.

ARE US GASOLINE PRICE ADJUSTMENTS ASYMMETRIC? *

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Abstract

We use the LSE-Hendry general to specific approach to analyse if US gasoline price adjustments are asymmetric with respect to changes in crude oil prices. Furthermore, we modify some weaknesses in the earlier works by Boreinstein, Cameron and Gilbert (1997) and Bachmeier and Griffin (2003) and shows that if the price adjustment equations are properly specified and estimated, alternative specifications and temporal aggregation of data do not affect the results. Monthly US data are used to show that alternative specifications give equally good results and there is no asymmetry in the US gasoline price adjustments.

JEL: Q4, Q40, D82, C22, C32.

KEYWORDS: Asymmetric price adjustments, Market power, General to specific approach, Error correction models and Gasoline and crude oil prices.

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I. INTRODUCTION

World-wide escalation of gasoline prices have often been under public scrutiny since expenditure on gasoline is significantly visible in the consumer budget. Gasoline price rises have led to speculations as to their causes, including the view that the multinational oil companies have been manipulating prices in an oligopolistic market to earn economic profits. Many also claim to have observed an asymmetric relationship between the retail prices of gasoline and the crude oil prices–that is retail prices respond more quickly to crude price increases than when they decrease. This is described by Bacon (1991) as the 'rocket and feathers' phenomenon in his examination of the UK gasoline market.

The Bacon rockets and feathers phenomenon was found to be also valid to the US gasoline prices by Borenstein, Cameron and Gilbert (1997). They have used a series of bivariate error correction models (ECM), at various stages of the production and distribution chain of gasoline, and found strong evidence for asymmetric price adjustment with weekly US data. Essentially their specifications of the price adjustment equations are misspecified variants of the LSE-Hendry general to specific (GETS) approach. Subsequently, Bachmeier and Griffin (2003) have examined the robustness the BCG findings, by using both the GETS type and the well-known ECM equations based on the Engle-Granger two-step estimation method. They have used both weekly and daily data. Their main findings are that there is no asymmetric price adjustment in the US gasoline market and data for longer frequencies, e.g., weekly or quarterly data, are likely to be favourable to asymmetric price adjustment.

Our objectives in the present paper are two fold. First, we examine the nature of price adjustments in the US gasoline market and second we show that GETS is a useful approach when it is used properly. This latter objective is important because the LSE-Hendry GETS approach, in spite of its computational attractiveness, is not widely used for modeling time series models. GETS is not popular, especially with the North American researchers, compared to the alternatives like VAR and cointegrating VAR approaches. Smith (2000) provides an excellent methodological perspective to evaluate these alternative techniques and Hoover and Perez (1999, 2004), by using the Monte Carlo approach, show that GETS is a useful approach.

The outline of this paper is as follows. Section II discusses the specification of our price adjustment equation. Empirical results of the estimated equations with monthly US data are presented in Section III. Summary and conclusions are in Section IV.

II. SPECIFICATION

It would be useful to briefly discuss first the specifications of symmetric and asymmetric price adjustment equations using the Engle and Granger (EG) two step procedure. If the equilibrium (long run) relationship between gasoline and crude oil prices is:

$$PG = \gamma_0 + \gamma_1 \; PC + \varepsilon \tag{1}$$

where PG and PC are, respectively, gasoline and crude oil prices and ε is an error term with the usul classical propertie. The short run dynamic price adjustment equation, without any asymmetry, based on the error correction model is:

$$\Delta PG_t = \sum_{i=0}^{n1} \beta_{ci} \; \Delta PC_{t-i} \; \sum_{i=1}^{n2} \beta_{gi} \; \Delta PG_{t-i} - \; \pi \; \widehat{Z}_{t-1} \; + \epsilon_{ti} \tag{2}$$

where $\widehat{Z}_{t-1} = \widehat{\varepsilon}_{t-1}$. It is well known that the OLS estimates of the parameters in (1) are super consistent and a parsimonious version of (2), by eliminating the insignificant lagged first differences of variables, would be consistent with the underlying DGP. Granger (1997, p.174), for example, favours this general to specific type of approach in the second stage of developing DGP consistent error correction models. Note that β_{ci} and β_{gi} measure the short run impact of changes in PC and PG respectively. π is the speed of adjustment to the long run equilibrium.

The asymmetric price adjustment variant of (2) is as follows:

$$\Delta PG_t = \sum_{i=0}^{n1} \beta_{ci}^{+} \; \Delta PC_{t-i}^{+} \; \sum_{i=1}^{n2} \beta_{gi}^{+} \; \Delta PG_{t-i}^{+} + \; \pi^{+} \; \widehat{Z}_{t-1} \; \sum_{i=0}^{n3} \beta_{ci}^{-} \; \Delta PC_{t-i}^{-} \; \sum_{i=1}^{n4} \beta_{gi}^{-} \; \Delta PG_{t-i}^{-} + \; \pi^{-} \; \widehat{Z}_{t-1} \; + \epsilon_{ti} \tag{3}$$

Equation (3) can be split into two parts. The part with the superscript + on the coefficients and the variables, is relevant when prices increase. Similarly the second part, with superscript −, is relevant when prices fall. This interpretation was originally used by BCG and BG. They assumed that β_{ci}^{+} apply when $\Delta PC_{t-1} > 0$ and β_{gi}^{+} apply when $\Delta PG_{t-1} > 0$. π^{+} is applicable when $\Delta PC_t > 0$ and π^{-} when $\Delta PC_t \leq 0$. The coefficients and variables with the superscript $-$ are relevant when the corresponding prices decrease.

To capture the asymmetric effects of crude oil price changes on gasoline prices, the BCG and BG interpretation of (3) is unsatisfactory because it is not clear why changes in the past gasoline prices should have asymmetric effects on the current changes in the gasoline prices. It may be noted that the error correction part, given by Z_{t-1} correctly excludes such effects of gasoline prices. Equation (3) can, therefore, be modified by reinterpring that β_{gi}^{+} apply when $\Delta PC_{t-i} > 0$ and β_{gi}^{-} apply when $\Delta PC_{t-i} \leq 0$.[1] Our main interest in estimating (3) is to determine if the two price adjustment coefficients viz., π^{+} and π^{-} are significantly different and whether $| \pi^{+} | > | \pi^{-} |$. If this latter condition is satisfied, then the data are consistent with the Bacon rockets and feathers hypothesis.

The GETS variants of the asymmetric equation is:

$$\begin{aligned}
\Delta PG_t = & \sum_{i=0}^{j1} \beta_i^{+} \Delta PC_{t-i}^{+} + \sum_{i=0}^{j2} \beta_i^{-} \Delta PC_{t-i}^{-} \\
& \sum_{i=1}^{j3} \alpha_i^{+} \Delta PG_{t-i}^{+} + \sum_{i=1}^{j4} \alpha_i^{-} \Delta PG_{t-i}^{-} \\
& + \theta^{+} (PG_{t-1} - \phi_0 - \phi_1 PC_{t-1} - \phi_2 T) \\
& + \theta^{-} (PG_{t-1} - \phi_0 - \phi_1 PC_{t-1} - \phi_2 T) + \xi_{ti} \qquad (4)
\end{aligned}$$

where T is time trend. In GETS, Z_{t-1} of the ECM in (2) or (3) is replaced with its equivalent $(PG_{t-1} - \phi_0 - \phi_1 PC_{t-1} - \phi_2 T)$. In (4) θ^{+} and θ^{-} are the speed of adjustment coefficients. The intercepts and trend variable can be removed from the error correction part of (4) and may be freely estimated, for example, as in BCG. The rearranged GETS specification is as follows:

[1] Price changes were never zero in our sample.

$$
\begin{aligned}
\Delta PG_t = {} & \gamma_0 + \gamma_1 \; T \\
& + \sum_{i=0}^{j1} \beta_i^{+} \Delta PC_{t-i}^{+} \; + \sum_{i=0}^{j2} \beta_i^{-} \; \Delta PC_{t-i}^{-} \\
& \sum_{i=1}^{j3} \alpha_i^{+} \; \Delta PG_{t-i}^{+} + \sum_{i=1}^{j4} \alpha_i^{-} \; \Delta PG_{t-i}^{-} \\
& + \theta^{+} \; (PG_{t-1} \; - \phi_1 \; PC_{t-1}) \\
& + \theta^{-} \; (PG_{t-1} \; - \; \phi_1 \; PC_{t-1}) \; + \xi_{ti} \qquad (4A)
\end{aligned}
$$

In our empirical estimation we found that (4A) gives more plausible estimates than (4). We take the view that there is no basic weakness in the specifications of (4) or (4A) based on the LSE-Hendry GETS approach. Nevertheless, it is often criticised because it does not test for cointegration but simply assumes that PG and PC are cointegrated. It can be said that GETS accepts the underlying theory behind the relationship between the dependent and explanatory variables in their levels. If that is valid, it is not appropriate to criticise GETS for mixing $I(0)$ and $I(1)$ variables, because if the levels of the variables are cointegrated, their linear combinations are $I(0)$.

III. EMPIRICAL RESULTS

Our data covers the period from January 1978 to December 2004. PG is all types of gasoline in the U.S. city average retail price and PC is the crude oil domestic first purchase price. Data are obtained from the Energy Information Administration's Monthly Energy Review of March 2005. We have searched for optimal lags with PcGets of Hendry and Krolzig (2001) starting with a long general unrestricted model (GUM). Seven lags for the first differences of the variables and eleven monthly seasonal dummies are used. The automatic model selection procedure in PcGets yielded parsimonious short run dynamic adjustment equations. We have reestimated these parsimonious PcGets equations with Microfit and found that it gives the same coefficient estimates but for minor changes in the fourth decimal places. Use of Microfit was necessary to conduct the Wald tests and estimate the GETS equation with NLLS. Our estimates and test results with Microfit are reported in Table-1.

The first stage OLS equation to generate Z_t for the ECM-EG equation in column 1 is at the bottom of Table-1 and it is similar to the BG equation, except that the mark-up of gasoline prices seems to have in-

Table-1
Asymmetric Price Adjustment Equations
Monthly US Data: 1978-2004

	Asymmetric ECM-EG Equation OLS		Asymmetric GETS Equation NLLS	
Regressor	Coeff.	t-ratio	Coeff.	t-ratio
Intercept	-0.029	3.68	0.034	3.28
Trend	0.000	3.63	0.000	3.44
ΔPG^+_{t-1}	0.354	6.66	0.883	23.89
ΔPG^+_{t-2}	-0.252	4.24	—	—
ΔPG^+_{t-5}	-0.168	3.13	-0.062	1.72
ΔPC^+_{t}	0.687	3.59	—	—
ΔPC^+_{t-3}	-0.280	3.72	0.201	3.14
ΔPC^+_{t-6}	—	—	—	—
ΔPG^-_{t-1}	0.270	6.66	0.170	3.21
ΔPG^-_{t-2}	-0.252	4.24	-0.110	2.29
ΔPC^-_{t}	0.615	6.15	0.528	7.85
ΔPC^-_{t-1}	0.301	2.58	0.332	3.65
ΔPC^-_{t-3}	0.262	2.51	—	—
ΔPC^-_{t-5}	-0.346	3.66	—	—
ΔPC^-_{t-6}	0.405	4.12	—	—
π^+	-0.083	2.72		
π^-	-0.132	4.52		
θ^+	—	—	-0.068	3.45
θ^-	—	—	-0.074	3.73
ϕ_1	—	—	1.016	9.13

OLS equation in the first stage ECM-GE

$$PG_t = 0.706 + \ 1.129\ PC_t$$
$$(27.65) \qquad (22.17)$$

Notes:

In the first equation seasonal dummies for August, September and October were significant and in the second equation seasonal dummies for May, June and September were significant. All the residual based χ^2 test statistics for serial correlation, heteroscedasticity, normality of errors and functional form misspecification are insignificant at the 5% level. These are not reported to conserve space.

creased from about 6% in GB to 13%. Both the ECM-EG and the GETS equations are well determined. All the 16 coefficients in the first equation (excluding the seasonal dummies) are significant at the 5% level. Similarly, all but one coefficient are significant in the GETS equation at the 5% level. The remaining coefficient of ΔPG^{+}_{t-5} is significant at the 10% level.

It is noteworthy that the dynamic lag structure in both equations is different. The asymmetric price adjustment coefficients π^{+} and π^{-} in the ECM-EG equation are well determined and significant. Although their point estimates imply that downward adjustments are faster, the Wald test indicated that there is no significant difference between them at a marginally less than the 5% level but conclusively at the 1% level.[2] The test statistic, with the p value in the parentheses, is $\chi^2_1 = 3.9728$ (0.046).

In the GETS equation, the asymmetric price adjustment coefficients θ^{+} and θ^{-} are much closer. The Wald test indicated that the null that these two adjustment coefficients are equal could not be rejected at the 5% level. The computed test statistic and the p value are $\chi^2_1 = 1.6322$ ($p = 0.201$).

On the basis of these results it is hard to say that GETS based specifications are unsatisfactory. In fact the GETS equation seems to have performed better than the ECM-EG equation. Our results thus highlight some weaknesses in the specification and estimation of these price adjustment equations in the earlier works of BCG and BG. Furthermore, temporal aggregation does not seem to be the main reason for the BCG finding of asymmetric price adjustments. The results of BG cover the period 1985-1998 and our sample is from 1978 to 2004 and both reach the conclusion that there is no evidence of asymmetric price adjustments in the US gasoline market. Therefore, it may be said that the US regulation policy has been effective and/or the oil firms have become sensitive to the perceptions of the public and media about their unfair price adjustment policies.

IV. CONCLUSIONS

In this paper we have shown that temporal aggregation and the GETS specification are not the main sources for the BCG conclusion that gasoline price adjustments are asymmetric in the USA. We have explained the underlying rationale of the GETS specification and showed

[2] Interestingly in the BG ECM-EG equation the point estimate of the downward adjustment coefficient was also more than the upward adjustment coefficient.

that if it is properly specified with a lag structure consistent with the DGP and properly estimated by imposing the constraints on the coefficients, it is as good as or better than the ECM-EG specification. The main weaknesses in the previous works seem to be a restricted and uniform lag structure in the dynamic adjustment equations, inappropriate specifications and estimation methods. We have not presented dynamic impulse responses for two reasons. Firstly, the lag structure in our equations is complicated, needing simulations with seventh order difference equations. Secondly, these simulation results are perhaps unnecessary when the estimated price adjustment coefficients are adequate for testing the asymmetric price adjustment hypothesis. It is hoped that our methodology and techniques would be useful to estimate price adjustment equations in other oligopolistic markets and in other countries that may differ in the enforcement of regulation policy.[3]

[3] It may be of interest to point out that Rao and Rao (2005) used both the ECM-EG and GETS based gasoline price adjustment equations for Fiji. Both equations, with quarterly data, gave similar estimates of the price adjustment coefficients and imply that gasoline price adjustments in Fiji are highly asymmetric. This finding is not surprising because Fiji is a small developing country and, unlike in the developed countries, regulation policies are difficult to implement and police in the developing countries.

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