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Estimating Cost Pass through and asymmetric price transmission in the UK's road fuels supply chain

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Estimating Cost Pass through and asymmetric price transmission in the UK's road fuels supply chain: [1]

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Abstract:

This study examines the cost pass-through and price transmission mechanism within the supply chain of the UK's road fuel sectors. Using newly utilized compiled updated datasets of 197 to 203 monthly observations from 2005 to 2021, I novelly estimate a significant amount of incomplete cost pass-through of a change in the input price to the wholesale price and a change in the wholesale price to the retail price of UK's road fuels. I follow the empirical method of distributed lag models applied in Nakamura and Zerom (2010) and Deltas and Polemis (2024). Using double log specifications, the study reveals a 0.79% increase (decrease) in wholesale price after a 1% increase (decrease) in the input price. The study reveals an amount of incomplete cost pass-through of the wholesale to the retail price; in all three distinct cases of super unleaded, premium unleaded, and diesel as well as product heterogeneity in the degree of asymmetric price transmission. More specifically the study reveals negative asymmetric price transmission in the Uk's road fuels sector. The study enhances robustness implementing the relatively new method of NARDL.

JEL : D43; D41; D60

[1] The author thanks Professor Peter Jackson* and Mr Mark Burridge for insightful comments. The author further wishes to thank Professor Monica Giulietti for insightful discussion-this paper extends the findings of my Phd thesis. Theodoulou (2023) Market Power and Price Transmission Mechanism in the Supply chain.

1. Introduction

Loy et al. (2016) use the terms vertical price transmission and cost pass-through "to characterize the impact of factor price (cost) changes on downstream product prices" (2016:184). In this study, we apply the term 'cost pass through' (CPT) to the pass-through of input price changes to wholesale prices, and wholesale price changes to retail prices. There is a consensus among studies that market power is one of the main driving forces behind incomplete CPT and asymmetric price transmission (Lloyd et al., 2006; Nakamura and Zerom, 2010), with imperfectly competitive markets leading to incomplete pass-through and perfect competition complete pass through.

The paper aims to investigate the extent of cost pass-through along the UK road fuels supply chain using Distributed Lag Models (DLM's), which to the best of this author's knowledge have not been applied to the UK setting and within CPT literature. I am motivated by the high market share of the big UK road fuel retailers. Based on CMA (2022), the three main supermarkets together with Bp, Shell, and Esso, boasted a market share of 64%; which can potentially lead to imperfect market conditions, and more specifically to an oligopolistic market structure. High market shares and high concentration can be a possible factor behind incomplete cost pass-through. Incomplete cost pass-through and asymmetric price transmission findings may therefore be invaluable to both regulators and the CMA in assessing post-merger impacts and enabling them to weigh the efficacy of regulating input or wholesale price for the ultimate consumer. Moreover, since inflated prices can trigger social tensions and political pressure, an understanding of cost pass-through and asymmetric price transmission is of immense importance: especially for products that represent a substantial proportion of the UK's GDP and everyday essentials to the consumer.

Further on, I implement a non-linear dynamic framework to consider simultaneously, and coherently model asymmetries; NARDL-non autoregressive distributed lag models. The method has been introduced in the price asymmetries literature post-2010 (Nimmi et al 2013; Shin et al 2014). This study empirically estimates the NARDL model to examine the price transmission mechanism of a wholesale price change to the retail price of road fuels within the period 2005-2021 incorporating into the analysis dummy variables for the three COVID-19 pandemic lockdowns.

I contribute to the literature on cost pass-through in a twofold way. Methodologically wise, this study is the first of its kind to apply distributed lag models for a novelly compiled monthly dataset incorporating exogenous shocks such as the Covid 19 pandemic. I deviate from conventional wisdom and do not use the vector error correction model commonly used in the literature because this has been attributed to inconsistent estimates resulting from the imposition of the wrong cointegration vector on the model (Aliyu et al., 2009; Favero, 2001). For robustness, I apply Newey West standard errors to correct any potential heteroskedasticity and autocorrelation. The study utilizes newly available data times series for the retail prices of petrol in the UK from the Department of Energy and Net Zero. To the best of this author's knowledge this is the first type of study that applies the DLM's within the UK.

Secondly, the results reveal an incomplete amount of cost pass through from input prices (crude oil prices) to wholesale prices. Policy wise I shed light on the extent to which consumers benefit from regulatory interventions or a change in input prices. My study can be complimentary to the recent UK government's and CMA's

examination of the UK's road fuel sectors which establishes high retail margins; making the sector susceptible to intervention.[2]

I further contribute in a twofold way to another very related strand of literature; that of asymmetric price transmission. Firstly, a statistically significant long run asymmetry is established for the change in the UK wholesale prices to the road fuel prices. This study provides statistically significant evidence for the three products for super unleaded premium unleaded and diesel; correspondingly; using the NARDL methodology, which to the best of this authors knowledge has not been applied to the UK gasoline APT/CPT literature. This study is complementary and advances the work of Nimmo et al. (2013), that estimate asymmetric price transmission following NARDL; from the brent spot crude oil price changes to the retail UK road fuel prices. I specifically focus on the last stages of the value chain; wholesale to retail; narrowing the economic participants and intermediaries involved; considering that the UK has a non-negligible refining acti**vity** (Nimmo et al. 2013; Amountzias 2023). Secondly and more specifically, the study reveals explores product heterogeneity and reveals negative asymmetric price transmission results for premium and super unleaded. Our results further highlight and shed light on the asymmetries that exist within the UK's road fuels sector.

[2] One should distinguish between industry wide pass through and firm specific pass through. Due to the nature of aggregate data available, this study focuses on industry wide pass through. "Industry-wide cost pass-through relates to the way prices respond to a cost change which affects all the firms in an industry/market." (RBB 2014, p. 17).

Motivation and research objectives:

i) Investigate the extent of cost pass through of a change in input cost to the wholesale price of UK road fuels sector.

ii) Investigate the extent of cost pass through of a change in wholesale cost to the retail price with empirical applications on specific products; aggregate; super unleaded; premium unleaded; diesel.

iii) Investigate the existence of asymmetric price transmission of a change in the wholesale cost to the retailer's price along the supply chain in the UK and investigate this with empirical applications on UK road fuels sector and petroleum products; aggregate; super unleaded; premium unleaded; diesel.

2. Theoretical framework:

This study has a formal theoretical grounding for cost pass through estimation following Weyl and Fabinger (2013):

The theoretical model is intentionally general and does not impose a specific market structure. It is compatible with perfect competition, monopoly, and oligopoly. In the UK road fuel market, high concentration and retail margins suggest imperfect competition. Therefore, the model is suitable for evaluating whether observed pass-through and asymmetry are consistent with market power. The model allows for different equilibrium conditions and is based on the profit maximisation condition following the neoclassical profit optimisation theory. Market equilibrium is different under every market structure or type of imperfect competition in the market.

Theoretical Framework: Cost Pass-Through and Asymmetric Pricing

2.1 Demand and Cost Structure

Consider a representative downstream firm (retailer) facing an inverse demand function:

$$R = R(q), \frac{dR}{dq} < 0$$

Let marginal cost depend on an exogenous cost component u, such that:

$$MC = MC(q, u), \frac{\partial MC}{\partial u} > 0$$

The variable u captures input or wholesale cost changes, such as crude oil or wholesale fuel prices.

Profit Maximization

The firm chooses quantity q to maximize profits:

$$\Pi(q) = R(q)q - C(q, u)$$

The first-order condition is:

$$R(q) + qR'(q) = MC(q, u) \quad (2.1)$$

Define marginal revenue as:

$$MR(q) = R(q) + qR'(q)$$

Thus, equilibrium is given by:

$$MR(q) = MC(q, u) \quad (2.2)$$

Cost Pass-Through

Totally differentiate (2) with respect to u:

$$\left[2R'(q) + qR''(q) - \frac{\partial MC}{\partial q}\right]\frac{dq}{du} = \frac{\partial MC}{\partial u}$$ [3]

Hence:

$$\frac{dq}{du} = \frac{\frac{\partial MC}{\partial u}}{2R'(q) + qR''(q) - \frac{\partial MC}{\partial q}}$$

The pass-through rate from costs to prices is:

$$\frac{dR}{du} = R'(q)\frac{dq}{du} \qquad (2.3)$$

This expression shows that pass-through depends on:

demand curvature $R''(q)$

- marginal cost sensitivity to output
- market power (via the slope of marginal revenue)

2.2. Economic Intuition (Wabinger-Type Mechanism)

Following Weyl and Fabinger (2013), asymmetry arises when:

1. Demand curvature differs across price levels:

$$R''(q \mid u^+) \neq R''(q \mid u^-)$$

2. Firms face adjustment frictions or strategic pricing incentives:

$$\frac{dR}{du^+} \neq \frac{dR}{du^-}$$

[3] "Industry-level heterogeneity in pass-through reflects differences in exposure to cost shocks, captured by $\partial MC / \partial u$, as well as differences in demand curvature and market structure (Weyl and Fabinger, 2013)."

3. Oligopolistic interaction induces state-dependent pricing responses:

$$R_i = R(u, R_{-i})$$

3. Material and Methods

3.1. The empirical model to estimate cost pass through:

I follow a leading paper in the cost pass through approach; that of Nakamura and Zerom (2010) that estimates cost pass through in the US coffee chain and Deltas and Polemis (2024) that estimate Cost Pass through for the Greek Electricity sector. The main empirical model, which estimates cost pass through and is used in the current study is as follows:

$$\Delta \log W_t = a + \sum_{k=1}^{G} b_k \Delta \, log \, I_{t-k} + \sum_{k=1}^{12} d_k q_t + \varepsilon \quad [4] \qquad (3.1)$$

Where $\Delta \log W_t$ is the log wholesale price change of product, while the independent variables are log commodity cost index change and q_t is a month of the year dummy controlling for seasonality; b_k and d_k are parameters and ε is a mean zero error term. The following similar model is adopted to estimate the cost pass through of a change in the wholesale price to the retail price:

$$\Delta \log R_t = \alpha^r + \sum_{k=0}^{2} \beta_k \, \Delta \log W_{t-k} + \sum_{k=1}^{12} \gamma \, q_k + \varepsilon \qquad (3.2)$$

Where $\Delta \log R_{t-k}$ is the log retail price change, while the independent variable is the log wholesale price change of product.

This study estimates the cost pass through of a change in the wholesale price to the retail price, using an aggregate retail price data-series; but also using three distinct prices for super unleaded, premium unleaded and diesel; road fuel products that are available to the UK consumer. To ensure stationarity of the first differences, I tested

[4] For the input to wholesale relationship and for robustness purposes the DLM is also estimated in levels. For all the separate specifications I also incorporate dummies for the three lockdown periods of the COVID 19 pandemic for-March 2020; late 2020; early 2021.

the variables for non-stationarity, using ADF test ensuring that when first differenced they are I(1). ADF results can be provided upon request. [5]

3.2. Nardl for price asymmetries

$$\Delta R_t = \alpha + \lambda R_{t-1} + \theta^{+} W_{t-1}^{+} + \theta^{-} W_{t-1}^{-} + \sum_{i=1}^{p-1} \phi_i \Delta R_{t-i} + \sum_{j=0}^{q-1} (\gamma_j^{+} \Delta W_{t-j}^{+} + \gamma_j^{-} \Delta W_{t-j}^{-}) + \varepsilon_t \quad (3.3)$$

Where:

$W_t^{+} = \sum_{j=1}^{t} \max(\Delta W_j, 0)$ (positive changes)

$W_t^{-} = \sum_{j=1}^{t} \min(\Delta W_j, 0)$ (negative changes)

I follow Nimmo et al. (2013) and Shin et al (2014) that introduces NARDL in the estimation of modelling asymmetries in the UK. The method contributes to literature by testing for a long run relationship being valid, despite the order of integration. It derives asymmetric cumulative dynamic multipliers that permit the tracing out of the asymmetric adjustment patterns following positive and negative shocks to the independent variables, in this case the wholesale prices. Nardl provides a single step estimation having a capacity to accommodate long run and dynamic asymmetries by exploiting the decompositions of the explanatory variables. As Shin et al. (2014) asserts, NARDL reveals little bias in estimation. The method provides a simple econometric route that incorporates short run and long run asymmetries, considering non linearities. While the DLM assumes symmetry in pass-through, the NARDL model accounts for potential asymmetry in firms' pricing responses. I follow Shin et al. 2014 and apply double log specifications. Table 1 provides a description of the variables and corresponding data sources that consist the newly updated compiled dataset of 197 observations.

[5] The number of lags is chosen up until when long run cost pass through is not affected. This follows Nakamura and Zerom (2010). Long run pass through is estimated using the stata lincom command.

Table 1: Description of Variables for Estimation of Cost Pass Through Petroleum (Road fuels)

Abbreviation	Description of variable	Unit	Data source
Input price	Crude oil acquired by refineries	Base year 2010=100	Typical/average annual retail prices of petroleum products and a crude oil price index (QEP 4.1.1 to 4.1.3)
Wholesale price	Wholesale price of refined petroleum products	Base year 2010=100	ONS Source dataset: Producer price inflation series MM22, Series:K37X
Retail price	Retail price of vehicle fuels and lubricants	Base year 2015=100	ONS Source dataset: Consumer price Inflation series MM23 Series: DK C4
	Retail price of super unleaded Retail price of premium unleaded Retail price of diesel		Typical/average annual retail prices of petroleum products and a crude oil price index (QEP 4.1.1 to 4.1.3)

4.1. Cost Pass Through and APT road fuels

As far as the input to wholesale cost pass through for the road fuels sector is concerned, estimations are undertaken using the standard cost pass through regression method and the natural logarithms specification provides statistically significant evidence short run pass through occurs with time lag. Table 2 presents

the results of three specifications. The first is a level specification of input to wholesale price; the second is a double log specification and the third a double log specification that includes the statistically significant Covid 19 pandemic dummy variable. More specifically and as evident in Table 2, in the levels' DLM model, the third and fourth lags are significant at the 1% level: deeming 0.722 of cost pass through at the third lag and 0.283 at the fourth lag. The second specification illustrated in Table 2; shows that there is an incomplete amount of pass through of the input price change towards the wholesale price of the road fuels sector which intrinsically occurs with a time lag and not instantaneously. Furthermore, and in terms of the long run, the double-log specification demonstrates that a 1% change (increase) in the input price is followed by a 0.795% change (increase) in the wholesale price. Altering the baseline model by incorporating dummies for the three lockdowns during the Global Covid-19 Pandemic for the periods: correspondingly, I enhance this analysis findings by providing further statistical evidence for pass through at the third and fourth lagged periods and a long run pass through of slightly higher magnitude of 0.80.

The second lockdown dummy variable is statistically significant and as expected the exogenous shock has had a significant effect on the long run pass through of a change in the input price to the wholesale price; through tiny to negligible. The pass-through is incomplete in both the short and long run. Both models enhance the fact that the pass through occurs with a time lag and more specifically in the third and fourth lagged periods.

It is worth mentioning in the first level specification of Table 2, this study provides statistically significant evidence at the 1% level for a level long run pass through of a change in the input cost price to the wholesale price of road fuels of 1.105 whilst

the third log specification indicates a pass through of 0.80. In this case due to the high market shares of the main road fuel retailers; this author asserts that both over shifting and incomplete cost pass through 1.102 and 0.80; deem the structure of the downstream market as imperfect on behalf of the retailers. Retailers either absorb some of the cost shock or overpass the change. The last might be due to pricing power they have indicating imperfect competition.

Petroleum Cost Pass Through Results

Table 2. Input to Wholesale Price Cost Pass Through DLM[6]

	(1)	(2)	(3)
	dp	dlp	dlp
ΔInput price	0.012	0.000	-0.033
	(0.027)	(0.02)	(0.020)
ΔInput price_t-1	-0.003	0.024	0.020
	(0.031)	(0.023)	(0.022)
ΔInput price_t-2	0.032	0.020	0.017
	(0.033)	(0.026)	(0.024)_
ΔInput price_t-3	0.722***	0.478***	0.481***
	(0.034)	(0.031)	(0.030)
ΔInput price_t-4	0.283***	0.203***	0.207***
	(0.028)	(0.021)	(0.024)
ΔInput price_t-5	0.038	0.030	0.039
	(0.027)	(0.023)	(0.027)
ΔInput price_t-6	0.022	0.040	0.041*
	(0.031)	(0.024)	(0.024)
Covid2			0.051***
			(0.004)
_cons	0.122	0.001	0.0001
	(0.187)	(0.002)	
N	197	197	197
Long run pass through	1.105*** (0.049)	0.795*** (0.040)	0.802*** (0.043)
Standard errors are in parentheses			
*** p<.01, ** p<.05, * p<.1			

The above table includes the standard cost pass through results for the effect of a change in input of road fuels to the retail price. Newey West standard errors are included in parentheses. Results are presented for the logs specifications for three distinct petroleum products. _t-1 to _t-6 indicate the first six lagged values. N is the number of observations.

[6] Monthly dummies were generated not altering the models results; and are therefore not included in the reported outputs. Long run pass through was obtained using the Stata lincom command.

Table 3: Wholesale to Retail Prices NARDL

Variable	SR (Short Run)	LR (Long Run)	LM Test	ARCH Test
LWholesale_p[7]	0.3171***	5.295**	1.9778	0.1893
	(0.021)	(1.920)		
LWholesale_p_1	-0.198***	-3.302*		
	(0.042)	(1.433)		
LWholesale_p_2	-0.094***	-1.571*		
	(0.026)	(0.753)		
LWholesale_n	0.352***	5.876**		
	(0.024)	(2.911)		
LWholesale_n-1	-0.286***	-4.772*		
	(0.040)	(1.878)		
LWholesale_n-2	-0.044 .	-0.738		
	(0.024)	(0.461)		
Covid1	-0.003	-0.044		
	(0.007)	(0.113)		
Covid2	-0.029	-0.0390		
	(0.011)	(0.262)		
Covid3	-0.004	-0.0709		
Asymmetry Wald P-value	0.697*	2.1068e^-44***		
N	259	259		259

Notes:
*Standard errors are in parentheses. Statistical significance is indicated as follows: *** p<0.01, ** p<0.05, * p<0.10. The dummy variables for Covid1, Covid2, and Covid3 represent the three UK lockdown periods during the Covid-19 pandemic.*
The dependent variable, indicates retail price of petroleum products at an aggregate level.
The results are presented for the log specification. LM test, and ARCH test are model diagnostic statistics., LM test: Lagrange Multiplier, ARCH test: Autoregressive Conditional Heteroscedasticity test.

The results reported in Table 3, suggest that the NARDL model successfully captures asymmetries in the response of the level of the retail price of road fuels to the changes in the levels of the wholesale price in the LR and SR as well.

I provide enough statistical evidence for short run asymmetric price transmission of weak form; significant at the 10% level.

Considering the institutional characteristics of the supply chain and time factors within asymmetric price transmission this study assesses the long run NARDL results, providing an addition to the long run pass through coefficients estimated in the DLMs aforementioned analysis. The Wald test of asymmetry suggests that there is a significant difference between the responses to positive and negative

[7] Definition of variables are explained in Appendix A for tables, 4 & 5.

movements. The adjustment of both a positive change and a negative change in the wholesale price is greater than proportionate instantaneously and gradually the effect is offset within the two lagged periods. In the long-run model, a 1% permanent increase in wholesale prices cumulatively increases the dependent variable, with lagged effects reflecting gradual partial corrections that occur in the periods following the initial increase.

Because the empirical specifications are estimated in logarithms and incorporate distributed lags, one should report the long-run coefficients as *cumulative dynamic elasticities*, rather than instantaneous pass-through rates.

For negative wholesale price changes, retail prices gradually adjust over subsequent periods, and a 1% permanent decrease in wholesale prices eventually reduces the dependent variable by 5.88% in the long run, reflecting full cumulative pass-through.

Therefore, this study provides statistically significant evidence for asymmetric price transmission of the wholesale price to the retail price of road fuels; and more specifically negative asymmetric price transmission, which is to the detriment of consumers welfare. Post diagnostics of the model provide enough statistical evidence that there is no autocorrelation as the null hypothesis of no autocorrelation (LM test) as well as no heteroskedasticity (ARCH test) cannot be rejected. The aforementioned findings contest the findings of the most recent contribution relevant to the UK wherein Pesaresi et al. (2014) do not provide enough evidence for price transmission asymmetries in the UK road fuels supply chain. Furthermore, the present thesis' findings challenge the work of Bermingham and O' Brien (2011) that similarly find insufficient evidence for asymmetric price transmission for the UK petroleum supply chain. However, this research findings do align with earlier work

which confirms the existence of asymmetric price transmission for UK road fuels (Bacon 1991; Manning 1991).

It further re-enhances from the NARDL methodological lens point of view; the findings of Nimmi (2013) and Amountzias (2023) which provide evidence for APT within the UK's road fuels value chain.

Given that the market power is deemed as a theoretical factor behind asymmetric price transmission, the road fuels results of the present study enhance evidence for oligopolistic market power on behalf of retailers which contributes towards incomplete pass through. With regards to the bound test provided by NARDL which is often used to confirm a long-run relationship in NARDL models, its exclusion does not impact the validity of the asymmetry results, which are the primary focus of this study.

For robustness and enhance of the analysis; drawn by the individual characteristics and road fuel products in the UK retail market following the CMA consultation; this study establishes statistically significant evidence for asymmetric responses to the change in wholesale prices for super unleaded and premium unleaded individually. This study reports the results of the NARDL specification for the three products in Table 5.[8]

[8] The results are presented for non-linearities.

Table 4: Cost Pass-Through of Wholesale Prices to Road Fuel Price

Variable	Premium Unleaded (SR)	Premium Unleaded (LR)	Super Premium (SR)	Super Premium (LR)	Diesel (SR)	Diesel (LR)
LWholesale_p	0.2690*** (0.0396)	1.173** (0.420)	0.204*** (0.035)	0.939** (9.22E^-0.5)	0.3079 (0.025)	+0.0205 (0.033)
LWholesale_p_1	-0.015 (0.068)	-0.067 (0.303)	0.028 (0.0597)	0.129 (0.0088)	-0.1767*** (0.039)	0.021*** (0.003)
LWholesale_p_2	-0.227*** (0.047)	-0.989*** (0.273)	-0.200*** (0.040)	-0.927*** (0.619)	-0.1065 (0.025)	-0.0336
LWholesale_n	0.3920*** (0.032)	1.709** (0.522)	0.323*** (0.029)	1.487** (0.006)	0.3607 (0.021)	-0.0352 (0.036)
LWholesale_n_1	-0.246*** (0.062)	-1.071* (0.5065)	-0.177** (0.055)	-0.816* (0.0015)	-0.3056 *** (0.038)	-0.0376*** (0.004)
LWholesale_n_2	-0.1242** (0.046)	0.541*** (0.1600)	-0.120** (0.000)	-0.554*** (0.006)	-0.332 (0.022)	
Covid1[9]	-0.024* (0.011)	0.103 (0.529)				
Covid2	-0.0244 (0.014)	-0.106 (0.069)				
Covid3	-0.003					
Asymmetry Wald p-value	0.1052	2.62e^-19***	0.063*	3.345e^-26***	0.0485**	none
LM		1.868		1.0975		
ARCH		2.878		3.2872		23.72
N		259		259		259

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Description: The above table includes the NARDL estimation results that decompose the effect of positive and negative changes in the wholesale price to the retail price of premium unleaded, super unleaded, and diesel correspondingly. The effect of the lagged values of the changes are also illustrated. P represents a positive change in the price, and p_1, p_2 represent the changes in the first and second lagged periods correspondingly. Standard errors are also included in parentheses. Covid1, Covid2, and Covid3 are dummy variables that represent the three UK lockdown periods during the Covid-19 pandemic. Results are presented for log specifications. Post-diagnostics statistics are also included.

[9] In case Covid period does not affect the regression outcome, its coefficients are given by R as zero and are not included in the output.

This study elucidates the asymmetric price transmission mechanism, with regards to premium unleaded petroleum product, the findings of which is evident from the first log specification of Table 4. This author considers the short run asymmetry Wald test to conclude on the existence of short run asymmetries within the premium unleaded petroleum product wholesale to retail price mechanism. The null hypothesis of no SR asymmetry cannot be rejected based on the p-value of the Wald test. For providing a holistic perspective of the asymmetric price transmission within the wholesale to retail price segment of premium unleaded I further comment on the LR asymmetry. In the LR, a 1% permanent increase in wholesale prices raises the dependent variable by 1.17%, with lagged effects reflecting gradual partial corrections that occur in the periods following the initial increase. For negative wholesale price changes, retail prices gradually adjust over subsequent periods, and a 1% permanent decrease in wholesale prices is passed on by 1.70% in the long run a pass through which is gradually decreased.

A positive change in the wholesale price is passed on at a lower amount to the premium unleaded retail price than a negative change. 1.173 is less in magnitude than 1.709, suggesting that positive price changes pass through less than negative ones. This is direct evidence of negative asymmetric price transmission. The LR statistical tests (like Wald tests) confirm that the difference between the two amounts of pass through are statistically significant at the 1% level. Post diagnostics of the model and the p-value of the LM test provide enough statistical evidence that there is no autocorrelation as the null hypothesis of no autocorrelation cannot be rejected. The long run period provides sufficient evidence for negative asymmetric price transmission. I argue that the negative type of APT in the long run-may indicate the presence of market power and oligopolistic market structure. Negative APT might

emerge in an oligopolistic setting and tacit collusion can lead to asymmetric pricing behaviour. Oligopolistic firms may hesitate to raise prices quickly when costs increase, fearing that competitors will undercut them. However, when costs fall, they might compete aggressively in price reductions to attract customers, (Ivaldi et al. 2003). Early findings of the literature such as Bailey and Brorsen (1989) insist that there is no straightforward explanation of whether market power leads to a positive or negative asymmetric price transmission, Karrenbrock (1991) claims that market power results to positive asymmetry. Hence it is expected that increases in wholesale prices which reduce marketing margins will be passed on to the output price faster and more completely than reductions due to market power. Bailey and Brorsen (1989) claim that market power led to positive asymmetry and therefore they consider firms facing a kinked demand curve which is either convex or concave to the origin.

If the firm believed that no rival would increase the price after an increase in the wholesale price and all rivals would decrease the price after a decrease in the price, then negative asymmetry occurs. In the case that the firm believes that all rivals would increase their price, and none would match a price decrease then positive asymmetry occurs. This study does not link negative long run asymmetric price transmission to potential effects of regulatory policies as the sector has been under scrutiny post the CMA 2022 investigation.

With regards to super unleaded, and as it is evident from the second set of log specifications of Table 3, the NARDL model successfully captures asymmetries in the response of the level of the retail price of super unleaded to the changes in the levels of the wholesale price. My study indicates that there is statistically significant evidence for SR asymmetry which is of a weak form as one can reject the null of no

asymmetry at the 10% level. The long run Wald test of asymmetry suggests that there is a significant difference between the responses to positive and negative movements. Therefore, this study provides statistically significant evidence for LR asymmetric price transmission of the wholesale price to the retail price of road fuels; and more specifically negative asymmetric price transmission. The long run dynamic cumulative effect of a positive change is 0.939 whilst long run dynamic effect of a negative change is 1.487. Post diagnostics of the model provide enough statistical evidence that there is no autocorrelation as the null hypothesis of no autocorrelation (LM test) as well as no heteroskedasticity (ARCH test) cannot be rejected.

This author further notes that with regards to the petroleum product of diesel, the Wald test does not provide statistical considerable evidence for asymmetry.

My findings enhance the findings of Amountzias (2023) that confirms that there is significant asymmetry in the transmission of price changes from wholesale to retail levels in the UK petrol market. Additionally, I highlight that the type of asymmetry that exists is not a priori positive. This asymmetry raises questions about the competitiveness and efficiency of the UK gasoline market and suggests that retail firms may have some degree of market power that affects consumers. (Charalambous and Clerides 2020). The existence of APT is one of the causes of low market efficiency, preventing free market forces to work towards pareto optimality and equilibrium. Asymmetric price transmission may further indicate fundamental malfunctioning of market participants behaviour deviating from economic social and pareto optimum. Market power and oligopolistic pricing as well as pricing power may be a factor behind negative APT. Further overshifting; coefficients that may be higher than 100%, may indicate pricing power. This

reinforces the hypothesis that high market shares of the retailers in the UK road fuel sector may affect the pass-through mechanism as they highlight the existence of potential market power. Other factors such as the curvature of the demand curve as well as state dependent pricing and menu cost may be counterfactual towards the robust econometric foundation of linking market power to asymmetric price transmission and are worth researching. The more inelastic the quantity demanded to a change in price the more likely that pass through is affected as well as price asymmetries are created. Negative asymmetric price transmission can be also enhanced by low consumer search or switching costs since the accessibility to alternatives in the LR, can offset market power effect. Retailers pass on the decrease in prices more aggressively as they fear they might lose customers; search costs low search costs impose higher competitive pressures. Further research can provide an in-depth analysis of the factors behind negative asymmetric price transmission.

Limitations

The author realizes that there are limitations to the study as the change in the frequency of the data may enhance the precision; based on Deltas and Polemis (2024) weekly observations rather than monthly can enhance the precision, shed light on a different lens on the pass-through mechanism in the UK's road fuels sector. Furthermore, the availability of data at the station level; panel data can provide grounds for further examining the link between market power and APT, as market power and its potential effects on price dynamics varies with distance between gas stations.

5. Conclusions and Policy Implications:

This study examines the amount of cost pass through among the UK road fuels supply chain. My study highlights the phenomenon of incomplete cost pass through in the Uk's Road fuels supply chain; contradicting, the recent literature such as Pesaresi. et al. 2014; that estimate the degree of asymmetric price transmission. On a more general context my findings are in alignment with very early Uk studies on asymmetric price transmission of the Uk's Road fuel retailers. (Bacon 1991; Manning 1991).

Empirically wise I apply for the first time a novel empirical approach following Nakamura and Zerom (2010) and Deltas and Polemis (2024); in the UK's road fuels value chain. I empirically establish an incomplete degree of cost pass through from the change in the input price to the wholesale price as well as from a change in the wholesale price to the retail price along the UK's petroleum supply chain.

In this paper, I further reinvestigate the perception that retail fuel prices respond more rapidly to crude oil price increases than decreases – a pricing pattern described as the rockets-and-feathers phenomenon. This is often associated with market inefficiencies and imperfections in the market and potential collusive practices or deviations in consumer search level following input cost changes.

My analysis examines the adjustment of retail fuel prices to crude oil price changes using a novel dataset of monthly retail prices for the period spanning January 2005-Dec 2021.

To the best of this author's knowledge, none of the previous studies has examined the phenomenon using aggregate UK monthly prices for three distinct petroleum products. I provide robust statistically significant evidence for the existence of negative asymmetric price transmission for the super unleaded product negatively

affecting welfare; and negative for the premium unleaded product. My findings can be complementary to the findings of Nimmi (2013), Amountzias (2023) and the recent 2022 CMA road fuels investigation. My study can enhance the recent government and CMA's interventions in the UK's road fuel sectors, which establish high road fuels margins for road fuel retailers. In response to high petrol and diesel prices, the UK government asked the CMA to undertake an urgent review of the road fuel market in June 2022. Consequently, the CMA examined the market and concluded its investigation in 2023. As part of this, there are two recommendations to the government: a) to set up a new open data fuel finder scheme and b) to establish a new public monitoring function with formal price monitoring powers. The recommendations resulting from the study aim at boosting competition in the sector and prevent any inefficiencies to the detriment of the consumer and society. My findings can provide a novel approach towards establishing incomplete cost pass through and APT in the sector which can be an indicator of malfunction competitive conditions along the supply chain reinforcing the needs for such schemes as well as potential merger effects concerns.

I propose that this study is beneficial to the CMA's, Department of Energy Security and Net Zero, regulatory authorities attempts and concerns and provides grounds for intervention such implementation of potential prices caps as well-grounds for further research on estimating the degree of market power of the UK Road fuel retailers.

It further reinforces the recent cap freeze by Chancellor Reeves.

APPENDIX A FOR TABLES 3 AND 4:

Variable Definitions:

- **LWholesale_p:**
  Log of positive wholesale price changes. This variable captures the percentage change in the wholesale price when it increases.
- **LWholesale_p_1:**
  First lag of the log of positive wholesale price changes. Represents the impact of the previous period's positive wholesale price change on the retail price.
- **LWholesale_p_2:**
  Second lag of the log of positive wholesale price changes. Captures the impact of the second preceding period's positive wholesale price change on retail prices.
- **LWholesale_n:**
  Log of negative wholesale price changes. This variable captures the percentage change in the wholesale price when it decreases.
- **LWholesale_n_1:**
  First lag of the log of negative wholesale price changes. Represents the impact of the previous period's negative wholesale price change on the retail price.

Explanatory Notes:

- **Positive Wholesale Price Changes (LWholesale_p):** This variable is used to model the immediate and lagged effects of wholesale price increases on retail prices. Asymmetric price transmission, especially the "rockets and feathers" effect, is often seen when retail prices increase more quickly than they decrease in response to changes in wholesale prices.
- **Negative Wholesale Price Changes (LWholesale_n):** This variable captures the retail price adjustment to decreases in wholesale prices. The model accounts for potential asymmetries in how quickly and completely these negative price changes are passed through to consumers.
- **Lags:** The use of lagged variables (LWholesale_p_1, LWholesale_p_2, and LWholesale_n_1) allows the model to account for delayed responses in retail prices to wholesale price changes, reflecting the gradual nature of price adjustments.[10]

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[10] I hereby confirm that there was no funding or conflict of interest involved in the study.

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