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Retail Fuel Price Response to Oil Price Shocks in EU Countries

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Abstract

There is a widely held belief that retail fuel prices rise very quickly following an increase in international oil prices but fall slowly when oil prices decrease. This study uses data from European Union countries to investigate the response of retail gasoline prices to changes in the world oil price. The findings indicate significant variation in the adjustment mechanism across countries. Fluctuations in the international price of oil are transported to local prices with some delay but evidence of asymmetric adjustment is fairly weak. Statistically significant evidence of asymmetric responses is only found in a small number of countries, while in some countries there is even (weak) evidence of asymmetry in the reverse direction: prices drop faster than they rise. For the case of Cyprus our estimates show that prices adjust somewhat faster to an increase in the international price than they do to a decrease, but the difference is neither statistically significant nor substantial in terms of economic consequences.

Keywords: asymmetric price response, rockets and feathers, retail fuel prices.

1. Introduction

The relationship between the international price of oil and retail fuel prices has been a subject of public debate in many countries, Cyprus being one of them. There is a widely held belief that oil companies and retailers rush to increase prices in local markets as soon as international oil prices rise, but do not respond with the same eagerness when international prices fall. This phenomenon is known in the economic literature as asymmetric price adjustment. It has also been labeled as the 'rockets and feathers' phenomenon, reflecting the notion that prices rise like a rocket and drop like a feather. If that is indeed true, it would imply that retailers have the opportunity of earning increased profits at the expense of consumers.

The possibility of asymmetric adjustment of local fuel prices to world oil price fluctuations has sparked the interest of economic researchers. During the last two decades, dozens of economic studies have examined this very

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question based on the experience of various countries at various times. The issue has also been taken up by the European Commission, which recently conducted a related study in 15 EU countries. The findings of the literature differ from country to country and even within the same country, depending on the period considered and the data and econometric methods applied. Several studies detect strong evidence of asymmetric price adjustment, whereas others do not.

The purpose of this paper is to present the findings of an analysis of retail gasoline price adjustment in European Union countries, paying special attention to Cyprus. The analysis applies the same methodology that has been widely used in the international literature. The econometric method separates the price adjustment mechanism into a direct (or short-term) and an indirect (long-term) component. This makes it possible to seek answers to three questions that are of interest to both researchers and policy makers.

The first question concerns the *rate of adjustment* of the prices, that is, the percentage of an increase in the world price that is passed onto the local price. If an increase in the international price is transferred one-to-one to the local market, then we say that the rate of adjustment is 100% and we have complete cost pass-through. The second question concerns the *speed of adjustment*. How long does it take for the change in the international price to be fully transmitted to the local market? The third and most controversial question concerns the *symmetry of adjustment*. Is the rate of adjustment to increases and decreases of the international price the same? Or do companies delay responding to international price reductions in order to enjoy greater profits?

The results of our analysis indicate that fluctuations in the international price of oil are transmitted almost one-to-one to local prices, and that they do so with some delay. However, evidence of asymmetric adjustment is weak. Statistically significant evidence of asymmetric responses is only found in a small number of countries, while in some countries there is even (weak) evidence of asymmetry in the reverse direction: prices drop faster than they rise. For the case of Cyprus our estimates show that prices adjust slightly faster after an increase in the international price than they do to after a decrease, but the difference is neither statistically significant nor substantial in magnitude. The behaviour of prices in the Cypriot market is generally similar to the markets of other European countries.

The absence of evidence of asymmetric price adjustment should not be regarded as a definitive rejection of this possibility. The data used in this study - as in most other studies on the topic - are not ideal and one cannot rule out the possibility that the same analysis can reach different

conclusions if executed using more detailed data. What can be said with a fair amount of certainty is that the emphasis given to this issue is probably exaggerated. Even if asymmetric adjustment does occur, the additional income derived by companies from such practices is relatively low and transient. What matters more is whether companies' profit margins are at a level that corresponds to a reasonable return on capital. Even a slight deviation from those levels on a permanent basis translates into much greater profits than a temporary overcharge in times of turbulence in international oil markets. An investigation of this issue would be very useful, but a proper analysis requires detailed data that are not publicly available.

2. Theoretical issues

This section analyzes from a theoretical standpoint the main factors that determine the rate, speed and symmetry of adjustment of retail fuel prices to international price fluctuations.

The term 'rate of adjustment' refers generally to the rate at which changes in the (marginal) cost are transferred to retail prices (cost pass-through). If, for example, the marginal cost of production of a good increases by one, how much will the final price of the good increase? In general, the answer depends on the nature of demand and on the intensity of competition in the market. In a perfectly competitive environment where price equals marginal cost, the rate of adjustment is 100%: any change in the marginal cost will be fully transmitted to the retail price. In monopoly markets, the rate of adjustment depends on the shape of the demand curve. For example, in the case of linear demand and constant marginal cost the rate of adjustment is only 50%, whereas in the case of isoelastic demand the rate of adjustment is in excess of 100%. Broadly speaking, it can be said that the rate of adjustment is greater when competition is more intense.

The speed of adjustment is mainly influenced by two factors. One is adjustment costs, which are costs that companies incur in order to compute the new prices and publish them in new price lists. These costs might be large in some industries and small in others. If prices are determined by a simple rule of thumb, which is likely the case for gasoline, the cost of calculating the new price is very low. The cost of making prices public also does not seem to be particularly high for oil companies, as it only requires an update of the signs outside the stations. Especially in light of currently available technology, adjustments costs are unlikely to be a major cause of rigidity in retail oil prices. The second factor affecting the speed of adjustment is inventories. If companies have reserves of a raw material

whose price suddenly changes, they have the choice of adjusting the retail price immediately or waiting until they receive the next shipment for which they will pay the new price. This element is very important in the case of fuel and complicates the problem greatly because it transforms it from a static to a dynamic one. A monopoly will prefer the second option because it is already maximizing profits at the current price and has no reason to change it. With more than one company in the market, the problem becomes more complex because it is difficult to predict how companies with different inventory levels will react to a change in cost.

The symmetry of adjustment is the most controversial issue. One factor that may lead to asymmetry is the exploitation of market power by companies, either independently or in some form of collusive arrangement. Asymmetry of adjustment can also occur if the cost of adjustment is different when prices rise than when they fall. The economic literature has proposed various mechanisms that might lead to asymmetric adjustment costs. The most plausible one suggests that if the elasticity of demand is high, then a company that reduces its price may not have sufficient reserves to meet demand and this creates a disincentive to unilaterally lower prices. However, the idea that differences in adjustment costs can explain asymmetric responses has not gained much traction.

The possibility that some form of collusion is behind asymmetric price responses has been raised by many researchers, yet there are no formal models detailing how collusion might be sustained in this setting. There is also no empirical evidence on how firms or gas stations might coordinate. Recent theoretical work by Yang and Ye (2008) and Tappata (2009) has provided a rationale for the existence of asymmetric price responses based on consumer search costs. This work is not the final word on this issue but it opens promising new possibilities for further research.

3. International evidence

The study of the relationship between the international price of oil and retail fuel prices was pioneered by Bacon (1991). Bacon's finding of asymmetric responses to oil price shocks in the UK led to a proliferation of studies examining the same question in a variety of different settings and using different data and methods. Most studies have used data from the United States but there are also many studies covering European and other countries. Data are often aggregated spatially (to the regional or national

level) and/or temporally (prices are observed once a week or month, or are averaged over some period). Aggregation can make it difficult to draw robust conclusions from the analysis.[1] Improvements in information technology now make possible the collection of daily price information at the individual station level. Such data have been utilized in recent work by Faber (2009) for the Netherlands and Remer (2010) for the US.

Table 1 provides a summary of 20 published articles and working papers dated between 1991 and 2010. About half of these studies use data from the United States and the rest from various other countries. The majority of the studies find evidence of asymmetric response to oil prices. At the same time, several studies find no evidence of asymmetry, suggesting that the phenomenon is not universal. One of the more recent studies cited in Table 1 was conducted by the Directorate General for Economic and Financial Affairs of the European Commission and covers 15 EU countries. The study focused on the prices of gasoline, diesel oil and heating oil and the results showed quite different behaviour across countries. Some evidence of different rate and speed of adjustment were identified for a small number of countries, but the study's general conclusion is that there is no significant evidence of systematic asymmetry of adjustment. The analysis reported here can be seen as an extension of the aforementioned study, covering a longer time period and more countries, including Cyprus.

[1] See Geweke (2004) for a discussion of this and other related issues.

TABLE 1

Summary of the international literature

YEAR	RESEARCHERS	COUNTRIES	DATA	FINDINGS
1991	Bacon	United Kingdom	Per 15-days 1982-1989	Slower adjustment to decreases, as compared to increases, by 1 week.
1991	Manning	United Kingdom	Monthly 1973-1988	No evidence of asymmetry. Slower adjustment of prices than found in Bacon (1991).
1992	Kirchgässner and Kübler	W. Germany	Monthly 1972-1989	Adjustment costs led to delays in price change. Strong evidence of asymmetry in the short-run.
1994	Shin	USA	Monthly 1982-1990	No evidence of asymmetry.
1996	Duffy-Deno	USA	Weekly 1989-1993	Significant asymmetries. Full adjustment of final prices when the price of oil rises and imperfect adjustment when it declines.
1997	Borenstein, Cameron and Gilbert	USA	Weekly 1986-1992	Asymmetry. Retail prices reacted faster to increases than to decreases in the international price (4 and 8 weeks respectively).
1998	Balke	USA	Weekly 1987-1997	No clear evidence for the existence of asymmetry. Consistent with ECM.
1998	Akarca and Andrianacos	USA	Monthly 1976-1997	From 1986 onwards, prices reflect higher profit margins for oil companies, they are less sensitive to price fluctuations and are more volatile.
2000	Asplund, Eriksson and Friberg	Sweden	Monthly 1980-1996	Price responses are slower to decreases in the price of oil than they are to increases.
2002	Eckert	Canada	Weekly 1989-1994	Asymmetry in the reaction of retail prices. Faster reaction to increases of the international prices than to decreases. The price increases are more sensitive to cost fluctuations, whereas decreases occur more for the larger market shares.
2002	Salas	Philippines	Weekly 1999-2002	The speed of adjustment of retail prices in their long-term equilibrium with the price of crude oil follows an accelerating trend. The final prices respond more quickly and completely to increases in the price of oil than to decreases.

(Table 1 continues on next page)

TABLE 1 (continued)

YEAR	RESEARCHERS	COUNTRIES	DATA	FINDINGS
2003	Bachmeier and Griffin	USA	Daily 1985-1998	No evidence of asymmetry.
2007	Grasso and Manera	France, Italy, Spain, Gernamy, United Kindom	Monthly 1985-2003	1. Some evidence of asymmetry in all countries in the distribution sector. 2. No asymmetric pricing, especially in France and in Germany. 3. Long-term asymmetry for each country in the direct changes of retail prices as compared to the change in the international price of oil.
2008	Deltas	48 USA states	Monthly 1988-2002	Asymmetry in the average difference between wholesale and retail price and the speed of adjustment of retail prices. Correlation of this difference with market competitiveness.
2008	Kuper and Poghosyan	USA	Weekly 1986-2005	Pre 1999: International oil price adjusts linearly to deviations from the long-term equilibrium. Post 1999: Non-linear approach of the price to the long-term equilibrium. During the post-1999 period, retail prices increased at a faster pace after an oil shock than during the pre-1999 period.
2009	European Commission	Several EU countries	Weekly Time period varies	Mixed evidence for asymmetry in the markets for heating oil, diesel oil and gasoline. Evidence significant in only a small number of countries. Weak evidence of reverse asymmetry in some countries.
2009	Faber	Netherlands	Daily 2006-2008	Tests for asymmetric response at the individual station level. Finds that 38% of stations respond asymmetrically. No evidence of asymmetry at the level of the oil companies.
2009	Valadkhani	Australia	Monthly 1998-2009	Evidence of asymmetry in four out of seven Australian capital cities.
2010	Bermingham and O' Brien	UK, Ireland	Monthly 1997-2009	No evidence of asymmetry.

4. Data and methodology

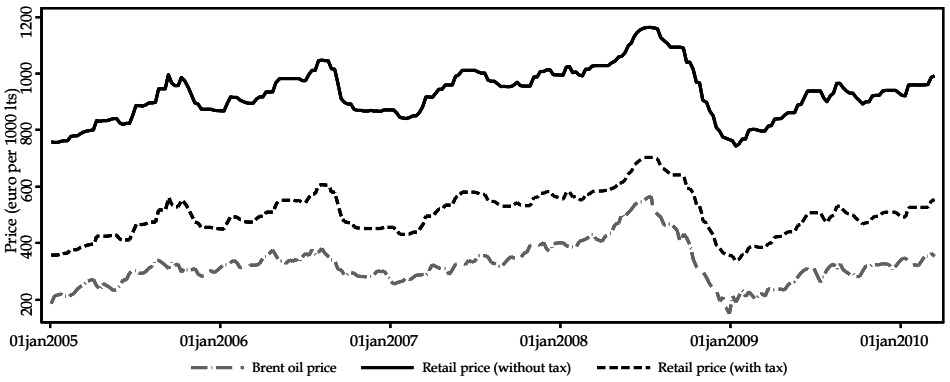
The main data required for the analysis are retail prices for different types of fuel. EU legislation requires member countries to monitor oil product prices and report them to the European Commission (EC). Prices are published on a weekly basis in the European Commission's Oil Bulletin. From this source we collected the data for the weekly retail prices for fuel in all European countries. The data cover the period January 2000 to March 2010 for older EU members. For countries that joined the EU after 2000 coverage starts soon after their accession. In the case of Cyprus, for example, data coverage starts in 2005, the year when the market was liberalized (prior to that date prices were dictated by the Ministry of Commerce). During this period there were large fluctuations in oil price, which are useful for identifying the desired relationships.

The analysis will focus on two products; regular (95 octane) unleaded gasoline and diesel oil. These products are widely used by the general public and have not experienced any major changes in quality or composition during the period under investigation. For each product two prices are observed, the final retail price (which includes all taxes) and the price net of tax. Until 2004 prices were reported in national currency. Where appropriate, they were converted to euro using the exchange rate provided by the EC. Starting in 2005, all prices are reported in euro.

Oil is the main cost element for fuel retailers. There is no single price of oil; prices differ depending on the specific product and the terms of delivery. We chose to use the Europe Brent Spot Price FOB, as reported by the US Energy Information Administration (EIA). The price is reported on a daily basis and we used the appropriate days in order to match with our retail price dates. The price is expressed in US dollars per barrel. In order to be comparable to the retail prices it was converted to euro per 1000 litres using the appropriate exchange rate and the correspondence 1 barrel = 158.987295 litres.

FIGURE 1

International price of oil and retail prices in Cyprus



Sources: U.S. Energy Information Administration and European Commission.

Figure 1 shows the evolution of the international price of oil and the retail price of regular gasoline in Cyprus (with and without tax) for the period 2005-2010. It is quite clear that the series move closely together. The simple correlation between the price of oil and the local retail prices is 0.935 and 0.933 for prices with and without tax respectively. One can observe some instances where fluctuations in the price of oil do not carry over to retail prices, but it seems clear that no conclusions can be drawn on the basis of visual evidence of this kind. The econometric analysis presented in the next section aims to disentangle this close relationship.

Table 2 reports the average price of each type of fuel in each country. In order to ensure that figures are comparable across countries, the average was taken over 61 weeks from January 2009 to March 2010 during which data are available for all countries. There are large price differences across countries. Much of the variation in the final retail price (inclusive of tax) can be attributed to the substantially different tax regimes across countries. But variation in price before tax is also substantial. The price of gasoline in the most expensive country (Sweden) is 41.0% higher than the price in the least expensive country (Netherlands), while in the case of diesel the figure is 28.2% (Ireland over Latvia). When taxes are included the differentials are 56.6% for gasoline (France over Germany) and 41.2% for diesel (Netherlands over Cyprus). Final retail prices in Cyprus are among the lowest, but prices without taxes are above EU average. This is because Cyprus imposes the minimum fuel taxes allowed by the European Union.

TABLE 2

Average prices of unleaded gasoline and diesel fuel

	Unleaded gasoline, without tax	Unleaded gasoline, with tax	Diesel, without tax	Diesel, with tax
Austria	397	897	401	850
Belgium	376	1,144	415	1,189
Bulgaria	414	1,067	420	1,021
Cyprus	420	1,227	423	1,017
Czech Rep.	411	952	428	937
Germany	398	1,059	433	983
Denmark	394	1,150	436	1,062
Estonia	419	1,277	437	1,080
Spain	415	979	438	869
Finland	447	1,370	438	1,019
France	430	1,256	443	963
Greece	429	973	445	933
Hungary	427	1,121	448	1,090
Ireland	447	1,046	448	862
Italy	411	1,129	449	1,044
Lithuania	434	1,041	450	901
Luxembourg	428	875	459	856
Latvia	432	1,059	466	1,014
Malta	436	1,033	467	984
Netherlands	478	1,303	467	1,064
Poland	458	1,025	471	929
Portugal	530	1,126	473	964
Romania	469	896	477	842
Sweden	460	1,251	484	1,018
Slovenia	478	1,250	489	1,095
Slovakia	448	1,293	494	1,005
United Kingdom	457	1,032	514	986
Min	376	875	401	842
Max	530	1,370	514	1,189
Mean	435	1,105	452	984
Std dev.	32	137	26	87

Note: Prices are in euro per 1000 liters. Averages are taken over the period January 2009-March 2010.

The methodological workhorse of this literature has been the model proposed by Borenstein, Cameron and Gilbert (1997).[1] The model is well-suited for the study of cost pass-through as it allows for the separate identification of short-run (or direct) and long-run (indirect) pas-through. The model is based on the assumption of a stable long-run relationship between two variables. In our case, these variables are the international oil price and the local price. The local price is determined by the international price (as well as other factors). This stable relationship is periodically disrupted by fluctuations in the international price, thus creating an imbalance between international and local price. The local price adjusts in order to restore the long-term relationship, but it does so gradually. The econometric model separates the effect of a disturbance in the international price on the local price into an immediate component and a long-run component. The former impacts the local price directly, while the latter works through the long-run relationship. The model can be generalized to test for symmetric adjustment by allowing for distinct speeds of response depending on whether the cost increases or decreases.

The methodology is implemented in two steps. First, the long-run relationship is estimated by means of a simple regression of local retail price on the world oil price. The residuals from this regression represent deviations from the long-run equilibrium. The second step is the main regression which specifies the change in local retail price as a function of the change in world oil price, of past changes in retail prices and of deviations from the long-run equilibrium (the residuals from the first step). The econometric model is developed more fully in the Appendix.

5. Results

The main estimates of interest are reported in Tables 3-5. Table 3 reports the results from estimating the long-run relationship. The reported coefficient is the *long-run pass-through*: it shows the amount by which the local retail price will increase (in the long-run) in response to a one-time increase of one unit (say, 1 cent per litre) in the world oil price. In the case of regular gasoline without tax, this amount is close to 1 for most countries, indicating a 100% cost pass-through.[2] The coefficient for Cyprus is 0.981.

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[1] The model is a variant of the well-known error correction model. See the Appendix for more details.

[2] Coefficients that are statistically no different from unity at the 5% level are denoted in boldface.

When price with tax is considered, the coefficients are greater than 1 and much more dispersed, reflecting the fact that cost increases are compounded by taxes, which vary substantially across countries. In the case of diesel the long-run pass through is greater than one even in the case of price without tax. Overall, these estimates are quite reasonable and consistent with the existence of the posited long-run relationship.

Results from estimating the main equation are reported in Table 4 (for gasoline) and Table 5 (for diesel). In order to enhance readability and to conserve space we report only the main parameters of interest from the regressions with tax-free prices. The analysis was also conducted using prices with tax and the conclusions are very similar.

The first three columns report the parameters capturing the short-run (within one week) pass-through of a change in oil price to local prices. As before, bold type represents statistical significance at the 5% level. The first column captures the response to a positive shock, the second column the response to a negative shock, and the third column is the difference between the two. All statistically significant coefficients in the first two columns are positive, as expected. Taking Austria as an example, the estimates suggest that when the world price increases by 1 cent (per litre), the price before tax in Austria will rise by 0.383 cents in the following week. When the world prices decreases by 1 cent, the local price will decrease by 0.487 cents. Hence in Austria local prices are more flexible downward than upward, which is the opposite of what conventional wisdom suggests. However, the difference of -.103 that is reported in the third column is not statistically different from zero at meaningful confidence levels.

The case of Austria turns out to be quite typical. Most differences reported in column 3 – including the one for Cyprus – are negative, suggesting a quicker response to negative shocks than to positive shocks. But the difference is only significant in Portugal and the UK, while Finland is the only country demonstrating the 'rockets and feathers' phenomenon in the short-run.

TABLE 3

Estimates of the long-run pass-through of world oil price to retail fuel prices in European countries

	Gasoline 95 without tax	Gasoline 95 with tax	Diesel without tax	Diesel with tax	Obs.
Austria	0.870	1.294	1.161	1.787	486
Belgium	1.030	1.711	1.292	1.707	486
Bulgaria	0.844	**1.013**	1.173	1.407	100
Cyprus	**0.981**	1.147	1.227	1.433	276
Czech Rep.	**1.004**	1.558	1.276	1.825	276
Germany	**0.995**	1.438	1.273	1.750	486
Denmark	**0.990**	1.276	1.318	1.667	486
Estonia	**0.986**	1.349	1.221	1.659	275
Spain	1.050	1.332	1.321	1.666	486
Finland	0.955	1.298	1.205	1.486	486
France	1.050	1.345	1.293	1.726	486
Greece	1.027	1.530	1.528	2.043	486
Hungary	0.916	1.091	1.163	1.385	278
Ireland	0.860	1.377	1.108	1.682	486
Italy	**1.015**	1.348	1.358	1.747	486
Lithuania	0.937	**1.096**	1.190	1.413	276
Luxembourg	**1.020**	1.630	1.302	1.695	486
Latvia	**0.995**	1.193	1.245	1.482	271
Malta	0.779	0.804	1.020	**1.096**	272
Netherlands	1.119	1.577	1.314	1.747	486
Poland	**0.966**	1.664	1.223	1.894	276
Portugal	0.843	1.901	1.369	2.159	486
Romania	0.884	1.136	**1.096**	1.366	100
Sweden	0.812	1.226	1.134	1.820	486
Slovenia	0.948	**1.009**	1.195	1.300	276
Slovakia	0.896	1.355	1.103	1.567	274
United Kingdom	**1.001**	0.902	1.163	1.093	486
Mean	0.955	1.319	1.232	1.615	
Std dev.	0.083	0.257	0.105	0.254	

Note: Standard errors are in the range 0.01-0.07 with a mean of 0.0289 and a median of .0249. All coefficients are statistically different from zero. Coefficients in bold are statistically no different from unity at the 5% level.

The next three columns report estimates of the adjustment to the long-run relationship between the two prices. The estimates are expected to be negative because a positive deviation from the long-run equilibrium will induce a negative change in retail price. Indeed, all coefficients are negative and the large majority of them are significantly different from zero at the 5% level. This is reassuring as one would expect adjustments to the long-run equilibrium to be the key determinant of price movements. The estimates represent the 'catch-up speed' of local to international prices. For example, the figures for Cyprus indicate that if the local retail is above its long-run level, it will return to that level by making up 13.0% of the difference each week. If the local price is below its long-run level, it will return to that level by making up 27.1% of the difference each week.

In contrast with short-run adjustments, the differences between catch-up speeds in response to positive and negative shocks are quite small (8.5% on average, versus 18.8% in the case of short-run responses). In three countries, Belgium Poland and Portugal, there is statistically significant evidence of the rockets and feathers phenomenon: prices respond faster when they are below their long-run level than when they are above it. The estimates suggest that the same may be occurring in Cyprus but the different is not statistically significant. Finland is the only country where the opposite seems to occur.

Table 5 reports a similar set of estimates for the (pre-tax) price of diesel fuel. In the case of short-run responses, things look much like they did with gasoline prices. Finland is again the only country exhibiting the rockets and feathers phenomenon and there is no country exhibiting asymmetric responses in the reverse direction. The estimates differ from the gasoline case in a surprising way when it comes to catch-up speeds. In most countries the speed of adjustment is faster when the price is above the equilibrium price than when it is below, which is the opposite of rockets and feathers. In seven countries this difference is statistically significant. This surprising finding may reflect differences in the end users of the two types of fuel. Diesel is the main fuel for many commercial uses (such as trucks) while gasoline is used by private motorists. These differences notwithstanding, the finding of inverse rockets and feathers behaviour in the prices of diesel is something that begs an explanation.

TABLE 4

Estimates of short-run pass-through and catch-up speed for retail gasoline prices

	Short-run pass-through			Catch-up speed		
	Positive	Negative	Difference	Positive	Negative	Difference
Austria	**0.383**	**0.487**	-0.103	-0.027	**-0.101**	-0.074
Belgium	**0.602**	**0.439**	0.163	**-0.142**	**-0.385**	**-0.243**
Bulgaria	0.199	**0.647**	-0.447	**-0.251**	**-0.320**	-0.069
Cyprus	-0.111	0.191	-0.303	**-0.139**	**-0.271**	-0.132
Czech Rep.	-0.005	0.134	-0.140	**-0.155**	**-0.101**	0.054
Germany	**0.534**	**0.612**	-0.078	**-0.123**	**-0.176**	-0.054
Denmark	**0.385**	**0.775**	-0.390	**-0.145**	-0.091	0.054
Estonia	0.188	**0.211**	-0.023	**-0.209**	-0.068	0.141
Spain	**0.166**	**0.315**	-0.149	**-0.072**	**-0.036**	0.035
Finland	**0.524**	-0.099	**0.623**	**-0.368**	-0.010	**0.358**
France	**0.410**	**0.444**	-0.034	**-0.102**	-0.011	0.092
Greece	**0.415**	**0.483**	-0.068	**-0.141**	**-0.126**	0.015
Hungary	0.036	**0.246**	-0.211	**-0.124**	**-0.273**	-0.149
Ireland	-0.119	-0.047	-0.072	**-0.177**	-0.082	0.095
Italy	**0.305**	**0.288**	0.016	**-0.091**	**-0.089**	0.002
Lithuania	0.165	**0.338**	-0.173	**-0.097**	**-0.188**	-0.091
Luxembourg	**0.392**	**0.675**	-0.283	**-0.095**	**-0.124**	-0.029
Latvia	-0.092	0.118	-0.210	**-0.178**	**-0.224**	-0.047
Malta	0.010	-0.041	0.052	-0.046	**-0.094**	-0.048
Netherlands	**0.256**	**0.613**	-0.357	-0.013	-0.106	-0.093
Poland	-0.044	0.136	-0.180	-0.046	**-0.183**	**-0.137**
Portugal	-0.140	**0.188**	**-0.329**	-0.003	**-0.087**	**-0.084**
Romania	-0.114	-0.138	0.024	**-0.501**	**-0.416**	0.085
Sweden	**0.432**	**0.751**	-0.319	-0.075	-0.085	-0.010
Slovenia	-0.079	-0.001	-0.078	**-0.278**	**-0.238**	0.039
Slovakia	0.142	**0.138**	0.004	**-0.152**	**-0.086**	0.066
United Kingdom	0.033	**0.280**	**-0.247**	**-0.072**	**-0.070**	0.002

Note: Coefficients in bold are statistically different from zero at the 5% level.

TABLE 5

Estimates of short-run pass-through and catch-up speed for retail diesel prices

	Short-run pass-through			Catch-up speed		
	Positive	Negative	Difference	Positive	Negative	Difference
Austria	**0.434**	**0.243**	0.190	**-0.136**	**-0.088**	0.048
Belgium	**0.559**	**0.435**	0.124	**-0.137**	**-0.167**	-0.031
Bulgaria	**0.615**	**0.650**	-0.035	-0.080	-0.047	0.033
Cyprus	0.094	-0.105	0.198	**-0.236**	**-0.187**	0.049
Czech Rep.	-0.031	-0.018	-0.014	**-0.196**	**-0.139**	0.056
Germany	**0.471**	**0.384**	0.086	**-0.181**	**-0.177**	0.004
Denmark	**0.451**	**0.564**	-0.113	**-0.152**	**-0.127**	0.026
Estonia	0.167	0.060	0.107	**-0.157**	-0.086	0.070
Spain	**0.258**	**0.165**	0.094	**-0.112**	-0.016	**0.096**
Finland	**0.590**	0.072	**0.518**	**-0.162**	**-0.101**	0.061
France	**0.492**	**0.340**	0.153	**-0.123**	-0.020	**0.103**
Greece	**0.379**	**0.324**	0.055	**-0.065**	**-0.080**	-0.015
Hungary	0.145	0.070	0.075	**-0.179**	**-0.190**	-0.010
Ireland	-0.140	-0.100	-0.040	**-0.118**	**-0.074**	0.044
Italy	**0.276**	**0.201**	0.075	**-0.090**	-0.011	**0.080**
Lithuania	**0.209**	**0.272**	-0.063	**-0.109**	**-0.120**	-0.011
Luxembourg	**0.609**	**0.442**	0.168	**-0.199**	-0.072	**0.127**
Latvia	0.009	0.196	-0.187	**-0.110**	**-0.135**	-0.025
Malta	-0.007	-0.101	0.093	**-0.056**	**-0.056**	0.001
Netherlands	**0.406**	**0.311**	0.095	**-0.199**	0.004	**0.202**
Poland	0.075	0.032	0.043	**-0.196**	-0.071	0.125
Portugal	0.007	0.067	-0.060	**-0.118**	-0.015	**0.103**
Romania	-0.022	-0.001	-0.021	**-0.233**	-0.021	0.212
Sweden	**0.491**	**0.480**	0.011	**-0.198**	-0.045	0.152
Slovenia	-0.034	**-0.376**	0.341	**-0.327**	**-0.195**	0.131
Slovakia	0.118	0.012	0.106	**-0.132**	**-0.130**	0.002
United Kingdom	0.071	0.094	-0.023	**-0.179**	**-0.045**	**0.134**

Note: Coefficients in bold are statistically different from zero at the 5% level.

The analysis has produced only very weak evidence of asymmetric price responses in European retail gasoline markets. The findings cannot be considered definitive, mainly because the data used are not ideal. Spatial and temporal aggregation of prices can hide much of the variation and

lead to imprecise estimates. This problem may be especially severe in large countries with many independently operated gas stations, with large geographical price variation and with frequently changing prices. Cyprus displays none of these features. Spatial aggregation is unlikely to be a problem as prices are known to vary very little across the island. The same is true of temporal aggregation, as prices change fairly infrequently and individual stations tend to follow the lead of their suppliers. Hence, we can be fairly confident that the findings for the case of Cyprus are a good approximation of the true price adjustment mechanism.

6. Conclusions

The price-setting mechanism in retail fuel markets is an interesting one to analyze because the nature of the product and the structure of the distribution network make it difficult to achieve the desirable level of competition. Moreover, fuel prices are often a subject of heated public debates and accusations of consumer exploitation are frequently directed towards oil companies.

The present study investigated a possible mechanism by which fuel retailers might exploit their market power. We examined whether retail fuel prices in European countries rise faster after an increase in the international price of oil than they decrease after a drop in oil prices. There is only very weak evidence of asymmetric pricing overall. In the case of Cyprus the estimates show that prices adjust slightly faster after increases in the price of oil than they decline after decreases, but the difference is neither statistically significant nor substantial in terms of economic magnitude.

The absence of evidence of asymmetric adjustment of the prices should not be regarded as a definitive rejection of this possibility. An analysis using more detailed retail price data or – better still - with data on wholesale prices could reach different conclusions. Whatever the outcome, two things should be borne in mind. First, any additional profits companies might earn from practices like asymmetric pricing are relatively low and transient. Second, even if price adjustment to cost shocks is completely symmetric, it does not necessarily follow that the level of competition in the market is the desirable one. What matters more is whether companies' profit margins are at a level that corresponds to a reasonable return on capital. Even a slight deviation from those levels on a permanent basis can translate into much greater profits than a temporary overcharge in times of turbulence in international oil markets. An investigation of this matter

would be very useful, but is not possible with the data that are currently publicly available.

Appendix

Econometric methodology

The analysis is based on the econometric methodology developed by Borenstein, Cameron and Gilbert (1997). The model posits a long-run relationship between the world price (WP) and the local retail price (LP) of the following form:

$$LP_t = \varphi_0 + \varphi_1 WP_t + \varepsilon_t \qquad (1)$$

The coefficient φ_1 represents the long-run response of the local price to a €1 increase in the world price. This is what we refer to as the *long-run pass-through*. The most basic formulation of the short-run response is:

$$\Delta LP_t = \alpha \Delta LP_{t-1} + \beta \Delta WP_t + \theta\left(LP_{t-1} - \varphi_0 - \varphi_1 WP_{t-1}\right) + \eta_t \qquad (2)$$

The change in the local price (ΔLP_t) is broken down into two parts: the short-term or direct effect that is captured by the coefficient β; and the long-run or indirect effect that is captured by the coefficient θ. The β coefficient measures the component of the response that can be attributed directly to the change in world price. We refer to this as the *short-run pass-through*. The θ coefficient measures the response that is due to the fact that the two prices are not in their long-run equilibrium relationship. This is what we refer to in the text as the *catch-up speed*. The model also includes lagged changes in retail price (ΔLP_{t-1}) in order to allow for the possibility of previous retail price changes affecting current pricing decisions. A more general formulation of the model can include additional lags of world price (ΔWP_t) and of lagged retail price changes. The appropriate number of lags will depend on the periodicity of the data and on market and institutional factors.

Borenstein, Cameron and Gilbert (1997) estimate equation (2) above in a single step using two-stage least squares. Bachmeier and Griffin (2003) argue in favour of estimating equations (1) and (2) separately, as originally proposed by Engle and Granger (1987), and show that OLS performs better that 2SLS in this setting. Recent studies, such as that of Remer (2010), have followed their recommendations of using the two-step approach with OLS. The current paper also follows this approach. In the first step equation (1) is estimated using OLS. The regression residuals $e_t = LP_t - \varphi_0 - \varphi_1 WP_t$ are estimates of the deviations from the long-run equilibrium and they are plugged into equation (2), which becomes:

$$\Delta LP_t = \alpha \Delta LP_{t-1} + \beta \Delta WP_t + \theta e_{t-1} + \eta_t \qquad (3)$$

Equation (3) is then estimated using OLS.

Testing for asymmetry involves allowing some or all of the coefficients in equation (3) to differ depending on whether the change in the world price is positive or negative. Define ΔWP_t^+ and ΔWP_t^- to denote the change in world price when the change is positive and negative respectively. That is, $\Delta WP_t^+ = 1(\Delta WP_t > 0)WP_t$, where $1(\ )$ is the indicator function, and likewise for ΔWP_t^-. Similarly, let e_t^+ and e_t^- denote positive and negative deviations from long-run equilibrium. The equation to be estimated is

$$\Delta LP_t = \alpha \Delta LP_{t-1} + \beta^+ \Delta WP_{t-1}^+ + \beta^- \Delta WP_{t-1}^- + \theta^+ e_{t-1}^+ + \theta^- e_{t-1}^- + \eta_t \qquad (4)$$

The coefficients β^+ and β^- are expected to be positive as they capture the response of the retail price to a change in the world price. The coefficients θ^+ and θ^- are expected to be negative. This is because if the price in the previous period was above its long-run level (e_{t-1} is positive), in the current period it is expected to fall in order to restore the long-run relationship.

The error correction model assumes that the two time series corresponding to the prices are non-stationary and co-integrated of order one. This was confirmed by appropriate statistical testing (augmented Dickey-Fuller tests). The model was estimated separately for each country and each type of fuel. The reported specification includes only a single lag oil price changes (and of retail price changes). This is because in most countries (especially those with shorter time series) it was not possible to precisely identify more than one coefficient. Estimates of the coefficients on adjustment to long-run deviations were not sensitive to this choice.

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References

Akarca, A.T. and Andrianacos, D. (1998) 'The Relationship between Crude Oil and Gasoline Prices', *International Advances in Economic Research*, 4, 282-288.

Asplund, M., Eriksson, R. and Friberg, R. (2000) 'Price Adjustments by a Gasoline Retail Chain', *Scandinavian Journal of Economics*, 102, 101-121.

Backmeier, L.J. and Griffin, J.M. (2003) 'New Evidence on Asymmetric Gasoline Price Responses', *Review of Economics and Statistics*, 85, 772-776.

Bacon, R.W. (1991) 'Rockets and Feathers: The Asymmetric Speed of Adjustment of U.K. Retail Gasoline Prices to Cost Changes', *Energy Economics*, July, 211-218.

Balke, N.S., Brown, S.P.A. and Yücel, M.K. (1998) 'Crude Oil and Gasoline Prices: An Asymmetric Relationship', *Federal Reserve Bank of Dallas Economic Review*, First Quarter, 2-11.

Bermingham, C. and O' Brien, D. (2010) 'Testing for Asymmetric Pricing Behaviour in Irish and UK Petrol and Diesel Markets', Research Technical Paper, Central Bank and Financial Services Authority of Ireland.

Borenstein, S., Cameron, A.C. and Gilbert, R. (1997) 'Do Gasoline Prices Respond Asymmetrically to Crude Oil Prices?', *Quarterly Journal of Economics*, February, 112, 305-339.

Borenstein, S. and Shepard, A. (2002) 'Sticky Prices, Inventories, and Market Power in Wholesale Gasoline Markets', *RAND Journal of Economics*, 33, 116-139.

Brown, S.P.A., and Yücel, M.K. (2000) 'Gasoline and Crude Oil Prices: Why the Asymmetry?', *Economic and Financial Review*, Third Quarter, 23-29.

Deltas, G. (2008) 'Retail Gasoline Price Dynamics and Local Market Power', *Journal of Industrial Economics*, 56, 613-628.

Duffy-Deno, K.T. (1996) 'Retail Price Asymmetries in Local Gasoline Markets', *Energy Economics*, 18, 81-92.

Eckert, A. (2002) 'Retail Price Cycles and Response Asymmetry', *Canadian Journal of Economics*, 35, 52-77.

Engle, R. and Granger, C.W.J. (1987) 'Co-Integration and Error Correction: Representation, Estimation, and Testing', *Econometrica*, 55(2), 251-276.

European Commission, Market Observatory for Energy – Oil Bulletin, http://ec.europa.eu/energy/observatory/oil/bulletin_en.htm

European Commission, Directorate General Economic and Financial Affairs (2009) 'Pass Through from Crude Oil Prices to Consumer Prices of Fuels'.

Faber, R. (2009) 'Asymmetric Price Responses of Gasoline Stations: Evidence for Heterogeneity of Retailers', Tinbergen Institute Discussion Paper 2009-106/1.

Geweke, J.F. (2004) 'Issues in the Rockets and Feathers Gasoline Price Literature', Report to the Federal Trade Commission, University of Iowa.

Granger, C.W.J. and Lee, T.H. (1989) 'Investigation of Production, Sales and Inventory Relationships using Multicointegration and Non-Symmetric Error Correction Models', *Journal of Applied Econometrics*, 4, S145-S159.

Grasso, M. and Manera, M. (2007) 'Asymmetric Error Correction Models for the Oil-Gasoline Price Relationship', *Energy Policy*, 35, 156-177.

Kirschgassner, G. and Kubler, K. (1992) 'Symmetric or Asymmetric Price Adjustments in the Oil Market: An Empirical Analysis of the Relations between

International and Domestic Prices in the Federal Republic of Germany', *Energy Economics*, 14, 171-185.

Kuper G. and Poghosyan, T. (2008) 'Non-Linear Price Transmission between Gasoline Prices and Crude Oil Prices', Working Paper, University of Groningen.

Manning, D.N. (1991) 'Petrol Prices, Oil Price Rises and Oil Price Falls: Evidence for the United Kingdom since 1972', *Applied Economics*, 23, 1535-1541.

Remer, M. (2010) 'An Empirical Investigation of the Determinants of Asymmetric Pricing', unpublished manuscript.

Salas, J.M.S.I. (2002) 'Asymmetric Price Adjustments in a Deregulated Gasoline Market', *Philippine Review of Economics*, 39, 38-71.

Shin, D. (1994) 'Do Product Prices Respond Symmetrically to Changes in Crude Oil Prices?', *OPEC Review,* 18, 137-157.

Tappata, M. (2009) 'Rockets and Feathers. Understanding Asymmetric Pricing', *RAND Journal of Economics*, 40 (4), 673-687.

Valadkhani, A. (2009) 'Do Retail Petrol Prices Rise More Rapidly Than They Fall in Australia's Capital Cities?', University of Wollongong Economics Working Paper 09-08.

Yang, H. and Ye, L. (2008) 'Search With Learning: Understanding Asymmetric Price Adjustments', *RAND Journal of Economics*, 39(2), 547-564.