Do Major Brands Have Market Power in the German Retail Gas Market?

Nolan Ritter, Alexander Kihm, and Colin Vance

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Research questions

- How does the crude oil price (Brent) influence the fuel price at the gas station?
- Can major brands charge extra in the German retail fuel market?

Relevance

- The German Monopolies Commission concluded that major brands have market power:
- "Eines der wichtigsten Ergebnisse der Sektoruntersuchung Kraftstoffe im Straßentankstellengeschäft ist der Nachweis, dass BP (Aral), ConocoPhilipps (Jet), ExxonMobil (Esso), Shell und Total ein marktbeherrschendes Oligopol auf regionalen Tankstellenmärkten bilden. Dies war zuvor nicht nur von den Konzernen selbst, sondern auch vom Oberlandesgericht Düsseldorf in Zweifel gezogen worden." (Sektoruntersuchung Kraftstoffe, p. 19)
- While the Monopolies Commission concentrated on Hamburg, Cologne, Munich, and Leipzig, this analysis is not restricted to select cities.

Outline of analysis

- The analysis uses roughly 4.5 million observations on gasoline and diesel fuel prices from approximately 14,000 German gas station.
- The data was collected between February 2012 and February 2013.
- A standard fixed-effects estimator is contrasted with the insights generated by quantile panel regression employing the estimator suggested by Ivan Canay (2011, *Journal of Econometrics*)
- I find that the standard fixed-effects estimator is over simplistic in assuming that the average impact of the controls on the response describes reality appropriately.

Data

Table : Descriptive statistics (N = 4,537,482)

| Variable	Gasoline		Diesel	
	Mean	*Std. Dev.*	*Mean*	*Std. Dev.*
Price at gas station (cent / liter)	161.110	5.589	149.038	4.972
Brent price (cent / liter)	54.445	3.211	54.452	3.216
Brent * Aral (cent / liter)	29.744	49.570	29.149	49.248
Brent * Shell (cent / liter)	25.891	47.392	25.462	47.115
Brent * Esso (cent / liter)	1.655	13.550	1.786	14.083
Brent * Total (cent / liter)	9.827	31.516	9.616	31.208
Brent * Jet (cent / liter)	8.609	29.907	8.422	29.606
Brent * Competitors (0 to 1 km buffer)	51.626	61.375	51.435	61.288
Brent * Competitors (1 to 2 km buffer)	100.395	113.020	99.878	112.999
Brent * Competitors (2 to 3 km buffer)	127.797	151.095	127.163	151.248
Brent * Competitors (3 to 4 km buffer)	150.683	180.749	149.983	180.917
Brent * Competitors (4 to 5 km buffer)	171.242	206.693	170.698	206.672
Monday	0.164	0.370	0.164	0.370
Tuesday	0.160	0.367	0.160	0.367
Wednesday	0.159	0.366	0.159	0.366
Thursday	0.166	0.372	0.166	0.372
Friday	0.160	0.366	0.160	0.367
Saturday	0.152	0.359	0.152	0.359
Winter holiday	0.007	0.083	0.007	0.083
Spring holiday	0.036	0.185	0.036	0.186
Pentecost holiday	0.012	0.110	0.012	0.110
Summer holiday	0.114	0.318	0.114	0.318
Autumn holiday	0.030	0.171	0.030	0.170
Christmas holiday	0.036	0.188	0.036	0.187
Public holiday	0.030	0.170	0.030	0.170
Day before holiday	0.008	0.088	0.008	0.088
Day between holidays	0.007	0.086	0.007	0.086

Std. Dev. is for standard deviation.

Prices over time

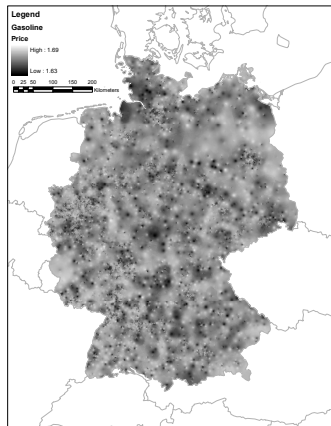Figure : Daily average prices for gasoline, diesel, and brent
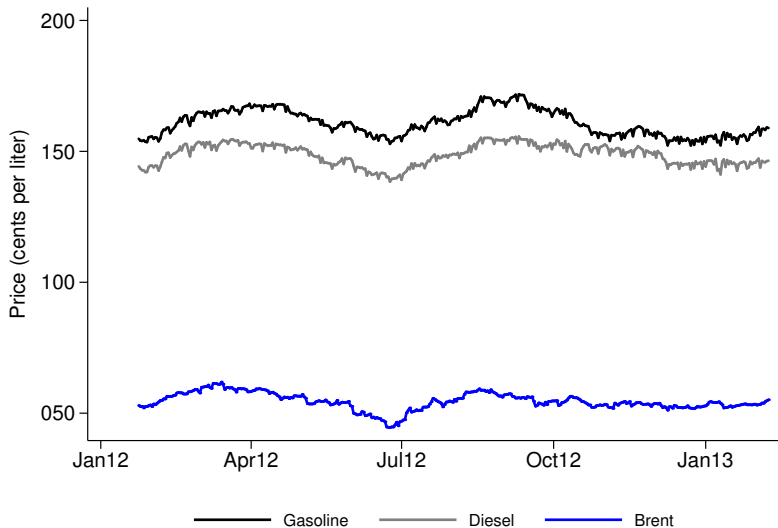
Distribution of observation units

Figure : Observed gas stations across Germany
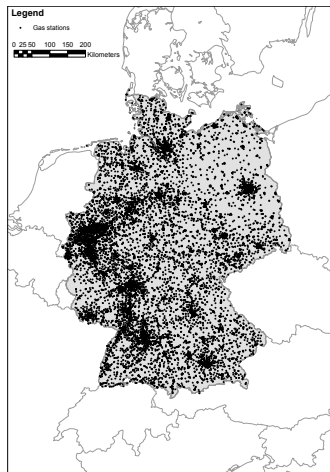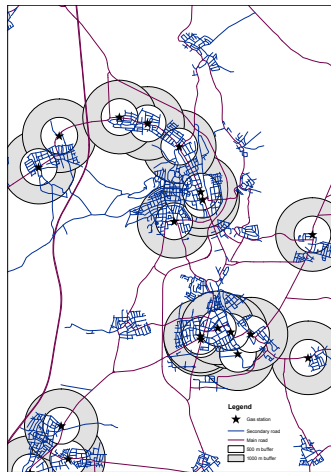
Regional prices

Figure : The average gasoline price in Germany in March 2012

Competition

Figure : Creating buffers around gas stations
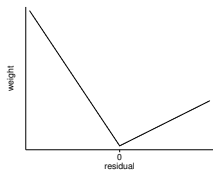
Unconditional quantiles

- The starting point of quantile regression are the unconditional quantiles of the dependent variable.
- The 50th quantile (the median, $Q_{\tau=0.5}(y)$) is the most commonly known.
- All quantiles ($Q_\tau(y)$) are obtained by minimizing the sum of (asymmetrically) weighed residuals by accordingly choosing a constant b:

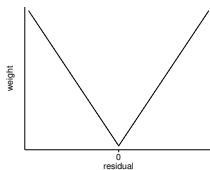$$Q_\tau(y) = \min_{b \in \mathbb{R}} \sum \rho_\tau \cdot (y_i - b) \ . \tag{1}$$

Weighting scheme

▶ The weighing scheme $\rho_\tau(\cdot)$ is the absolute value function that takes on different slopes depending on the sign of the residuals and the quantile of interest.
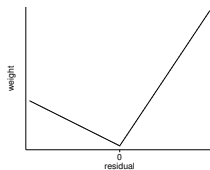
Figure : Weighting functions for quantiles

(a) 25th quantile   (b) median   (c) 75th quantile

Conditional quantile functions

- The formal definition of the unconditional quantiles can be generalized to define the conditional quantile function.
- This is done by replacing b with the parametric function $b(\mathbf{x}_{it}, \boldsymbol{\beta})$:

$$Q_\tau(y) = \min_{\boldsymbol{\beta} \in \mathbb{R}} \sum \rho_\tau \cdot (y_{it} - b(\mathbf{x}_{it}, \boldsymbol{\beta})) . \qquad (2)$$

- Minimizing Equation (2) gives us the impact of the control variables at percentile τ.

The quantile panel method suggested by Canay

- Canay (2011) first estimates the fixed-effect

$$\hat{u}_i = y_{it} - \hat{y}_{it} \ , \tag{3}$$

- which is assumed constant across the quantiles using a standard mean regression estimator for the model

$$y_{it} = x_{it}^T \cdot \beta + \epsilon_{it} + u_i \ . \tag{4}$$

- where y is the response for individual i at time t, x is a matrix of controls with a corresponding vector of coefficients β, ϵ is an error term while u_i signifies an individual fixed effect.

The quantile panel method suggested by Canay

▶ Transforming the response variable by subtracting the fixed effect from the observations,

$$\hat{y}_{it} = y_{it} - \hat{u}_i \ , \tag{5}$$

▶ it is possible to employ standard quantile regression (Koenker and Basset, 1978) and yet deal with unobserved heterogeneity.

Results for gasoline

Table : Price and competition variables

Variable			Percentile			FE
	10th	30th	50th	70th	90th	
Brent price (cent / liter)	1.135***	1.147***	1.145***	1.168***	1.285***	1.170***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Brent * Aral (cent / liter)	−0.093***	−0.092***	−0.094***	−0.096***	−0.095***	−0.095***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Brent * Shell (cent / liter)	−0.080***	−0.080***	−0.081***	−0.083***	−0.083***	−0.081***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Brent * Esso (cent / liter)	−0.092***	−0.088***	−0.088***	−0.089***	−0.089***	−0.089***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)
Brent * Total (cent / liter)	−0.076***	−0.077***	−0.078***	−0.079***	−0.079***	−0.078***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Brent * Jet (cent / liter)	−0.078***	−0.078***	−0.080***	−0.081***	−0.081***	−0.080***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Competitors (0 to 1 km buffer)	−0.003***	−0.002***	−0.002***	−0.002***	−0.001***	−0.002**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Competitors (1 to 2 km buffer)	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Competitors (2 to 3 km buffer)	0.001***	0.001***	0.001***	0.001***	0.001***	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Competitors (3 to 4 km buffer)	0.001***	0.001***	0.001***	0.001***	0.001***	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Competitors (4 to 5 km buffer)	0.001***	0.001***	0.001***	0.002***	0.002***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

***, **, and * denotes significance at the 0.1%, 1% and 5% level. FE is for fixed-effects estimator.

Results for gasoline

Table : Weekday variables

Variable	Percentile					FE
	10th	30th	50th	70th	90th	
Mondays	0.620***	0.191***	0.380***	0.639***	0.051**	0.337***
	(0.030)	(0.021)	(0.016)	(0.017)	(0.020)	(0.014)
Tuesdays	0.780***	0.145***	0.322***	0.614***	−0.012	0.348***
	(0.029)	(0.018)	(0.018)	(0.018)	(0.018)	(0.014)
Wednesdays	0.757***	−0.094***	0.159***	0.463***	0.013	0.200***
	(0.027)	(0.016)	(0.014)	(0.018)	(0.014)	(0.014)
Thursdays	0.447***	−0.096***	0.130***	0.316***	0.742***	0.250***
	(0.030)	(0.018)	(0.017)	(0.019)	(0.025)	(0.014)
Fridays	0.475***	−0.084***	0.266***	0.435***	0.353***	0.270***
	(0.030)	(0.019)	(0.014)	(0.019)	(0.021)	(0.014)
Saturdays	0.955***	0.342***	0.544***	0.750***	0.102***	0.522***
	(0.027)	(0.021)	(0.019)	(0.021)	(0.018)	(0.014)

***, **, and * denotes significance at the 0.1%, 1% and 5% level. FE is for fixed-effects estimator.
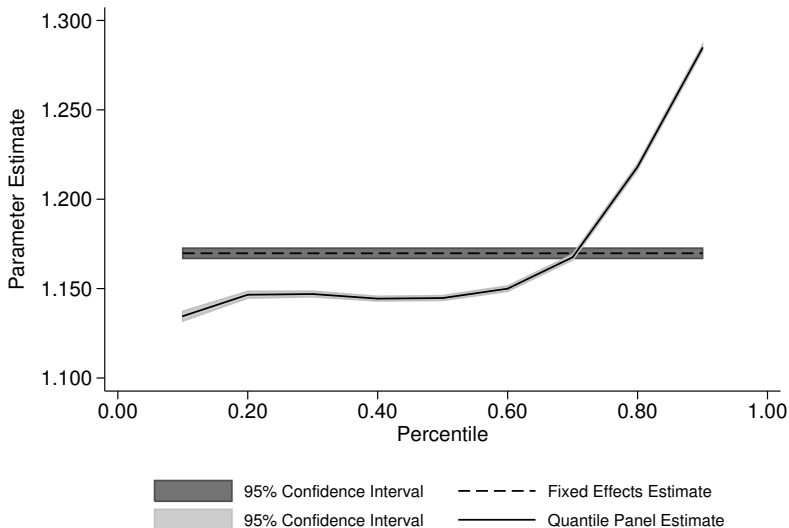
Results for gasoline

Table : Holiday variables

Variable	Percentile					FE
	10th	30th	50th	70th	90th	
Winter holidays	−1.657∗∗∗	−2.120∗∗∗	−2.404∗∗∗	−3.194∗∗∗	−5.056∗∗∗	−2.919∗∗∗
	(0.031)	(0.029)	(0.028)	(0.024)	(0.035)	(0.029)
Spring holidays	3.924∗∗∗	3.448∗∗∗	2.531∗∗∗	0.972∗∗∗	−2.104∗∗∗	1.778∗∗∗
	(0.019)	(0.012)	(0.011)	(0.011)	(0.010)	(0.013)
Pentecost holidays	3.097∗∗∗	2.430∗∗∗	1.600∗∗∗	0.387∗∗∗	−1.258∗∗∗	1.156∗∗∗
	(0.033)	(0.026)	(0.026)	(0.022)	(0.023)	(0.022)
Summer holidays	2.807∗∗∗	2.681∗∗∗	2.162∗∗∗	1.431∗∗∗	0.308∗∗∗	1.922∗∗∗
	(0.013)	(0.008)	(0.008)	(0.010)	(0.010)	(0.008)
Autumn holidays	0.376∗∗∗	−0.402∗∗∗	−0.969∗∗∗	−1.451∗∗∗	−1.266∗∗∗	−0.700∗∗∗
	(0.015)	(0.010)	(0.012)	(0.027)	(0.047)	(0.014)
Christmas holidays	−2.169∗∗∗	−2.725∗∗∗	−3.780∗∗∗	−5.248∗∗∗	−7.496∗∗∗	−4.368∗∗∗
	(0.019)	(0.010)	(0.010)	(0.008)	(0.010)	(0.013)
Public holiday	0.564∗∗∗	0.407∗∗∗	0.052∗∗∗	−0.378∗∗∗	−0.608∗∗∗	0.003
	(0.013)	(0.013)	(0.010)	(0.010)	(0.015)	(0.014)
Day before holiday	−0.001	−0.022	0.348∗∗∗	−0.252∗∗∗	−1.720∗∗∗	−0.372∗∗∗
	(0.030)	(0.035)	(0.030)	(0.038)	(0.046)	(0.027)
Day between holidays	1.707∗∗∗	1.127∗∗∗	0.387∗∗∗	−0.708∗∗∗	−3.345∗∗∗	−0.177∗∗∗
	(0.034)	(0.020)	(0.027)	(0.021)	(0.022)	(0.028)

∗∗∗, ∗∗, and ∗ denotes significance at the 0.1%, 1% and 5% level. FE is for fixed-effects estimator.
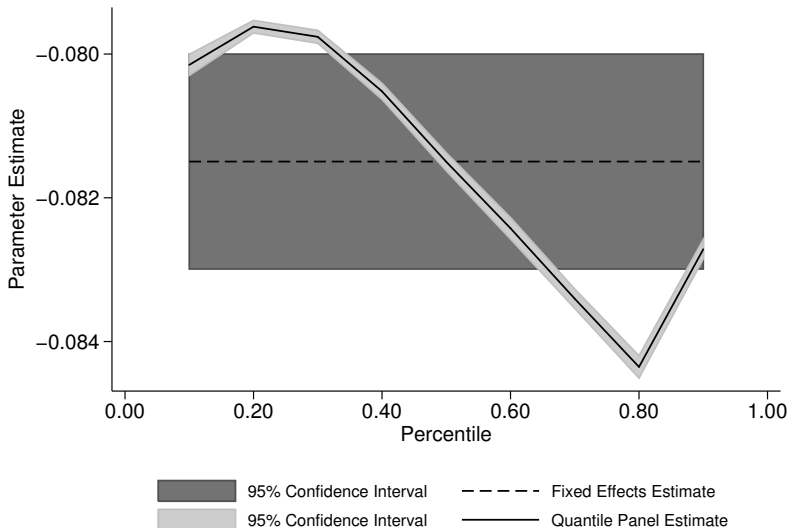
Results for gasoline

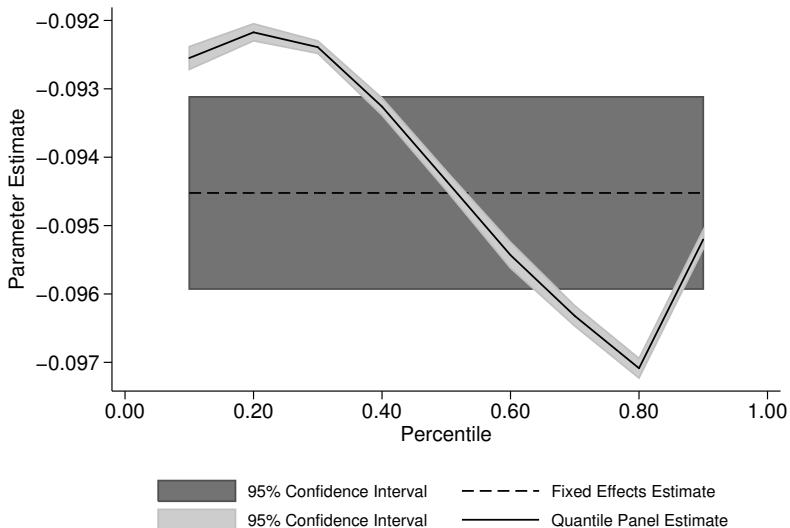Figure : How other brands than the majors react to the brent price

Results for gasoline

Figure : How differently Shell reacts to the brent price compared to non-majors
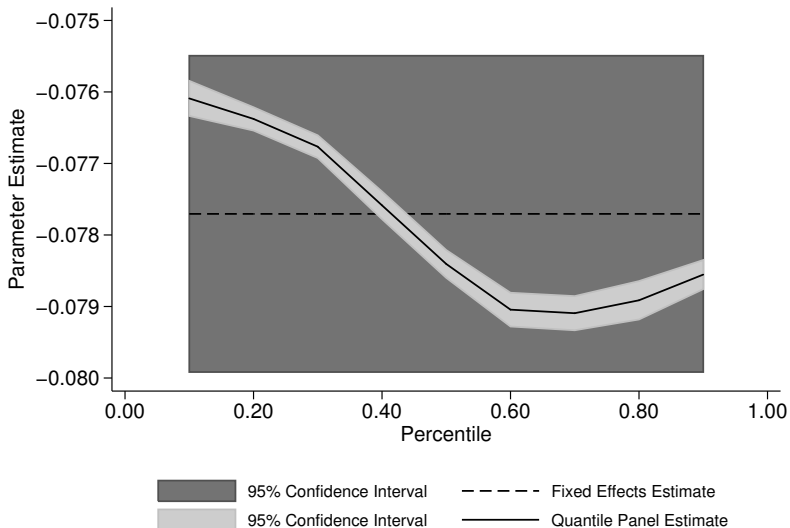
Results for gasoline

Figure : How differently Aral reacts to the brent price compared to non-majors

Parameter Estimate

Percentile

95% Confidence Interval
95% Confidence Interval
Fixed Effects Estimate
Quantile Panel Estimate

Results for gasoline

Figure : How differently Total reacts to the brent price compared to non-majors

Percentile (x-axis), Parameter Estimate (y-axis)

95% Confidence Interval — Fixed Effects Estimate
95% Confidence Interval — Quantile Panel Estimate

Results for gasoline

Figure : How differently Esso reacts to the brent price compared to non-majors
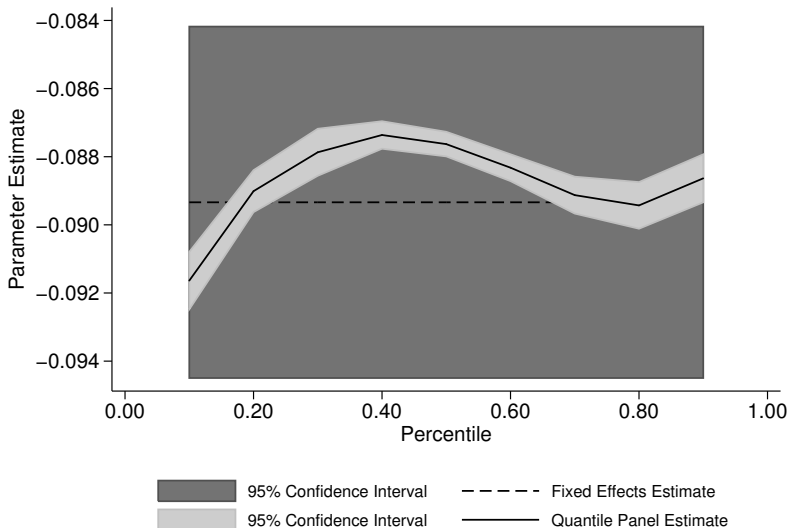
Results for diesel

Table : Price and competition variables

Variable	Percentile					FE
	10th	30th	50th	70th	90th	
Brent price (cent / liter)	0.983***	1.003***	1.045***	1.075***	1.090***	1.031***
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
Brent * Aral (cent / liter)	−0.025***	−0.024***	−0.024***	−0.024***	−0.025***	−0.025***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Brent * Shell (cent / liter)	−0.023***	−0.022***	−0.022***	−0.023***	−0.024***	−0.023***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Brent * Esso (cent / liter)	−0.035***	−0.030***	−0.029***	−0.027***	−0.025***	−0.029***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.002)
Brent * Total (cent / liter)	0.000	0.002***	0.002***	0.002***	0.000*	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Brent * Jet (cent / liter)	−0.010***	−0.011***	−0.011***	−0.012***	−0.013***	−0.012***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Competitors (0 to 1 km buffer)	−0.000***	−0.000***	0.000	0.000***	0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Competitors (1 to 2 km buffer)	−0.001***	−0.001***	−0.001***	−0.001***	−0.001***	−0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Competitors (2 to 3 km buffer)	0.000**	0.000***	0.000***	0.000***	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Competitors (3 to 4 km buffer)	0.000***	0.000***	0.000***	0.001***	0.001***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Competitors (4 to 5 km buffer)	0.000	0.000***	0.000***	0.000***	0.000***	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

***, **, and * denotes significance at the 0.1%, 1% and 5% level. FE is for fixed-effects estimator.

Results for diesel

Table : Weekday variables

Variable	Percentile					FE
	10th	30th	50th	70th	90th	
Mondays	0.859***	0.259***	−0.031	−0.122***	−0.435***	0.101***
	(0.032)	(0.020)	(0.020)	(0.014)	(0.017)	(0.012)
Tuesdays	0.860***	−0.071***	−0.317***	−0.478***	−0.790***	−0.159***
	(0.029)	(0.019)	(0.018)	(0.015)	(0.014)	(0.012)
Wednesdays	0.759***	0.132***	−0.189***	−0.450***	−0.807***	−0.107***
	(0.031)	(0.022)	(0.020)	(0.015)	(0.014)	(0.012)
Thursdays	0.535***	0.034	−0.235***	−0.299***	−0.217***	−0.009
	(0.034)	(0.018)	(0.019)	(0.016)	(0.016)	(0.012)
Fridays	0.855***	0.097***	−0.157***	−0.284***	−0.336***	0.030*
	(0.032)	(0.017)	(0.018)	(0.012)	(0.015)	(0.012)
Saturdays	1.196***	0.488***	0.116***	−0.032*	−0.399***	0.291***
	(0.033)	(0.018)	(0.017)	(0.014)	(0.013)	(0.012)

***, **, and * denotes significance at the 0.1%, 1% and 5% level. FE is for fixed-effects estimator.

Results for diesel

Table : Holiday variables

Variable	Percentile					FE
	10th	30th	50th	70th	90th	
Winter holidays	−2.178∗∗∗	−1.904∗∗∗	−1.772∗∗∗	−2.096∗∗∗	−2.421∗∗∗	−2.039∗∗∗
	(0.065)	(0.043)	(0.031)	(0.024)	(0.036)	(0.026)
Spring holidays	0.096∗∗∗	0.044∗∗∗	−0.662∗∗∗	−1.653∗∗∗	−2.990∗∗∗	−1.029∗∗∗
	(0.019)	(0.010)	(0.008)	(0.010)	(0.010)	(0.012)
Pentecost holidays	−0.384∗∗∗	−0.583∗∗∗	−0.947∗∗∗	−1.675∗∗∗	−2.810∗∗∗	−1.336∗∗∗
	(0.035)	(0.015)	(0.013)	(0.014)	(0.015)	(0.020)
Summer holidays	0.092∗∗∗	0.223∗∗∗	0.057∗∗∗	−0.401∗∗∗	−0.953∗∗∗	−0.169∗∗∗
	(0.014)	(0.009)	(0.005)	(0.006)	(0.010)	(0.007)
Autumn holidays	1.160∗∗∗	2.975∗∗∗	3.568∗∗∗	3.042∗∗∗	1.884∗∗∗	2.550∗∗∗
	(0.034)	(0.022)	(0.012)	(0.011)	(0.012)	(0.013)
Christmas holidays	−0.814∗∗∗	−1.117∗∗∗	−1.526∗∗∗	−2.317∗∗∗	−3.559∗∗∗	−1.910∗∗∗
	(0.015)	(0.017)	(0.007)	(0.006)	(0.010)	(0.012)
Public holiday	0.488∗∗∗	0.599∗∗∗	0.648∗∗∗	0.659∗∗∗	0.897∗∗∗	0.740∗∗∗
	(0.026)	(0.012)	(0.009)	(0.012)	(0.020)	(0.013)
Day before holiday	−0.397∗∗∗	−0.621∗∗∗	−0.843∗∗∗	−1.290∗∗∗	−0.869∗∗∗	−0.832∗∗∗
	(0.029)	(0.029)	(0.024)	(0.029)	(0.051)	(0.024)
Day between holidays	−0.330∗∗∗	−1.156∗∗∗	−1.139∗∗∗	−1.204∗∗∗	−1.218∗∗∗	−0.910∗∗∗
	(0.025)	(0.024)	(0.027)	(0.026)	(0.113)	(0.025)

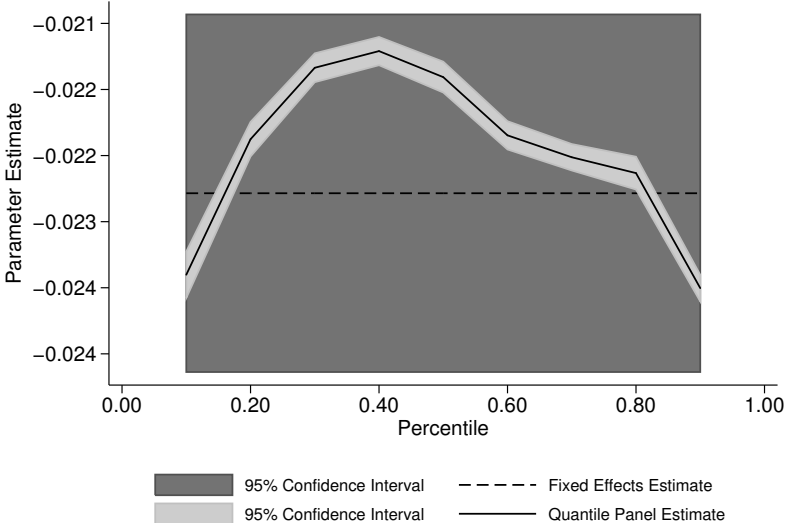***, **, and * denotes significance at the 0.1%, 1% and 5% level. FE is for fixed-effects estimator.

Results for diesel

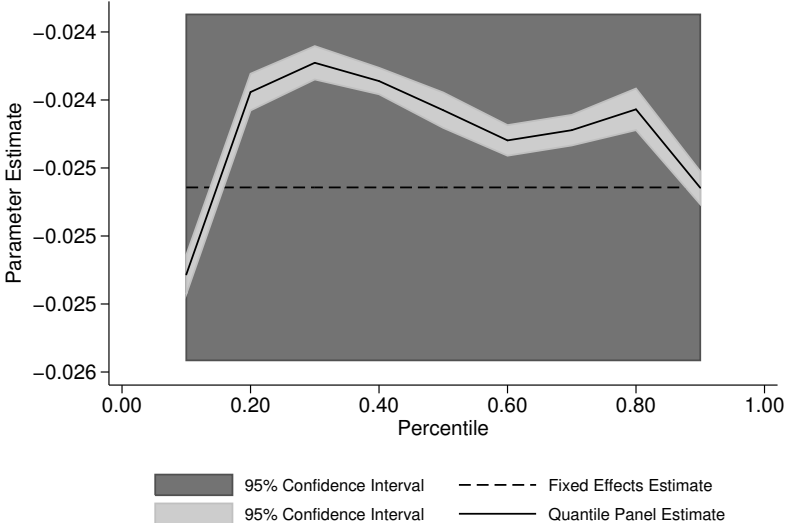Figure : How other brands than the majors react to the brent price
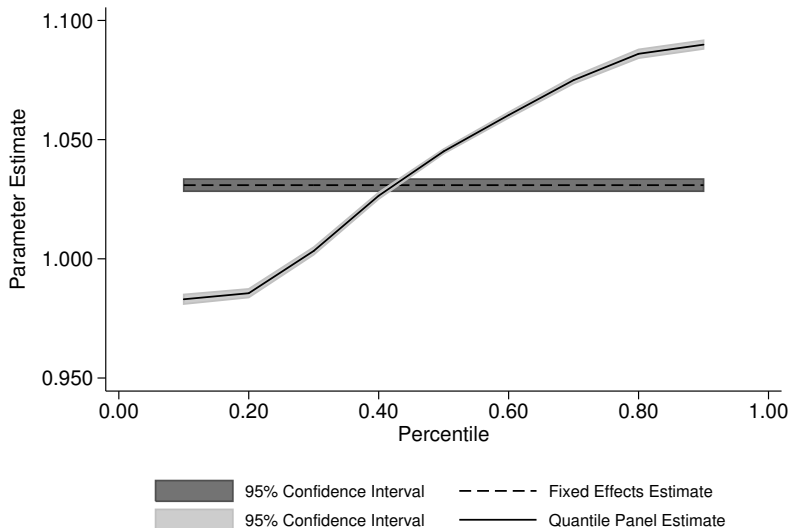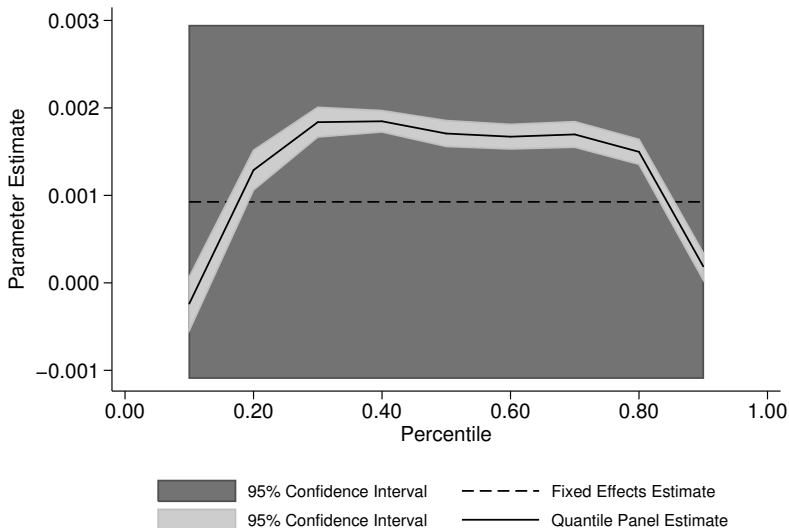
Results for diesel

Results for diesel

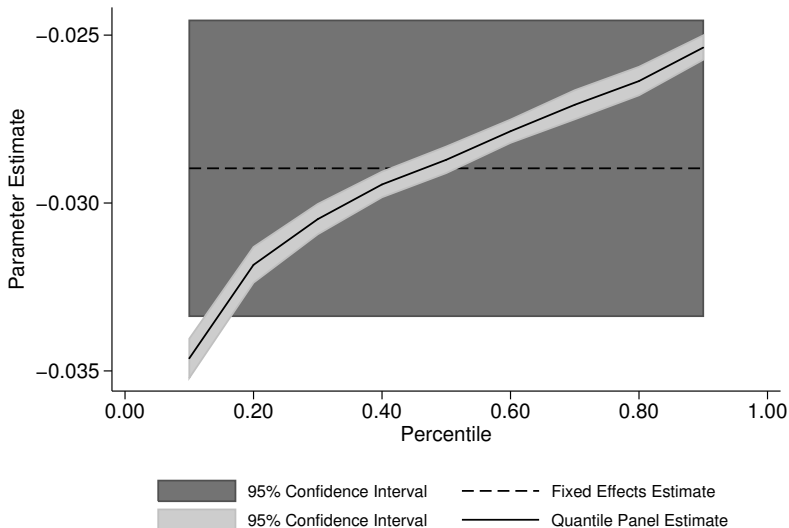Figure : How differently Aral reacts to the brent price compared to non-majors

Results for diesel

Figure : How differently Total reacts to the brent price compared to non-majors

Results for diesel

Figure : How differently Esso reacts to the brent price compared to non-majors

Conclusions

- Using approximately 4.5 million observations, nearly all controls are statistically significant.

- While the major brands react significantly different compared to other brands, the differences are very small in economic terms.

- Hence, there is no evidence that major brands react differently in an economic sense to oil price changes.

- Moreover, employing quantile panel methods shows that the effect of the controls on the response is very heterogeneous across the conditional distribution of the response.