Analyzing the competition in the Hungarian gas market

Dr. Zombor Berezvai Tamás Bereczki Csaba Medgyes

***Abstract*—This article investigates the factors influencing price evolution and competitive dynamics in Hungary's fuel market following the lifting of a fuel price freeze imposed during the Russia-Ukraine conflict. By applying mathematical and statistical tools, the study models pricing strategies and behavior within the market using data from holtankoljak.hu and ksh.hu. Three significant dates in the spring of 2023 are selected for analysis. The paper examines pricing strategies at three levels: global, wholesale, and local. Regression models, market responses to wholesale price changes, and price endings are analyzed in each respective section.**

I. Introduction

The primary focus of the article revolves around exploring the factors that influence price evolution and competitive dynamics within the fuel market of Hungary. The significance of this topic arises from the fuel price freeze imposed in Hungary due to Russia's conflict with Ukraine, which lasted for over a year until its suspension in December 2022. Examining the manner in which market competition reemerged in the Hungarian fuel industry as a consequence of these events presents an intriguing inquiry.

Our main focus was to employ mathematical and statistical tools in order to model the pricing strategies and behavior within the fuel market. To conduct our analysis, we utilized data obtained from reputable sources such as holtankoljak.hu and the Hungarian Statistical Office (ksh.hu) websites. For the purpose of data collection, we specifically selected three significant dates in the spring of 2023: March 28, April 6, and April 23.

In this paper, our primary emphasis will be on examining pricing strategies across three distinct levels. At the global level, we will present a regression model in Section II-A that incorporates numerous variables. Moving to the wholesale level in Section II-B, we will analyze the market's response to changes in wholesale prices. Finally, at the local level in Section II-C we will analyze the price endings and their outcomes.

A. Literature Overview:

Given our focus on the Hungarian market, we drew inspiration from the study discussed in [1]. This study aimed to offer valuable insights into the determinants of fuel pricing decisions and the strategies employed by gas stations to adjust their prices in response to factors like competition, location, and market conditions. By considering this study, we sought to gain a deeper understanding of the dynamics and influences within the Hungarian fuel market.

In a retail gasoline market, [2] examined the impact of price transparency on fuel prices in the Italian highway system. The effects of price competition on firms' operations and market prices were investigated by [3]. Psychological pricing strategies employed by retail gasoline stations were analyzed by [4] and the relationship between price response, information, and the asymmetry of price dispersion was explored in [5]. The effects of antitrust prosecution on retail fuel prices were studied by [6], and [7] examined the price effects of spatial competition in retail fuel markets. The asymmetric dynamic pricing in a local gasoline retail market was analyzed by [8], while [9] provided evidence on the pricing behavior of Italian gas stations using data from the Cuneo retail fuel market.

Collectively, these studies contribute to our understanding of pricing dynamics, competition, price transparency, psychological pricing strategies, and the effects of antitrust prosecution in retail fuel markets.

B. Available Data:

Our primary data source was holtankoljak.hu which is a popular Hungarian website that provides information about fuel prices and petrol stations across Hungary. The website serves as a valuable resource for individuals seeking up-to-date information on fuel prices, promotions, and discounts offered by various petrol stations in the country. Users can access real-time data on fuel prices, compare prices between different stations, and find the nearest petrol stations based on their location.

As part of our data collection process, we utilized Python's web-scraping tools, including Selenium and BeautifulSoup, to select three significant dates in the spring of 2023: March 28, April 6, and April 23. Unfortunately, due to inconsistencies in the website's link generation, certain links had to be manually replaced.

After collecting regional data from ksh.hu we our dataset attributes can be found in Table I.

C. The Hungarian Gas Market:

To accurately depict the Hungarian fuel market conditions, it is essential to identify the key players who hold significant shares. By referring to Figure 1, we can examine the distribution of gas stations among various companies which reveals that MOL, OMV, and Shell dominate the market in Hungary. This structure aligns with the fuel sectors of many Western European countries, where a small number of large vertically integrated oil companies control the entire production process,

Attributes
Address
City
Post Code
Franchise (or private)
Highway
Link
Services
95-ös Benzin E10
Gázolaj
100-As Benzin E5
Prémium Gázolaj
Number of competitions 1km
Number of competitions 5km
Number of competitions 10km
Number of competitions 20km
Number of competitions 30km
Number of competitions 40km
Housing
Retail stores
Unemployed 15-64
Allowance
Income tax per person
Commuters Abroad
N drinking water
Employed 15-64
Tax per 1000
N of cars per 1000
N of agriculture
Commuter Difference
Income Tax per Person
Locally Employed

Table I: Dataset Attributes

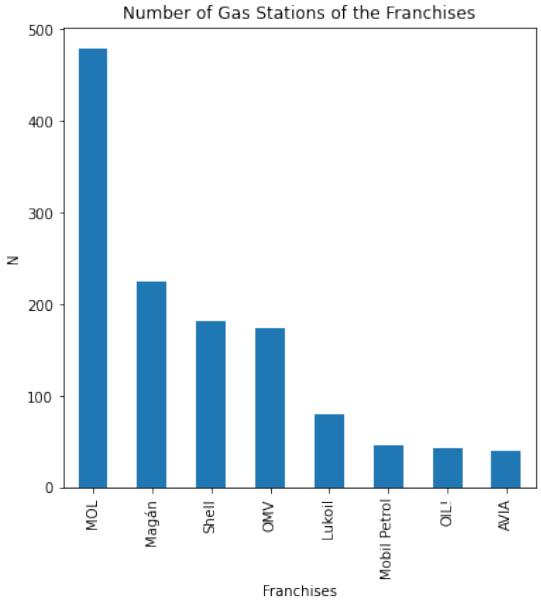

Figure 1: Number of Franchises in Hungary

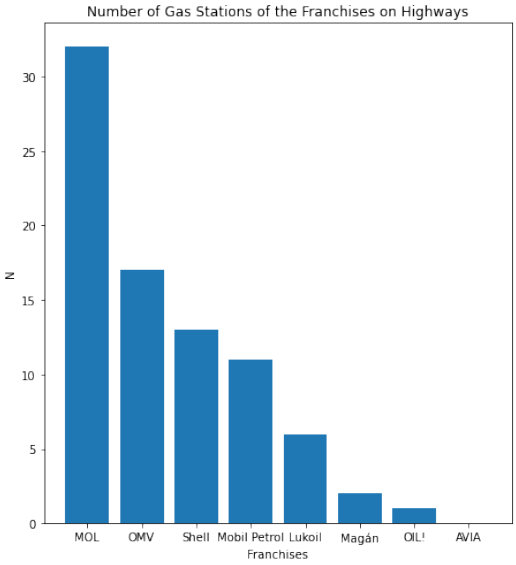

Figure 2: Number of Franchises next to Highways

ranging from oil extraction to fuel sales at the pump. These established brands engage in competition with each other as well as with independent unbranded retailers commonly referred to as ”white pumps” (referred to as ”Magán” in our analysis). Due to the significantly higher number of gas stations in Budapest, the capital city of Hungary, compared to the rest of the country, we conducted a separate analysis for each district within Budapest.

In our data analysis, our initial focus was on examining the number of gas stations in specific cities, namely Győr, Budapest XI, Miskolc, Kecskemét, and Szeged, as they stood out prominently. By applying the Chi-Squared statistic to analyze the relationship between the City and Franchise attributes, we determined that there exists a significant association between these variables.

Additionally, we investigated the presence of a highway near gas stations and observed a noteworthy price difference. By employing the same Chi-Squared statistic to explore the association between Franchise and Highway, we discovered a significant relationship. This finding indicates that major franchises, such as Mol, OMV, and Shell, dominate the higher-priced highway market since they own a significant number of gas stations located alongside highways (Figure 2).

From our analysis of competition and franchises, we can draw the following conclusions: OMV, Shell, Lukoil, and Mobil Petrol have a significant number of gas stations located within a competition radius of 1, 5, 10, 20, 30, and 40 km. This suggests that smaller franchises tend to position themselves in more isolated areas.

Regarding the correlation and association analysis, we primarily found trivial relationships. For example, there was a notable association between the postcode and city attributes and a correlation between the number of employed individuals aged 15 to 64 and the income tax per person attribute.

The analysis of average fuel prices across different counties confirms a widely recognized observation: counties located closer to countries with higher GDP tend to have higher average fuel prices compared to those farther away.

Upon examining the prices and competition within a given radius, we observed significant variations. These findings indi-

cate that we cannot definitively conclude that higher competition within the radius results in lower prices. Therefore, further analysis is required to determine the factors that influence pricing.

II. Pricing Strategy

In the following section, we will analyze the pricing strategies of gas stations on three levels. We will present a regression model in Section II-A, on wholesale level in Section II-B, we will analyze the market's response to changes in wholesale prices. Finally, at the local level in Section II-C we will analyze the price endings and their outcomes.

A. Global Level:

In this project, as outlined in Section I-B, we gathered data from three specific dates: March 28, April 6, and April 23. To obtain more reliable results for the four price attributes mentioned in Table I (95-ös Benzin E10, Gázolaj, 100-As Benzin E5, Prémium Gázolaj), we opted not to create separate regression models for each date. Instead, we incorporated all the data into our dataset, utilizing a Time attribute.

We conducted ordinary least squares (OLS) linear regression on the complete dataset, with the constant term being the price of MOL on the date of 03.28. The outcome of this regression analysis is presented in Table II.

As we can see in Table II the constant coefficient (621.433) represents the average price of MOL at the reference date (03.28). This can be considered the baseline price.

Each variable's coefficient (e.g., Highway, Services, WC, etc.) represents the estimated effect of that variable on the price of MOL. The "std err" column provides the standard error of the coefficient estimates, while the "t" column presents the t-statistic, which assesses the significance of the coefficient. The $P > |t|$ column shows the corresponding p-value for each coefficient. The signs (positive or negative) of the coefficients indicate the direction of the relationship between the independent variable and the price of MOL. A positive coefficient suggests a positive relationship, meaning an increase in the independent variable is associated with an increase in the MOL price, while a negative coefficient indicates an inverse relationship. The magnitude of the coefficient indicates the strength of the relationship.

At a significance level of 0.05, we can determine that the significant variables in the analysis were the time attributes, franchise, constant, and highway. Additionally, the number of competitions within a 5km radius, Allowance, and N drinking water attributes were also found to be statistically significant. These variables are particularly noteworthy as they inherently incorporate the number of households in the corresponding regions.

The coefficient of Highway (binary variable) is 22 which suggests that a one-unit increase in the "Highway" variable is associated with an estimated increase of 22 units in the dependent variable (the price of MOL) when holding other variables constant.

	coef	std err	t	$P > \|t\|$	0.025	0.975
const	621.433	10.13	61.343	0	601.569	641.298
Highway	22.7231	0.404	56.253	0	21.931	23.515
Services	0.0583	0.034	1.698	0.09	-0.009	0.126
WC	-0.0806	0.272	-0.296	0.767	-0.615	0.454
Number of competition 1km	-0.0628	0.117	-0.538	0.591	-0.292	0.166
Number of competition 5km	-0.1011	0.029	-3.514	0	-0.157	-0.045
Number of competition 10km	0.027	0.016	1.674	0.094	-0.005	0.059
Number of competition 20km	-0.014	0.007	-1.946	0.052	-0.028	0
Number of competition 30km	-0.0084	0.006	-1.402	0.161	-0.02	0.003
Number of competition 40km	-0.0021	0.005	-0.422	0.673	-0.012	0.008
Housing	-0.0009	0.003	-0.317	0.751	-0.006	0.005
Retail stores	0.0007	0.003	0.254	0.8	-0.005	0.006
Unemployed 15-64	-0.0999	0.091	-1.098	0.272	-0.278	0.079
Allowance	-0.1508	0.048	-3.159	0.002	-0.244	-0.057
Income tax per person	0.0082	0.006	1.397	0.162	-0.003	0.02
Commuters Abroad	-0.0284	0.015	-1.845	0.065	-0.059	0.002
N drinking water	0.049	0.017	2.921	0.004	0.016	0.082
Employed 15-64	-0.0485	0.048	-1.015	0.31	-0.142	0.045
Tax per 1000	-0.0289	0.02	-1.43	0.153	-0.069	0.011
N of cars per 1000	0.0063	0.003	1.868	0.062	-0	0.013
N of agriculture	-3.344e-05	0	-0.1	0.921	-0.001	0.001
Commuter Difference	-0.1104	0.128	-0.864	0.388	-0.361	0.14
Income Tax per Person	-0.0042	0.003	-1.402	0.161	-0.01	0.002
Locally Employed	-0.0115	0.012	-0.978	0.328	-0.034	0.012
AVIA	-1.9795	0.854	-2.317	0.021	-3.655	-0.304
Lukoil	-0.5315	0.433	-1.227	0.22	-1.381	0.318
Magán	-6.9795	0.341	-20.468	0	-7.648	-6.311
Mobil Petrol	-11.1369	0.553	-20.153	0	-12.221	-10.053
OIL!	-2.2655	0.622	-3.641	0	-3.486	-1.045
OMV	5.1657	0.362	14.252	0	4.455	5.876
Shell	2.5592	0.328	7.808	0	1.916	3.202
2023.04.06	4.4824	0.246	18.248	0	4.001	4.964
2023.04.23	-12.1528	0.245	-49.582	0	-12.633	-11.672

Table II: Regression Results on 95 Benzin target variable

	coef	std err	t	$P > \|t\|$	0.025	0.975
const	605.544	1.628	372.037	0	602.352	608.736
Highway	22.9086	0.397	57.739	0	22.131	23.687
Number of competition 1km	-0.0736	0.114	-0.644	0.52	-0.298	0.151
Number of competition 5km	-0.0939	0.022	-4.255	0	-0.137	-0.051
Number of competition 10km	0.02	0.015	1.337	0.181	-0.009	0.049
Number of competition 20km	-0.0123	0.007	-1.742	0.082	-0.026	0.002
Number of competition 30km	-0.0086	0.006	-1.505	0.132	-0.02	0.003
Number of competition 40km	0.0004	0.005	0.079	0.937	-0.009	0.01
Allowance	-0.1162	0.033	-3.558	0	-0.18	-0.052
N drinking water	0.0383	0.015	2.582	0.01	0.009	0.067
AVIA	-1.8314	0.839	-2.182	0.029	-3.477	-0.186
Lukoil	-0.6971	0.413	-1.686	0.092	-1.508	0.114
Magán	-7.0864	0.321	-22.105	0	-7.715	-6.458
Mobil Petrol	-11.1299	0.521	-21.35	0	-12.152	-10.108
OIL!	-2.4125	0.597	-4.04	0	-3.584	-1.241
OMV	5.2965	0.331	15.996	0	4.647	5.946
Shell	2.4597	0.297	8.274	0	1.877	3.043
2023.04.06	4.4827	0.246	18.243	0	4.001	4.964
2023.04.23	-12.1483	0.245	-49.552	0	-12.629	-11.668

Table III: Regression Results on 95 Benzin with backward elimination

Based on the coefficients related to different franchises, we can deduce the following: When it comes to larger franchises like OMV and Shell, an increase in the price of MOL has a positive effect, leading to a price increase. However, for smaller franchises, the opposite holds true. An increase in the price of MOL typically results in a decrease in prices for these smaller franchises.

Table IV: RMSE and R-squared values of Full Regression

Fuel Type	RMSE	R-squared
95-ös Benzin E10	5.084855271863849	0.8025650342758177
Gázolaj	5.189138249600153	0.8815621025078273
100-As Benzin E5	5.964257498570454	0.9050528390220525
Prémium Gázolaj	4.658349653499055	0.928231507221032

In Table IV, it is evident that all four regressions yielded comparable outcomes, indicating that analyzing worst-case scenarios leads to more robust conclusions. This observation will hold true even during the process of Backward Elimination.

During the application of Regression with backward elimination, we can draw the same conclusions as before since the statistically significant variables have remained significant (Table III). The consistent presence of these patterns indicates that our findings appear to be robust in this scenario as well.

Table V: RMSE and R-squared values of Backward Elimination

Fuel Type	RMSE	R-squared
95-ös Benzin E10	5.100226627082201	0.8013695508471175
Gázolaj	5.191139031175463	0.8814707524470685
100-As Benzin E5	5.984115325475745	0.9044195387143255
Prémium Gázolaj	4.668728217963816	0.9279113579267474

B. Wholesale Level:

Significant differences can be observed in the frequency distributions of market price changes in two distinct time periods and across different types of fuels, as depicted in Figure 3. The price changes between Benzin and Gasoline exhibit noticeable differences.

Almost all gas stations followed the wholesale market price change, indicating that both Gasoline and Premium Gasoline responded similarly to price fluctuations. The high responsiveness of this market to market changes is evident from these findings, which is why our regression models exhibited better performance as demonstrated in Table IV and Table V.

The situation is different when it comes to Benzin prices. While an increase in the wholesale price does not necessarily lead to a corresponding increase in prices at all gas stations (as shown in the blue part of Figure 3), it is important to note that the increases observed are not insignificant either. This can be attributed to many factors, also to the fact that holtankoljak.hu is an open-source database, that primarily relies on customer uploads of current prices. Despite its open-source nature, we can conclude that the rate of price increase is not necessarily proportional to the rate of wholesale price increase. When the price decreases, gas stations tend to make only minimal reductions in their prices, often in a trivial manner.

C. Local Level:

At the local level, it is important to examine the price endings. The results of a study [4] are consistent with our findings, as nearly all gas stations employ the psychological pricing tactics described in the study by setting their prices to end with either 0 or 9 (for example 604.9).

A noticeable pattern in the penultimate characters of prices can be observed, as many gas stations tend to end their prices with either 0, 9, or 5 (or a value close to 5). This phenomenon aligns with well-documented psychological effects that have been extensively studied in the field of economics.

III. Conclusion and Summary

In summary, we conducted an analysis of the Hungarian gas market, which is highly competitive and dominated by major

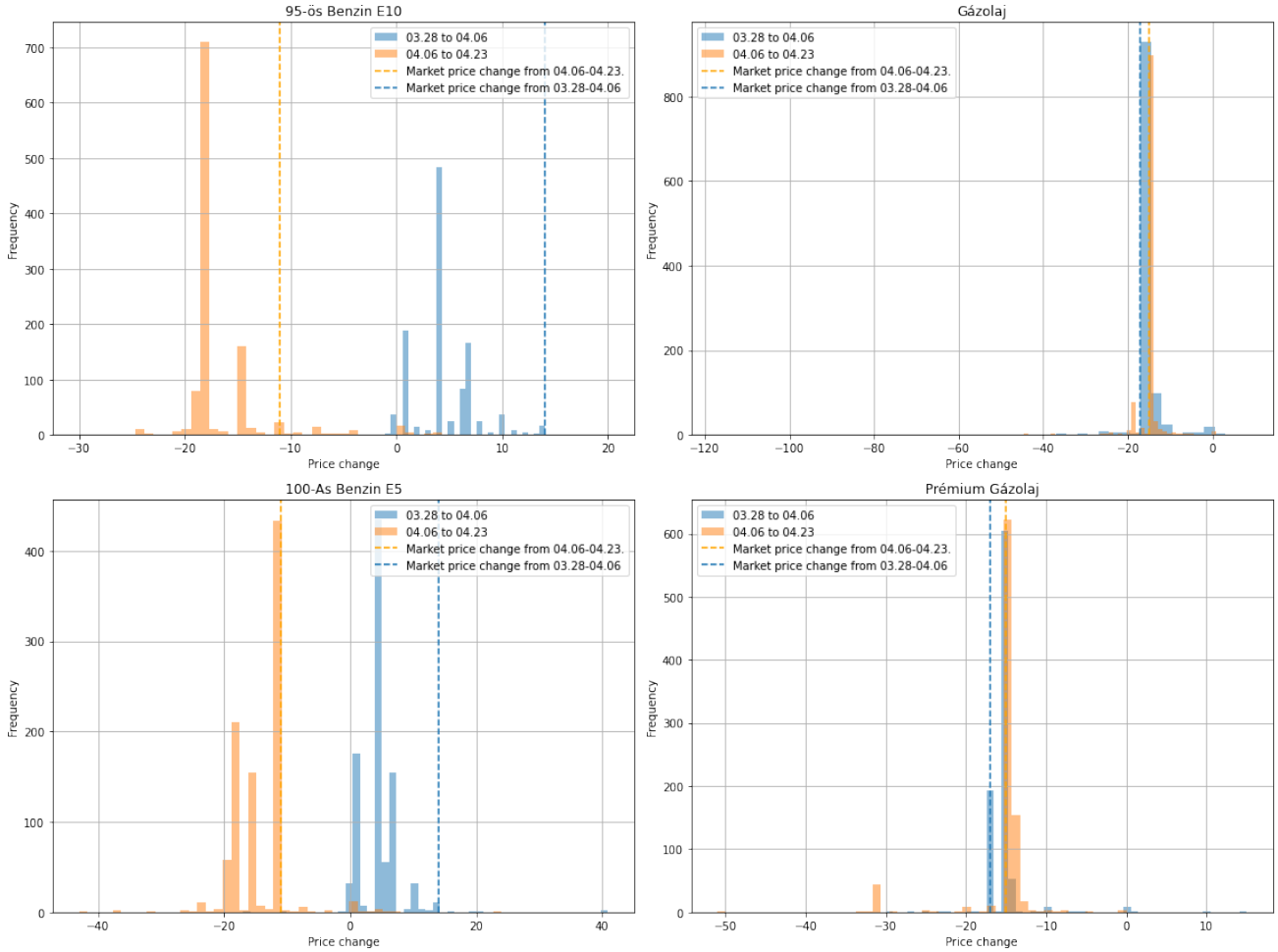

Figure 3: Price change frequencies due to wholesale price change

franchises. Our data was collected from holtankoljak.hu, and the script and datasets are publicly available at the link below[1].

In Section I-C, during our exploratory analysis, we discovered several well-known patterns and insights. However, we also found that the relationship between competition and pricing is not simply linear but exhibits a more complex structure in the market.

Moving to Section II-A, we performed OLS linear regression on the four main gas prices using data obtained from various sources, including ksh.hu. Both the backward elimination and full regression approaches yielded similar performance, with a root mean squared error of around 5 and an r-squared value of at least 80%. Notably, we found that the response of gas stations to a unit price increase by MOL (a major player) depends on the size of their franchises, as larger franchises exhibited a positive response while smaller ones did not.

In Section II-B, we examined the reasons behind the better performance of our regression model for Gasoline and Premium Gasoline prices. We discovered that gas stations generally align their prices with wholesale price changes in these cases. However, we could not draw the same conclusion for Benzin types.

Finally, in Section II-C, we conducted an analysis of price endings and confirmed the well-established psychological effects of price endings in economics.

Overall, our analysis provides valuable insights into the Hungarian gas market, shedding light on pricing dynamics, competition, and the influence of wholesale prices and psychological factors on gas station pricing.

[1]https://github.com/csabamedgyes/Hungarian-Gas-Market-Analysis

REFERENCES

[1] D. FARKAS, G. CSORBA, and G. KOLTAY, "Árak és koncentráció a magyar kiskereskedelmi üzemanyagpiacon." *Kozgazdasagi Szemle/Economic Review*, vol. 56, 2009.

[2] F. Rossi and P. K. Chintagunta, "Price transparency and retail prices: Evidence from fuel price signs in the italian highway system," *Journal of Marketing Research*, vol. 53, no. 3, pp. 407–423, 2016.

[3] K. Koh, S. Jeon, and J. Lee, "The effects of price competition on firms' operations and market price: Evidence from a retail gasoline market," *Energy Economics*, vol. 108, p. 105889, 2022.

[4] N. Huck, R. Y. Chenavaz, and S. Dimitrov, "Psychological prices at retail gasoline stations: the policies of 0-, 5-, and 9-ending prices," *Applied Economics*, vol. 53, no. 48, pp. 5584–5598, 2021.

[5] B. Choi, D. Kim, and H. C. Cho, "Price response, information, and asymmetry of price dispersion," *Applied Economics*, vol. 51, no. 39, pp. 4270–4281, 2019.
[6] X. González and M. J. Moral, "Effects of antitrust prosecution on retail fuel prices," *International Journal of Industrial Organization*, vol. 67, p. 102537, 2019.
[7] L. C. Cardoso, C. F. A. Uchôa, W. Huamani, D. R. Just, and R. V. Gomez, "Price effects of spatial competition in retail fuel markets: the impact of a new rival nearby," *Papers in Regional Science*, vol. 101, no. 1, pp. 81–105, 2022.
[8] F. Balmaceda and P. Soruco, "Asymmetric dynamic pricing in a local gasoline retail market," *The Journal of Industrial Economics*, vol. 56, no. 3, pp. 629–653, 2008.
[9] M. Alderighi and M. Baudino, "The pricing behavior of italian gas stations: Some evidence from the cuneo retail fuel market," *Energy Economics*, vol. 50, pp. 33–46, 2015.