Crude Oil and Gasoline Prices in Fiji: Is the Relationship Asymmetric?

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ABSTRACT

This paper tests and confirms asymmetry in the Fiji gasoline price adjustment equations with respect to changes in the crude oil prices. More satisfactory specifications and estimation are used than in the earlier studies. It is found that two alternative approaches viz., the Granger two-step and the LSE-Hendry general to specific approaches, give similar results. Our results show that oil firms in Fiji seem to adjust gasoline prices twice faster than decrease them.

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

Keywords: Crude Oil and Gasoline Prices, Asymmetric Price Response, Rockets and Feathers Hypothesis, Granger Two-Step Estimation, the LSE-Hendry General to Specific Approach.

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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 (MNC) 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), BCG henceforth. 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 variants of the LSE-Hendry general to specific (GETS) approach, although this was not made explicit. Subsequently, Bachmeier and Griffin (2003), BG henceforth, have examined the robustness the BCG findings, by using both the BCG GETS type and the well-known ECM equations based on the 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 objective in the present paper is to examine the nature of price adjustments in the gasoline market of Fiji. This is of interest for the following reasons. Firstly, Fiji is a small island country where the MNC oil firms are likely to be more powerful. In addition the regulatory powers of the government agencies are likely to be less effective in a developing country than in the more advanced countries where such powers are more effectively policed and implemented. Secondly, in both BCG and BG there are a few important weaknesses in the specification and estimation of the price adjustment equations. In particular, they have used a fixed lag structure in their dynamic short run equations. Although that may be convenient for dynamic simulations, it may not be consistent with the underlying data generating process (DGP). Therefore, it would be useful to examine, afresh, how the rockets and feathers hypothesis can be tested with better specifications and estimation methods. Thirdly, the LSE-Hendry GETS approach, in spite of its computational attractiveness, is not widely accepted for modeling time series models. GETS is not widely popular, especially with the North American researchers, compared to the alternatives of VAR and cointegrating VAR approaches; see Smith (2000) for an evaluation of these three approaches. Our present paper shows that the LSE-Hendry GETS based price adjustment equations are empirically as good as the Granger two-step ECM equations of BG. Therefore, it is hoped that our paper would be useful to examine the nature of price adjustments in the other oligopolistic markets.

The outline of this paper is as follows. Section II gives a brief description of the special features of the gasoline market in Fiji. Section III discusses the specification of our price adjustment equation. Empirical results of the estimated equations and dynamic simulation results are presented in Section IV. Summary and conclusions are in Section V.

II. Gasoline Market in Fiji

Fiji is a small country in the South Pacific and the MNC oil firms can easily take advantage of this situation. Three large multi-national companies service the country: Mobil, Shell and British Petroleum. All three companies buy the refined product from either Australia or Singapore. Fiji does not have any petroleum refining facilities. These companies own the petrol stations, equipment and vehicles for product delivery to petrol stations around the country. Their major task is to facilitate the infrastructure for product delivery to customers. Contractors, paid on a commission basis, serve rural areas. The petroleum is bought from the refineries and stored for delivery in Fiji or to be re-exported to other island nations in the South Pacific. Depending on turnover per year at each locality, the petrol stations are leased to operators at different rates of rental. There are no independent operators like in Australia, New Zealand or USA.

The gasoline price in Fiji is under price-control by the government. The price fixing formula called the Petroleum Pricing Template (PPT), developed by the Forum Secretariat[1] in consultation with The Fiji Government and the Oil companies, provides the price fixing mechanism for fuel in Fiji. PPT quantifies all supplier costs: 'free on board' (FOB) prices based on Singapore world price, freight, insurance, exchange rates effects, demurrage and losses, operating costs, fiscal duty and tax paid to government, distributional costs and a return on investment for the oil companies[2].

III. Modeling Gasoline Market for Fiji

A general model for gasoline in Fiji can be expressed as:

$$RM = f\,(PC, E, TAM, RFM) \qquad (1)$$

where

[1] Forum Secretariat is a regional organisation of 14 South Pacific Island nations.

[2] A detail description of how the prices are determined is described in Rao (2005).

RM = the retail price for gasoline

E = is the exchange rate

TAM = taxes paid to the government of Fiji

RFM = the refinery prices.

One obvious problem of using many explanatory variables with a limited number of observations of only 35 is that it places restrictions on the degrees of freedom. Rao (2004) has shown that the major influence on the gasoline prices is the crude oil prices and government taxation. However, the rate of taxation on gasoline has remained stable over a long period of time and does not add to the volatility of the gasoline prices. Furthermore, BCG and BG, in their US empirical work have found that gasoline prices can be adequately explained by the crude oil prices. Therefore, we abstract from the effects of TAM and RFM and explain the ex-tax price of gasoline PG with PC and E i.e.,

$$PG = f(PC, E) + \textit{seasonal dummies}; \qquad (2)$$

where, $PG = RM - TAM$

There are a few alternative methods of estimation of (2). The seasonal unit root tests and cointegration methods can be used, but these are computationally demanding and the results would be difficult to compare with those of BCG and BG. Both have used two other simpler methods. BG have used the Granger two-step procedure and also the GETS version used by BCG. Therefore, we shall use these two approaches. In the Granger two step procedure, first OLS can be used to estimate a relationship between *PG* and *PC* and *E*. In the second stage, using the one period lagged values of the residuals *(Z)* of this OLS equation, the following dynamic error correction model (ECM) can be estimated when price adjustment is symmetric.:

$$\Delta PG_t = \sum_{i=1}^{n} \beta_{gi} \Delta PG_{t-i} + \sum_{i=0}^{k} \beta_{ci} \Delta PC_{t-i} + \sum_{i=0}^{j} \beta_{ei} \Delta E_{t-i} + \theta Z_{t-1} + \epsilon_t \qquad \textbf{(3)}$$

The estimate of the parameter *q* indicates the speed of adjustment of prices. However, BCG and BG have assumed a special lag structure where $n=k=j=2$. We shall estimate both this version as well as an equation in which the lag lengths of the variables are determined by the data.

The asymmetric price adjustment equation can be derived from (3) in a straightforward manner and it is:

$$\Delta PG_t = \sum_{i=0}^{n1} \beta_{ci}^{+} \, \Delta PC_{t-i}^{+} \, \sum_{i=1}^{n2} \beta_{gi}^{+} \, \Delta PG_{t-i}^{+} + \, \theta^{+} \, \widehat{Z}_{t-1}$$
$$\sum_{i=0}^{n3} \beta_{ci}^{-} \, \Delta PC_{t-i}^{-} \, \sum_{i=1}^{n4} \beta_{gi}^{-} \, \Delta PG_{t-i}^{-} + \, \theta^{-} \, \widehat{Z}_{t-1} \, + \epsilon_{ti} \quad \textbf{(4)}$$

Note that the superscript + stands for coefficients and variables when there is an increase in *PC* and **–** stands for coefficients and variables when there is a decrease or no change in *PC*.

We now briefly discuss the GETS specifications used by BCG. To conserve space, we shall use the symmetric price adjustment equation. Z_{t-1} from the Granger first stage OLS equation is replaced in GETS with its equivalent viz., $(q\, PG_{t-1} - q\, f_1\, PC_{t-1} - q\, f_2\, E_{t-1})$, and estimated in one step with OLS or non-linear least squares (NLLS). Equation (5) below can be said to the BCG GETS version of our model without the time trend. Notice that BG have estimated this equation with OLS and therefore the parameters restrictions in the error correction part of (5) were not imposed.

$$\Delta PG_t = -\theta\phi_0 + \sum_{i=1}^{n}\beta_{gi}\Delta PG_{t-i} + \sum_{i=0}^{k}\beta_{ci}\Delta PC_{t-i} + \sum_{i=0}^{j}\beta_{ei}\Delta E_{t-i} + \Big[\theta PG_{t-1} - \theta\phi_1 PC_{t-1} - \theta\phi_2 E_{t-1}\Big] + \epsilon_t \qquad (5)$$

The disadvantage of (5) is that it is not possible to identify the adjustment coefficient q in a straight forward manner. Therefore, BG have used the following modified variant of BCG, and using this our equation will be:

$$\Delta PG_t = \sum_{i=1}^{n}\beta_{gi}\Delta PG_{t-i} + \sum_{i=0}^{k}\beta_{ci}\Delta PC_{t-i} + \sum_{i=0}^{j}\beta_{ei}\Delta E_{t-i} + \theta(PG_{t-1} - \phi_1 PC_{t-1} - \phi_2 E_{t-1}) + \epsilon_t \qquad (6)$$

However, it is not obvious how BG have estimated their equation with OLS since the coefficients are non-linear. Therefore, it is necessary to estimate (6) with NLLS. BG's version of GETS is an improvement over BCG equation because q can be identified and its significance can be tested by estimating (6) with NLLS. Using (6), the asymmetric version of the GETS based equation can be specified as:

$$\begin{aligned}\Delta PG_t = {} & \sum_{i=1}^{n1}\beta^{+}_{gi}\Delta PG^{+}_{t-i} + \sum_{i=0}^{k1}\beta^{+}_{ci}\Delta PC_{t-i} + \sum_{i=0}^{j1}\beta_{ei}\Delta E_{t-i} \\ & + \theta^{+}\Big(PG_{t-1} - \phi_0 C_{t-1} - \phi_1 PC_{t-1} - \phi_2 E_{t-1}\Big) \\ & \sum_{i=1}^{n2}\beta^{-}_{gi}\Delta PG^{-}_{t-i} + \sum_{i=0}^{k2}\beta^{-}_{ci}\Delta PC_{t-i} + \sum_{i=0}^{j2}\beta^{-}_{ei}\Delta E_{t-i} \\ & + \theta^{-}\Big(PG_{t-1} - \phi_0 C_{t-1} - \phi_1 PC_{t-1} - \phi_2 E_{t-1}\Big) + \epsilon_t \qquad (7)\end{aligned}$$

where C is the intercept. We shall estimate (6) and (7) with NLLS.

IV. EMPIRICAL RESULTS

First, estimates of the symmetric price adjustment equations in (3) and (6) are given in Table-1. Columns (1) and (2) contain estimates with the Granger two-step procedure and columns (3) and (4) report NLLS estimates of the GETS equation (6). When PG was regressed on CP and E, to obtain Z for the estimates in columns (1) and (2), we found that the coefficient of E was highly insignificant. Therefore, Z is the residuals of the OLS equation of PG on the intercept and PC. It is well-known that the coefficient estimates of this OLS equation are super-consistent, especially when the dependent variable is regressed on only one explanatory variable. The estimated first stage OLS equation for the period 1997(Q1) to 2004(Q3) is as follows:

$$PG_t = 0.24712 + 1.1105\, CP_t \qquad (8)$$
$$(9.32) \qquad (13.10)$$

where t-ratios are in the parentheses below the coefficients. Our slope coefficient of 1.1105 is similar to BG's estimate of 1.063 for the USA, although our intercept term differs significantly from BG's estimate of 2.970. One interpretation is that the mark-up of 11% in Fiji is higher than the 6% mark-up in the USA.[3]

In the equations of columns (1) and (3) we have used the BCG and BG restricted lag structure of two lags and henceforth we shall refer to them as equations with restricted lags. In columns (2) and (4) we give estimates with lags implied by the data generating process (DGP). These will be referred to as equations with flexible lag structure. In

[3] BG did not test whether their first stage OLS equation's residuals are I(0). However, our CRADF(0) test, since there was no serial correlation in the residuals without the lagged first differences, and without the intercept gave a value of -3.433 for the estimated τ_γ and its absolute value is more than the absolute critical vale of -3.094 at the 10% level but marginally less than the 5% critical value of -3.438. Therefore, the null that PG and PC are not cointegrated can be conclusively rejected at the 10% and marginally at more than the 5% levels. When we have used the DF test from Microfit, where an intercept is included, the absolute value of the test statistic at 3.1549 is more than the 5% critical value of 2.9558.

Insert Table-1

selecting our lag structure, we have started with 3 lags on the variables. Variable deletion tests are used to obtain the parsimonious equations.[4]

In the equations with restricted lags of column 1, 7 out of its 11 coefficients are insignificant even at the 10% level. Only the coefficient of the seasonal dummy is significant at the 5% level and 3 are significant at the 10% level. In comparison, in equation with flexible lags of column 2, except the intercept, all the remaining 10 coefficients are significant at the 5% level. Furthermore, its summary goodness of fitness measures viz., the adjusted R^2, SEE and LLH, are superior to those of the BCG and BG type restricted equation of column 1. However, all the 4 χ^2 diagnostic test statistics in both equations are satisfactory. Since the equation in column 2 has better summary statistics and virtually all of its coefficients are significant, it is preferable to the restricted equation in column 1. The preferred equation implies that about 64% of adjustment towards the equilibrium gasoline price takes place in one quarter.

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[4] In a large number of empirical works, with ECM specifications, there is an element of arbitrariness in the search for parsimonious short run dynamic equations. This is so because the usual search procedures are not free from the path dependency limitation and time consuming. Therefore, based on the simulation work of Hoover and Perez (1999), Hendry and Krolzig (2001) have developed an automatic model selection software viz., PcGets. PcGets minimizes the path dependency problem by using a multi-path search strategy to obtain the most congruent parsimonious lag structure; see Hendry and Krolzig (2005). We have a limited number of observations, compared to the number of parameters, in our asymmetric price adjustment equations. Therefore, when PcGets was used, .we have to shorten our lag structure and often delete the seasonal dummies from our general unrestricted model.(GUM). We found no major differences, in our present paper, between the parsimonious equations obtained with the usual search methods and from PcGets, although we found that PcGets is useful in our other empirical works with a large number of data observations.

The GETS equations with the restricted lag structure is in column 3 and with flexible lag structure in column (4). They are similar, in their overall properties, to those in columns 1 and 2. In the GETS equation, with restricted lags, 7 out of 12 parameters are insignificant at the 10% level and 3 are significant at the 5% level. In contrast, in the flexible lags equation of column 4, 11 out of 12 coefficients are significant at the 5% level and 2 are significant at the10% level. The goodness of fit statistics of the column 4 equation are higher than its restricted version and therefore it is to be preferred. It implies that the same 64% adjustment towards the equilibrium price of gasoline takes place in one quarter. It may be noted that, irrespective of their relative merits, the coefficients of the two GETS based equations are similar to the corresponding two Granger type ECM equations in columns 1 and 2. For this reason, it may be said that GETS is useful as an alternative approach to estimate time series models.

The asymmetric price adjustment equations have a large number of coefficients and it is difficult to tabulate them fully. Therefore, in Table-2, we report only the estimates of the crucial adjustment parameters and the summary statistics. Full details of the estimated equations can be obtained from the authors. The quality and relative merits of the estimates of the asymmetric equations are similar to the symmetric equations. In the Granger-ECM equation with the restricted lag structure of column 1, only 2 out of the 20 parameters are significant at the 5% level and another 2 at the 10% level. The upward price adjustment coefficient θ_1 is insignificant and its absolute value of 0.349 is less than 0.870 for the downward price adjustment coefficient θ_2^-, implying that gasoline prices are adjusted much faster downwards, perhaps a somewhat implausible implication in this context. In contrast, in the Granger-ECM equation based on the flexible lag structure of column 2, there are only 10 parameters and except the intercept, all are significant at the 5% level. It implies that the upward price adjustments are twice faster than downward adjustments since the absolute value of θ_1 at 0.75 is double the size of θ_2 of 0.32. Furthermore, all the goodness of fit summary statistics of this equation are much higher than the restricted lags equation.

Insert Table-2

Four GETS based asymmetric price adjustment equations, GETS-I and GETS-II, are in columns 3 to 6. In GETS-I, the intercepts in the error correction parts are estimated but they are constrained in GETS-II. In GETS-I equation, with restricted lags in columns 3, out of the 21 coefficients, 5 are significant at the 5% level and another one at the 10% level. However, like its counter part Granger two-step ECM equation in column 1, this GETS specification also implies that upward price adjustment is slower than downward adjustment, since the absolute value of θ^- of 1.23 is more than twice of θ^+ at 0.407. In contrast, in the GETS-I equation, with flexible lags of column 5, all the 12 coefficients are significant at the 5% level. However, its χ^2 test statistics for serial correlation and functional form are insignificant only at the 1% level. Therefore, we have re-estimated this equation by constraining its intercept (ϕ_1) to equal 0.247 which is the intercept of the cointegrating equation in (8). These estimates are given by GETS-II in column 6. It may be noted that the aforesaid two diagnostic χ^2 test statistics for serial correlation and functional form in the equation of column 6 are now insignificant at the 5% level. Furthermore, there are no significant differences in the estimates of the two equations with flexible lags in columns 5 and 6. For comparison, we have also re-estimated the GETS restricted lags equation, by construing its intercept and the results are given as GETS-II in column 4. As in the previous case, there are no significant differences between the equations in columns 3 and 4. However, only 4 parameters out of 20 of the equation in column 4 are significant at the 5% level and another 2 at the 10% level. In contrast, 8 out of 11 coefficients of column 6 equation with flexible lags are significant at the 5% level and the remaining 3 are significant at the 10% level. Although the LLH of column 4 equation is more than column 6 equation, this may be due to the inclusion of too many regressors in the former. A comparison of the SEEs of these two equations shows that the latter equation is marginally better. Since the majority of the coefficients in the column 6 equation are insignificant, it is our preferred asymmetric GETS equation.

Two tentative conclusions may be drawn at this stage. First, both in the symmetric and asymmetric versions, equations with the flexible lag structure determined by the underlying DGP performed far better than equations with constrained lag structure of the type used in the earlier works by BCG and BG. Second, while the ECM equations with the Granger two-step procedure have yielded good results, the LSE-Hendry GETS equations have also given comparably good results. This seems to be plausible for the following reasons. The GETS approach was developed well before the unit roots and cointegration approach (URCI) had any significant impact and GETS was later extended to be consistent with the URCI approach. GETS reconciles a basic methodological conflict between the static economic theory, with sparse information on the nature of dynamic adjustment processes, and estimation of these dynamic equations with data generated from the real world that is seldom in a static equilibrium. Therefore, GETS accepts the underlying theory behind the static specifications of the relationships, but searchers for the dynamic adjustment structures that are consistent with the underlying DGP. As such, GETS is a pragmatic and synthetic methodological solution to reconcile seemingly irreconcilable methodological complications. Therefore, the standard North American style criticisms of GETS that it combines I(0) with I(1) variables, needs to be viewed with some reservations. This is so because if the underlying economic theory of the static relationships is adequate, the levels of the relevant variables, if they are I(1), must be also cointegrated and their linear combination, in the GETS error correction part, is I(0). Therefore, the aforesaid influential North American style criticism of the GETS approach is difficult to justify.

In light of the above digression into the methodological issues, it is not surprising that the estimates given by both the Granger two-step and GETS approaches, of the symmetric and asymmetric price adjustment equations, are very close. In Table 1, the Granger two-step equation of columns 2 and the GETS equation in column 4 gave similar coefficient estimates and their summary statistics are also close. Both equations imply that about 64% of the adjustment towards equilibrium gasoline prices in Fiji takes place in one quarter. Similarly, a comparison of the two asymmetric equations in columns 2 and 6 of

Table-2 yielded close estimates of the two adjustment coefficients. They imply that oil firms in Fiji adjust prices upwards about twice faster than downwards. A Wald test with the null that the upward price adjustment coefficient of -0.75 in column 2 equation is not significantly different from the downward price adjustment coefficient of -0.32 is marginally rejected at the 5% level but conclusively at the 1% level. The test statistic is (with the p value in the parenthesis) $\chi^2_{(1)}$=3.793 (0.051). The results of the Wald test for significant differences in the adjustment coefficients of the GETS equation in column 6 are similar. The test statistic is $\chi^2_{(1)}$=3.884 (0.049). However, when the Newy-West adjusted standard errors are used, the test statistic of $\chi^2_{(1)}$=16.328 (0.000) rejects the null convincingly at the conventional 5% level. Therefore, it may be concluded that oil firms in Fiji are about twice faster in adjusting gasoline prices upwards than downwards.

Our conclusion is further supported by the results of a dynamic simulation given in Figure-1. For this purpose, we have used the GETS equation in column 6 of Table 2 to analyse the impact of a 20% fall in the price of crude oil. For the effects of a 20% increase in crude oil prices, the ECM equation in column 2 of Table-2 is used.[5] The dynamic simulation takes into account the effects of the estimated coefficients of the first differences of the lagged variables, in addition to the error correction term, on price adjustments.

Insert Figure-1

[5] The ECM equation of column 2 of Table2 yielded a non-convergent cyclical solution for the decrease in the price of crude oil. Therefore, the GETS equation of column 6 is used because of its simpler lag structure. However, this also produced cycles but with a decreased amplitude. Therefore, four-quarter moving averages of the predicted values from both simulations are used in Figure-1. This is reasonable because the equilibrium values of gasoline price are computed from the cointegrating equation (8) and abstracted from seasonal effects. When the third quarter seasonal dummy effects are ignored in both of our simulations, the predicted values are closer to the equilibrium values. We did not use this option because the seasonal dummy is highly significant in all our equations.

We started with a crude oil price of $0.509, the price in 2004 (3) which implies an equilibrium for gasoline price of $0.812. This is our period 0. The effects of an increase in crude oil prices to $0.611, say period 1, on gasoline prices are shown by the line marked UP in Figure-1. The implied new equilibrium gasoline price is $0.925. It can be seen from Figure-1 that in the price of gasoline of $0.921 in period **7** is sufficiently close to its new equilibrium. In the subsequent periods gasoline price fluctuates by small amounts around this value. Therefore, it may be said that oil firms fully adjust their prices upwards in about 6 periods after the shock. In this simulation, while gasoline prices converged quickly, the effects of a drop in crude oil prices to $0.407 in period 1 did not quickly converge to the new equilibrium gasoline price of $0.699. This adjustment path is shown by the line marked DOWN. It took another **12** periods for gasoline prices to reach $0.713, the first closet value to the new equilibrium price. In the later periods, the price continued to fluctuate around a value of $0.70. These simulation results are consistent with our earlier observation, based on the magnitudes of the estimated adjustment coefficients, that oil firms adjust gasoline prices upwards twice faster than they mark down.

V. Summary and Conclusions

In this paper we have used improved specifications and estimation methods to evaluate the validity of the rockets and feathers hypothesis for the Fiji gasoline market and found strong support for asymmetric price adjustments. Oligopolistic oil firms in Fiji seem to be adjusting gasoline prices twice faster than reducing them when crude oil prices change. Dynamic simulation of our equations also supported our inference based on the estimated asymmetric price adjustment coefficients. We have used two alternative approaches to modelling our time series models viz., the Granger two-step ECM and the LSE-Hendry GETS approaches, and found that both methods gave close estimates of the parameters. Therefore, it may be said that the often accepted criticism that GETS combines both I(0) and I(1) variables and therefore unsatisfactory for modelling time series models, needs further scrutiny.

An important finding of our paper is that while modelling short run dynamic models, it is necessary to search for a lag structure consistent with the underlying data generating process. Inappropriate and ad hoc lag structures, although convenient for dynamic simulations, are likely to yield implausible coefficient estimates. In our present work, we found that the restricted lag structure of BCG and BG in the US empirical work, yielded many insignificant and implausible coefficient estimates in our price equations for Fiji.

Finally, it is hoped that our improved approach and methodology, although used for a small island country, would be useful to other investigators to evaluate the rockets and feathers hypothesis in other oligopolistic markets.

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Appendix

Definitions of Variables and Data Sources

PG = Price of gasoline, excluding all taxes

PC = Tapis crude oil price

E = Exchange rate is the price of F$ in US$.

Data Sources: Bureau of Statistics, Trade Report, Government of Fiji, various issues and Singapore platts: subscribed site http://www.platts.com/Oil/Newsletters%20&%20Reports/Crude %20Oil%20Marketwire/

Table-1

Symmetric Price Adjustment Equations

	1	2	3	4
	Granger 2-step Restricted lags	Granger 2-step Flexible lags	GETS Restricted lags	GETS Flexible lags
INTERCEPT	0.0002	-0.0038 (0.60)		
S3	0.0359 (2.37)	0.0356 (3.12).	0.0355 (2.25)	0.0358 (3.00)
ΔPG_{t-1}	0.06822 (0.37)	0.5671 (3.69)	0.06663 (0.353)	0.4965 (3.23)
ΔPG_{t-2}	-0.0578 (0.39)		-0.6077 (-0.391)	
ΔPG_{t-3}		0.3637 (2.93)		0.3148 (2.519)
ΔPC_{t}	0.3083 (1.85)	0.6411 (4.30)	0.3128 (1.786)	0.6435 (4.09)
ΔPC_{t-1}	-0.0123 (-0.045)	-0.4528 (-2.18)	-0.1898 (-0.066)	-0.4313 (-2.01)
ΔPC_{t-2}	0.2874 (1.14)		0.2830 (1.085)	
ΔPC_{t-3}	----	-0.4752 (-2.63)		-0.4271 (-2.522)
ΔE_{t}	0.1531 (0.765)		0.1481 (0.707)	
ΔE_{t-1}	-0.2714 (-.355)		-0.2099 (-1.318)	-0.3027 (-1.828)
ΔE_{t-2}	0.3804 (1.812)	0.4420 (2.72)	0.3717 (1.64)	0.4954 (2.81)
ΔE_{t-3}		-0.6777 (-3.73)		-0.6054 (-3.224)
ΔE_{t-4}		0.3891 (2.24)		
θ	-0.4269 (-1.992)		-0.4281 (-1.944)	-0.640 (-4.68)
ϕ_1		-0.6378 (-4.83)	0.2405 (4.07)	0.1959 (5.64)
ϕ_2			1.134 (6.05)	1.25 (12.09)
R^2(adj)	0.5526	0.7339	0.5281	0.7148
SEE	0.0327	0.0252	0.0335	0.0261
LLH	66.9288	74.7248	66.9421	74.4933
χ^2_{sc}	2.8262 (0.587)	3.3716 (0.498)	2.8910 (0.576)	3.8035 (0.433)
χ^2_{ff}	0.69355 (0.405)	1.5223 (0.217)	0.69128 (0.406)	2.6052 (0.107)
χ^2_{n}	2.6759 (0.262)	2.0868 (0.352)	2.7988 (0.247)	1.3654 (0.505)
χ^2_{hs}	2.6151 (0.106)	0.6135 (0.433)	2.4976 (0.114)	0.03505 (0.851)

Notes: χ^2 diagnostic test statistics are respectively for serial correlation, functional form misspecification, normality of the residuals and heteroscedasticity. Their p values are in the parenthesis

Table-2

Asymmetric Price Adjustment Equations

	1	2	3	4	5	6
	Granger 2-step Restricted lags	Granger 2-step Flexible lags	GETS-I Restricted lags	GETS-II (constrained intercept and restricted lags)	GETS-I Flexible lags	GETS-II (constrained intercept and flexible lags)
q_1	-0.3491 (-1.0655)	-0.7500 (-6.2328)				
q_2	-0.8703 (-1.8955)	-0.3167 (-1.9378)				
$q^{(+)}_{t-1}$			-0.4069 (-1.4480)	-0.3957 (-1.6103)	-0.7322 (-4.7198)	-0.7708 (-4.9389)
$q^{(-)}_{t-1}$			-1.2326 (-2.3080)	-1.1989 (-2.2928)	-0.4462 (-3.1434)	-0.3676 (-2.8431)
ϕ_1			0.2712 (8.9873)	0.247^c	0.28357 (7.4235)	0.247^c
ϕ_2			1.1971 (7.7011)	1.3023 (15.9649)	0.9142 (6.7551)	1.0193 (18.6792)
R^2(adj)	0.5666	0.8055	0.5852	0.5987	0.6521	0.6591
SEE	0.0322	0.02154	0.03145	0.0309	0.0288	0.0285
LLH	77.033	81.09	79.272	78.19	71.512	71.007
χ^2_{sc}	4.2511 (0.373)	1.445 (0.836)	4.262 (0.372)	3.70 (0.448)	10.232 (0.037)	9.400 (0.052)
χ^2_{ff}	1.64 (0.200)	0.4928 (0.483)	3.353 (0.067)	2.513 (0.113)	4.042 (0.044)	2.056 (0.152)
χ^2_{n}	0.3542 (0.838)	2.0591 (0.357)	0.8246 (0.662)	0.9247 (0.630)	2.125 (0.346)	2.884 (0.236)
χ^2_{hs}	0.01885 (0.891)	0.2889 (0.591)	0.0014 (0.970)	0.2298 (0.632)	0.0045 (0.946)	0.4504 (0.502)

Notes: c signifies restricted parameter. χ^2 diagnostic test statistics are respectively for serial correlation, functional form misspecification, normality of the residuals and heteroscedasticity. Their p values are in the parentheses.

FIGURE-1
EFFECTS OF CRUDE OIL PRICE CHANGES