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Autores

Mark J. Holmes

Jesús Otero



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Asymmetric behaviour and the 9-ending pricing of retail gasoline

Mark J. Holmes^{a,*}, Jesús Otero^b

^a Department of Economics, Waikato University, New Zealand

^b Facultad de Economía, Universidad del Rosario, Colombia

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ABSTRACT

Using daily unleaded gasoline data for almost the totality of Western Australian retail outlets over twenty years, we find that retail prices are most rigid when they are 9-ending as opposed to other price endings. Upward rigidity from a 9-ending retail price is found to be greater than downward rigidity in terms of a lower number of price movements. Irrespective of whether or not a 9-ending price is being charged, an upward gasoline price movement is likely, in absolute terms, to lead to a larger size of price change than a downward movement. In sharp contrast, we find that wholesale gasoline prices are not characterised in such ways and that irrespective of whether or not taxes are included, there is uniformity across the frequency distribution of price endings. The presence of 9-ending pricing affects the nonlinear response of retail gasoline prices to wholesale price movements.

1. Introduction

For many, keen attention to the behaviour of the retail price of gasoline is warranted. Not only is gasoline an essential energy source whose price behaviour can impact the use of alternative energy sources, but there is an expectation of fair or appropriate pricing on consumers who might engage in comparing prices across gasoline stations.¹ In addition, retail gasoline price fluctuations impact employment, output, and producer and consumer prices.² The impact on prices is particularly relevant in the current international economic context, where the recent oil price spike raises awareness of its inflationary consequences and optimal policy response.

In furthering our understanding of gasoline price fluctuations, a considerable body of literature investigates whether or not retail price fluctuations are asymmetric. It is exemplified by the rockets and feathers debate which considers whether retail gasoline prices move more readily upwards than downwards in response to fluctuations in crude oil prices. While a range of studies that include recent work by Martín-Moreno et al. [8], and Baghestani and Bley [9] are supportive of the rockets and feathers hypothesis, work by Bermingham and O'Brien [10], Eleftheriou et al. [11] find the opposite of rockets and feathers in their assessments of adjustment in retail gasoline prices. However, when considering the asymmetric adjustment of retail gasoline prices,

an additional relatively unexplored dimension is worthy of consideration. Casual observation across stations and cities can reveal the presence of 9-ending prices as a dominant feature of retail gasoline markets. Indeed, retail gasoline prices are often quoted in cents to one decimal place where the decimal digit or price-ending is a 9. Yet there is a shortage of studies investigating the presence of 9-ending prices and how this impacts on retail gasoline price adjustment.

Studies in consumer research such as Thomas and Morwitz [12] suggest that as consumers read from left to right, they will often focus on the first digits in deciding how reasonable the price is. But there is evidence reported by Schindler [13,14] and others that as consumers inspect goods prices, they process the right-most digit information, particularly 9-endings, as a signal for low prices. Indeed, focusing on 9-endings can reduce the possibility that consumers will notice some price increases. Goods might appear cheaper than they are, and retailers are mindful that the presence of a 9-ending price can influence the behaviour of price-conscious consumers. Indeed, Levy et al. [15,16] find that 9-ending prices are more upwardly rigid than other prices in supermarket pricing behaviour. Given the motivations that competitive retailers may have in setting 9-ending prices and how consumers perceive such prices, it is essential to re-assess the rockets and feathers viewpoint that a downward rigidity of prices characterises

* Corresponding author.

E-mail addresses: mark.holmes@waikato.ac.nz (M.J. Holmes), jesus.otero@urosario.edu.co (J. Otero).

¹ In this paper, we do not examine gasoline price setting as a way to encourage or discourage the use of alternative non-renewable and renewable energy sources and the effect on the environment. For this, salient recent contributions include Baz et al. [1], Chishti et al. [2], Khan et al. [3], among others.

² See, for instance, the work by Salisu et al. [4], Ordóñez et al. [5], Awartani et al. [6], and Ozgur et al. [7], among others.

retail gasoline price asymmetry. Our new contribution to the literature is based on analysing gasoline price asymmetry in a different way. We investigate the presence and impact of 9-ending pricing for unleaded gasoline by almost the totality of gasoline retailers based in Western Australia over twenty years of daily observations.

In the empirical rockets and feathers literature, the pass-through from crude oil cost changes to retail prices is of primary interest. However, there is the possibility that the experience of retail gasoline price movements depends on whether or not gasoline prices are 9-ending. Rather than explain retail gasoline price asymmetries as driven by the traditional rockets and feathers perspective, we instead explain price asymmetries as driven from a 9-ending viewpoint. For our contribution, new insights into asymmetric retail gasoline price adjustment are obtained through answering a number of important research questions about 9-ending pricing. These questions include the following. To what extent are 9-ending prices, as opposed to other price endings, the most rigid? Is upward rigidity from a 9-ending price greater than downward rigidity? Against a background of 9-ending pricing, is the response of retail gasoline prices to wholesale price movements nonlinear?

The studies mentioned above by Levy et al. [15,16] consider a heterogeneous range of products that does not include fuels. In gasoline, we analyse a single, more homogeneous fuel product. Thus, our analysis is closer to Lewis [17], who investigates retail gasoline prices in the U.S., but our study period spans almost two decades (instead of the two years analysed in that work). The granularity of the data we analyse avoids the potential masking of effects due to spatial and temporal aggregation procedures, permitting a better assessment of how much and with what frequency wholesale gasoline price variations find their way to retail prices. Indeed, we provide results that account for the standing of Perth, the capital of Western Australia. In principle, one might expect to observe more intense competition among gasoline retailers and supermarkets compared with less populated areas in the remainder of the region. Lastly, the length of the time dimension in our database allows us to gain insights into the constancy of the estimated effects as time progresses.

The paper is structured as follows. Section two describes the data used for our study based on almost four million retail gasoline prices. Sections three and four present our empirical analysis. Subject to some qualifications, there is evidence of upward retail price rigidity based on 9-ending pricing. In addition, by examining the differentiated effect of small and large wholesale price variations, we unearth the presence of non-linearities in the wholesale–retail price relationship. We also uncover several additional insights into retail pricing. Section five concludes.

2. Data description

Our analysis is based on daily transaction retail and wholesale prices freely downloaded from the website of FuelWatch (www.fuelwatch.wa.gov.au), which is a government initiative to monitor fuel (petrol, diesel and LPG/Autogas) prices in Western Australia. The motivation behind the website is to empower motorists by providing accurate price reports (including the possibility of consulting tomorrow's prices today) so that they can make informed decisions when purchasing. The information on retail prices goes back to January 2, 2001; choosing December 31, 2019 as the end of our study period and using a 7-day week calendar produces a maximum of 6938 daily observations. Throughout the study period the number of stations in the database increases from 425 in January 2001 to 655 in December 2019; according to the FuelWatch website, the monitoring service currently covers approximately 80% of regional and the totality of metropolitan retail stations in Western Australia.³ The total number of retail prices available is 3,964,101.

³ The geographic coverage of the database comprises all ten regions of Western Australia. These are (in alphabetical order): Gascoyne, Goldfields-Esperance, Great Southern, Kimberley, Metro (Perth), Mid-West, Peel, Pilbara,

Turning to wholesale prices, FuelWatch offers information on terminal gate prices which correspond to the nominated price for fuel that a purchaser on the spot market is charged for a purchase with delivery occurring at the terminal gate; while these prices include taxes, they do not include services such as branding, delivery, and credit facilities, among others. Retailers who purchase fuel outside of a contract will pay terminal gate prices, and those retailers who are negotiating a contracted price will take terminal gate prices into account. The terminal gate price data are available since December 19, 2002; setting December 31, 2019 as the end of the study period and using a 7-day week calendar yields a maximum of 6222 daily observations. The total number of wholesale prices available is 104,065. In our econometric analysis of retail prices, we employ for each time period the wholesale price that corresponds to the minimum price across refineries. We analyse unleaded petrol (ULP) which is the most commonly used fuel for passenger vehicles. Also, both retail and wholesale prices in the database are reported in cents of Australian Dollars per litre, with one decimal point; thus, for example, 159.4 means A\$1.594 per litre.

The database of retail prices also contains variables with information on the trading name of the station, brand (e.g. BP, Caltex, Coles, Mobil, independent, among others), address, postcode, location (361 in total), area (61 in total), and region (10 in total). For data management purposes, the database is organised as a panel, where the unit of observation is given by a new variable which results from concatenating the variables address and brand. The motivation behind this new variable is to recognise the fact that when a retail outlet changes ownership during the study period, the new owner comes in with an entirely different pricing policy; this way, for example, Coles Express station in 101 Hampton Road is assumed to be different from Shell station in the same address. In the database of wholesale prices there are also variables containing information on terminal gate, brand, address, postcode, and location. Viewing the data as a panel, the unit of observation in this case results from concatenating the variables address and terminal gate; thus, for example, Port Drive BP Broome is different from Port Drive Caltex Broome. The retail (wholesale) prices panel is unbalanced as outlets (refineries) enter and exit the market at different points in time.⁴

There are a number of characteristics of the Perth market that are noteworthy. Firms in this market have been subject to a rigid pricing rule in which prices can only be set once per day (see Wang [20] for a discussion). Also, asymmetric cycles in prices are observed in metropolitan areas (see Wang [20], Byrne and de Roos [18]) and there is evidence of tacit coordination (see Byrne and de Roos [18]).

3. Retail and wholesale price endings

As with Levy et al. [15,16], we begin by summarising our findings regarding the frequency distribution of retail price endings and the probabilities of transitioning from one price ending to another. We also compare and contrast our findings with those of wholesale prices. Fig. 1 reveals that in about 70% of the cases, prices have ended with a 9; the second most popular ending is 5 with approximately 10% of the cases. Interestingly, these percentages are remarkably similar to those reported by Levy et al. [15], in their Fig. 1, using data for a wide range of products from the Dominick's grocery store located in

South-West, and Wheatbelt. The interested reader is referred to Byrne and de Roos [18] and the online appendix in Byrne and de Roos [19] for more details on the FuelWatch database, including a description of institutional aspects (supply, demand and regulation).

⁴ One could argue that consumers rarely purchase one litre of gasoline, and so the analysis of unit prices may perhaps be less meaningful than for other products. In response to this, one might appreciate that unit prices are the ones motorists see displayed in stations and use in their approximation or calculation of much fuel they can acquire (for their given budget).