Price Adjustment in Taiwan Retail Gasoline Market

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Abstract

This paper uses weekly data over a sample research period of 2002M4 - 2011M11 to estimate the impact of crude oil price on pre-tax retail gasoline price in Taiwan. We found that there is a significant, long-run equilibrium relationship between crude oil price and retail gasoline price. In the asymmetric ECM framework, this paper finds that there was distributed lag effect symmetry (DLES) between oil price and retail gasoline price. By the cumulated adjustment function, we show that retail gasoline price in Taiwan respond more quickly to reductions in crude oil price.

Keywords: crude oil price, retail gasoline price, asymmetric adjustment, error correction model

1. Introduction

A high degree of fluctuation in crude oil prices during 2007-2009 had a powerful impact on gasoline prices worldwide. For example, in the period spanning Jan 2007 to July 2008, the pre-tax retail price of 95 octane unleaded gasoline in Taiwan increased from NT3990 to NT5740 per barrel. By December 2008, the price had plummeted to NT3362/barrel, before sharply increasing to NT4928/barrel (December 2009). The public is extremely sensitive to changes in the retail price of gasoline; therefore, these fluctuations sparked considerable controversy regarding the pricing policies of petroleum companies.

Galeotti, Lanza, & Manera (2003) described the reliance of modern society on the flexibility and mobility afforded by motor vehicles, which makes the demand for gasoline relatively inelastic. While the public reacts favorably to any reduction in gasoline prices, increases are met with strong displeasure. Whether in Taiwan or abroad, public opinion is generally of the mind that an increase in oil prices leads directly to an increase in gasoline prices, while reduction in oil prices correspond to a slower decline in the prices of gasoline. (Note 1) Price fluctuations in the gasoline market described above represent price asymmetry, which has long been a topic of significance to both economists and the general public (see, for example, Manning, 1991; Borenstein, Cameron, & Gilbert, 1997; Eltony, 1998; Reilly & Witt, 1998; Godby, Lintner, & Wandschneider, 2000; Bachmeier & Griffin, 2003; Radchenko, 2005; Radchenko & Shapiro, 2011).

Figure 1 shows the price of crude oil (per barrel) in NTD. Dubai Crude and Brent Crude comprise the majority of crude oil imported in Taiwan. As Taiwan's main petroleum company, CPC Corporation bases its adjustment of gasoline prices on changes in marker crude price. The marker crude price is Dubai and Brent Crude prices calculated at weights of 70% and 30%, respectively. The price shown in Fig. 1 was obtained through a conversion of the marker crude price described above from USD to NTD. The trend of gasoline price in Taiwan is largely similar to that of crude oil price; however, it does not show immediate adjustment to oil price fluctuations, but appears to exhibit asymmetry and lag (Bettendorf, van der Geest, & Varkevisser, 2003). Additionally, the relatively large fluctuations in crude oil prices after 2007 caused more frequent adjustments to gasoline prices in Taiwan. These phenomena appear consistent with the viewpoint of Radchenko (2005).

Price asymmetry reveals differing degrees of adjustment to output price in response to cost impact. It also shows lag and rigidity in price adjustment. Theoretically, the causes of this type of input-output price asymmetry are categorized as follows: the trigger or focal point pricing strategies of oligopolistic sellers (increase in oil prices diminishes profit on retail gasoline, which immediately drives gasoline prices up; however, a reduction in oil prices does not produce the same inhibitory effect); adjustment to storage and production costs; menu costs, and consumer search costs (Reagan & Weitzman, 1982; Thurman, 1998; Borenstein, 1991; Pindyck, 1993, 1994; Ball & Mankiw, 1994; Borenstein & Sheperd, 1996; Damania & Yang, 1998). However, Borenstein & Shepard (2002) felt that the international crude oil market is an efficient open market, without factors such as menu costs or incomplete information. (Note 2)

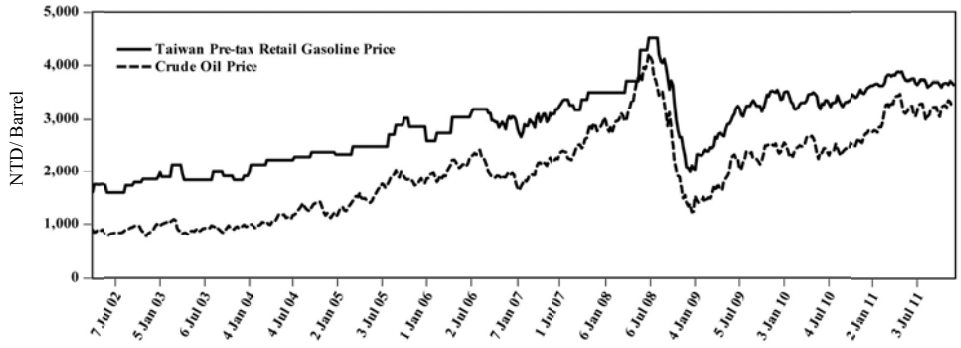

Figure 1. Crude Oil Price and Taiwan Pre-tax Retail Gasoline Price

1. Crude oil price is substituted by marker crude price, which is Dubai and Brent Crude prices calculated at weights of 70% and 30%, respectively. Retail gasoline price is average announced retail price (before taxes).

2. Data are weekly. Crude oil price and retail gasoline price have been obtained from Bureau of Energy and Central Bank of Taiwan for the period from 2002M4 to 2011M11.

Kirchgassner & Kubler (1992) proposed another reason for short-run price asymmetry in wholesale gasoline: The politico-economic reaction of wholesalers. When crude oil prices increase, gasoline wholesalers are hesitant and unwilling to immediately raise their prices, for fear of being accused of abusing market power and engaging in consumer gouging. These reservations, however, do not come into play when crude oil prices decrease. Thus, gasoline prices are adjusted to a lesser extent when oil prices rise, as compared to when oil prices decrease. Kirchgassner & Kubler (1992) described this type of price asymmetry as "politico-economic asymmetry". They demonstrated that this phenomenon was observable in Germany during the 1970's but was no longer evident following the 1980's. (Note 3)

Viewpoints on asymmetric or incomplete pricing in the gasoline market generally refer to two types of price adjustment: short-run and long-run. The emphasis of long-run price adjustment is whether cost changes can fully pass-through into the retail price. Short-run adjustment is mainly expressed through the length of time or extent of the adjustment process (Godby et al., 2000). This study used the asymmetric error correction model (asymmetric ECM) to estimate how positive and negative oil price shocks influence the retail gasoline price in Taiwan. We found that there is a significant, long-run equilibrium relationship between crude oil price and retail gasoline price. In the short-term, the test results rejected the null hypothesis of distributed lag effect symmetry (DLES) between oil price and retail gasoline price. However, there is a lack of clear evidence to prove the existence of contemporaneous impact asymmetry (COIA), cumulated impact asymmetry (CUIA), and equilibrium adjustment path asymmetry (EAPA). On the cumulated adjustment to gasoline price, it is interesting to note that in the first two weeks, gasoline price was adjusted more rapidly in response to positive oil price shock. After the third week, gasoline price was adjusted more rapidly in response to negative oil price shocks. Maximum asymmetry (difference of 0.22%) was evident after the sixth week. When oil price increased by 1%, gasoline price increased by approximately 0.61% after a quarter. Conversely, when oil price declined by 1%, gasoline price decreased by approximately 0.69% after a quarter. This shows that gasoline price in Taiwan respond more quickly to reductions in crude oil price.

This paper is structured as follows. In Section 2, we describe the model and the data adopted in this paper. In Section 3 compile the empirical results of the symmetric and asymmetric ECM. In Section 4 we discuss the gasoline price asymmetries of Taiwan. Section 5 recapitulates the conclusions.

2. Models

In recent years, error correction models (ECM) have become the standard tool for researching dynamic price adjustment (Bettendorf et al., 2003), as well as the primary method of constructing models of cointegrated series (Bachmeier & Griffin, 2003). (Note 4) Error correction models connect the short-run dynamics and long-run equilibrium of such series. Engle & Granger (1987) stated that any cointegrated series can be expressed in error correction form. The absence of a cointegrating relationship indicates misspecification. Therefore, although crude oil price and gasoline price are non-stationary, a cointegrating relationship can still be found between the two variables, as shown below:

$$rg_t = \beta_o + \beta_1 o_t + u_t \quad (1)$$

where rg_t indicates retail gasoline price, o_t indicates crude oil price (in NTD), and u_t is the error term. All variables are expressed as natural logarithms. Equation (1) shows the equilibrium relationship between variables of output price and costs. If there were a stable industry structure, changes in costs would not affect this equilibrium relationship (Johnson, 2002). A super-consistent coefficient estimator (β_0, β_1) can be obtained using OLS.

The retail price of gasoline in Taiwan is substituted for by the pre-tax retail price of 95 octane unleaded gasoline (average announced price). Crude oil price is indicated by marker crude price (in NTD). All prices are expressed as unit price per barrel, obtained from the website of the Bureau of Energy of Taiwan (http://www.moeaboe.gov.tw/oil102/). Information on the Taiwan-U.S. exchange rate was obtained from the Central Bank of Taiwan. Weekly data was collected over a sample research period of 2002M4 - 2011M11 (sample size = 504).

If the price series in Equation (1) were I(1) series and showed a cointegrating relationship, the short-run dynamic model expressed in error correction form would be as follows:

$$\Delta rg_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i \Delta rg_{t-i} + \sum_{i=0}^{n} \gamma_i \Delta o_{t-i} + \lambda EC_{t-1} + \varepsilon_t \quad (2)$$

where Δ indicates the first difference; ε_t is the error term; γ_i measures the short-run impact of oil price fluctuation, and γ_0 indicates the immediate effect of variation in oil price. γ_i, $\forall i = 1, \cdots, n$ denotes the distributed lag effects of oil price variation; α_i measures the short-run impact of lagged gasoline prices; EC is the error correction term, and λ is the adjustment coefficient of long-run equilibrium.

The ECM tells us that if crude oil price were unchanged and long-run equilibrium between gasoline and oil prices was attained, then there would be no further change to gasoline price. β_1 measures the long-run equilibrium relationship of permanent change to the price of oil. Even if asymmetric adjustment responses are plausible, the long-run cointegrating relationship between gasoline and oil prices must be identical for price increases or decreases (Bachmeier & Griffin, 2003).

To explore the asymmetric short-run response to price changes, we must now extend the basic ECM to an asymmetric ECM (Granger & Lee, 1989), as shown below:

$$\Delta rg_t = \alpha_0 + \sum_{i=1}^{m} \alpha_i \Delta rg_{t-i} + \sum_{i=0}^{n} \gamma_i^{+} \Delta o_{t-i}^{+} + \sum_{i=0}^{n} \gamma_i^{-} \Delta o_{t-i}^{-} + \lambda^{+} EC_{t-1}^{+} + \lambda^{-} EC_{t-1}^{-} + \varepsilon_t \quad (3)$$

The above equation differentiates changes in oil prices and the error correction terms as positive and negative variations. Δo_t^{+} is defined as $max\{\Delta o_t, 0\}$ and Δo_t^{-} as $min\{\Delta o_t, 0\}$; EC_t^{+} and EC_t^{-} are also similar definitions. Equation (3) retains the basic concept of ECM but allows for more flexible adjustment of gasoline price in response to oil price.

Table 1 shows the annual number of adjustments to retail gasoline prices in Taiwan. During the sample period of this study, retail gasoline prices were adjusted a total of 224 times (123 of these adjustments were increases in price (55%) while 101 were reductions (45%)). Retail gasoline prices were not adjusted on a weekly basis (for example, prices were adjusted roughly once every 3.55 weeks at 2002 on average); particularly during the pre-2006 period, prices were adjusted roughly once every 5.16 weeks. Following 2007, however, price adjustment occurred approximately once every 1.45 weeks. Table 2 shows the distribution of adjustments (by value) to retail gasoline prices in Taiwan. It is evident that most price adjustments were on a relatively small scale ($-2 \leq x \leq 2$).

Table 1. Number of Taiwan Retail Gasoline Price Adjustments

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Total	Average
Increases	8	4	5	3	9	17	6	27	25	19	123	4.09
Decreases	3	5	1	2	8	13	17	18	18	16	101	4.98
Total	11	9	6	5	17	30	23	45	43	35	224	2.25
Average	3.55	5.78	8.67	10.6	3.06	1.73	2.26	1.16	1.21	1.49	2.25	-

Data are weekly, spanning from 2002M4 to 2011M11. There are 39 weeks and 48 weeks in 2002 and 2011, respectively. Retail gasoline price is average commended retail price (before taxes). The data have been obtained from Bureau of Energy of Taiwan and this study.

Table 2. Distribution of the Size of Taiwan Retail Gasoline Price Adjustments (x%)

x<-5	-5≤x<-4	-4≤x<-3	-3≤x<-2	-2≤x<-1	-1≤x<0	0<x 1	1<x 2	2<x 3	3<x 4	4<x 5	x>5
7	6	6	17	28	33	38	38	26	8	10	7

Data are weekly, spanning from 2002M4 to 2011M11. There are 39 weeks and 48 weeks in 2002 and 2011, respectively. Retail gasoline price is average commended retail price (before taxes). The data have been obtained from Bureau of Energy of Taiwan and this study.

3. Empirical Findings

To analyze the symmetrical (Equation 2) and asymmetrical (Equation 3) pass-through effects of retail gasoline price caused by oil price shocks, we first determined whether there was a stationary equilibrium relationship between rg_t and o_t. If rg_t and o_t were integrated of order one and exhibited a cointegrating relationship, this would imply an equilibrium relationship between rg_t and o_t. This facilitated the construction of an ECM (Engle & Granger, 1987). The results of ADF (augmented Dicky-Fuller) and PP (Phillips-Perron) unit root tests (including both the constant term and the time trend) showed that the null hypothesis with a unit root was not rejected for either rg_t or o_t. After obtaining the first-order difference for the variables, we applied the same test process and found that the null hypothesis with a unit root was significantly rejected for both Δrg_t and Δo_t. The test results are as shown in Table 3, which indicate that rg_t and o_t are I(1) series.

Table 3. Unit Root Tests

	Levels		First difference	
Variable	ADF	PP	ADF	PP
o_t	-2.622	-2.412	-10.500***	-17.793***
rg_t	-2.458	-3.034	-19.270***	-19.956***

The autoregression models include both constant term and time trend, and the optimal lags are determined using AIC (maximum lags = 12). The ADF test and PP test are based on the null hypothesis of a unit root. ***, **, and * indicate that the null hypothesis is rejected at the 1 %, 5 %, and 10 % significance levels.

Next, we used OLS to estimate Equation (1) and applied ADF and PP unit root tests to the residual. The results strongly rejected the null hypothesis with a unit root, indicating a cointegrating relationship between rg_t and o_t. The results of the Johansen cointegrating tests also showed that, with regard to both trace eigenvalue and maximum eigenvalue statistics, the null hypothesis of no conintegrating relationship was rejected (see Table 4). This outcome supports the results of the unit roots to the residual. Equation (1) implies that fluctuation in crude oil price lead to changes in the retail gasoline price and not vice versa. The results of Granger causality tests suggest the null hypothesis that the crude oil price does not Granger cause the retail gasoline price was rejected. However, the null hypothesis of that the retail gasoline price does not Granger cause the crude oil price was not rejected.

Table 4. Johansen Cointegrating Tests on Oil Price and Retail Gasoline Price

Null Hypothesis	Eigenvalue	$\lambda - trace$	$\lambda - max$
$r = 0$	0.054	29.693***	27.651***
$r \leq 1$	0.004	2.043	2.043

1. The optimal lags of VAR system are determined using AIC (maximum lags = 12).
2. $\lambda - trace$ refers to the trace eigenvalue statistics; $\lambda - max$ refers to the maximum eigenvalue statistics; and r in the null hypothesis refers to the number of cointegration relationships in the VAR system; and ***, **, and * indicate that the null hypothesis is rejected at the 1 %, 5 %, and 10 % significance levels.

Under the premise that rg_t and o_t are I(1) series and have a cointegrating relationship, we were able to construct the ECM for Equation (2) or Equation (3). We utilized Akaike information criterion (AIC) to determine the optimal lags of *m* and *n* in Equation (3), and used Schwarz criterion (SC) as the basis to identify minimum lags. The purpose was to avoid an overly short lag phase, which would prevent full expression of the data form. Under the premise of maximum lags = 13 (a quarter), we set *m*=6 and *n*=9.

Table 5 shows the estimation results of the cointegrating relationship, and demonstrates that there is a significant long-run equilibrium relationship between retail gasoline price and crude oil price. The long-run pass through effect

of oil price into retail price is 0.563. When oil price increased by 1%, which will be passed 0.563% into retail gasoline price. Table 6 shows the coefficient estimation results for Equations (2) and (3). The standard deviation of the coefficients was calculated using Newey-West HAC covariance matrix estimation. With regard to both symmetric and asymmetric ECM, it is evident that the immediate effect of oil price shocks is not significant. In the symmetric ECM, oil price shocks showed significant distributed lag effects (lags of 1, 2, 7, and 9). In asymmetric ECM, positive oil price shocks showed significant distributed lag effects in lags of 1 and 7; negative oil price shocks showed significant distributed lag effects in lags of 1, 2, and 7. Although oil price shocks appear to have an asymmetric pass-through effect, positive shocks do not necessarily produce a greater response. The adjustment coefficients of error correction were estimated to have negative values, which imply that the system is converging to equilibrium. Negative disequilibrium, however, was responded to with more rapid adjustment.

Table 5. Cointegration Relationship

Variable	Coefficient	Std Deviation
Constant	3.703***	0.038
o_t	0.563***	0.005

***, **, and *, which indicate significance at the 1 %, 5 %, and 10 % levels.

4. Gasoline Price Asymmetries

Frey & Manera (2007) proposed a clear definition and categorization of price asymmetries, which we have interpreted using Equation (3) as follows:

1. γ_0^+ and γ_0^- measure the contemporaneous impact of Δo_t^+ and Δo_t^- on Δrg_t.Therefore, if test results reject $H_0: \gamma_0^+ = \gamma_0^-$, this is defined as contemporaneous impact asymmetry (COIA); the opposite is defined as contemporaneous impact symmetry (COIS).

2. If test results reject $H_0: \gamma_i^+ = \gamma_i^-, \forall i = 1, \cdots, n$, then this indicates the existence of distributed lag effect asymmetry (DLEA); if the null hypothesis is not rejected, then this indicates distributed lag effect symmetry (DLES).

3. The third type of price asymmetry is the cumulated impact asymmetry (CUIA) of Δo^+ and Δo^- with regard to Δrg_t (in the past *n* periods). If the test results reject $H_0: \sum_{i=0}^{n} \gamma_i^+ = \sum_{i=0}^{n} \gamma_i^-$, this type of price asymmetry is known as CUIA; if the null hypothesis is not rejected, the phenomenon is termed cumulated impact symmetry (CUIS). Interestingly, COIS and DLES were established as sufficient but non-required conditions for CUIS. The simultaneous establishment of COLA and DELA does not necessarily imply CUIA or CUIS.

4. Because λ^+ and λ^- respectively measure the adjustment speed when $EC_{t-1} > 0$ and $EC_{t-1} < 0$, if the test results reject $H_0: \lambda^+ = \lambda^-$, this is defined as equilibrium adjustment path asymmetry (EAPA); the reverse is defined as equilibrium adjustment path symmetry (EAPS).

Finally, although the coefficients of the error correction term are labeled adjustment speeds, the actual paths of adjustment are also determined by other coefficients in the model. In other words, when Δo_t^+ or Δo_t^- occurs, the cumulative adjustment function must be used to calculate the scale of cumulated adjustment to gasoline price. When crude price is assumed to increase by 1% at time *t*, then C_i^+ indicates the cumulated adjustment process of the retail gasoline price at time *t*+*i*. The cumulative adjustment function can be expressed as follows:

$$\begin{gathered} C_0^+ = \gamma_0^+ \\ C_1^+ = C_0^+ + \gamma_1^+ + \lambda^+(C_0^+ - \beta_1) + \alpha_1 C_0^+ \\ C_2^+ = C_1^+ + \gamma_2^+ + \lambda^+(C_1^+ - \beta_1) + \alpha_1(C_1^+ - C_0^+) + \alpha_2 C_0^+ \\ C_n^+ = C_{n-1}^+ + \gamma_n^+ + \lambda^+(C_{n-1}^+ - \beta_1) + \sum_{i=1}^{m} \alpha_i (C_{m-i}^+ - C_{m-i-1}^+) \end{gathered} \tag{4}$$

The cumulated adjustment process involved in the reduction of oil prices is similar to Equation (4). The cumulated adjustment function measures the persistent influence of increases (or decreases) in oil price on gasoline price.

Table 6. Error Correction Models

	Symmetric ECM		Asymmetric ECM	
Regressor	Coefficient	Std Deviation	Coefficient	Std Deviation
Constant	0.000	0.001	0.001	0.004
Δrg_{t-1}	0.019	0.041	0.022	0.043
Δrg_{t-2}	-0.053	0.047	-0.059	0.045
Δrg_{t-3}	-0.005	0.050	-0.007	0.052
Δrg_{t-4}	0.102**	0.049	0.102**	0.048
Δrg_{t-5}	0.069	0.042	0.065	0.046
Δrg_{t-6}	-0.154***	0.047	-0.149*	0.046
Δo_t	0.046	0.028		
Δo_t^+			0.083	0.053
Δo_t^-			0.019	0.041
Δo_{t-1}	0.212***	0.042		
Δo_{t-1}^+			0.221***	0.058
Δo_{t-1}^-			0.182***	0.068
Δo_{t-2}	0.084**	0.034		
Δo_{t-2}^+			0.004	0.043
Δo_{t-2}^-			0.186***	0.063
Δo_{t-3}	0.059	0.041		
Δo_{t-3}^+			0.080	0.062
Δo_{t-3}^-			0.045	0.056
Δo_{t-4}	0.019	0.032		
Δo_{t-4}^+			-0.020	0.058
Δo_{t-4}^-			0.043	0.058
Δo_{t-5}	0.001	0.033		
Δo_{t-5}^+			-0.030	0.051
Δo_{t-5}^-			0.034	0.052
Δo_{t-6}	-0.013	0.031		
Δo_{t-6}^+			-0.045	0.045
Δo_{t-6}^-			0.009	0.050
Δo_{t-7}	0.131***	0.033		
Δo_{t-7}^+			0.095*	0.050
Δo_{t-7}^-			0.154**	0.069
Δo_{t-8}	0.017	0.024		
Δo_{t-8}^+			0.071	0.043
Δo_{t-8}^-			-0.042	0.056
Δo_{t-9}	0.048**	0.024		
Δo_{t-9}^+			0.045	0.043
Δo_{t-9}^-			0.044	0.047
EC_{t-1}	-0.114***	0.024		
EC_{t-1}^+			-0.071	0.048
EC_{t-1}^-			-0.149***	0.051

1. The optimal lags of asymmetric ECM are determined using AIC (maximum lags = 12). ***, **, and *, which indicate significance at the 1 %, 5 %, and 10 % levels. Since it is impossible to eliminate the presence of correlated and heterogeneous variable in the residuals, the standard derivation is calculated using the Newey-West HAC covariance matrix estimation.
2. Data are weekly, spanning from 2002M4 to 2011M11 (sample size = 504). The data have been obtained from Bureau of Energy and Central Bank of Taiwan.

Table 7 shows the test results of price asymmetries (COIA, DLEA, CUIA, and EAPA). Regarding the adjustments of gasoline price in response to oil price changes, the null hypothesis of DLES was rejected at a 10% significance level. The other null hypotheses relating to the existence of COIS, CUIS, and EAPS were not rejected, even at a 10% significance level. In other words, the gasoline price only shows DLEA.

Table 8 shows the process involved in the cumulated adjustment of gasoline price in response to changes in crude

oil price. Oil price shocks were categorized as symmetric, positive, and negative. The effects of symmetric oil price shocks on retail gasoline price are calculated from symmetric ECM (equation (2)). It is interesting to note that in the first two weeks, gasoline price was adjusted more rapidly in response to positive oil price shock. After the third week, gasoline price was adjusted more rapidly in response to negative oil price shocks. Maximum asymmetry (difference of 0.22%) was evident after the sixth week. When oil price increased by 1%, gasoline price increased by approximately 0.61% after a quarter. Conversely, when oil price declined by 1%, gasoline price decreased by approximately 0.69% after a quarter. This shows that gasoline price in Taiwan respond more quickly to reductions in crude oil price. We have also illustrated C_i^+, C_i^-, and $C_i^+ - C_i^-$ in Figure 2, demonstrating this unique phenomenon.

Table 7. Asymmetric Tests

	$H_0: COIS$	$H_0: DLES$	$H_0: CUIS$	$H_0: EAPS$
F-Statistics	0.678	1.721*	0.678	0.813

1. ***, **, and * indicate that the null hypothesis is rejected at the 1 %, 5 %, and 10 % significance levels.

2. COIS denotes contemporaneous impact symmetry; DLES denotes distributed lag effect symmetry; CUIS denotes cumulated impact symmetry; EAPS denotes equilibrium adjustment path symmetry.

Table 8. Cumulative Responses

	Period after Crude Oil Price Shock (Week)												
	0	1	2	3	4	5	6	7	8	9	10	11	12
Symmetry	0.046	0.318	0.432	0.494	0.520	0.554	0.565	0.666	0.661	0.689	0.674	0.666	0.659
Positive	0.083	0.341	0.361	0.440	0.436	0.442	0.413	0.488	0.569	0.600	0.590	0.591	0.607
Negative	0.019	0.241	0.453	0.498	0.534	0.591	0.630	0.762	0.680	0.708	0.704	0.701	0.685

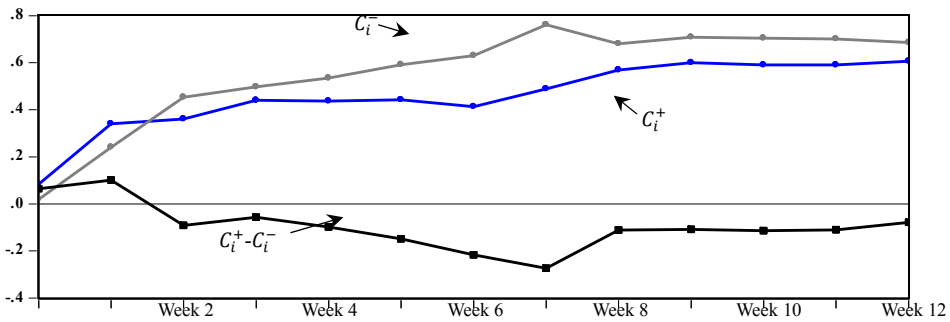

Figure 2. Cumulative Adjustment Function

5. Concluding Remarks

This paper collects weekly data over a sample research period of 2002M4 - 2011M11 to estimate the impact of oil price on pre-tax retail gasoline price in Taiwan. In this study, the crude oil price is substituted by marker crude price, which is Dubai and Brent Crude prices calculated at weights of 70% and 30%, respectively. We found that there is a significant, long-run equilibrium relationship between crude oil price and retail gasoline price. In the asymmetric ECM framework, the test results rejected the null hypothesis of distributed lag effect symmetry (DLES) between oil price and retail gasoline price in the short-run. However, there is a lack of clear evidence to prove the existence of contemporaneous impact asymmetry (COIA), cumulated impact asymmetry (CUIA), and equilibrium adjustment path asymmetry (EAPA). On the cumulated adjustment to gasoline price, it is interesting to note that in the first two weeks, gasoline price was adjusted more rapidly in response to positive oil price shock. After the third week, gasoline price was adjusted more rapidly in response to negative oil price shocks. Maximum asymmetry (difference of 0.22%) was evident after the sixth week. When oil price increased by 1%, gasoline price increased by approximately 0.61% after a quarter. Conversely, when oil price declined by 1%, gasoline price decreased by

approximately 0.69% after a quarter. This shows that gasoline price in Taiwan respond more quickly to reductions in crude oil price. In Taiwan, CPC Corporation is the market leader with a market share of 75%. But CPC Corporation is also attached to the Ministry of Economic Affairs in Taiwan. This would explain why the adjustment of Taiwan retail gasoline prices in response of shocks to oil price is "politico-economic asymmetry".

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Notes

Note 1. Bacon (1991) has described this type of asymmetrical adjustment in gasoline prices as “rockets and feathers effects”.

Note 2. Johnson (2002), Kaufmann & Laskowski (2005), and Radchenko (2005) also indicated that there are no menu costs with regard to the price announcements of retail gasoline.

Note 3. Kirchgassner & Kubler (1992) indicated that this change may be associated with markets becoming more competitive.

Note 4. Von Cramon-Taubaded (1998) posited that only error correction models are suited to testing asymmetric price response.