Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.
Are anticompetitive behaviours rampant in global retail energy markets? A study of price elasticity, asymmetric price adjustment and rent-seeking

Jonathan E. Ogubabor a,1, Anthony Orji a, Onyinye I. Anthony-Orji a,b

a Department of Economics, University of Nigeria, Nsukka, Nigeria
b Department of Economics and Related Studies, University of York, Heslington, York YO10 5DD, UK

ARTICLE INFO

JEL Classification:
Q43
D40
L22
C22
L40

Keywords:
Rockets and feathers effect
Rent-seeking
Price elasticity
Nonlinear ARDL model
Antitrust policy

ABSTRACT

This study investigated the role of price elasticity in the asymmetric adjustment of global retail energy prices and in the rent-seeking behavior of retail energy firms. Overall, 58 nonlinear ARDL models were estimated for the period 2004:M12 – 2016M8 using data for gasoline, automotive diesel, domestic heating oil, industrial fuel oil and crude oil markets. The results indicate that global retail energy markets are still pervasively fraught with the problems of rockets and feathers effect and the likelihood of retailers manipulating the tax system to hide rent-seeking behaviors. The results also indicate that there is more likelihood of rent-seeking activities in the markets for road fuels whose demand is relatively more price-inelastic than in the markets for non-road fuels whose demand is relatively more price-elastic, thereby suggesting that differences in market structure could offer a possible explanation for rent-seeking and asymmetric price adjustment in global retail energy markets. These results have far-reaching antitrust and consumer welfare implications, which require regulators and policy makers to interminably monitor the global retail energy markets, especially during periods of economic crisis like the ongoing COVID-19 pandemic, in order to safeguard the overall social welfare.

1. Introduction

One of the sad realities of modern economies is the concept of rent-seeking. Black [1] explained this concept as the act of using the resources of an individual or firm (directly or indirectly) to obtain benefits from others. This benefit can be monetary or economic and it usually goes without giving anything in return to the society or the individuals through wealth creation. For example, the concept of rent-seeking has been pertinently used to describe the behavior of some retailers in the petroleum industry who obtain a subsidy from the government on every litre of petroleum product they sell to the consumers, whereas they sell the subsidized products to consumers at prices that are far higher than the government approved prices [2]. Such retailers are known as rent-seekers and their price manipulation activities pose serious antitrust and consumer welfare challenges. These challenges arise because the rent-seekers neither create new wealth nor contribute towards an improved overall social welfare. They always and everywhere render the society as a whole worse off.

The concept of rent-seeking has a long economic history dating back to the seminal work of Tullock [3], which painstakingly studied the welfare cost of tariffs, monopolies, subsidies and theft. Following this initial work, many economists have stressed the pervasiveness of this phenomenon across the global economy. For instance, in the study of the political economy of the rent-seeking society, Krueger [4] explained that government restrictions upon economic activity are pervasive facts of life in most market economies. However, such restrictions give rise to various forms of rent, which economic agents usually compete for; and such rent-seeking could take various forms like bribery, corruption, smuggling, and black markets, among others. Buchanan et al. [5] specifically identified entry restrictions as the main factor underlining the

https://doi.org/10.1016/j.erss.2020.101783
Received 5 June 2020; Received in revised form 2 September 2020; Accepted 16 September 2020
Available online 10 October 2020
2214-6296/© 2020 Elsevier Ltd. All rights reserved.
problem of rent-seeking; and therefore explained that rent-seeking is primarily used to depict the effects of attempts by individuals or groups to achieve profits through government restrictions on entry. Calderón and Chong [6] investigated the role of democratic regimes in the rent-seeking behaviours of economic agents. In the main, the study established that democratic regimes are negatively linked with rent-seeking actions. In other words, the longer the duration of democracy, the less rent-seeking in a society. The study further demonstrated that legislation enacted more transparently is negatively correlated with rent-seeking behavior. Clearly, enormous efforts have been made towards a more comprehensive understanding of the various ramifications of the phenomenon of rent-seeking. In the financial markets, Khwaja and Mian [8] established that rent-seeking involves both state and non-state actors. For instance, the study identified bureaucrats, politicians, banks and investors as some of the key players. Quite recently, Ogbuabor et al. [2] studied South African and selected Eurozone road fuel markets for the prevalence of rent-seeking behavior by retailers. This study established that while the Eurozone markets are fraught with this problem, the South African markets did not exhibit the problem. However, the most important contribution of this study is the submission that the government regulatory activities present a critical factor in explaining the prevalence or otherwise of rent-seeking behaviour by retailers. Other studies that have examined this phenomenon include Pasour Jr. [9], Collier and Goderis [10], Sachs and Warner [11,12], and the references therein.

Presently, there are concerns that retail prices of petroleum products in the global economy may likely be responding in an asymmetric manner to changes in crude oil costs. This could be as a result of the rent-seeking activities of retailers in the petroleum downstream sector. These concerns arose from the realization that the recent but persistent tumbling in international oil prices is not being felt by consumers of retail petroleum products at pump. Since crude oil is the main raw material or input in the production of different petroleum products, the economic expectation is that such products as gasoline, domestic heating oil, industrial fuel oil, and automotive diesel should have their retail or pump prices responding symmetrically to changes in crude oil costs. Unfortunately, the contrary appears to be the case. For instance, the International Energy Agency (IEA) monthly oil price statistics indicate that the average end-user price for regular unleaded gasoline was $0.94 per litre in the United States of America (USA) when the price of imported crude oil averaged at $103.14 per barrel in August 2013. However, while the cost of crude oil declined to $96.01 per barrel in April 2014, the price of gasoline rose to $0.97 per litre. Such pattern of price adjustment is clearly asymmetric and reveals what may be considered as rent-seeking behavior in such markets.

The pattern of price transmission from crude oil markets to retail energy markets which may be termed asymmetric is not peculiar to the USA. Indeed, it has become a major feature of the global retail energy sector. For example, in the United Kingdom (UK), the average cost of imported crude oil declined massively from $128.14 per barrel in March 2012 to $51.61 per barrel in January 2015, while the retail price of gasoline only declined marginally from £1.39 per litre to £1.10 per litre respectively. In the Eurozone, the IEA statistics also capture asymmetric patterns that are similar to those of the USA and the UK. For example, the average cost of imported crude oil in France declined drastically from €133.35 per barrel in July 2008 to €42.97 per barrel in January 2009, while the average retail price of gasoline only declined marginally from €1.10 per litre to €1.02 per litre respectively. This asymmetric pattern of response to changes in crude oil costs is also prevalent in other retail energy markets such as the automotive diesel markets. It is also an issue of great concern in other Eurozone economies like Italy, Germany, and Spain. Indeed, the IEA statistics indicate that following the COVID-19 pandemic, the average cost of imported crude oil in Italy, Germany, and Spain declined drastically by 69.81%, 68.85%, and 65.59% between December 2019 and April 2020, while the average retail price of automotive diesel declined slightly by 11.37%, 14.60%, and 16.63%, respectively. This particular statistics suggest that asymmetric adjustment of retail energy prices could be an important policy issue, especially during periods of crisis.

Numerous empirical studies have examined the asymmetric price transmission to different retail energy markets from crude oil market using different methodologies. Some of these studies established evidence in support of the presumed asymmetry [13–27], while others found no statistically significant evidence of the supposed asymmetry [28–37]. Reports of the three main investigations of the gasoline markets show that when faced with increasing input costs, sellers do swift upward adjustment of prices. However, when faced with decreasing costs, price adjustment is usually done sluggishly downwards. These studies were conducted by the Monopolies and Mergers Commission (MMC), UK, between 1965 and 1990. The MMC called this adjustment pattern of prices ‘rockets and feathers’. Thus, the rockets and feathers effect is said to occur in retail energy markets when the adjustment speed of retail prices to cost changes is more rapid when costs rise (i.e. “retail prices go up like rockets”) than when they fall (i.e. “retail prices go down like feathers”). However, they used descriptive and graphical analysis of weekly company administrative records to argue their position without establishing it through econometric work [38–40].

In other studies, various econometric procedures were adopted by Grasso and Manera [41] and Greenwood-Nimmo and Shin [21], among others, to empirically analyse the issue of rockets and feathers effect in the UK. Greenwood-Nimmo and Shin [21] found that firms that are into retail business may be hiding rent-seeking behavior by influencing the tax system. This is evident because according to the paper, asymmetry is mainly obscured at pump where prices account for both tax and duty. For the retail energy markets in the USA, some studies found evidence in support of the presumed asymmetry and also of the rockets and feathers effect. Such studies like Borenstein et al. [14], Karrenbrock [28], Borstein and Shepard [15], and Murry and Zhu [42] also attributed the observed asymmetric patterns to market power of some retailers and adjustment lags in production/inventory. In other related studies done for the Canadian and Swedish retail energy markets, Chacrà [43] and Asplund et al. [44] respectively found that asymmetric price adjustment is evident in those economies. Grasso and Manera [41] and Ogbuabor et al. [45] have also made global documentation of empirical evidence of asymmetric price adjustment in retail gasoline markets. For retail energy markets in Europe, Ogbuabor et al. [25] recently found widespread evidence in favour of the hypothesized asymmetry. Contrary to these empirical evidences, some other papers, while studying the retail energy markets, did not find any evidence in support of either the rockets and feathers effect or the presumed asymmetry. Such studies include Bachmeier and Griffin [32] and Kristoufek and Lunakova [37], among others. Other studies that have remarkably contributed towards a broad understanding of asymmetric price adjustment in global retail energy markets are Johnson [46], Lewis [47] and Perdiguero-García [48]. While Johnson [46] and Lewis [47] attribute the hypothesized asymmetry to consumer search effort, Perdiguero-García [48] documents a survey of 48 empirical studies on asymmetric price adjustment for retail energy markets across the globe.

From the foregoing studies of retail energy markets, it is easily seen that the growing literature on the asymmetric adjustment of prices and rent-seeking has very little theoretical or empirical papers that have identified the relevant market features responsible for these phenomena. Specifically, the above paragraphs indicate that possible explanations for these phenomena include oligopolistic pricing behavior or market power of some retailers [14,49], consumer search effort [46,47], inventory/production capacities and costs [15], and lack of regulation.
This means that the role of market structure arising from the nature of price elasticity\(^\text{4}\) for the various products is yet to be investigated. This paper fills this gap in the literature.

To do this, the retail petroleum products were categorized into road fuels (which are automotive diesel and gasoline) and non-road fuels (which are industrial fuel oil and domestic heating oil)\(^\text{5}\). According to Greenwood-Nimmo and Shin [21], non-road fuels are generally delivered in relatively large average volumes and at low frequency of transactions so that consumers normally have more bargaining power and greater reward for their search efforts. In addition, the deliveries of non-road fuels are sometimes subject to contractual agreements. These deliveries are commonly made by tank truck and stored in above-ground storage tanks or underground storage tanks. In UK, for instance, many villages also use buying groups to order non-road fuels at the same time, thereby increasing their bargaining power and accessing lower costs. Similar patterns exist in other countries captured in this study [52]. These facts indicate that the demand for non-road fuels is generally more elastic compared to the demand for road fuels such that in economic terms, there should be more likelihood of rent-seeking and asymmetric price adjustment in the markets for road fuels. This categorization of retail petroleum products into road fuels and non-road fuels is consistent with the existing literature, including Greenwood-Nimmo and Shin [21] and Ogbuabor et al. [2]. For the eight countries included in this study, Organisation for Economic Co-operation and Development (OECD) [52] conducted a country by country evaluation and found that price elasticity in their road fuel markets is generally low due to some structural factors, such as frequent and relatively small transactions with a fragmented demand side, high barriers to entry, symmetry between leading suppliers due to the vertical relations and nationwide presence of the companies (especially in Italy, Germany, and Spain, where dominant firms are quite visible in the downstream petroleum markets), and difficulties in setting up retail outlets and securing supplies of road fuels, among others.

The remaining sections of this paper are structured as follows. In Section 2, the methodology is presented, detailing the nonlinear ARDL framework and the justification for the choice of this framework. Section 3 presents the data, its transformations and time series plots, while Section 4 presents the empirical results and discussions. Section 5 concludes the paper.

2. Methodology

2.1. The nonlinear ARDL model

This study adopted the nonlinear autoregressive distributed lag (NARDL) methodology popularized by Shin et al. [53] for modeling dynamic multipliers and asymmetric cointegration. Under this framework, the positive and negative partial sum decompositions of the regressors are used to capture the short-run and long-run nonlinearities in the model. It is interesting to note that partial sum decompositions have been successfully and extensively applied in the analysis of dynamic asymmetry. Studies such as Borenstein et al. [14], Lee [54], and Bachmeier and Griffin [32], among others, give credence to this. More recent studies like Greenwood-Nimmo and Shin [21] and Ogbuabor et al. [2] also applied this framework in modeling asymmetric price adjustments across various retail energy markets. The method is fundamentally an extension (in an asymmetric manner) of the linear ARDL framework for modeling equilibrium relationships initially advanced by Pesaran et al. [55] (henceforth PSS). The framework follows an asymmetric cointegrating relationship of the form:

\[
Y_i = \theta^+ X_i^+ + \theta^- X_i^- + U_i
\]

where \(Y_i\) denotes the retail energy prices in our various estimations. Different components of the retail energy prices include prices of automotive diesel, gasoline, domestic heating oil and industrial fuel oil. The explanatory variable \(X_i\) denotes the cost of crude oil. This study decomposed the explanatory variable \(X_i\) into positive and negative partial sum processes. This enabled us to relate with the increases (or positive changes) and decreases (or negative changes) in crude oil costs. This is shown in equation (2.2) as follows:

\[
X_i = X_{i0} + X_i^+ + X_i^-
\]

where \(X_i^+ = \sum_{j=1}^{\max} (\Delta X_i, 0)\) and \(X_i^- = \sum_{j=1}^{\min} (\Delta X_i, 0)\) are the partial sum processes of negative and positive changes in \(X_i\). Also, following Greenwood-Nimmo and Shin [21], this study assumes \(X_{i0}\) to be zero. This is because it is assumed to be the initial threshold value. This is also consistent with Shin et al. [53]. The first difference operator is represented by the notation \(\Delta\), while the asymmetric long-run coefficients that are denoted by \(\theta^+\) and \(\theta^-\). For ease of exposition but without loss of generality, the intercept in equation (2.1) is suppressed. TheADF unit root tests (controlling for trend and intercept) indicate that all the variables in this study are integrated of order one, I(1), except for the Phillips-Perron unit root test, the gasoline data for USA was found to be I(0). Thus, this study concludes that all the variables are I(1), which is consistent with the underlying assumptions of the NARDL framework. To conserve space, these tests of stationarity are not reported explicitly; however, the cointegration test results based on the bounds testing procedure of PSS and the \(\phi_{00}\) statistic of Banerjee et al. [56] are reported in this study as part of the empirical results.

Following Greenwood-Nimmo and Shin [21], equation (2.1) can be expressed as a NARDL(p,q) model in its level form as follows:

\[
Y_i = \sum_{j=1}^{p} \phi_j Y_{i-j} + \sum_{j=1}^{q} \left( \theta^+_j X_{i-j}^+ + \theta^-_j X_{i-j}^- \right) + \epsilon_i \tag{2.3}
\]

where \(\phi_j\) captures the autoregressive coefficients; \(\theta^+_j\) and \(\theta^-_j\) account for the asymmetric distributed lag coefficients; while \(\epsilon_i\) is assumed to be an identically and independently distributed error term. For the empirical estimations, this study adopted the general-to-specific lag selection approach following Greenwood-Nimmo and Shin [21]. To ensure that the functional form of the equilibrium relationships and the model dynamics are not arbitrarily misspecified, the study set the starting maximum lag length in the general-to-specific modeling procedure at 5 months so that \(p_{max} = q_{max} = 5\) months, with a unidirectional 5% decision rule. The model in equation (2.3) accounts for only the equilibrium or cointegrating relationship. However, once cointegration is established, a good empirical work should account for both long-run relationships and short-run dynamics. Thus, to account for both long-run and short-run asymmetries, the NARDL(p,q) model in equation (2.3) is expressed in its error correction form as follows:

\[
\Delta Y_i = \sum_{j=1}^{p} \psi_j \Delta Y_{i-j} + \sum_{j=1}^{q} \left( \delta^+_j \Delta X_{i-j}^+ + \delta^-_j \Delta X_{i-j}^- \right) + \epsilon_{i,t} \tag{2.4}
\]
\[ \Delta Y_t = \rho Y_{t-1} + \theta^+ X^+_{t-1} + \theta^- X^-_{t-1} + \sum_{j=1}^{\infty} \rho_j \Delta Y_{t-j} + \sum_{q=1}^{\infty} \pi_q^+ \Delta X^+_{t-q} + \pi_q^- \Delta X^-_{t-q} + \epsilon_t \]  

(2.4)

where \( \rho \) captures the speed of adjustment; \( \beta^+ = -\frac{\rho}{\pi^+} \) and \( \beta^- = -\frac{\rho}{\pi^-} \) capture the asymmetric long-run parameters; while \( \pi_q^+ \) and \( \pi_q^- \) capture the short-run parameters. The model for this study in equation (2.4) is used to investigate how road fuels and non-road fuels respond to the ups and downs of the crude oil market. Essentially, two kinds of asymmetry are evaluated in this study, namely: long-run and short-run asymmetries. For the former, the standard Wald coefficient restriction tests are used to assess the null hypothesis of long-run symmetry, \( H_0: \beta^+ = \beta^- \); and for the latter, the standard Wald coefficient restriction tests are also used to assess the null hypothesis of short-run additive symmetry, \( H_0: \sum_{j=0}^{\infty} \pi_j^+ = \sum_{j=0}^{\infty} \pi_j^- \).

The patterns in the short-run additive symmetry tests are thereafter evaluated to determine if they are consistent with the rockets and feathers effect. The intuition behind this evaluation is fairly straightforward. If the positive short-run additive parameter is higher than the corresponding negative short-run additive parameter; and if the difference between them is statistically significantly different from zero; then it means that evidence has been established on the prevalence of the rockets and feathers effect. In other words, the retail prices respond more swiftly to crude oil cost increases than to cost decreases. Apart from long-run and short-run asymmetries, this study also evaluates the speed of adjustment (\( \rho \)) to see if it is sluggish (i.e. well below 50%) or otherwise. This evaluation is particularly important because sluggish speed of adjustment has been generally associated with various forms of market failure in the literature, such as asymmetric price adjustment and rent-seeking [2,21].

To investigate the likelihood that retail firms may be manipulating the tax system to hide rent-seeking behavior in the various retail energy markets, this study compared the results of the short-run additive symmetry tests for each individual retail product for pump prices (which includes tax and duty) with the corresponding results for ex-tax prices (which excludes tax and duty). Let us consider the intuition behind this comparison. Suppose the short-run additive symmetry test reveals patterns that are consistent with the rockets and feathers effect for the ex-tax prices. Suppose also that these observed patterns of rockets and feathers effect are not present when the pump prices (that include tax and duty) are used in place of the ex-tax prices. The study will then conclude that the observed asymmetry or rockets and feathers effect is obscured at pump. Of course, once asymmetry is obscured at pump, it raises the likelihood that retailers may be manipulating the market to conceal rent-seeking activities. This intuition is consistent with the established literature such as Greenwood-Nimmo and Shin [21] and Ogbuabor et al. [2].

2.2. Justification for the choice of NARDL model

This study adopted the NARDL modeling framework due to its numerous desirable features. For instance, the model is easily estimated using the ordinary least squares technique since it is linear in parameters. The model allows the inclusion of variables that are stationary at level or at first difference. In fact, the model accommodates explanatory variables that are I(0), I(1) or mutually cointegrated. In this study, however, both ADF and Phillips-Perron unit root tests show that the series are overwhelmingly integrated of order one, I(1), and thus satisfy the underlying assumptions of the model. The model allows for the null hypothesis of no equilibrium relationship between the levels of \( Y_t \), \( X^+_t \) and \( X^-_t \) (i.e., \( \rho = \theta^+ = \theta^- = 0 \)) to be effortlessly tested using the t-statistic of Banerjee et al. [56] and the PSS bounds-testing procedure. These tests for equilibrium relationship remain valid regardless of whether the explanatory variables are I(0), I(1) or mutually cointegrated. Besides, the model allows for the movement from initial equilibrium, through short-run disequilibrium following a shock, to a fresh long-run equilibrium to be illustrated graphically using the cumulative dynamic multipliers. This study exploited this feature by using these multipliers to demonstrate the patterns of both short-run and long-run asymmetries in the various retail markets. Thus, asymmetric cumulative dynamic multiplier effects of a unit change in the regressors (\( X^+_t \) and \( X^-_t \)) on the retail energy prices (\( Y_t \)) derived from equation (2.4) are expressed as follows:

\[ m^+_h = \sum_{j=0}^{\infty} \Delta Y^+_j / \Delta X^+_j, \quad m^-_h = \sum_{j=0}^{\infty} \Delta Y^-_j / \Delta X^-_j, \quad h = 0, 1, 2, \ldots \]  

(2.5)

By construction, as \( h \to \infty \), \( m^+_h \to \beta^+ \) and \( m^-_h \to \beta^- \). Here, the asymmetric patterns are illustrated over a 12-month horizon so that \( h_{\text{max}} = 12 \). The choice of this horizon is to ensure that the long-run patterns are adequately captured. This choice is also consistent with Greenwood-Nimmo and Shin [21] and Ogbuabor et al. [2]. To assess the statistical significance of both the short-run and long-run asymmetries, two standard error confidence intervals are calculated for each dynamic multiplier.

3. The data

The dataset for this study includes monthly observations from 2004:12 – 2016:8 on both the ex-tax and pump prices of retail petroleum products. The petroleum products include: domestic heating oil, gasoline, automotive diesel and low sulphur industrial fuel oil. The average costs of imported crude oil in the USA, UK, Canada, Italy, Germany, France, Spain, and Japan were also used. These markets were chosen for this study because their data are readily available from the International Energy Agency (IEA) publication on monthly oil price statistics. The use of both ex-tax and pump prices ensured that the rent-seeking analysis in this study was conducted at econometric level, unlike earlier studies such as [13]. The average costs of imported crude oil for the respective countries were used in order to efficiently capture the asymmetries in the response of the various retail markets to the dynamics of the crude oil market.

To prepare the data for estimation, this study performed the following transformations. First, the retail prices that were initially measured in national currencies were converted to U.S. dollar using the monthly exchange rates taken from the OECD Statistics (this statistics is available at: http://stats.oecd.org/OECDStat_Metadata/). This conversion was done in order to align the units of measure with that of the crude oil market, which is U.S. dollars per barrel for all the countries. After achieving uniformity in data measurement, the entire dataset was indexed to 2010 base year so that 2010Y = 100. The goal of this indexing was to ensure uniform scaling for all the series and hence improve the robustness of the estimates. Lastly, the entire data was logged in order to reduce the possibility of being too noisy. It must be stressed that logging the data also ensures that the estimates retain clear economic interpretations. These data transformations are transparently reported here so that our computations can be easily replicated and compared with the extant literature including Greenwood-Nimmo and Shin [21] and Ogbuabor et al. [2].

Fig. 1 plots the data for France based on the indexed representation of the data before it was logged for estimation. The data plots for the other countries in this study follow similar patterns. To conserve space, the plots for these other countries are not included in this report, but they are available on request. In terms of notation, PfrI denotes the pump price of gasoline in France (the last letter ‘I’ shows that the data is indexed) while XfrI denotes the ex-tax price of gasoline in France. Similarly, PfrD, Pfhd, and Pfpr denote the pump prices of diesel, domestic heating oil and industrial fuel oil in France, respectively; while XfrD, XfrH, and XfrI also denote the respective ex-tax prices. In the case
relationship between the variables. This reinforces our decision to test
cow-movement in Fig. 1 also suggests that there may be an equilibrium
energy markets may not be tenable after all. Furthermore, the observed
symmetric relationship between them. It also suggests that the concerns
oil costs as enunciated by the rockets and feathers hypothesis. In fact,
lence of asymmetric relationship between the retail prices and the crude
surrounding analysis, the notations for other countries follow the same

\[ \text{OilI denotes the indexed crude oil prices.} \]

**4. Empirical results and discussions**

To achieve the goal of this study as stated in the introduction, the
baseline conditional nonlinear error correction model in equation (2.4)
was estimated for the various retail markets. In what follows, the esti-
mation results for each country and the associated cumulative dynamic
multipliers are presented and discussed.

**4.1. Estimation results for Italian markets**

Altogether, this study estimated eight NARDL models for the Italian
markets following equation (2.4) and the results are reported in Table 1.
Four models were estimated for the ex-tax prices of the four retail
products as shown in Panel 1, while four models were also estimated for
the pump prices as shown in Panel 2. The responses of ex-tax prices
to changes in crude oil costs are shown in the first panel (Panel 1), while
the responses of pump prices to changes in crude oil costs are shown in
Panel 2. Fig. 2 shows the cumulative dynamic multipliers corresponding
to the results in Table 1. From the results shown in panel 1, there is an
indication that the speed of adjustment ranges between 16 and 59% per
month. This is quite sluggish. This pattern of sluggish speed of adjust-
ment usually occur when markets experience extended periods of mis-
pricing, weak competition and other forms of market failures. Indeed,
several recent studies attest to the prevalence of various forms of ir-
regularities in energy markets, such as cartel possibilities, crony capi-
talism, and corruption, among others [57-63]. In UK, Greenwood-
Nimmo and Shin [21] and Ogbuabor et al. [25] also find similar results
in their own analysis. Interestingly, it is also consistent with the struc-
ture of the non-road fuel markets.

The short-run additive asymmetry is shown to be statistically sig-
nificant only in the road fuel markets. This is also revealed by the results
in panel 1 of table 1. The pattern of this asymmetry is such that the
positive short-run additive parameters are greater than the corre-
sponding negative short-run additive parameters. This goes to show that
in the periods following the shocks immediately, crude oil price in-
creases (positive changes) are passed through more rapidly and strongly
than price decreases (negative changes). As far as the Italian road fuel
markets are concerned, this result provides clear evidence that rockets
and feathers effect is a reality.

Fig. 2 depicts the results graphically. In this figure, the four tick
marks on the horizontal axis denote quarterly or 3-month intervals,
which sums up to 12-month horizon, while percentage points are used to

calibrate the vertical axis. Again, with respect to the percentage positive
and negative change in crude oil cost, the solid and dashed black lines
capture the dynamic multipliers respectively. Also, the two light dashed
red lines capture the two standard error confidence interval for the
heavy middle dashed line calculated by stochastic simulation, while the
heavy middle dashed red line shows the difference between the two
black lines. The plots in Fig. 2 indicate strong and rapid response to
increases (positive changes) in crude oil cost by the ex-tax prices of the
road fuels, while the response to decreases (negative changes) in oil cost
is more gradual.

From Panel 2, it is observed that the speed of adjustment has become
more sluggish at pump, ranging between 10 and 22%. This reinforces
our earlier findings. The results also show significant long-run asym-
metry only in the road fuel markets just as in Panel 1. This result clearly
supports the fact that the demand for non-road fuels is less inelastic,
while the demand for road fuel is more inelastic.

Interestingly, Panel 2 (where prices are inclusive of tax and duty)
reveals that the short-run asymmetries earlier observed in Panel 1 for
road fuels disappeared. In other words, the short-run asymmetries that
are consistent with the rockets and feathers effect are obscured at pump.
This raises the prospects that there may be manipulation of the tax
system to hide rent-seeking behaviors by retailers in the Italian road fuel
markets. This result also reveals that the possibility of manipulating the
tax system to hide rent-seeking activities is a characteristic of only the
road fuel markets in Italy whose demand is relatively more inelastic.

The foregoing results speak volumes about the happenings in the
Italian oil industry. For instance, Italy is an oil-deficient economy that
imports virtually all its crude oil requirements. Since 1990, the oil
import dependency ratio in Italy ranged between 92.3 and 95.8%. Thus,
there is a possibility that in Italy, road petroleum products markets may
be vulnerable to the price swings in the international oil market. Pane 2
shows that the estimated coefficients for road fuel markets also support
this fact.

It is also interesting to note that in 2012, the transport sector
accounted for 49% consumption of overall oil supply in Italy. This high
consumption rate by the transport sector is consistent with the
submission of Simcock and Mullen [51] that the consumption of energy services is a fundamental requirement for everyday mobility in modern societies. The high consumption rate by the transport sector is also typical of markets characterized by rockets and feathers effect and rent-seeking, which have been established in this study. These findings are contrary to Kristoufek and Lunackova [37], but indicative unchanged. The adjusted R-squared values of the Newey-West HAC method. This is not surprising because the ordinary least squares coefficients are consistent in the presence of autocorrelation and heteroskedasticity, though the estimated standard errors and the usual t-tests are not longer valid. This study finds that after using the Newey-West HAC standard errors, the t-test results remained qualitatively unchanged. The adjusted R², which ranges between 60 and 85%, is considered desirable.

### 4.2. Estimation results for Canadian markets

For Canada, the industrial fuel oil market was not included because of unavailability of data. Table 2 presents the results of the estimations, while Fig. 3 shows the associated cumulative dynamic multipliers. From the analysis, the results show that the speed of adjustment for heating oil and automotive diesel markets are quite sluggish. Again, except in the automotive diesel markets, the results show that there is long-run asymmetry in all the Canadian markets at the 1% significant level. However, in the automotive diesel market at pump, there is significant long-run asymmetry at the 10% level. The pattern of this asymmetry indicates that the markets respond more strongly and rapidly to increases in crude oil price than to crude oil price decreases. The results indicate that the long-run coefficients for the ex-tax prices in Panel 1, are higher than their corresponding values for pump prices (which includes tax and duty) in Panel 2 across all markets. This suggests that in the long-run, consumers observing the pump prices are relatively more prone to the fluctuations in the crude oil market.

Interesetingly, the results also show significant evidence of short-run additive asymmetry at the 5% level only in the pump prices of domestic heating oil markets and gasoline. However, the pattern of this asymmetry is such that the positive short-run additive parameters that capture the response of retail prices to increases in crude oil costs are lower than the corresponding negative short-run additive parameters that

---

**Table 1**

| PANEL1: Ex-Tax Price | PANEL 2: Pump Price |
|----------------------|---------------------|
| Xgit | Xdit | Xhit | Xfit | Pgit | Pdit | Phit | Pfit |

Notes: Xgit, Xdit, Xhit and Xfit are the ex-tax prices of gasoline, automotive diesel, domestic heating oil and industrial fuel oil, respectively; while Pgit, Pdit, Phit and Pfit are the corresponding pump prices. The notations for the coefficients that were estimated are based on equation (2.4). The standard Wald coefficient restriction tests provides the base for the symmetry tests. The serial correlation test is carried out using the Breusch-Godfrey (B-G) method, while the test for heteroskedasticity is done using the ARCH test. The relevant critical values for the t-statistic are 4.78, 5.73 and 7.84. *** shows significance at 1% level; ** shows significance at 5% level and * shows significance at 10% level. Source: Authors’ computations with data from the IEA monthly oil price statistics.
capture the response of retail prices to decreases in crude oil costs. This means that the observed short-run asymmetries do not support the rockets and feathers effect. The absence of the rockets and feathers effect in the Canadian retail energy markets means that this study has not found any evidence that there may be some level of manipulations of the tax system among the retailers to conceal rent-seeking behavior.

In what follows, the foregoing results are shown to be in line with the realities of the Canadian petroleum industry. As one of the world’s largest crude oil producers, Canada has low fuel taxes of $0.96 and $0.77 per gallon of gasoline and diesel, respectively. These tax rates are relatively low compared to Italy. Canada’s total oil production averaged 3.8 million barrels per day in 2012, out of which 40% were exported with net exports averaging 1.47 million barrels per day. The exports are destined almost entirely for the USA. Canada had 15 operational refineries as of the end of 2012 with a combined crude oil refining capacity of 1.94 million barrels per day, whereas its domestic demand averaged 1.8 million barrels per day. This means that Canada was able not only to satisfy its domestic demand for most refined petroleum products but also to export to other countries, mainly the USA. Clearly, these facts are consistent with the findings of this study, especially the absence of the rockets and feathers effect and rent-seeking in the Canadian retail energy markets.

Fig. 2. Cumulative Dynamic Multipliers for Italy. Notes: The vertical axis is calibrated in percentage points, while the four tick marks on the horizontal axis denote quarterly or 3-month intervals, which sums up to 12-month horizon. With respect to a percentage positive change (increase) and negative change (decrease) in crude oil cost, the solid and dashed black lines capture the dynamic multiplier respectively. While the two light dashed red lines capture the two standard error confidence intervals for heavy middle dashed line (calculated by stochastic simulation), the heavy middle dashed red line shows the difference between the two black lines. Source: Authors, with data from the IEA monthly oil price statistics.
As of the end of 2012, Canada also had an extensive network of pipelines covering about 825,000 km, which supplies crude oil and refined products to both domestic and USA markets. Constitutional provisions indicate that both federal and provincial governments play active roles in Canada’s energy sector. The natural resources are owned by the provinces and they are responsible for the conservation, management and development of the natural resources that lie within their geographic boundaries. This means that the provinces do all that is necessary to protect oil installations within their territories, such that the country as a whole witnesses very minimal disruptions on its oil facilities. During an oil supply disruption or demand restraint leading to the declaration of national emergency, the Energy Supplies Emergency
The foregoing results are quite consistent with the dynamics of the German petroleum industry. For instance, the country is an oil-deficient country and has a high oil import dependency ratio ranging between 16 and 46%. Specifically, the speed of adjustment shows 29% and 16% for gasoline and diesel at pump, while the corresponding ex-tax values are 46% and 35%, respectively. This means that consumers observing only pump prices are more prone to the vagaries of the international oil market. In general, these speeds of adjustment are sluggish as in the case of Italy and France. The empirical evidence also reveals that there is long-run asymmetry only in the ex-tax prices of domestic heating oil and gasoline. However, the movement of this asymmetry for the gasoline market indicates that there is a more swift response of retail prices to increase in oil price than to decrease in oil price in the long-run; whereas the contrary is the case for domestic heating oil market. This finding underlines the distinction emphasized in this study regarding the nature of price elasticity for road fuels and non-road fuels.

The results show that even at 1% level, the presence of the rockets and feathers effect can still be noticed in the ex-tax markets for domestic heating oil and automotive diesel. The interesting fact, however, is that while this effect became obscured at the pump in the case of automotive diesel, it remained persistent and pronounced in the case of domestic heating oil. This means that strong evidence has been found that only firms in the retail automotive diesel market may be manipulating the system of taxation in order to hide their rent-seeking behavior. Furthermore, the absence of rent-seeking behavior in the market for non-road fuel (i.e. the domestic heating oil market) shows that price elasticity can be an important indicator or factor in explaining the pattern of asymmetry and rent-seeking across energy markets that are in retail business. For the retail gasoline market, the results indicated rockets and feathers effect that is significant only at pump. Note that in the estimations for the German markets, the industrial fuel oil market was excluded due to lack of data.

The following results are quite consistent with the dynamics of the German petroleum industry. For instance, the country is an oil-deficient country and has a high oil import dependency ratio ranging between 95.7 and 96.9% since 1990 (IEA Energy Supply Security 2014). This agrees with the sluggish speed of adjustment found in the country’s retail energy markets. Interestingly, 51% of overall oil supply in 2012 was consumed by the transport sector. This is coupled with demand deficits of 230 thousand barrels per day (kb/d) for automotive diesel.
This also agrees with the rent-seeking behavior and rockets and feathers effect established in the automotive diesel market. It is important to note that in addition to VAT of 19%, Germany imposes €4.10 and €2.95 per gallon of gasoline and diesel as tax, respectively. These high tax rates for road fuels are consistent with the possibility of rent-seeking found in the automotive diesel market. Overall, the results are consistent with Grasso and Manera [41], but contrary to Kristoufek and Lunackova [37]. Furthermore, the results are consistent with the earlier finding that rent-seeking by retail firms can indeed be a problem mainly in road fuel markets of oil-deficient countries with relatively less elastic demand.

4.5. Estimation results for Spanish markets

The results for Spanish markets are largely consistent with those of Italy, Germany and France. This is not surprising because all the four countries belong to the Eurozone and have high oil import dependency ratios. Specifically, the speed of adjustment ranges between 14 and 47%, which is sluggish. This also agrees with the study of Greenwood-Nimmo and Shin [21]. In the ex-tax prices, the empirical findings also show the presence of long-run asymmetry only in the market for gasoline. However, this asymmetry became widespread in the pump prices across all the retail energy markets, except the market for industrial fuel oil (which is a non-road fuel market). In all cases, the pattern of this asymmetry is consistent with long-run rent-seeking since the markets respond more rapidly to increases than to decreases in crude oil costs in the long-run. Furthermore, in the markets for domestic heating oil, the presence of the rockets and feathers effect is seen at the 1% level. But in the automotive diesel market, the presence of rockets and feathers effect is found at the 10% level. This is also the same for the market for industrial fuel oil. Interestingly, however, while the rockets and feathers effect became obscure at pump in the case of automotive diesel, it remained persistent and pronounced for the markets for industrial fuel oil and domestic heating oil. This suggests that to hide their rent-seeking behavior, only retailers in the diesel market may be indulging in manipulating the tax system. Clearly, the absence of rent-seeking activities in the non-road fuel markets shows that market structures in terms of price elasticity can offer possible explanation for the prevalence of rent-seeking in the Spanish retail energy sector.

The results are robust to the realities of the Spanish petroleum industry. Spain imports virtually all its crude oil. It has oil import dependency ratio averaging 99.8% since 1990. Since 2005, per gallon of gasoline and diesel attracts tax rates of $2.66 and $2.08, respectively, in addition to VAT of 18%. These taxes are relatively high. Besides, Repsol and Cepsa control 35% and 15% of Spanish retail outlets, respectively. This means that these two retail brands together control 50% of the retail outlets in Spain. The existence of the relatively high tax rates on road fuels and dominant retailers are realities in the Spanish petroleum downstream sector. This agrees with the rockets and feathers effect revealed in the various retail markets. It also suggests that some firms in these markets may have been manipulating the tax system to hide coordinated rent-seeking behaviors as observed in the diesel market. These facts are further reinforced by the fact that the transport sector alone accounts for 59% consumption of total oil supply in 2012. This high consumption rate supports the inelastic nature of demand for road fuel. It also agrees with the rent-seeking behavior found in the market for automotive diesel (which is a road fuel). Overall, this study finds evidence of rent-seeking, at least in the automotive diesel market, which has relatively less elastic demand compared to non-road fuels.

4.6. Estimation results for UK markets

From the estimations, the results show that the speed of adjustment for UK markets ranges between 12 and 31%. This is quite sluggish and it agrees with the previous studies conducted by Greenwood-Nimmo and Shin [21], Grasso and Manera [41], and Ogbuabor et al. [45]. The results also show strong presence of long-run asymmetry at the 5% level in the ex-tax market for gasoline and in the pump prices of diesel and heating oil. The pattern of this asymmetry suggests that in the long-run, the retail prices respond more rapidly to increases than to decreases in the costs of crude oil in the UK. The results did not show any evidence of long-run asymmetry in the industrial fuel oil market, either at pump or ex-tax prices. However, this study finds that in the markets for non-road fuel, the rockets and feathers effect is quite strong. In the domestic heating oil market, this effect is observed at pump; but it is observed in both ex-tax and pump prices in the market for industrial fuel. Hence, these markets are not bedeviled by the problem of rent-seeking since the rockets and feathers effect is not obscured at pump for these non-road fuels. In other words, for the UK road fuel markets, the results did not show any evidence of short-run asymmetry or rockets and feathers effect or likelihood of rent-seeking behaviour. Indeed, the complete absence of rent-seeking behavior in both the road and non-road fuel markets is consistent with the earlier presumption that rent-seeking is a problem mainly associated with non-oil rich countries.

Moving on, let us relate the above findings with the happenings in the petroleum industry in the UK. It is interesting to note that oil import dependency ratio in the UK has been rising over the years. It rose gradually from –9.2% in 1990 to –1.0% in 2005, indicating that UK was a net oil exporter within this period. Again, it rose to 16.1% and 29.6% in 2010 and 2011, respectively. As of the end of 2012, it had risen to 36.7%. In fact, UK’s domestic oil production has declined on average by 7% yearly since 1999, and the country became a net oil importer since 2006. According to IEA, government statistics indicate that this declining trend is expected to continue for the foreseeable future. These facts are consistent with the long-run asymmetry found in most of its retail energy markets. They also underline the fact that rockets and feathers effect is real in the market for non-road fuel. However, despite the rising oil import dependency ratio, UK’s domestic oil production cannot be called negligible. The significant domestic oil production in the country may be responsible for the complete absence of rent-seeking in the markets for road fuels. This is particularly likely since the transport sector has remained the largest area of oil consumption in the UK since 1990. It accounted for 71% of overall oil consumption in 2011. Apart from the foregoing facts, UK had seven major refineries operating as of 2012, which were able to meet wholly the domestic demand for refined products such as gasoline and residual fuels. In addition, domestic refining was able to substantially meet the country’s demand for diesel. These facts support the absence of rent-seeking behavior seen in the markets for road fuel as well as the absence of rockets and feathers effect also noticed in the road fuel markets. However, UK still had non-negligible demand deficits in kerosene or heating oil used domestically and in the markets for gas oil. This accounts for what is seen at pump (in the market for non-road fuel) that the rockets and feathers effect is a reality. According to IEA statistics, other products witnessing substantial demand deficits as of 2012 are liquefied petroleum gas and ethane. The petroleum downstream sector operations are generally market-based, but the costs of holding compulsory oil stocks are implicitly passed on to consumers through market prices. Excise duty is charged on road fuels, while VAT is charged on non-commercial usage. However, unlike other European countries, there is no differential between taxes on gasoline and diesel. Though four brands (i.e. BP, Esso, TExaco and Shell) control about 40% of the retail outlets as of 2012, the markets are nonetheless competitive with 8,600 filling stations as of the end of 2012. UK has an extensive 4,800 km of oil pipeline network used in transporting various oil products around the country, including both road and non-road fuels. The Department of Energy and Climate Change (DECC) co-ordinates all responses to oil supply emergencies, thereby ensuring minimal disruptions in oil supply. The country maintains a relatively diversified oil import sources such that as of the end of 2012, Norway, Nigeria and the Russian Federation respectively accounted for 46%, 13% and 12% of oil imports. Overall, the dynamics of UK’s petroleum industry agree with the finding of no rent-seeking in the retail energy markets. This contrasts with the finding of Greenwood-Nimmo
and Shin [21] and Grasso and Manera [41], but consistent with Kristoufek and Lunackova [37].

4.7. Estimation results for U.S. Markets

The estimation results revealed sluggish speeds of adjustment ranging between 15 and 27%. In addition, the results also show that in both ex-tax and the pump prices of domestic heating oil and gasoline, there is evidence of long-run asymmetry. This is significant at 5% level. The pattern of this asymmetry indicates that in the long-run, retail prices respond more rapidly to increases than to decreases in crude oil costs. However, at the 5% level, the results did not show any evidence of short-run additive asymmetry or rockets and feathers effect. This means that this study did not find any significant reason to agree that there is rent-seeking behavior across all the retail markets in the U.S.

An indepth examination of the dynamics of the U.S. petroleum industry shows that the above results are quite tenable. Available statistics show that relative to Canada, U.S. oil import dependency ratio is quite high. It was 51.5% as of the end of 2012. Its imports totaled 11.1 million barrels per day in 2012, including 8.75 mb/d of crude oil and 1.2 mb/d of refined products such as diesel, gasoline, jet fuel and heating oil. The sluggish speed of adjustment and the long-run asymmetries observed in the results are consistent with this high import dependency. Nonetheless, the U.S. still has significant domestic oil production capacity, which has maintained an increasing trend since 2005. Domestic oil production increased from 7.08 million barrels per day in 2005 to 7.78 million barrels per day in 2010. In 2012, domestic oil production was 9.17 million barrels per day. Besides, as of the end of 2012, there were 145 operational refineries with combined capacity of 17.3 million barrels per day while capacity utilization rate was 88.7%. Interestingly, U.S. is a net exporter of some refined products such as diesel, gasoline, jet fuel and heating oil. This is further enhanced by their huge domestic oil production and refining capacity. In 2012, the country exported nearly 1.3 million barrels per day of these products. These facts are consistent with the fact that across all the markets in retail oil business in the U.S., rent-seeking behavior and rockets and feathers effect are absent. They are also consistent with the complete absence of short-run additive asymmetry in the U.S. markets.

Apart from the above facts, the U.S. also has about 156,065 fueling stations owned by numerous independent entrepreneurs as of 2012. This means that the retail market is highly competitive and this agrees with our finding that rockets and feathers effect is absent and there is no short-run asymmetry in the U.S. market for retail oil business. In addition, the U.S. has an extensive network of pipelines for moving crude oil and refined products. As of the end of 2012, there were 172,048 miles of pipelines operated by 2,338 companies. Furthermore, crude oil and refined products are also transported by rail, where the most cost-effective option is the rail or there is lack of pipelines. These infrastructures ensure that the country distributes both crude oil and refined products seamlessly. Again, these facts support our empirical results that neither rent-seeking behavior nor rockets and feathers effect is prevalent in the U.S. retail energy markets. Indeed, it must be stressed that the findings are equally supported by some of the existing studies in the literature, such as Bachmeier and Griffin [32] and Kristoufek and Lunackova [37], among others. However, the results are contrary to other studies such as Borenstein et al. [14] and Borenstein and Shepard [15], among others. Overall, the results clearly reveal that for the U.S., there is no significant evidence of rent-seeking, which supports the earlier finding that rent-seeking by retail firms can indeed be a problem mainly associated with countries that have negligible domestic oil production.

4.8. Estimation results for Japanese markets

The findings show that the speed of adjustment ranges between 10 and 28% for the Japanese market. The results also show higher values for ex-tax prices of road fuels than their corresponding values at pump. Specifically, the speed of adjustment shows 10% and 11% for gasoline and diesel at pump, while the corresponding ex-tax values are 20% and 13%, respectively. This means that consumers observing only pump prices are more prone to the vagaries of the international oil market. In general, these speeds of adjustment are quite sluggish, just as in Italy, France and Spain. In the market for industrial fuel oil, the results show significant long-run asymmetry at the 1% level. However, at the 10% level, this study also finds evidence of long-run asymmetry in the pump prices of automotive diesel and domestic heating oil. The pattern of this asymmetry indicates that in the long-run, retail prices respond more swiftly to increases in oil price than to decreases in oil price. Interestingly, the results also indicate strong evidence of the rockets and feathers effect across all the retail markets in Japan at the 5% level. In fact, the rockets and feathers effect appears pervasive in both ex-tax and pump prices. In both the ex-tax and pump prices, the pronounced nature of the rockets and feathers effect means that this study has not revealed the presence of rent-seeking across all the markets for retail oil business in Japan. Overall, the study finds that rent-seeking is absent in Japanese retail markets, though the problem of rockets and feathers effect is an important feature of the markets. In what follows, it is demonstrated that these results are in agreement with the realities of the Japanese petroleum industry.

Japan’s oil industry profile reveals that it has high oil import dependency ratio, which averaged 99.7% since 1990. This shows that the country’s domestic oil production is quite negligible. On the one hand, domestic oil production declined consistently from 18.1 thousand barrels per day in 2010 to 17.4 kb/d and 16.5 kb/d in 2011 and 2012, respectively. On the other hand, net oil imports increased consistently from 4.44 million barrels per day (mb/d) in 2010 to 4.45 mb/d and 4.70 mb/d in 2011 and 2012, respectively. These stylized facts agree with the long-run asymmetry found in the markets for heating oil, diesel and fuel oil, and also with the low speed of adjustment found across all the retail energy markets. These realities of the Japanese oil industry also agree with the pervasive feature of rockets and feathers effect found across all the markets. In 2012, the transport and industrial sectors consumed 36% and 29% of overall oil supply, respectively. In addition, the country witnessed demand deficits in gasoline, residual fuels, and liquefied petroleum gas, among other products. These issues support the fact that the rockets and feathers effect found in this study is a reality.

Japan has just one oil pipeline that conveys jet fuels to Narita International Airport from Chiba refinery. Indeed, Japan is surrounded by ocean as an Island country. Available records show that oil tankers are the major means through which petroleum products and crude oil are transported within and outside the country. The challenge of tanker breakdown means that the risk of supply disruption is high. This also agrees with the rockets and feathers effect which this study found in the road and non-road fuel markets. Nonetheless, refining and distribution of oil products are completely privatized and open to both domestic and foreign investors. There were 27 operational refineries as of 2012, with a total capacity of 4.5 mb/d. Also, there were 38,777 retail filling stations as of 2011. This means that the downstream sector is somewhat competitive and in tandem with our finding of no rent-seeking behavior across the retail markets. Overall, the results are contrary to the earlier finding that rent-seeking by retail firms is a problem associated mainly with non-oil-rich countries like Japan. However, the finding of pervasive rockets and feathers effect in the Japanese retail energy markets is completely consistent with the characterization of Japan as an oil-deficient country.

5. Conclusion and recommendations

This study classified retail petroleum products into road and non-road fuels and thereafter investigated whether differences in market structure in terms of price elasticity can offer possible explanation for
the prevalence of rent-seeking behavior and asymmetric price adjustment in global retail energy markets. To estimate 58 nonlinear ARDL models for U.S., UK, Spain, Italy, France, Germany, Canada and Japan, monthly data on the retail prices of road fuels (i.e. automotive diesel and gasoline) and non-road fuels (i.e. industrial fuel oil and domestic heating oil) and the average costs of imported crude oil were used. For the retail petroleum products, both prices at pump and ex-tax were used to facilitate rent-seeking analysis. The results indicate that except for Canada and U.S. (with significant oil production at the domestic level), the global retail energy markets are still pervasively fraught with the problem of rockets and feathers effect. In addition, the likelihood of firms exploiting the tax system to cover their activities in rent-seeking was also established exclusively in the road fuel markets of oil-deficient Eurozone countries, including Italy, Spain, France and Germany. These results indicate that there is more likelihood of rent-seeking behavior in the relatively more price-inelastic road fuel markets than in the markets for relatively more price-elastic non-road fuels. This suggests that the markets for global retail energy, differences in market structure in terms of price elasticity could offer a possible explanation for rent-seeking and asymmetric adjustment of prices. Furthermore, the findings indicate that global retail energy markets have been exhibiting adjustment patterns that are characteristic of markets witnessing oligopolistic collusive behaviors, weak competition, and extended periods of mispricing.

These findings have far-reaching antitrust and consumer welfare implications. This study, therefore, recommends that those that regulate the global retail energy dealers and markets, policy makers and governments across the globe should interminably monitor these markets and strengthen the enforcement of their antitrust policies in order to enhance and safeguard the overall social welfare. Such monitoring should be considered vital particularly during periods of crisis like the ongoing COVID-19 pandemic since the stylized facts presented in the introductory section of this paper indicate that asymmetric adjustment of retail energy prices could be an important policy issue during periods of economic crisis. The stylized facts indicate that the decline in crude oil costs during periods of economic crisis is not usually reflected fully in retail prices of petroleum products. In addition to monitoring the markets and enforcing competition laws, this study also recommends that regulators and policymakers should work towards increasing price transparency in service stations (by ensuring that prices are not only displayed conspicuously but are also made accessible by consumers through mobile devices), providing online channels for public complaints and inquiries about the retail energy markets, and reducing barriers to entry at every level of the supply chain. These measures could be effective policy responses to asymmetric price adjustment and anti-competitive conducts in retail energy markets.

This study recognizes that the ongoing COVID-19 pandemic, which has virtually crippled various sectors of the global economy (including the oil sector), may have somewhat affected the relationships reported in this study, but this is not yet empirically proven. Thus, as the data become available, future studies may want to investigate the structural change that the COVID-19 pandemic may have induced in these relationships. Furthermore, as the data become available, future studies may also evaluate these relationships at sub-national levels (such as state and city-levels) in order to expose the disparities that may exist at these levels. Such evidence will then guide policymakers to ensure that effective policies are targeted at those sub-national markets exhibiting irregular behaviours. Lastly, future studies may also revisit the relationships reported in this study by using higher frequency data (like daily or weekly data) when they become available since such data can capture important dynamics that may be concealed by the monthly data used in this study.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

References

[1] J. Black, Oxford Dictionary of Economics, second ed., Oxford University Press, New York, 2002.
[2] J.E. Ogbuabor, G.O. Ebigbomolen, C.O. Manasseh, I.C. Mba, Asymmetric price transmission and rent-seeking in road fuel markets: a comparative study of South Africa and selected Eurozone countries, African Development Review 30 (3) (2018) 278–290, https://doi.org/10.1111/1467-6268.12596.
[3] G. Tullock, The welfare cost of tariffs, monopolies and theft, Econ. Inq. 5 (3) (1967) 224–232, https://doi.org/10.1111/j.1465-7295.1967.tb01923.x.
[4] A.O. Krueger, The political economy of the rent-seeking society, Am. Econ. Rev. 64 (3) (1974) 291–305.
[5] J.M. Buchanan, R.D. Tollison, G. Tullock, Toward a theory of the rent-seeking society, Texas A & M University, College Station, Texas, United States, 1980.
[6] C. Calderón, A. Chong, Do democracies breed rent-seeking behavior? The Journal of Policy Reform 9 (4) (2006) 247–260, https://doi.org/10.1080/12098324.2006.10577009.
[7] F. Teichmann, M. Falker, B.S. Sergi, Gaming environmental governance? Bribery, abuse of subsidies, and corruption in European Union programs, Energy Res. Soc. Sci. 66 (2020), 101481, https://doi.org/10.1016/j.erss.2020.101481.
[8] A.I. Khwaja, A. Mian, Rent seeking and corruption in financial markets, Annual Review of Economics 3 (2011) 579–600, https://doi.org/10.1146/annurev-economics-061109-091347.
[9] E.C. Pasour Jr., Rent seeking: some conceptual problems and implications, The Review of Austrian Economics 1 (1987) 123–143, https://doi.org/10.1007/BF01595337.
[10] P. Collier, B. Goderis, Commodity prices, growth, and the natural resource curse: reconsidering a conundrum, University of Oxford, Oxford, Department of Economics, 2009.
[11] J.D. Sachs, A.M. Warner, The big push, natural resource booms and growth, J. Dev. Econ. 59 (1) (1999) 43–76, https://doi.org/10.1016/S0304-3878(99)00005-X.
[12] J.D. Sachs, A.M. Warner, The curse of natural resources, European Economic Review 45 (4–6) (2001) 827–838, https://doi.org/10.1016/S0014-2921(01)00125-8.
[13] R.W. Bacon, Rockets and feathers: the asymmetric speed of adjustment of UK retail gasoline prices to cost changes, Energy Econ. 13 (3) (1991) 211–218, https://doi.org/10.1016/0140-9883(91)90022-R.
[14] S. Borenstein, A.C. Cameron, R. Gilbert, Do gasoline prices respond asymmetrically to crude oil prices? Q. J. Econ. 112 (1) (1997) 305–339.
[15] S. Borenstein, A. Sheppard, Sticky prices, inventories, and market power in wholesale gasoline markets, Rand J. Econ. 33 (1) (2002) 116–139.
[16] L. Bettendorf, S.A. van der Geest, M. Varkevisser, Price asymmetry in the Dutch retail gasoline market, Energy Econ. 25 (6) (2003) 669–689, https://doi.org/10.1016/S0140-9883(03)00035-5.
[17] M. Galeotti, A. Lanza, M. Manera, Rockets and feathers revisited: an international comparison on European gasoline markets, Energy Econ. 25 (2) (2003) 175–190, https://doi.org/10.1016/S0140-9883(02)00156-1.
[18] G. Delia, Retail gasoline price dynamics and local market power, The Journal of Industrial Economics 56 (3) (2008) 613–628.
[19] J.A. Verlinda, Do rockets rise faster and feathers fall slower in an atmosphere of local market power? Evidence from the retail gasoline market, The Journal of Industrial Economics 56 (3) (2008) 581–612.
[20] M.H. Liu, D. Margaritis, A. Tzourani-Rad, Is there an asymmetry in the response of diesel and petrol prices to crude oil price changes? Evidence from New Zealand, Energy Economics 32 (4) (2010) 926–932, https://doi.org/10.1016/j.eneco.2009.12.008.
[21] M. Greenwood-Nimmo, Y. Shin, Taxation and the asymmetric adjustment of selected retail energy prices in the UK, Economics Letters 121 (3) (2013) 411–416, https://doi.org/10.1016/j.econlet.2013.09.020.
[22] M.L. Polemio, P.N. Fotis, The taxation effect on gasoline price asymmetry nexus: Evidence from both sides of the Atlantic, Energy Policy 73 (2014) 225–233, https://doi.org/10.1016/j.enpol.2014.05.025.
[23] A. Bagnai, C.A.M. Ogidina, Long- and short-run asymmetries and hysteresis in the Italian gasoline market, Energy Policy 78 (2015) 41–50, https://doi.org/10.1016/j.enpol.2014.12.017.
[24] M.L. Polemio, M.G. Tsianos, An alternative semiparametric approach to the modelling of asymmetric gasoline price adjustment, Energy Econ. 56 (2016) 384–388, https://doi.org/10.1016/j.eneco.2016.04.004.
[25] J.E. Ogbuabor, A. Orji, R.K. Edeme, I.C. Mba, Diesel and petrol prices to crude oil price changes? Evidence from New Zealand, Economics Letters 129 (2) (2016) 278–280, https://doi.org/10.1016/j.econlet.2016.06.034.
[26] K. Szomolanyi, M. Lukacik, A. Lukacikova, Asymmetric retail gasoline and diesel price reactions in Slovak market, Ekonomicky casopis 68 (2) (2020) 115–133.
[27] J.D. Karrenbrock, The behavior of retail gasoline prices: symmetric or not? Federal Reserve Bank of St. Louis Review July (1991) 19–29, https://files.stlouisfed.org/files/hdocs/publicat...v__Jul_Aug1991.pdf (accessed 18 January 2018).
[28] D. Shin, Do product prices respond symmetrically to changes in crude oil prices? OPEC Energy Review 18 (2) (1994) 137–157, https://doi.org/10.1111/1468-0076.1994.000497.x.
