Less pain at the pump? The effects of regulatory interventions in retail gasoline markets — Source link

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Less Pain at the Pump? The Effects of Regulatory Interventions in Retail Gasoline Markets

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May 2012

Abstract

Increasing price levels, high price volatility and the suspicion of collusive behavior are important topics of public debates on competition in retail gasoline markets in many countries. Several governments and competition authorities introduced fuel price regulations in form of restrictions on the frequencies of fuel price changes per day. We present empirical evidence of the effects of fuel price regulation in Austria and Western Australia using difference-in-differences methods to estimate treatment effects of the implementation of such pricing rules. Our estimates provide evidence that fuel price levels in Austria decreased after implementation of regulation. However, we cannot find robust significant effects of regulation on fuel price levels in Western Australia.

JEL-Codes: K2, K23, L5, L51, L71

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1 Introduction

Fuel prices have been a controversial topic widely debated in public and media for a long time (see e.g. Kirchgässner, 1984). However, economists are also interested in markets for fuel products because of certain market characteristics. On the one hand input prices are easy to observe, because prices for crude oil can be obtained from the world oil market, on the other hand market participants are often accused of collusive practices by the public, the media, and even by politicians. The rising interest in gasoline markets is not surprising, because gasoline prices reached all-time highs in many countries in the world. Furthermore, customers face very high price volatility, which increases uncertainty significantly and is usually not observed in other markets for consumer goods. In other retail markets 90% of the prices often change less than five times per year (see Ceccheti, 1986 and Lünnemann and Matha, 2005). Recently the price for unleaded gasoline reached more than 1.70 Euro per liter at the beginning of the Easter holidays in Germany, moreover, similar price trends can be found in most European countries. Governments in nearly all industrialized countries are put under pressure by the public to take action and find suitable measures to decrease fuel prices and avoid excessive volatility.[1] Decreasing fuel prices by measures of economic policy is nearly impossible, unless direct price regulation is implemented as it has been the case in the Canadian province Nova Scotia or in Luxembourg (see e.g. Gardner, 2007). Several countries do not primarily intend to decrease fuel price levels, but direct their measures on the second moment of the price process, the variance. Such regulatory measures have been introduced in Austria and Western Australia and intend to decrease the number of price changes per day to increase transparency for consumers. These measures clearly reduce price volatility but it is a priori unknown, whether they have any effects on the price level. To the best of our knowledge, there is no empirical study investigating the effects of fuel price regulation on price levels. We analyze the effects of fuel price regulation in Austria and Western Australia on price levels in a panel data setting using well established treatment-effects methods.

[1] In the media it is often assumed that the large oil companies conduct explicit collusion, but usually official investigation could not find evidence for such suspicions (see Kasten and Klepper, 2001).

The paper is structured as follows. In the following chapter we discuss the regulatory measures introduced in Austria and Western Australia. Furthermore, related literature will be discussed. The next chapter presents our empirical analysis including the identification strategy, a description of our data set and the results. The last section concludes and gives some ideas for further research.

2 Related Literature

From a technical point of view, gasoline is a highly homogenous product. As a result, given identical transport costs, economic theory predicts uniform prices for different fuel brands. However, one can usually observe significant price differences between brands. For example Eckert and West (2003) provide empirical evidence of this phenomenon for the retail fuel market in Vancouver, Canada. Besides the finding of non-uniform prices, it is often doubted for very good reasons, that retail fuel markets can be described by workable competition. There are several strands of literature analyzing competition in fuel markets. The earlier literature is usually concerned with asymmetric price transmission, however, later studies also focus on the aspect of pricing. These studies usually analyze the speed of the transmission of increasing crude oil prices as the main input factor of gasoline into retail prices. Usually it has been found that price increases of crude oil are much faster included in retail prices than decreases (see e.g. Bettendorf et al., 2003 for an analysis of the Dutch retail gasoline market). Galeotti et al. (2003) document asymmetric price adjustment in France, Germany, Italy, Spain, and the UK characterized by significant differences in adjustment speeds. An exception is Kirchgässner (1987) who shows that asymmetric price adjustment only holds in the short run, whereas in the long run symmetric adjustment is observed. Furthermore, Kirchgässner and Kübler (1992) provide evidence of symmetric and full adjustment of prices for Germany in the 1970s. These findings are usually interpreted as indicator of significant market power in retail fuel markets. As a result of the asymmetric price adjustment literature it is reasonable to assume, that retail fuel markets face a lack of workable competition which clearly harms consumers.[2]

A second strand of literature is based on Maskin and Tirole (1988), who describe the concept of Edgeworth cycles in a formal model.[3] Edgeworth cycles are characterized by sharp price increases. After the price level increased, prices go down as a result of competition in many small steps. The phenomenon of Edgeworth cycles has been found in several fuel markets around the world. Noel (2007) estimates markov-switching models to provide evidence for Edgeworth cycles. He finds evidence for cyclical behavior in regional fuel markets in Canada and the Midwestern states of the US. Noel's findings are of certain interest with regard to fuel price regulation, since they show that even in highly concentrated retail gasoline markets competitive behavior can be observed due to the existence of competitive fringe firms (see Noel, 2007 and 2009). If the fringe is sufficiently large, price series are characterized by Edgeworth cycles. If the competitive fringe has very small market shares, price stickiness is more likely, because it is hardly possible for the small fringe firms to decrease prices significantly.[4] To understand this finding it is important to note, that oligopolistic collusion is one reason for price stickiness suggested by IO theory (see Blinder et al., 1998: 17).

Surprisingly, there are only few studies dealing with the effects of pricing rules on fuel price levels. Two recent papers analyze the effects of the fuel price regulations in Austria and Western Australia in experimental settings. Berninghaus et al. (2012) provide evidence that the Austrian fuel pricing rule does not decrease but rather increase price levels. In contrast to the intention of the regulatory measure, collusion will be even more likely than before. Haucap and Müller (2012) study the effects of fuel price regulations in Austria and Western Australia. In line with Berninghaus et al. (2012) they predict increasing fuel price levels after the implementation of regulation. For the Western Australian rule they do not find significant differences in price levels before and after introducing regulation in their experimental setting.

[2]An attempt to explain asymmetric price adjustment in gasoline markets in a theoretical model can be found in Jannsen et al. (2011).

[3]See Noel (2011) for a non-technical discussion of the concept of Edgeworth price cycles.

[4]Price stickiness is a common feature of fuel markets (see Delpachitra, 2002 documents price stickiness in retail fuel markets in New Zealand).

3 Regulation of Gasoline Markets

This section discusses two relatively light-handed regulatory interventions implemented in Austria and Western Australia, respectively. Both regulations aim at restricting the frequency of price changes rather than determining the exact price levels. By this means, firms are still able to set their gasoline prices independently from any regulatory price caps. However we do not refer to any direct price regulation as applied in, e.g., Canada and Luxembourg where regulatory authorities directly set fuel price levels.

3.1 Pricing rules in Austria and Western Australia

In 2009 Austria introduced a new pricing rule for gasoline markets, which commits gas stations only to increase prices once a day. The regulatory approach is asymmetric in the sense, that decreasing prices is not restricted. From July 2009 to December 2010 fuel stations were allowed to rise prises once a day depending on the type of business model. While 24-hours gas stations were allowed to rise prices only at 12 o'clock at night, stations with restricted opening hours were permitted to increase prices only at the opening hour. Finally, self-serving stations had to rise prices only at 8:30 am. This regulation changed in 2011, where all fuel stations were allowed to increase prices once a day at noon. Additionally, the Austrian regulatory authority introduced an internet platform where gasoline stations have to post their prices. The intention is to increase market transparency for consumers and reduce transaction costs (see Bundeswettbewerbsbehörde, 2011).[5]

In Western Australia the Government introduced a symmetric pricing rule. Companies are obliged to post their prices for the following day until 2 pm on the so called "FuelWatch" internet platform. At this platform not only retail prices but also wholesale gasoline prices at the most important Australian hubs are available. Retail prices have to be left unchanged from 6 am on the following day for 24 hours (see ACCC, 2007). The Western Australian model also combines restrictions of price volatility and consumer information as is also implemented in Austria. In the following sections we

[5]For an experimental analysis of the role of price search in retail gasoline markets see Castilla and Haab (2010).

provide a comprehensive discussion of the related literature and a theoretical framework to predict the effects of regulatory measures on gasoline markets.

3.2 Expected Effects of Pricing Rules

A priori different effects are expected from the pricing rules in Austria and Western Australia. Obviously, the intra-day frequency of price changes will decrease in both countries, but to a lesser extend in Austria, because of the possibility of price decreases at all times. However, the effects of pricing rules on price levels are difficult to predict ex ante. Since demand is typically not constant over (day-)time, fuel prices are characterized by relatively high volatility. Restricting the price setting behavior in terms of the Western Australian model would most probably lead to some kind of average prices. Since demand varies over daytime and prices under regulation are not allowed to change for 24h firms are expected to set an average optimal price. Assuming cartels behave as a profit maximizing monopolists one would expect that the average price equals a weighted average of prices without regulatory constraints. In case that the large oligopolistic companies have sufficient market power one would neither expect increasing nor decreasing but constant prices. We do not expect competitive pressure of fringe firms to be more intense than without regulation. In contrast also fringe firms are restricted to set prices only once a day and therefore also lack the ability to react to the large firms' pricing decisions. If there has been tacit collusion in the market before introducing regulation, there are no substantial reasons for absence of parallel behavior under regulation. Although the Western Australian model constraints price setting, the trial and error process needed for parallel behavior may be distorted to some extent. This may under some circumstances slow down the adjustment process to stable collusive behavior.[6] Indeed, as Wang (2009) shows there has been a shift in strategic behavior of oligopolistic firms in Western Australia due to the introduction of the pricing rule. Before regulation only three firms acted as price leaders, after the introduction of the rule price leadership can be described by some kind of mixed strategy. While the learning process to re-coordinate prices after the regulatory shock took

[6] Of course, in case of high frequency of large unexpected shocks coordination over time could be extremely difficult. Therefore firms may not be able to reach stable collusive equilibrium.

about four months subsequently also companies of the competitive fringe occasionally turned from a pure following behavior to price leadership.

In contrast to the Western Australian model, the Austrian model allows unlimited price decreases per day and therefore more flexible pricing patterns. Hence, also Edgeworth cycles as a typical pricing behavior of fuel markets are still likely to be observed. However intertemporal increases in firms' gasoline prices are no longer possible. That is, while before regulation some firms acted as price leaders in both directions, after the introduction of the pricing rule coordinated pricing behavior is now only possible for price decreases. Furthermore, while the highest possible prices have to be set at noon following price increases of leading firms by fringes is now excluded.

Moreover, given cyclical intra-day demand firms' price setting behavior is most likely to depend strongly on the exact time of the day. In case that price increases are allowed during a period of high demand one would also expect relatively high prices followed by price cuts during off-peak periods. In case that prices have to be set in off-peak periods relatively lower prices have to be expected. The amount of following price cuts should be however significantly lower compared to the high-demand scenario. Due to the possibility to undercut prices, at least the coordination of collusive behavior is probable to be more complex. Therefore, it is reasonable to predict less stable parallel behavior than under the pricing rules of the Western Australian model.

Based on the previous discussion we expect to observe different effects of the Western Australian and Austrian pricing rules on respective price levels. While for Australia we assume that regulation has no impact on average prices, regulation in Austria is much more likely to lead to lower gasoline prices.

4 Empirical analysis

In this section, we examine the impact of pricing rules on the fuel price levels in Austria and Western Australia, respectively. For this purpose, we use two different panel data sets describing the price paths of both 25 European countries and 7 Australian states and territories. We are therefore able to analyze price changes over time as well as over different countries. In the following section we describe our approach how to separate the effects of fuel price regulation from other effects caused by, for example, macroeconomic conditions or changes in oil prices.

4.1 Identification strategy

Identifying the effects of the implementation of the so called Austrian and Western Australian rules in 2009 and 2001, respectively, is no trivial task. Fuel prices highly depend on prices of crude oil and macroeconomic conditions. Additionally, we have to ensure, that measured price changes do not depend on institutional differences other than fuel price regulations. To identify the effects of the pricing rules on price levels in Austria and Western Australia, we apply the so called difference-in-differences framework (see Angrist and Pischke, 2009: 227-243 as well as Wooldridge, 2010: 147-151 for a detailed discussion).[7] The aim is to observe the differences in an outcome variable, here the price levels for gasoline, over time in a treatment group which in our analysis is Austria or Western Australia and in a control group. By this means we account for a counterfactual situation which is unobserved for the treatment group. Furthermore, the panel structure of our data also allows us to compare also the differences between groups before and after the introduction of the rules in Austria and Western Australia in both countries. Studying the differences between a treatment group and a control group before and after the introduction of the pricing rules enables us to identify the so called treatment effect, which is solely caused by the regulation. Including a control group into the data set avoids biases caused by effects which are based on general economic conditions and institutional differences between countries. This method is well established in empirical economics and has a long tradition in labor and development economics, where it proved to be an essential method in applied econometrics. It has been shown that the difference-in-differences methods is often much more effective than methods ignoring counterfactual situations (see Wooldridge, 2010: 148.).

[7] The difference-in-differences method is part of the program evaluation literature in econometrics. For an overview of early and recent developments see Imbens and Wooldridge (2009).

4.2 Data

The data used in this study was collected from different sources (see Table 1 in the appendix): Fuel prices for Austria and 24 other European countries were extracted from the Weekly Oil Bulletin by the European Commission.[8] European member countries report average pump prices for Euro-Super 95 gasoline as well as for diesel oil (both without taxes) on a weekly basis to the EC. We use both prices in our analysis in order to account for any adjustment in fuel demand and for matters of robustness testing.

Weekly crude oil prices are extracted from Thomson Reuters' Datastream and monthly industrial production is obtained from OECD Stats on a monthly basis. While crude oil is the most important input factor and therefore also the most important cost driver, industrial production index serves as a measure for fuel demand.

To account for the regulation period a dummy variable REG09 is used which is equal to one for the period where the pricing rule was active.[9] A dummy AUSTRIA indicates the Austrian fuel prices and the product REGAUS (=REG09 $*$ AUSTRIA) measures the difference-in-differences between treatment and control groups as well as regulation and non-regulation periods. We furthermore use a linear trend (TREND) as well as dummy variables for each month (MONTH1 to MONTH12) and each week (WEEK1 to WEEK52). All variables but industrial production are on a weekly basis and available from the first week of 2005 to the seventh week of 2012. Overall, our sample for Austria consists of 7,224 observations.

Concerning Western Australia we use monthly average fuel prices for unleaded petrol provided by the Australian Automobile Association (AAA). The AAA collects prices for 113 regional and rural centers and eight capital cities from the 7 states and territories of Australia.[10] Because of limited availability for some regions, we decided to include information on only 107 areas and cities.[11]. The panel is unbalanced, where

[8]Prices are collected for Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, Poland, Portugal, Spain, Sweden, Slovenia, Slovakia, The Netherlands and the United Kingdom.

[9]We also used a dummy REG11 which is equal to unity for January 2011 to February 2012 in order to test for whether the change in regulation had any effect on prices.

[10]The states/territories are: Western Australia, Northern Territory, South Australia, Queensland, New South Wales and Australian Capital Territory (ACT), Victoria and Tasmania.

[11]See Table 2 in the Appendix.

the earliest observation is from April 1998 and the most recent one from February 2012. The sample therefore consists of over 17,000 observations.

We also include the spot price of brent crude oil to account for cost shifts, a linear trend and a monthly dummies. Similar to the analysis of the Austrian regulation, we again include a variable REG01 which indicates the period of regulation (January 2001 to February 2012), a dummy WESTAUS for regulated cities and areas (i.e. located in Western Australia) and the interaction term REGAUS which is the product of REG01 and WESTAUS.

4.3 Results

4.3.1 The Austrian model

Analyzing the effects of price regulation in Austria, we start with a simple pooled difference-in-differences model. Regressing the gasoline as well as the diesel price without taxes on the explanatory variables (INDPROD, BRENT, HOLIDAYS, TREND, TIME DUMMIES) and the dummies indicating the treatment and control group before and after the implementation of the price regulation leads to

$$GAS_{it} = \beta_0 + \beta_1 REG09_{it} + \beta_2 AUSTRIA_{it} + \beta_3 REGAUSTRIA_{it} + \beta'\mathbf{x} + \varepsilon_{\mathbf{it}}, \quad (1)$$

and

$$DIESEL_{it} = \beta_0 + \beta_1 REG09_{it} + \beta_2 AUSTRIA_{it} + \beta_3 REGAUSTRIA_{it} + \beta'\mathbf{x} + \varepsilon_{\mathbf{it}}, \quad (2)$$

where $\mathbf{x}$ is a vector of our explanatory variables and β is a vector of coefficients. Both regressions are carried out in levels as well as in logs.

As can be seen from Table 3, the treatment group (i.e. Austria) has statistically significantly lower prices during the period of regulation than the control group. The same holds for the non regulation period. The difference-in-differences parameter (β_3) is also negative and statistically significant for both gasoline and diesel.[12] β_3 therefore

[12]Results are reported without coefficients of the covariates. Expected values for the non regulation period are given by $\beta_0 + \beta_2$ for the treatment group and β_0 for the control group. Expected values for the regulation period are given by $\beta_0 + \beta_1 + \beta_2 + \beta_3$ for the treatment group and $\beta_0 + \beta_1$ for the control group.

suggests an about 19.6% (11.6%) discount on the average prices for gasoline (diesel) in comparison to the control group during the regulation period ($\beta_3/(\beta_0+\beta_1)$). However, measured at the sample means of the control groups (fuel prices without taxes) the discount is only about 6.8% (6.1%).[13]

Table 3: Difference-in-differences regressions of Austrian fuel prices

	Non Regulation			Regulation			
Variable	Control	Treatment	Diff.	Control	Treatment	Diff.	Diff.-in-diff.
GAS	111.85	101.66	-10.18	177.58	132.45	-45.13	**-34.94**
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	**(0.00)**
DIESEL	167.74	156.11	-11.63	189.90	156.15	-33.75	**-22.12**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	**(0.00)**

Note: Heteroscedasticity and autocorrelation robust bootstrapped p-values are given in parentheses.

In a second step, in order to account for unobserved heterogeneity, we run fixed effects panel regressions of gasoline and diesel prices, such as:

$$GAS_{it} = \beta_0 + \beta_1 REG09_{it} + \beta_3 REGAUSTRIA_{it} + \beta'\mathbf{x} + \upsilon_{\mathbf{i}} + \varepsilon_{\mathbf{it}}, \tag{3}$$

where υ_i are country fixed effects.

As can be seen from Table 4, gasoline as well as diesel regressions show evidence for a negative impact of regulation on prices (in levels and in logs). While REG09 has a positive impact in nearly all of the regressions, AUSTRIA and REGAUSTRIA are negative. Despite of an increase in gasoline and diesel prices for the period from 2009 to 2012 and despite of a statistically significant lower price level in Austria for the whole period, a negative price effect of regulation can be observed. Measuring the discounts under regulation in terms of the sample means of the control groups leads to about 8.2% and 4.8% with respect to gasoline and diesel fuels.

Turning to log-linear specifications (LGAS and LDIESEL) leads to similar results. As coefficients can be interpreted as percentage changes in prices, again, an 8% change in gas prices and a 4% change in diesel prices can be observed.

Industrial production as well as crude oil prices are as expected positive related to fuel prices, which is confirmed by our data. Both a higher demand as well as increasing

[13] Using prices with taxes instead of fuel prices without taxes, leads to similar results. While Austrian price regulations leads to discounts of about 12% (11%) for gasoline (diesel) measured by expected values for the control group, discounts measured by sample means can be found by about 6.1% (4.0%).

cost should lead to higher prices. Somewhat surprisingly, holidays have a negative effect on prices on average. Note, however, that we do not account for school holidays but only for legal holidays.[14]

Overall, both the standard difference-in-differences approach as well as fixed effects panel techniques show a statistically significant impact of price regulation on gasoline and diesel prices in Austria, in comparison to 24 European countries. Discounts vary between 4% and 8% measured at the sample means and between 11% and 19% measured at the expected values.

Table 4: Panel regressions of Austrian fuel prices

Variable	GAS	LGAS	DIESEL	LDIESEL
REG09	68.64	0.12	24.31	0.02
	(0.00)	(0.00)	(0.00)	(0.12)
REGAUSTRIA	-42.04	-0.08	-27.30	-0.04
	(0.00)	(0.00)	(0.00)	(0.00)
INDPROD	1.61	0.01	1.22	0.01
	(0.00)	(0.00)	(0.01)	(0.01)
BRENT	2.62	0.41	3.97	0.54
	(0.00)	(0.00)	(0.00)	(0.00)
HOLIDAYS	-8.23	-0.01	-4.78	-0.01
	(0.00)	(0.00)	(0.05)	(0.01)
TREND	-0.01	-0.01	0.01	0.01
	(0.80)	(0.80)	(0.64)	(0.10)
CONSTANT	9.16	4.08	90.08	3.76
	(0.79)	(0.00)	(0.01)	(0.00)
MONTH Dummies	YES	YES	YES	YES
WEEK Dummies	YES	YES	YES	YES
Observations	7224	7224	7224	7224
Groups	21	21	21	21
Wald Chi	20379	19043	29639	31112
	(0.00)	(0.00)	(0.00)	(0.00)
R^2	0.64	0.64	0.75	0.76

Note: Heteroscedasticity and autocorrelation robust bootstrapped p-values are given in parentheses.

[14] In a second step we also used prices with taxes as dependent variables to test for robustness. The results are very similar and support the previous from the former regressions. Regression results are not reported here but can be made available by the author upon request.

4.3.2 The Western Australian model

Turning to the Western Australian model, again we start with analyzing the impact of price regulation on average prices using standard difference-in-differences techniques. Because of the much higher homogeneity of Australian states/territories (in comparison to European countries), we use a more parsimonious specification in levels as well as in logs:

$$PETROL_{it} = \beta_0 + \beta_1 REG09_{it} + \beta_2 WESTAUS_{it} + \beta_3 REGAUS_{it} + \beta' \mathbf{x} + \varepsilon_{\mathbf{it}}, \quad (4)$$

where $\mathbf{x}$ includes the covariates crude oil prices (BRENT), a linear TREND and MONTH dummies. Estimates in levels (see Table 5) show a a difference between control and treatment groups during the pre-regulation period as well as during the regulation period. However, no statistically significant difference-in-differences effect can be found. Considering DiD results in logs even a positive impact of 1.4% on average prices can be found. However, price regulation seems not to have a significant price reducing treatment effect.

Table 5: Difference-in-differences regressions of Western Australian fuel prices

	Non Regulation			Regulation			
Variable	Control	Treatment	Diff.	Control	Treatment	Diff.	Diff.-in-diff.
PETROL	70.20	66.26	-3.94	76.39	76.39	-4.49	**-0.54**
	(0.0)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	**(0.11)**
LPETROL	3.53	3.48	-0.049	3.55	3.51	-0.036	**0.014**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	**(0.00)**

Note: Heteroscedasticity and autocorrelation robust bootstrapped p-values are given in parentheses.

Next, we turn to panel techniques by using fixed effects regression. Again, a specification in levels as well as in logs is used:

$$PETROL_{it} = \beta_0 + \beta_1 REG09_{it} + \beta_2 WESTAUS + \beta_3 REGAUSTRIA_{it} + \beta' \mathbf{x} + \upsilon_{\mathbf{i}} + \epsilon, \quad (5)$$

where υ_i are fixed effects for cities and regional areas, respectively.

Table 6: Panel regressions of Austrian fuel prices

Variable	PETROL	LPETROL
REG01	5.97	0.02
	(0.00)	(0.00)
WESTAUS	-4.53	-0.03
	(0.00)	(0.00)
REGAUS	-0.03	0.01
	(0.94)	(0.02)
(L)BRENT	0.54	0.30
	(0.00)	(0.00)
TREND	0.10	0.01
	(0.00)	(0.80)
CONSTANT	70.44	3.50
	(0.00)	(0.00)
MONTH Dummies	YES	YES
Observations	17301	17301
Groups	107	107
Wald Chi	12413	62748
	(0.00)	(0.00)
R^2	0.89	0.90

Note: Heteroscedasticity and autocorrelation robust bootstrapped p-values are given in parentheses.

Table 6 summarizes the results form fixed effects regressions. While prices are significantly higher during the regulation period and also lower for Western Australia in both regressions, there is no statistically significant overall effect (REGAUS) following the estimates in levels. Considering log-linear estimates, again, a slightly positive effect of about 1% price increase can be detected. Oil prices are ,as expected, positive related to petrol prices.

Overall, we are not able to find a statistically significant effect (at least no negative) of regulation on petrol prices in Western Australia. While regressions in levels show no evidence for any difference between both periods, log-linear regressions suggest even higher prices induced by the pricing rules.

5 Conclusion

Competition on retail gasoline markets is one of the most important topics for competition authorities in many countries of the world. Several countries implemented pricing rules to decrease price volatility and sometimes price levels. These pricing rules have been criticized rather heavily in the economics profession. We analyze the effects of fuel price regulation in Austria and Western Australia in a panel data setting using difference-in-differences methods. Our results show that the implementation of the pricing rule in Austria has a significant negative effect on fuel price levels. In line with our theoretical considerations, firms are able to lower (but not to increase) prices over time and therefore induce some kind of price competition in the Austrian model. As a result, coordinating collusive behavior will be more difficult.

Concerning Western Australia, we cannot find statistically significant effects of fuel price regulation on price levels. Without the possibility to decrease prices intraday, firms are still able to coordinate collusive behavior and do not face significant competitive pressure, at least not in the very short run. The Australian model therefore seems not to be an adequate method to foster competition in gasoline markets, but only to reduce price volatility.

Given our empirical results, both approaches seem to reach the targets intended by regulatory authorities. Depending on institutional differences, it is not clear whether these rules are applicable to other countries. Furthermore, costs of regulatory intervention have to be taken into account, to get an impression of the relation of costs and benefits.

In addition and most importantly, competition authorities should put more emphasis on the analysis of vertical structures in fuel markets as large oil companies are usually vertically integrated and control large parts of the refinery industry. As a result, the ability to discriminate smaller competitors on the retail market via wholesale prices is a serious concern from a competition policy point of view. We do not propose that pricing rules are the best solution for competition problems in retail gasoline markets and work under all circumstances, but based on our results it may be worth thinking about the pros and cons of such pricing rules.

However, much more empirical work is needed and should be undertaken to gain a better understanding of the mechanisms of pricing behavior and fuel price regulation to find adequate instruments for competition policy.

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Appendix

Tables

Table 1: Data description and sources

	Variable	Description	Source
Austria		GAS	Weekly price of 1000 liters of gasoline (Euro-Super 95) without taxes.
	GAS	Weekly price of 1000 liters of gasoline (Euro-Super 95) without taxes.	EC, DG Energy, Oil Bulletin
	DIESEL	Weekly price of 1000 liters of diesel without taxes.	EC, DG Energy, Oil Bulletin
	BRENT	Weekly Europe brent spot price per barrel	Datastream, Thomson Reuters
	HOLIDAYS	Dummy variable indicating legal holidays in the member states	Own investigations
	INDPROD	Index of industrial production	OECD Stat, MEI Original Release Data and Revisions Database
	TREND	Linear trend	Own calculations
	REG09	Dummy variable equal to one from July 2009 to February 2012, indicating the period of price regulation	Own calculations
	REG11	Dummy variable equal to one from January 2011 to February 2012, indicating the change in regulation in 2011	Own calculations
	AUSTRIA	Dummy variable equal to one for Austria and zero otherwise	Own calculations
	REGAUSTRIA	REG09 x AUSTRIA, dummy variable indicating the regulation period in Austria	Own calculations
Western Australia	PETROL	Monthly average price of unleaded petrol (in cents per liter)	Australian Automobile Association
	BRENT	Europe brent spot price per barrel (monthly basis)	Datastream, Thomson Reuters
	TREND	Linear trend	Own calculations
	REG01	Dummy variable equal to one from January 2001 to February 2012, indicating the period of price regulation	Own calculations
	WESTAUS	Dummy variable equal to one for West Australia and zero otherwise	Own calculations
	REGAUS	REG09 x AUSTRIA, dummy variable indicating the regulation period in West Australia	Own calculations

Table 2: Cities and ares in the Australian sample

A-G ADELAIDE METRO, ALBANY, ALBURY, ALICE SPRINGS, ARARAT, ARMIDALE, BAIRNSDALE, BALLARAT, BATEMANS BAY, BATHURST, BEGA, BENALLA, BENDIGO, BOWEN, BRISBANE METRO, BROKEN HILL, BUNBURY, BUNDABERG, BURNIE, CAIRNS, CALOUNDRA, CANBERRA, CARNARVON, CASINO, CEDUNA, CHARLEVILLE, CHARTERS TOWERS, COFFS HARBOUR,COOBER PEDY, COOMA, COONABARABRAN, COWRA, DARWIN, DEVONPORT, DUBBO, ECHUCA, EMERALD, EUCLA, FORBES, FORSTER, GEELONG, GLADSTONE, GLEN INNES, GOLD COAST, GOULBURN, GRAFTON, GRIFFITH

H-P HAY, HOBART, HORSHAM, INVERELL, KALGOORLIE, KATHERINE, KEMPSEY, KINGAROY, LAKES ENTRANCE, LAUNCESTON, LISMORE, LONGREACH, MACKAY, MAITLAND, MANDURAH, MANSFIELD, MARYBOROUGH, MELBOURNE METRO, MILDURA, MOREE, MT GAMBIER, MT ISA, MURRAY BRIDGE, NARRABRI, NEW NORFOLK, NEWCASTLE, NORTH COAST, ORANGE, PARKES, PERTH METRO, PORT AUGUSTA, PORT LINCOLN, PORT MACQUARIE, PORT PIRIE, PORTLAND

R-Z RENMARK, ROCKHAMPTON, ROMA, SALE, SHEPPARTON, SWAN HILL, SYDNEY METRO, TAMWORTH, TAREE, TENNANT CREEK, TOOWOOMBA, TOWNSVILLE, TRARALGON, ULLADULLA, ULVERSTONE, VICTOR HARBOUR, WAGGA WAGGA, WANGARATTA, WARRNAMBOOL, WARWICK, WHYALLA, WODONGA, WOLLONGONG,YARRAWONGA,YASS

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