

Fuel price pass-through in Cyprus

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Abstract

We analyse the pass-through of international oil price fluctuations to wholesale and retail fuel prices in Cyprus and test for the possibility of asymmetric pass-through (the “rockets and feathers” phenomenon). We analyse both the total adjustment of the general price level (from the international price to the average local retail price) and the intermediate stages: from the international price to the wholesale price and from the wholesale price to the retail price. We find no evidence of asymmetric price adjustment in the former channel, but we do find limited evidence of asymmetric adjustment in the latter channel.

Keywords: Rockets and feathers, asymmetric price adjustment, gasoline pricing.

1. Introduction

The adjustment of retail fuel prices to international price fluctuations has been the subject of an extensive economic literature, as well as a topic of intense public scrutiny in many countries. The expression “rockets and feathers” is often used to describe the idea of asymmetric adjustment of retail prices to changes in the price of the primary input. The claim is that local retail fuel prices rise quickly in response to increases in international oil prices but decline slowly in response to decreases in international oil prices. This widely held belief is often interpreted as evidence of collusion among fuel distributors or gas stations.¹

Dozens of papers have been written on this topic since Bacon’s (1991) initial study, but only one of them has included Cyprus.² Clerides (2010) found very weak evidence for the rockets and feathers phenomenon in Cyprus. The present study revisits this issue and improves on the earlier work in several ways, but mainly by exploiting more extensive and detailed data. International oil prices have fluctuated substantially in the period since the last study,

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¹This does not have to be the case. Remer (2015) finds evidence of asymmetric price adjustment but rejects the collusion hypothesis. A number of theoretical models that give rise to asymmetric adjustment without coordination have been proposed, most of them based on consumer search; for example, see Yang and Ye (2008), Lewis (2011), and Cabral and Fishman (2012).

² Clerides (2010) provides a useful summary of the literature up to that point. There is a continuous stream of papers being produced, mostly published in energy journals. Some recent examples include Remer (2015), Polemis and Tsionas (2017), Apergis and Vouzavalis (2018), Cook and Fosten (2018), and Eleftheriou, Nijkamp and Polemis (2019).

providing useful variation in the data. If the rockers and feathers phenomenon exists, it is easier to identify during periods of frequently changing prices.

A key advantage of the present study is the use of refinery prices, which are a better measure of the importers' cost than the crude oil price used in Clerides (2010) and in many other studies. We also obtained wholesale price changes for two fuel distribution companies. We were thus able to analyse the chain of pass-through from the international price to the wholesale price to the retail price. As with much of the literature, we used the error correction model as the main method of analysis. When appropriate, this was complemented with other types of analysis.

We found no evidence of asymmetric adjustment of the retail price to changes in refinery prices. Convergence rates are slightly higher when prices are lower, but the difference is far from being statistically significant. The same result emerges from the ECM model for the refinery-to-wholesale price channel. However, some descriptive evidence seems consistent with *reverse* asymmetric adjustment along this channel. This is an interesting finding, especially when viewed in conjunction with the fact that wholesale price changes are highly synchronized, even though firms purchase fuel at different times. In the retail channel we found mixed evidence, with some stations exhibiting asymmetric adjustment of the rockets-and-feathers type while others exhibit reverse asymmetry. Our overall conclusion is that some degree of asymmetric adjustment occurs in the Cyprus fuel market, but it is not a first-order phenomenon.

2. Market, data and methodology

2.1. From the oil field to the pump

The journey of fuel from its source to the gas station goes through several stages, each of which is associated with a different price. When people speak of the international oil price, they usually refer to the Brent or WTI prices of a barrel of crude oil. Crude oil is refined to produce different fuels that are used to power different types of engines. Refineries enter into bilateral contracts with buyers, who are fuel distribution companies. The contracts determine the terms of the exchange, including prices. S&P Global Platts is an information provider that collects contract prices and constructs daily price indices for each type of fuel. Platts prices are used internationally as an index of the cost of refined fuel on a particular day. There are several indices; the appropriate index for Cyprus due to its geographical location is Platts Basis Italy.

Refined fuel goes through another stage of processing that involves filtering and the addition of additives. The final product is then distributed to retailers (gas stations) under the distributor's brand name. Some distributors may sell fuel to other resellers who supply their own network of retailers, or directly to independently owned and managed gas stations.

2.2. Market structure

There were three importers of automobile fuel into Cyprus in 2018: Hellenic Petroleum Cyprus, ExxonMobil Cyprus and Petrolina.³ Hellenic Petroleum Cyprus is a wholly owned subsidiary of Hellenic Petroleum (ELPE). It distributes its products under the EKO brand name through a network of 94 stations and claims a 32.5% market share. ExxonMobil Cyprus

³ All information in this paragraph obtained from company websites on September 4, 2017.

runs a network of 60 stations under the Esso brand name. Petrolina is a locally owned company that sells fuel under the Petrolina and Agip/Eni brand names through a network of 100 stations.⁴

All three importers purchase refined fuel primarily from the ELPE-owned Aspropyrgos refineries in Greece.⁵ Each company has a separate contract with the refinery with different terms and different delivery schedules. The importers supply affiliated retailers (gas stations) with fuel. In addition, some importers sell fuel to distributors, who then go on to resell it through their own station networks. The largest one of these distributors was Lukoil, with a network of 31 stations.⁶ The remaining stations are affiliated with smaller networks such as Staroil (10 stations) and Total Plus (4), or are independently owned and operated.

We do not have any information on the transactions between importers and distributors. We will use the term wholesale price to refer to the price at which distributors sell fuel to the gas stations. Gas stations sell the fuel to consumers at the retail price.

2.3. Data

We have two main sources of data: (a) weekly data at the national level for European Union (EU) countries; and (b) daily data at the distributor and gas station level. We will focus on the two main fuel types used by automobiles: 95-octane unleaded gasoline and diesel engine fuel. We will henceforth use the terms gasoline and diesel to refer to the two fuel types.

The EU's Oil Bulletin reports prices of several types of fuel in every member country. Prices are weekly; the guideline is to report Monday prices, and substitute with next day prices if those are not available. We collected prices for gasoline and diesel fuel for the period January 2009 to June 2016. For the same period we obtained daily Platts prices for the two types of fuel from the Consumer Protection Service (CPS) of the Ministry of Energy, Commerce, Industry and Tourism.⁷

The CPS provided us with two more price series. The first is a series of wholesale price *changes* from two of the three fuel importers for the period 1/12/2012-30/8/2017. For the other two major distributors we have recommended retail prices instead of wholesale prices. For confidentiality reasons it was not possible to have actual wholesale prices, but changes in prices are sufficient for our analysis. The second price series is the daily price at every gas station in Cyprus. It covers a period of about 22 months, from 21/10/2015 to 24/8/2017. There are 306 active gas stations during this period.

Asymmetric adjustment could occur at every stage of the distribution chain: from the price of crude oil to the price of the refined fuel (Platts); from the Platts price to the wholesale price;

⁴ The Agip brand name is being used on the basis of an agreement with its owner, Eni S.p.A. Under the latest agreement between Petrolina and Eni, which came into force on January 1, 2017, Agip stations will be rebranded to Eni (<http://www.petrolina.com.cy/Portals/0/PropertyAgent/898/Files/727/30.1.17%20Petrolina%20-%20Eni%20Cooperation.pdf>, accessed December 10, 2019).

⁵ Petrolina purchases its diesel fuel from an alternative supplier.

⁶ In January 2017, Greek distributor Motor Oil Hellas (MOH) announced the purchase of Lukoil's network of 31 stations. In the fall of 2017 the company started switching the stations to the Shell brand name managed by MOH. MOH owns refineries in Greece and is expected to start importing its own fuel, but to our knowledge has not done so yet.

⁷ For confidentiality reasons, the CPS provided us with a masked index (prices were multiplied by an unknown constant).

and from the wholesale price to the retail price. Our analysis focuses on the last two stages. We will first use the weekly data to analyze the pass-through from the Platts price to the market-level retail price. We will then turn to the daily distributor and station data to investigate the two sub-stages: from Platts to wholesale and from wholesale to retail.

3. Methodology

Our main tool of analysis will be the widely used Error Correction Model (ECM). In addition, we will use informal methods that look for patterns in the data that are consistent with asymmetric adjustment. We explain each below.

3.1. The Error Correction Model (ECM)

The error correction model (ECM) is the workhorse model of this literature. Borenstein, Cameron and Gilbert (1997, henceforth BCG) modified the standard ECM to allow for asymmetric adjustment, and Bachmeier and Griffin (2003) added some further refinements to the model. Our analysis follows Remer's (2015) exposition; we will provide a sketch of the model here and refer the interested reader to Remer (2015) for the details.

The ECM describes the relationship between two variables and its evolution over time. The two variables are assumed to be linked by a stable long-run causal relationship.⁸ A change in the independent variable (the wholesale price in our case) is passed through to the dependent variable (the retail price) at a fixed rate (not necessarily one-to-one). The adjustment is gradual, meaning that a shock to the independent variable leads to the long-run relationship being temporarily disturbed. The relationship is restored when the pass-through is complete.

The econometric model consists of two equations. The first equation describes the long-run relationship. It is a simple univariate regression of the retail price on the wholesale price. The residual from this equation is the deviation of the retail price from its long-run level. To be concrete, let R_t and C_t denote the retail and wholesale price respectively (the wholesale price is denoted by C because it is the firm's cost). The long-run relationship is specified as:

$$R_t = \varphi_0 + \varphi_1 C_t + \varepsilon_t \quad (1)$$

The second equation describes the adjustment process. The dependent variable is the change (Δ) in the retail price. The set of regressors is constructed from three variables: the change in the wholesale price, the change in the retail price, and the deviation calculated in the first step. Several lags of changes in retail and wholesale price can be included. The equation takes the following form:

$$\Delta R_t = \sum_{j=0}^n \beta_j \Delta C_{t-j} + \sum_{j=1}^n \gamma_j \Delta R_{t-j} + \vartheta_1 (R_{t-1} - \hat{\varphi}_1 C_{t-1} - \hat{\varphi}_0) + \eta_t, \quad (2)$$

where $\hat{\varphi}_0$ and $\hat{\varphi}_1$ are the estimated parameters from the first equation.

In order to allow and test for asymmetry, each variable is split into two variables, one containing the positive values (and replacing the negative values with zeros) and one containing the negative values (and replacing the positive values with zeros). We therefore

⁸ In econometric terms, the assumptions are that the two series are non-stationary (have a unit root) and are cointegrated of order one. In all cases below these assumptions were tested and confirmed using the appropriate econometric tests (augmented Dickey-Fuller test).

estimate two coefficients, one measuring how the retail price responds to *increases* in the value of the wholesale price and one measuring how the retail price responds to *decreases* in the value of the wholesale price. The final equation allowing for full asymmetry is notation-heavy and we do not display it here.⁹

3.2. Additional evidence

In addition to the econometric model, we will look for patterns in the data that might reflect asymmetric price adjustment. Our approach is based on a simple insight. If the retail price adjusts symmetrically, the length of time between two price changes should be independent of whether the second price change is an increase or a decrease. If the adjustment process is asymmetric (in the rockets-and-feathers sense), then we would expect a price to remain at the same level longer when followed by an increase than when followed by a decrease.

The above claim is a natural consequence of delayed pass-through when rockets-and-feathers holds. To illustrate this point, we sketch a simple model that is designed to mimic the Cyprus market as closely as possible, while noting that many other markets operate in a similar way. Consider a firm buying fuel from the international market at a price we shall call the wholesale price. Assume that every period the wholesale price increases or decreases with equal probability. The firm purchases fuel once every N periods and has a policy of charging a retail price equal to its marginal cost plus a fixed markup. Assume that there are no other costs, so that marginal cost in each period is equal to the wholesale price the firm paid when it last purchased fuel. To be concrete, suppose the firm makes a purchase at time t and then again at time $t + N$. Then its marginal cost in periods $t, t + 1, \dots, t + N - 1$ is equal to the wholesale price at time t . Mathematically, if W_t is the wholesale price then the cost $C_t = W_{t-t \bmod N}$, where $t \bmod N$ is the remainder from the division $\frac{t}{N}$ and denotes the number of periods since the last purchase.

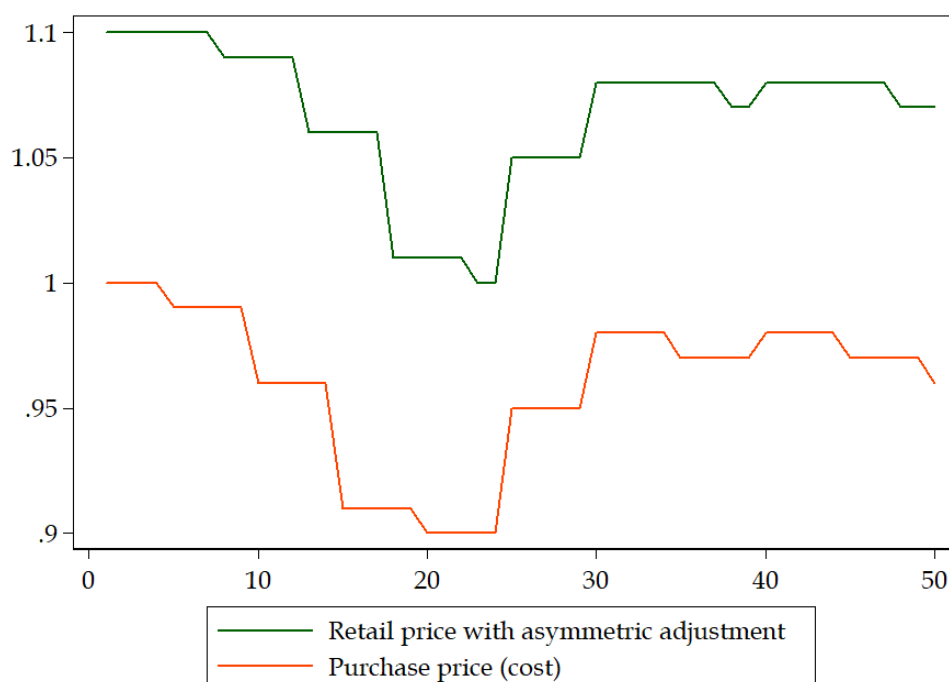
Consider the case of symmetric adjustment and assume for convenience that the firm adjusts its retail price immediately. Then the retail price will always be equal to cost plus the fixed markup. The longevity of a price (the time between price changes) will be independent of whether its end is brought about by an increase or a decrease in price. Now suppose that the firm adjusts the retail price asymmetrically: when the purchase price rises, it immediately raises the retail price by the same amount. When cost decreases, it lowers the retail price with a one period delay. As a result, price levels will last longer if they are followed by a price increase instead of a price decrease.

In order to illustrate the patterns we simulate this model with $N = 5$, the initial wholesale price $W_0 = 1$, and with a price increment equal to .1. We set the delay in adjusting prices upwards to three periods in order to make effects more pronounced. Figure 1 displays the wholesale and retail prices for the first 50 periods only, in order for the effects to be visible. One can observe that prices linger at the same level for longer when they are followed by decreases rather than increases. This is also borne out in the overall statistics: the mean time before a price increase and a price decrease if we simulate the model for a long time converges to 3.5 and 6.5 respectively.

⁹ For the interested reader, it is equation (3) in Remer (2015).

FIGURE 1

Simulation of asymmetric price adjustment



4. Analysis

4.1. Pass-through from Platts to retail price

We analysed the pass-through from the Platts price to the average retail price using the weekly data described in section 2.3. The evolution of the Platts and retail prices for gasoline and diesel are displayed in Figure 2 and Figure 3. The Platts price indices are normalized to 1 in the first period of data. A cursory examination of the graphs shows that changes in retail prices follow changes in Platts prices with some lag, but more precise conclusions are not possible from just looking at the pictures.

We use the ECM model to formally test the asymmetric adjustment hypothesis from Platts to retail for the period January 2009 to June 2016. Based on the Akaike Information Criterion (AIC), we included five lags in the model. This lag length also makes intuitive sense as we use weekly data, and it is reasonable to expect price changes to dissipate within five weeks. This means that for each fuel type we estimate 25 coefficients that have no clear interpretation. The best way to present the results is by computing and graphing the *cumulative response function (CRF)*, as in BCG and Remer (2015). The CRF computes how a unit change in the independent variable (the Platts price) passes through to the dependent variable (the retail price). We estimate one CRF for positive changes and one for negative changes, and compare the result.

FIGURE 2

Platts price index and retail price for gasoline

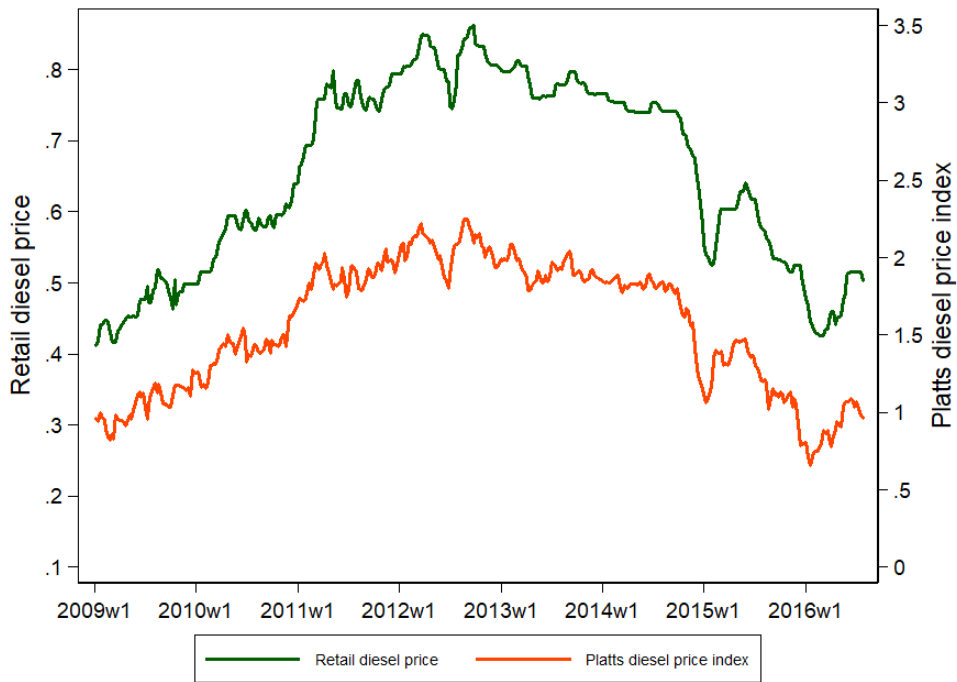
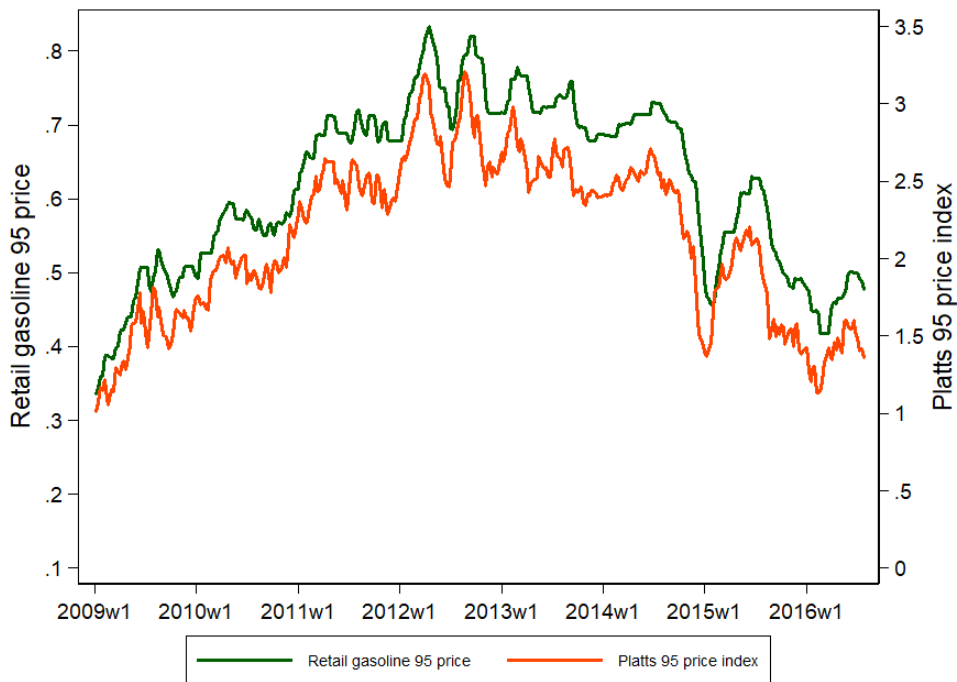


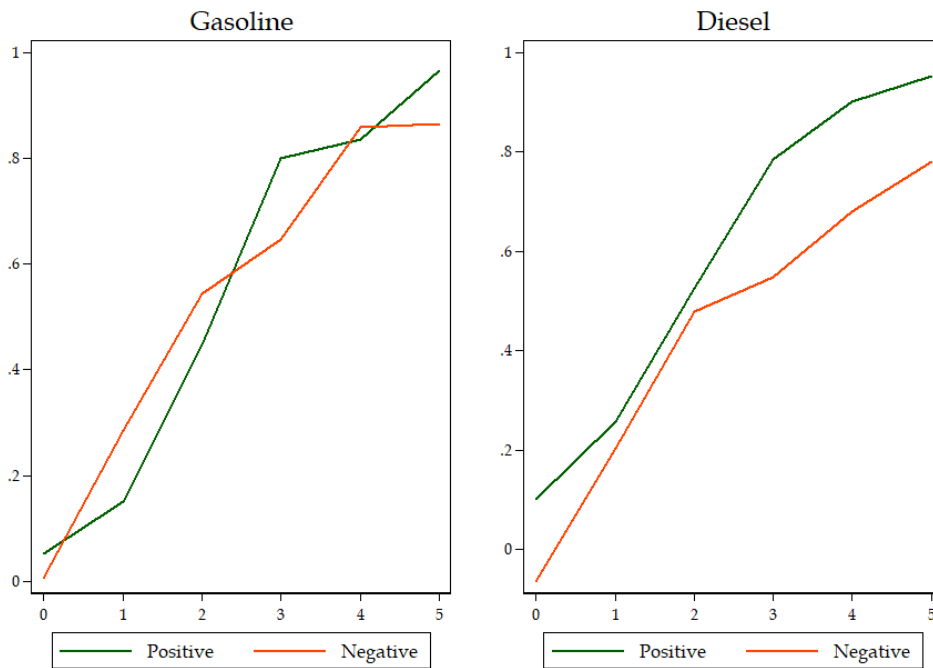
FIGURE 3

Platts price index and retail price for diesel



The two CRFs are displayed in Figure 4. The CRFs for gasoline are closely aligned. There is no evidence of asymmetric adjustment. The CRFs for diesel fuel start off very close together but split off after the third week. Given that the confidence interval around the CRFs widens as we move further from the time of the initial change, this difference is unlikely to be statistically significant. Moreover, this pattern is different from that reported by BCG and Remer (2015), who found evidence of asymmetric adjustment. In those cases, the asymmetry shows up at the beginning and then dissipates over time. Indeed, this is what the rockets-and-feathers hypothesis predicts. We conclude that the evidence does not give any support to the asymmetric adjustment hypothesis.

FIGURE 4
Cumulative response functions from Platts to retail



An additional test is to compare the estimates of ϑ_1^+ and ϑ_1^- , which measure the price adjustment speed given the previous period's deviations from the long-run relationship. The estimates are provided in Table 1; the first two rows give the estimates for gasoline and the next two for diesel. All estimates are negative, as they should be: if deviations are positive (negative), price should go down (up) in order to converge to its long-run level. In both cases $|\vartheta_1^+| < |\vartheta_1^-|$, meaning that convergence is faster when deviations are negative. This is consistent with the rockets-and-feathers hypothesis, but the difference between the coefficients is small and statistically insignificant. In fact the results closely mirror the evidence from the CRFs: in the case of gasoline, the thetas are precisely estimated but very close to each other; in the case of diesel, ϑ_1^- is almost twice the size of ϑ_1^+ but it is imprecisely measured and statistically indistinguishable from zero.

TABLE 1
Estimates of ϑ_1^+ and ϑ_1^- from different models

Channel and data		Estimate	Std. error	p-value
Platts to average retail price, weekly data Gasoline	ϑ_1^+	-0.204	0.034	0.000
	ϑ_1^-	-0.216	0.087	0.014
Platts to average retail price, weekly data Diesel	ϑ_1^+	-0.055	0.023	0.015
	ϑ_1^-	-0.100	0.078	0.199
Platts to wholesale, daily data Company A, gasoline	ϑ_1^+	-0.027	0.011	0.017
	ϑ_1^-	-0.033	0.014	0.021
Platts to wholesale, daily data Company B, gasoline	ϑ_1^+	-0.029	0.011	0.011
	ϑ_1^-	-0.031	0.014	0.026
Platts to wholesale, daily data Company A, diesel	ϑ_1^+	-0.025	0.014	0.082
	ϑ_1^-	-0.037	0.017	0.028
Platts to wholesale, daily data Company B, diesel	ϑ_1^+	-0.027	0.014	0.044
	ϑ_1^-	-0.034	0.016	0.040

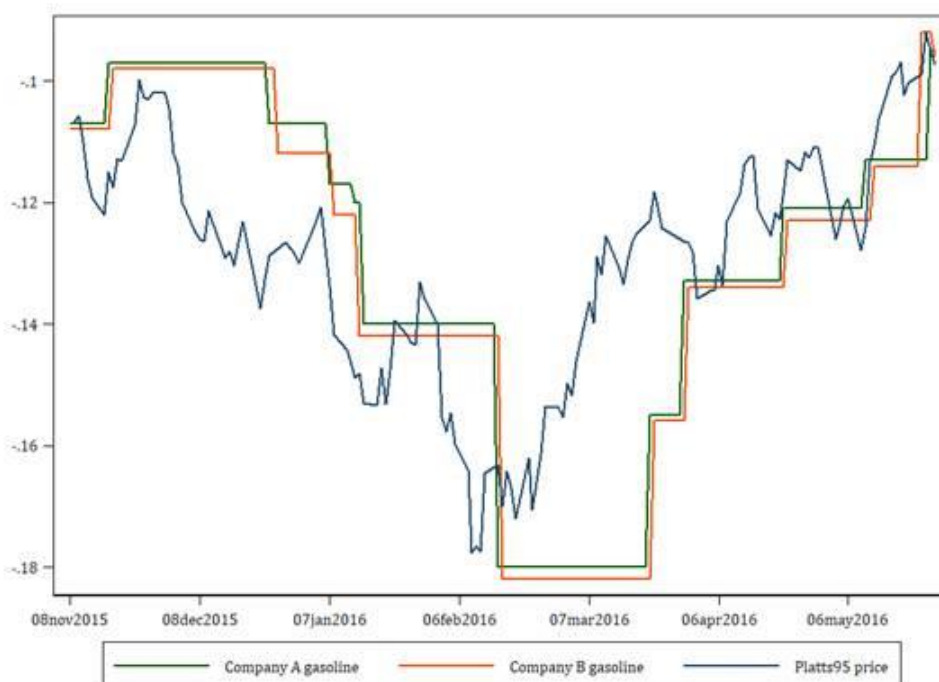
Note: Coefficients in bold are significant at the 5% level. Equality tests were conducted for each pair of thetas; the null of equality was never rejected.

4.2. Pass-through from Platts to wholesale price

Our wholesale data cover the period December 2012 to June 2016. Recall that we have changes in wholesale prices, not the prices themselves, for two importers. Figure 5 shows the Platts price and the change in the retail price for each company between November 2015 and May 2016. We chose this six-month window because it includes a gradual drop in price followed by a gradual increase. We observe that changes in the wholesale prices are far less frequent than changes in the Platts price. The average number of days between price changes is about 17 for gasoline and 20 for diesel. This is consistent with the fact that importers receive shipments once every 2-3 weeks.

FIGURE 5

Platts prices and changes in wholesale gasoline prices



We estimated the ECM model for the pass-through from the Platts price to the wholesale price. The AIC criterion indicated that the optimal lag length is one. This suggests that additional lags provide little explanatory power and the resulting CRFs would have large standard errors and therefore be uninformative. We estimated the model using one lag as indicated by the AIC criterion and report the estimates of ϑ_1^+ and ϑ_1^- in Table 1. We have two companies and two fuel types, giving us four models in total. Seven of the eight coefficients are statistically significant at the 5% level; the eighth one is significant at the 10% level. In all four cases, cases $|\vartheta_1^+| < |\vartheta_1^-|$, as conjectured by the rockets-and-feathers hypothesis. But the differences between the estimates are very small and are far from being statistically significant (all four p-values for the equality test are > 0.65).

We conducted an additional test on the basis of the simple insight described in section 3.2. We counted the number of price increases and decreases, as well as the average duration of a price before an increase and before a decrease. If rockets-and-feathers exists, then we would expect prices preceding a decrease to last longer than prices preceding an increase.

The figures are presented in Table 2. We note that during the period under examination Platts prices increased about 48% of the time and decreased 52% of the time. For companies A and B, the frequency of decreases is even larger (about 58%), which is consistent with asymmetric adjustment in the opposite direction than what the rockets-and-feather hypothesis suggests. The same is true for price duration, which is greater before increases than it is before decreases. In the case of company C there are indications of asymmetric adjustment in the conjectured direction but the number of observations is too small to allow for robust conclusions. The small number of observations is also the reason we did not estimate the ECM for this company. Overall, the results from this simple exercise indicate reverse asymmetry, but definitive statements are not possible in the absence of formal statistical testing.

TABLE 2
Frequency of changes in wholesale price and time between changes

Company	Fuel	Price increases	Price decreases	Mean time before increase	Mean time before decrease
A	Gasoline	32	45	22.5	13.4
	Diesel	27	42	23.1	17.2
B	Gasoline	32	47	22.4	13.2
	Diesel	27	41	23.8	17.2
C	Gasoline	6	5	10.5	13.4
	Diesel	7	4	9.0	16.8

An additional piece of evidence is that the mean increase in price is greater than the mean decrease in price for all three companies and both types of fuel. A possible explanation that is also consistent with the findings above is that companies avoid frequent price increases. They prefer to have fewer and larger increases, relative to decreases, perhaps in order to minimize the negative publicity associated with price increases.

4.3. Pass-through from wholesale to retail price

We used the daily data for 306 gas stations in the period 21/10/2015 – 24/8/2017 to look for evidence of asymmetric adjustment at the retail level. The frequency of price increases at gas stations is about 45.5% of all price changes. This is somewhat higher than the percentage observed in wholesale price (Table 2). At the same time, there is substantial variation across stations, as illustrated in Figure 6. In about 76% of stations we observe a higher frequency of price increases than we observe in wholesale prices. For most stations the difference is small, as indicated in the figure. We investigated whether this variation can be traced back to the supplier, but were unable to uncover any relationship.

We computed the mean price duration before increases and before decreases for 285 stations with sufficient data. The results are displayed in Figure 7. The color of the dots represents the company with which the station is affiliated. If we have the same number of wholesale price increases and decreases and adjustment is symmetric, then we would expect all points to be on the 45 degree line. If adjustment is asymmetric of the rockets-and-feather type, then dots should be above the 45° line. In actuality we have more decreases than increases of wholesale prices, hence we expect more stations to be below the line than above. This is indeed the case: 48 stations are above the line and 237 are below.

We estimated the ECM for 239 stations with sufficient data, including 44 of the 48 stations that are above the line mentioned in the previous paragraph. We find evidence in favor of the rockets-and-feathers hypothesis for 41 of those stations. Hence the findings of the ECM are consistent with the conclusions from the descriptive analysis of price increase and decreases. The rockets-and-feathers hypothesis is not confirmed in general, but we do find a number of stations exhibiting behavior that is consistent with it. The evidence is not conclusive but suggests that further investigation may be needed.

FIGURE 6

Price increases as fraction of all price changes, across stations

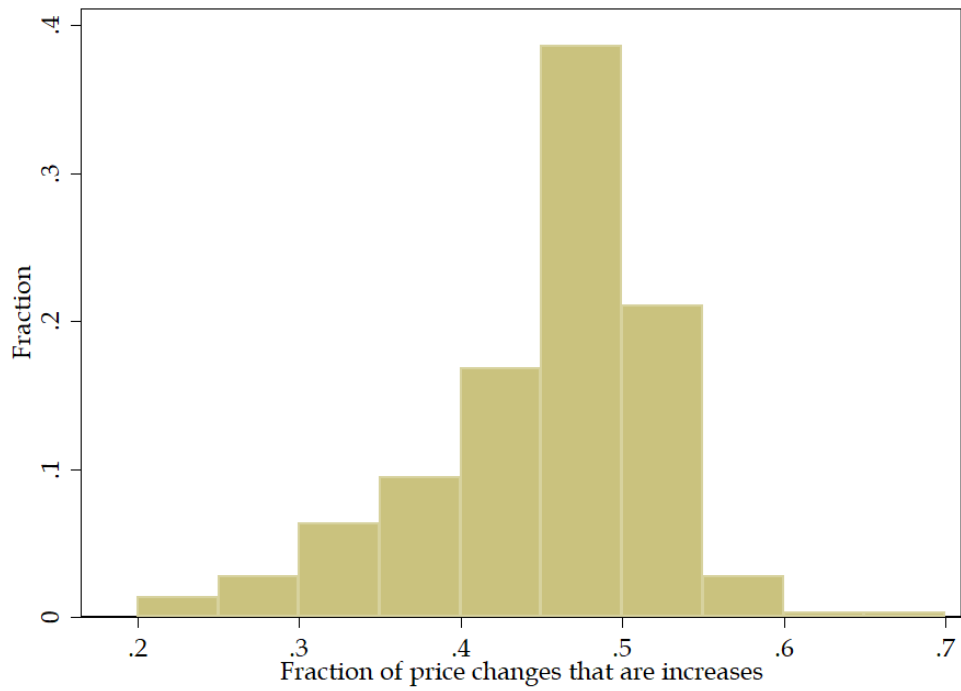
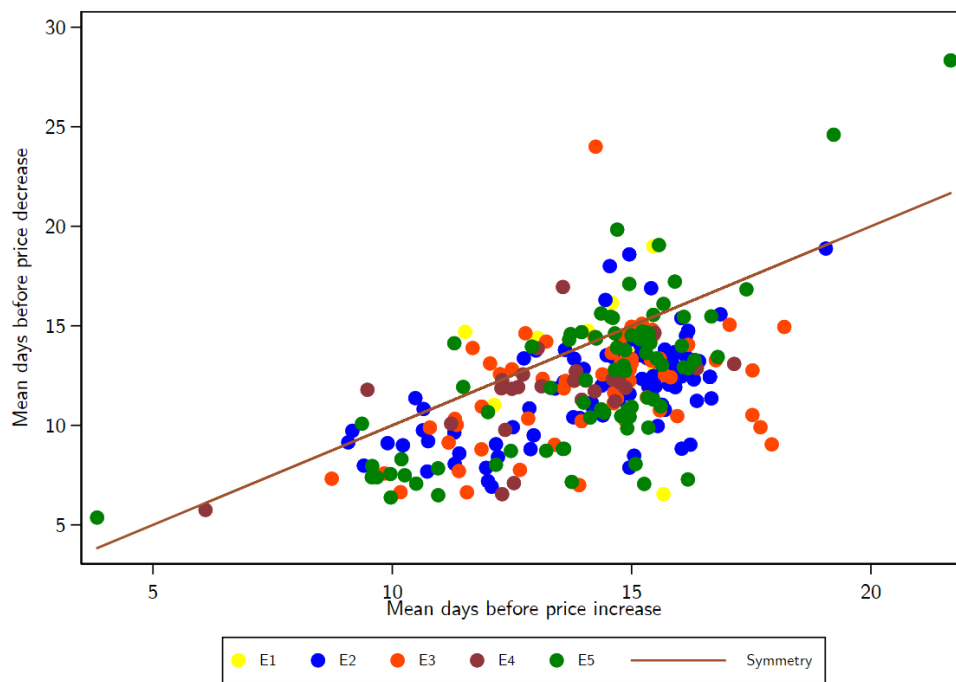


FIGURE 7

Mean time before price increase/decrease by station



5. Summary

We have investigated the possibility of asymmetric adjustment in the pricing of fuel in Cyprus. We used weekly data to examine the adjustment of the average retail price to changes in the international price and found no evidence of asymmetry. We further investigated two sub-stages of this process using daily data from two fuel distributors and the retail data at the station level. We found evidence of asymmetry in the adjustment from the international price to the wholesale price, but the asymmetry is in the opposite direction from that prescribed by the rockets-and-feathers hypothesis. The analysis of the adjustment from the wholesale price to the retail price produced mixed results, with evidence of asymmetry pointing in both directions. For a number of stations there is enough evidence of asymmetry of the rockets-and-feathers kind to warrant further investigation with more detailed data.

The finding of reverse asymmetry in the refinery-wholesale price adjustment also warrants further investigation, especially in conjunction with the observation that firms adjust their wholesale prices almost simultaneously, even though they purchase fuel at different times. Data on purchase dates would be very helpful in conducting such an analysis.

The paper aims to provide an answer to a specific question: do the data provide any support to the rockets-and-feathers hypothesis? Our conclusion is that the analysis does not support the hypothesis of widespread behavior of this type, but does find some evidence for a subset of market participants. It should be noted that we are not trying to investigate the possibility of collusion or to establish whether the price level is what would have prevailed if this was a competitive market. Had we found evidence of asymmetric adjustment, this could have been taken as evidence of collusion between distributors and/or stations. The fact that we do not find such evidence does not mean that there is no collusion, as this could have been achieved in other ways.

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