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Do petrol prices rise faster than they fall when the market shows significant disequilibria?

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ABSTRACT

This paper examines if the long-run relationship between retail and wholesale petrol prices is subject to adjustment asymmetric behaviour using weekly Australian data (2007–2012) across 111 locations. A short-run dynamic model is specified in which three feedback coefficients capture three different types of disequilibria: large and positive; large and negative; small positive/negative. Significant evidence of asymmetric behaviour is found in 28 locations, which are mainly in Tasmania, Queensland and New South Wales. In these locations when prices are conspicuously above the equilibrium path, retailers sluggishly lower their prices but when prices are substantially below the equilibrium values, the adjustment speed is significantly faster.

1. Introduction

Like in many other countries, Australian households spend a significant share of their income on petrol thus price rises of this commodity have a tangible effect on their standard of living particularly for poor families (Valadkhani and Mitchell, 2002; Valadkhani, 2013).[1] This paper utilises a unique and rich dataset containing consistently-defined weekly retail price series to test the extent of adjustment asymmetry for a large number of cities, towns and regional centres. By splitting the deviations from the long-run equilibrium path into three subseries according to their "size" and "sign", this paper makes an important contribution to existing theories underpinning asymmetric behaviour of petrol prices. The proposed framework in this study can also broadly be used to detect asymmetric pricing behaviour in other commodities.

At an empirical level, this paper provides convincing econometric evidence that the true extent of adjustment asymmetry can be revealed only when both the size and sign (direction) of the deviations from the long-run path are taken into account. As discussed in the next section, the majority of previous studies only distinguished between positive and negative deviations from the equilibrium path without considering the magnitude of disequilibria. Such an approach may not fully disclose the possible adjustment asymmetry in two cointegrated price series. This paper examines whether retail unleaded petrol prices rise more readily than they fall as a result of sizable positive or negative disequilibria in the market. Put otherwise, do petrol prices respond quickly or slowly if prices deviate from their equilibrium path in small or large magnitudes? Hence, this paper contributes to our understanding of how petrol prices are set and has direct practical implications for motorists and regulatory authorities. The results also enable us to identify the location-specific asymmetric pricing behaviour by revealing in which locations the adjustment asymmetric behaviour is more likely to occur. To the best of my knowledge this is the first disaggregated study in which the extent of adjustment asymmetry is tested considering both the size and direction of the error correction term.

The remainder of this paper is structured as follows: Section 2 discusses a new modelling approach in identifying the adjustment asymmetry, whereby both the magnitude and sign of disequilibria are taken into account. Section 3 provides a succinct review of literature on adjustment asymmetry. Section 4 presents a brief overview of petrol pricing in Australia. Section 5 describes the data sources and examines the unit-root test results. Section 6 presents the empirical results and the policy implications of the study. Section 7 concludes the paper followed by some directions for future research in Section 8.

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[1] Australian households spend between 2.2 and 7.4% of their total income on petrol Mitchell et al. (2000).

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2. Econometric framework

The conceptual framework of this paper is based on previous work of Rousseas (1985) and Bacon (1991) which tested the hypothesis that the retail price of unleaded petrol and its cost were cointegrated in the long run.[2] Eq. (1) is similar to Rousseas' (1985) mark-up model and Bacon's (1991) long-run full-adjustment model for retail petrol prices in that both retail price and (wholesale) cost are expressed in local currency. Bacon (1991) assumes that the time trend variable captures the average increase in other related costs associated with the supply of petrol (such as transport, insurance and storage) over the sample period and the intercept term denotes the level of such costs at time t_0. However, due to possible endogeneity between the retail price and wholesale cost, in the present study the Dynamic Least Square (DLS) method (Stock and Watson, 1993) is used to estimate the long-run relationship between retail and wholesale prices as follows:

$$P_{jt} = \theta_{0j} + \theta_{1j} T_t + \theta_{2j} PW_{dt} + \sum_{i=-k}^{i=+k} b_{ij} \Delta PW_{dt-i} + e_{jt} \tag{1}$$

where:

- P_{jt} the retail price of unleaded petrol at period t and the jth location ($j = 1,2,\ldots 111$) in Australian cents per litre,
- PW_{dt} the wholesale price of unleaded petrol at time t purchased by the corresponding retailer from the nearest distribution centre d (where $d = 1,2,3,\ldots,17$) in Australian cents per litre,
- θ_{1j} is the estimated coefficient for a trend variable (T_t),
- θ_{0j} and θ_{2j}, respectively, are the retailers' average mark-up and pass-through coefficients, and
- e_{jt} the relevant error term.

Ceteris paribus, the retailers' average mark-up consists of transport, insurance, storage and other related overhead costs as well as their net profits. As the wholesale price of petrol increases, the retail price is expected to rise and hence in the long run both θ_{0j} and $\theta_{2j} \geq 1$.

Bacon (1991, p.214) argues that one needs to specify a short-run dynamic model due to two main reasons: "There are lags between the costs changing and the retailers experiencing these because of transport time and the presence of inventories; The firms, once experiencing the changed costs, may decide not to react fully immediately. Instead they may choose some partial adjustment policy. This could involve further delays in changing price and/or a gradual series of price rises to the new equilibrium level." It is also important to ensure that the resulting residual term from Eq. (1) is stationary. Conventional cointegration tests assume that the adjustment process is symmetric but if prices are sticky in the downward direction, these tests cannot be relevant. In this paper, following Enders and Granger (1998) and Enders and Siklos (2001), both the TAR (threshold autoregressive) and M-TAR (Momentum-TAR) tests are also used to test for stationarity of the residuals.

Previous studies in the literature (*e.g.* Bachmeier and Griffin, 2003; Balaguer and Ripollés, 2012; Borenstein et al., 1997; Honarvar, 2009; Liu et al., 2010; Radchenko, 2005), in their estimated short-run dynamic models incorporated only two feedback coefficients capturing different speed of adjustment depending on whether the resulting deviation or $EC_{jt} = e_{jt}$ was below (negative) or above (positive) the long-run equilibrium path. However, this approach may be inadequate in some cases particularly if the responses to small and large price changes are different. In order to address this problem, in this study three feedback coefficients are incorporated into the short-run dynamic model by splitting all values of EC_{it} into three parts of almost the same length:

$$\Delta P_{jt} = \xi_{0j} + \sum_{i=0}^{q} \lambda_{ij} \Delta PW_{dt-i} + \sum_{i=1}^{q} \gamma_{ij} \Delta P_{jt-i} + \sum_{i=1}^{q} \eta_{ij} u_{jt-i} + v_{jt} + \begin{cases} \omega_{Lj}^{+} EC_{jt-1}^{+} \\ \omega_{Lj}^{-} EC_{jt-1}^{-} \\ \omega_{Sj}^{\pm} EC_{jt-1}^{\pm} \end{cases} \tag{2}$$

where the coefficient λ_{ij} denotes the short-run effect of changes in the corresponding wholesale price of petrol at time t-i on retail price at the jth location. The coefficient γ_{ij} captures the effects of the lagged dependent variable at time t-i in location j whereby $\sum_{i}^{q} \gamma_{ij} < 1$, and η_{ij} is the coefficient of MA (Moving Average) error process of the ith order for the jth location. $EC_{jt} = \hat{e}_{jt}$ is the estimated residual series obtained from Eq. (1).

Fig. 1 shows how all possible values of EC_{jt} are split into roughly three equal-length parts utilising a normal distribution. That is:

$$EC_{jt}^{+} = EC_{jt} \text{ if } EC_{jt} \geq 0.44\sigma_j \text{ and } EC_{jt}^{+} = 0 \text{ if } EC_{jt} < 0.44\sigma_j \tag{3}$$

$$EC_{jt}^{-} = EC_{jt} \text{ if } EC_{jt} \leq -0.44\sigma_j \text{ and } EC_{jt}^{-} = 0 \text{ if } EC_{jt} > -0.44\sigma_j \tag{4}$$

$$EC_{jt}^{\pm} = EC_{jt} \text{ if } -0.44\sigma_j < EC_{jt} < 0.44\sigma_j \text{ and } EC_{jt}^{\pm} = 0 \text{ otherwise} \tag{5}$$

Where σ_j denotes the standard deviation of the corresponding error correction term (or EC_{jt}). Assuming that $EC_{jt} \sim NID(0,\sigma_j)$, the three feedback coefficients thus capture the speed of adjustment when the deviations from the long-run path (or disequilibria) are relatively: positive and large (ω_{Lj}^{+}); negative and large (ω_{Lj}^{-}); or small positive or small negative ($\omega_{Sj}^{\pm}$). All three ECM coefficients are expected to be negative. It is possible that price series may also exhibit the ARCH and GARCH effects (Balaguer and Ripollés, 2012). For this reason, a GARCH(1,1) model in Eq. (6) is used to capture possible volatility clustering due to the use of weekly time series data:

$$h_{jt}^2 = \delta_j + \alpha_j u_{j_{it-1}}^2 + \beta_j h_{jt-1}^2 + w_{jt} \tag{6}$$

In Eq. (6) α_j and β_j are the corresponding ARCH(1) and GARCH(1) coefficients, respectively. Based on the maximum likelihood estimation of both Eqs. (2) and (6), a Wald test can then be used to examine the nature of adjustment asymmetry. If the null hypotheses $\omega_{Lj}^{+} = \omega_{Lj}^{-}$ or $\omega_{Lj}^{+} = \omega_{Lj}^{-} = \omega_{Sj}^{\pm}$ are not rejected, one can then argue that the adjustment process towards the long-run equilibrium is symmetric.

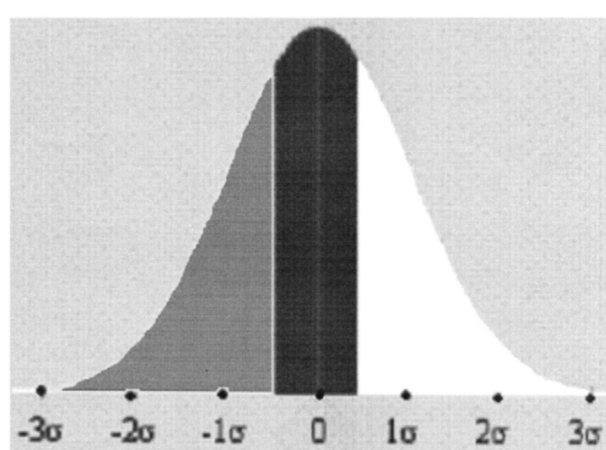

Fig. 1. Splitting EC_{it} into three parts. Note: the white area (where $EC_{jt} \geq 0.44\sigma_j$) and the grey area on the left (where $EC_{jt} \leq -0.44\sigma_j$) each cover approximately 33% of the total area and the middle black area represents 33% of the small negative or small positive values around the mean of zero ($-0.44\sigma_j < EC_{jt} < 0.44\sigma_j$).

[2] In the literature there are several other studies which have also used a linear mark-up relationship between the retail price of petrol and its cost, see inter alia Duffy-Deno (1996) and Liu et al. (2010), Balaguer and Ripollés (2012).