to Peterborough or increased by 0.51 cents per litre overall. In the Erutku method, the indicator is 1 after the end, whereas the indicator is 0 after the end in the reduced form. The reduced form equivalent[H] suggests that post-cartel prices in Kingston fell by -0.70 cents overall.[I] However, I do not account for trend in the Erutku method, as I follow their methodology for comparability.

5 Daily Data

As mentioned in section 3.3, the Bureau's backgrounder notes that this cartel communicated primarily to coordinate responses to price changes initiated by brands. I present this section which runs daily and has firm-specific behaviour. If the collusive firms did not raise prices and only coordinated responses, it would show up best in daily, firm-specific data. This data is not used in the primary analysis, as it started in June 2007, during the cartel period.

I begin first by plotting the weekly and daily data together, done in figure 6. Visually, there are more apparent cycles in Kingston and less so in Peterborough. The weekly observation in Kingston often corresponds with a trough, while this is less clear in Peterborough.

[H] Defining the cartel as 3/2006-11/2007.

[I] The cartel indicator dummy was 0.70, so the negative is the price effect post cartel in the reduced form model.

Figure 6: Daily gasoline prices (with tax) in Kingston and Peterborough. Weekly prices are overlaid. Series run from 6/16/2007 to 12/31/2008.

Table 5 presents results about where the weekly observations lie. In Kingston, approximately 40% of the weekly observations occurred at a trough, compared to Peterborough's 16%. Likewise, only 2% of weekly observations occurred at peaks in Kingston, compared to 31% in Peterborough. Both of these proportions are statistically different across cities and suggests that the weekly data captures different portions of the price cycle, depending on the city.

Next, I present table 6, which summarizes the collusive firms' cycle behaviour, as well as a brand, Esso, and Kingston's aggregate cyclic behaviour. Kent marketing provides station counts from 2006 due to data availability.[10]

Statistic	Kingston	Peterborough	P-value
Observation Occurs at Peak	1.92%	30.86%	<0.00***
Observation Occurs at Trough	39.51%	16.05%	<0.00***

Table 5: Probability that the weekly observation falls on the peak or trough. P-value are p-values determined from a simple t-test between the two cities, for that statistic.

Station	Time Period	Cycle Length (days)	Trough to Peak (days)	Restoration (c/litre)
Canadian Tire (2 Stations)	Full Period	5.61	1.39	5.66
	Cartel Period	4.67	1.33	4.64
	Post-Cartel Period	5.97	1.42	6.01
	P-value	0.65	0.5	0.09*
Mr. Gas (1 Station)	Full Period	5.48	1.43	5.82
	Cartel Period	4.22	1.17	6.28
	Post-Cartel Period	6.07	1.55	5.7
	P-value	0.01***	0.05**	0.6
Pioneer (4 Stations)	Full Period	7.01	1.62	5.73
	Cartel Period	7.00	1.62	5.03
	Post-Cartel Period	7.02	1.62	5.96
	P-value	0.99	0.91	0.17
Esso (7 Stations)	Full Period	6.04	1.71	5.54
	Cartel Period	6.79	1.65	5.70
	Post-Cartel Period	5.85	1.73	5.49
	P-value	0.24	0.65	0.81
Total (39 Stations)	Full Period	6.29	1.67	5.04
	Cartel Period	6.3	1.62	4.22
	Post-Cartel Period	6.28	1.69	5.30
	P-value	0.98	0.64	0.12

Table 6: Average price cycle length, price restoration length, and price restoration magnitude in Kingston for a variety of periods. P-values are p-values determined from a simple t-test between the during and after cartel samples.

Overall, cyclic behaviour does not change much, except for Mr. Gas. As the Bureau stated, the firms coordinated responses, but strategies such as restoration price jumps, vary between collusive firms, ranging from 4.64 cents per litre to 6.28 cents per litre.

This result gives minimal evidence of a change in strategies, but further work on timings is needed. For instance, determining how quickly the collusive firms respond to changes initiated by brands during the cartel period and how fast they change relative to each other.

6 Conclusion

QLR testing did not provide a conclusive cartel start date, but the Bureau's definition and econometric methods validate a November 2007 end date. The Erutku and Hildebrand model suggests that post cartel prices in Kingston decrease by 2.84 cents per litre, compared to Peterborough, for an overall increase of 0.51 cents per litre, post-cartel. A similar reduced form analysis suggested that post-cartel Kingston prices decrease by 0.70 cents per litre overall. Since these magnitudes are within a single cent of one another, they are more or less consistent with one another.

Finally, the Bureau noted that these firms colluded by coordinating reactions to brands in the market. Therefore, I looked at daily level data to see how their behaviour changed. I found limited evidence of change between the cartel and post-cartel periods. Further analysis into more frequent data (multiple times daily) and looking closer at the timings between firms' responses to one another may be required to completely characterize collusion in the market.

References

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