The Philippine Review of Economics
Vol. LI No. 2, December 2014 pp. 1-20

Market competition in the downstream oil industry: is there evidence of price asymmetry?

Ma. Joy Abrenica*, Rolando Danao*, and Ma. Nimfa Mendoza*

Casual observation that domestic gasoline prices increase immediately and more than proportionately when global prices rise, while they tend to decrease slowly and less than proportionately when global prices decline, has fuelled speculation that the major oil industry players are engaging in collusion. This perception has persisted despite three independent probes into the state of market competition in the industry—none of which found direct evidence of collusion. However, the third inquiry has found some evidence of price asymmetry in a recent period. Applying a standard price asymmetry model with error correction term on weekly price data, this study finds no evidence of price asymmetry. Instead, local pump prices are confirmed to be tracking global prices symmetrically and with only a week's lag. This finding is robust for different fuel types.

JEL classification: L11, L41
Keywords: collusion, price asymmetry, downstream oil industry

1. Motivation

Late in the first semester of 2013, the antitrust authorities of the European Union and United States launched independent probes into the practices of Platts, an energy information services provider. The company compiles information from traders and other oil market participants to develop benchmarks that are applied globally in setting wholesale and retail oil prices. Major oil companies are suspected of rigging these benchmarks through selective reporting of transactions after some market participants observed that the Platts' reference prices seemed not be moving in sync with their actual trade transactions.

To be sure, the inquiry into the integrity of Platts' prices was preceded by similar inquests into the London interbank offered rate, a reference for short-term interest rates, and the ISDAfix, a benchmark for interest-rate swaps. There are clear parallels to these cases. These price benchmarks, compiled by private organizations and considered global standards, are subject to minimum regulation and oversight, even if they are vulnerable to manipulation and distortion. Collusion among suppliers tends to be more successful under conditions prevailing in these markets: homogeneous product, frequent transactions, observable price adjustments, high entry barriers, and high concentration.

Not surprisingly, consumers are leery of downstream oil markets.[1] In the Philippines, discussions about reregulating the industry are often fervent during price upswings, but they tend to fade when prices are less volatile. Still, the major industry players are perennially suspected of engaging in price collusion. This perception has not changed in spite of three independent inquiries, initiated by the Department of Energy (DOE), all refuting claims of "unreasonable" prices and collusion. The most recent inquiry in 2012 by the Independent Oil Price Review Committee provided statistical evidence that domestic pump prices moved with international crude oil prices, albeit with some lag. (See Annex for details.) The committee also found that, consistent with expectations of market competition, domestic pump prices have become more responsive to changes in international oil prices and returns to investments of major oil players declined since deregulation.

Yet several factors continue to foster public skepticism. First, the industry remains highly concentrated despite the entry of new players. The so-called "big 3" players in the industry still account for almost three-quarters of total sales. Second, the profits of the "big 3" seem unperturbed by market challenges. More significantly, none of the independent review committees has refuted the public perception that downward adjustments in domestic prices in response to decline in international oil prices have been slower and less than proportionate compared to adjustments triggered by increases in international prices. Groups opposed to market deregulation allege that this downward stickiness of domestic pump prices, also referred to as price asymmetry, is evidence of collusion among major industry players. They claim that such uncompetitive behavior remains unchecked because the government has relinquished control over prices. For this reason, these groups clamor for a reversal of the policy of market deregulation. While a return to regulation is clearly a retreat from market liberalization—the direction that the Philippines has decidedly pursued since the 1990s—it has not lost all adherents.

This paper investigates the issue of price asymmetry and its inference regarding market competition in the domestic oil industry. It seeks evidence

[1] See, for example, the reports of the Australian Competition and Consumer Commission [2007 and 2012], Office of Fair Trading [1998], and Organization for Economic Cooperation and Development [2009].

that may support or correct the casually held view of market collusion based on perceived asymmetry in price adjustments.

The econometric model applied in this study is in line with other studies investigating similar issues where an asymmetrical adjustment may apply not only to changes in world oil prices but also to exchange rate fluctuations. An inquiry of this nature, however, does not end with the finding of asymmetry. There is still a need to establish if such is linked to market competition before any reference to market collusion can be made.

2. State of market competition

The economic activities of the petroleum industry may be divided into three segments: exploration and production of crude oil; refining of crude oil into finished products; and distribution and sale of refined products to end consumers. The first two segments represent the "upstream" sector, while the third constitutes the "downstream" sector. The upstream sector operates independently of the downstream sector in many economies. Competition in the downstream sector is often more intense, therefore margins are relatively thinner, compared to the upstream sector.

In 1998, the Philippines deregulated its downstream oil market. Like other economies that pursued a similar market reform, the avowed objective of deregulation was to improve the efficiency of the industry considering that oil is a major input to many production processes.

2.1. Industry structure

Three oil companies currently dominate the downstream industry, namely: Petron[2], Pilipinas Shell Petroleum Corporation, and Caltex Philippines (Chevron). The first two are engaged in refining and marketing of oil products, while the third company converted its refinery into an import terminal in 2003. Hence Chevron is now purely into marketing and distribution of imported fuel. Domestic production of crude oil is modest and mostly exported, while the crude oil requirements of local refiners are mostly sourced through imports.

A significant number of new dealers and retailers have entered the market since deregulation. Some of the new entrants are subsidiaries of multinational companies, such as Total of France's TotalFinaElf, Liquigaz of SHV Netherlands, and PTT of Petroleum Authority of Thailand PTT. Others are local companies, namely Flying V, Seaoil, Unioil, and Pryce Gases.

[2] Petron spun off from the Philippine National Oil Company. The government has fully divested its equity in the company; it is currently 83 percent private-owned and 17 percent publicly traded.

The DOE categorizes the oil companies as majors, new players, and independents. Oil majors refer to the incumbents prior to deregulation, i.e., Shell, Petron, and Caltex. New players are bulk importers of refined petroleum products, which include Flying V, Total Phil., Unioil, Seaoil, Jetti, PTT/SBDI, Eastern, City Oil, Metro Oil Subic, Uno Fuel, Nation Petroleum, USA88, Filoil Gas, and Phoenix. Independents are not affiliated formally with any of the oil majors or new players. They own refilling stations and sell "unbranded" fuel. It is usual for unbranded stations to price aggressively. [3]

Although a uniform tariff has been applied to crude and refined oil since deregulation (i.e., 3 percent until 2009; currently, 0 percent), domestic market prices are often set by oil majors, generally in step with changes in world prices, specifically of Dubai's for crude oil, and of the Mean of Platts in Singapore (MOPS) for finished products. The ability of oil majors to act as price leaders, despite the loss of tariff protection, emanates from their control of two-thirds of nearly 5,000 gasoline stations all over the country. The new players own 21 percent of these stations, while the independents control the remaining 13 percent.

In 2012, the combined market shares of major oil companies was 73 percent, while the balance was divided among 14 other players[4] and large end users. The local refiners, Petron and Shell, supplied 63 percent of total market demand while direct importers and distributors of finished petroleum products account for the remainder.

The petroleum products supplied by Petron and Shell are not all domestically refined. Petron and Shell accounted for 26 percent of country's total imports of petroleum products. About 48 percent and 54 percent of gasoline and diesel demand, respectively, are supplied through imports.

2.2. Price setting

As in other deregulated markets, oil companies in the Philippines are not only engaged in price competition. They also compete for customer base by choice of locations of retail stations, brand equity, provision of facilities and services such as restrooms, convenience stores and quick-service restaurants, product quality, and customer-loyalty programs like company fleet cards and credit cards. Price competition is stronger in low-quality petroleum products, which are considered relatively homogeneous and therefore interchangeable between oil company brands. There is more product differentiation in higher-end premium products, such as high-octane gasoline, which allows for price variations across brands.

---

[3] Hastings [2004], using data from Southern California, shows that the presence of independent retailers exerts downward pressure on local retail prices.

[4] The "other players" are Phoenix, Isla Gas, Jetti, Prycegas, Petronas, Liquigaz, Unioil, Seaoil, Filpride, TWA, Filoil, Microdragon, PTTC, and Total Phil.

Most retail stations adjust their prices weekly, usually at the start of the week. Occasionally, however, the DOE requests the oil companies to stagger their price adjustment over several weeks instead of implementing a one-time adjustment.

The price adjustments may be triggered by changes in oil prices in the global market, or by changes in foreign exchange, or by both. Adjustments are often not applied uniformly across petroleum products. For example, diesel and kerosene prices may be lowered while regular and premium gasoline prices are raised.

Oil companies do not apply uniform price adjustments across the country. Prices vary geographically mainly because of differences in costs of transporting fuels, hence gasoline prices are generally higher in Visayas than in Luzon. But even within Metro Manila, gasoline prices of the same brand can vary between cities. The 2005 independent review committee observed that prices tend to be lower in areas where there are more suppliers.

2.3. Independent price reviews

Since market deregulation, there have been three reviews of the state of competition and impact of deregulation in the downstream oil industry by independent committees formed by the DOE. These reviews focused on verifying claims of anticompetitive behavior by oil suppliers.

The first independent review in 2005 was convened to determine if the main cause of the oil price increases then was the deregulation of the downstream oil industry; if there were measures or alternatives available to reduce prices; and if the country's interests would be best served by repealing the deregulation law. The second independent review, in 2008, centered on the "reasonableness" of prices of Petron and Shell. Both committees refuted public perceptions concerning noncompetitive behavior by oil companies. Specifically, their reviews showed local prices increased more slowly than world oil prices; real margins of oil companies had declined since deregulation; returns on equity of Petron and Shell were comparable to interest rate benchmarks; and the stock price of Petron did not reflect extraordinary profits. In sum, the two committees did not find evidence of abuse of market power by any oil company to warrant a return to regulation.

The DOE had to form a third independent review committee yet again in 2012 to assuage the public clamor for reregulation amid rising fuel prices. The third review committee was tasked to determine if oil companies accumulated excessive profits and if they were guilty of unfair pricing to the detriment of the public. The committee employed several models, including a regression analysis, to determine if local pump prices track world oil prices.

Among the findings and conclusions of the third review, two stand out. First, under a deregulated regime, local pump prices (represented by Metro

Manila prices) are more responsive to world oil prices (represented by MOPS), and the ratio of local pump prices to world oil prices is lower and less volatile. These are desirable outcomes and support the continuation of deregulation. Second, while the responses of local pump prices to changes in world oil prices have been generally symmetrical, for some recent period (i.e., July 2010 to June 2012), oil firms adjusted local prices less than proportionately to world price decreases than to increases. The committee encouraged the DOE to further explore this apparent asymmetric price adjustment.

It is worth noting that the three review committees concurred that the repeal of the deregulation law is unwarranted. They concluded that high domestic prices of petroleum products are not due to deregulation but were caused by external factors, specifically rising world oil prices. All three committees were convinced that the apparent convergence of local prices was not caused by cartelization of the industry, but it is, instead, an outcome of competition. That pump prices tend to be lower in areas where there are more retail stations is regarded as sign of market competition at work. The committees also underscored the gains from deregulation, such as the entry of new players especially in the gasoline and liquefied petroleum gas retail business.

Nonetheless, all three committees observed that domestic price adjustments have been asymmetrical, bolstering public perception of collusion among oil suppliers. Only the most recent review however provided some empirical support to such an assertion.

3. Price asymmetry

The first step in correcting public perceptions about the state of market competition is to verify if price adjustments are indeed asymmetrical. This is not the first inquiry of its kind. Since the 1990s, following the Iraqi invasion of Kuwait that triggered rapid increases in retail gasoline prices, public protests against alleged price gouging by oil companies and gasoline retailers have become a recurrent phenomenon. Gasoline prices are perceived to increase almost immediately and more than proportionately when there is a price shock or supply disruption in the crude oil market, while they tend to decrease slowly and less than proportionately when the price shock disappears or input price declines. Bacon [1991] likens such adjustment to the launch of a rocket when prices are increasing and to the fall of a feather when prices are falling.

The growing body of literature investigating the existence of price asymmetry in the gasoline market has produced mixed results.[5] These studies differ in terms of country examined, periodicity of the data (weekly, bi-weekly, daily,

[5] See Table 1 of Polemis [2012] for a summary of major empirical papers investigating price asymmetry in the gasoline market.

etc.), sample period of estimation, stage of transmission (wholesale or retail), econometric model, and nature of price shock (temporary or permanent). It is also not uncommon to find price adjustments symmetrical in one period but not in another. [6] Because of the sensitivity of any finding of asymmetry to a host of factors, it should be examined for robustness or subjected to stringent tests.[7]

3.1. Detection

Most studies investigating price asymmetry utilize an error correction model (ECM), although others have employed a quadratic quantity adjustment model [Bacon 1991] or a threshold autoregressive (TAR) model (e.g., Chen et al. [2005]; Gholampour et al. [2012]). The use of ECM to uncover asymmetry started with Kirchgässner and Kübler [1992], but it is the specification of Borenstein, Cameron and Gilbert [1997] that was widely adopted, modified, and extended by numerous authors.

The following ECM is typical:

$$\begin{aligned}\Delta NPP_t = \alpha &+ \sum_{i=0}^{k}\beta_i \Delta MOPS_{t\text{-}i} + \sum_{i=1}^{l}\delta_i \Delta NPP_{t\text{-}i} + \sum_{i=0}^{m}\gamma_i \Delta ER_{t\text{-}i} \\ &+ \sum_{i=0}^{n}\lambda_i C_{t\text{-}i}\Delta MOPS_{t\text{-}i} + \sum_{i=1}^{p}\varphi_i D_{t\text{-}i}\Delta NPP_{t\text{-}i} + \sum_{i=1}^{q}\sigma_i F_{t\text{-}i}\Delta ER_{t\text{-}i} \\ &+ \mu_1 \Delta MOPS_{t\text{-}1} + \mu_2 NPP_{t\text{-}1} + \mu_3 R_{t\text{-}1} + v\ tariff + \mu_t \end{aligned} \tag{1}$$

where NPP_t is pump price net of VAT, special duty and excise tax (but inclusive of tariff)[8]; $MOPS_t$ is Mean of Platts Singapore, ER_t is dollar-peso exchange rate; $\Delta NPP_t = NPP_t - NPP_{t\text{-}1}$, $\Delta MOPS_t = MOPS_t - MOPS_{t\text{-}1}$, $\Delta ER_t = ER_t - ER_{t\text{-}1}$, $C_{t\text{-}i}$ is a dummy variable that is equal to one when $MOPS_{t\text{-}i} > MOPS_{t\text{-}i\text{-}1}$ and is zero otherwise; $D_{t\text{-}i}$ is a dummy variable that takes the value one when $NPP_{t\text{-}i} > NPP_{t\text{-}i\text{-}1}$ and is zero otherwise; is a variable that takes the value one when $ER_{t\text{-}i} > ER_{t\text{-}i\text{-}1}$ and is zero otherwise; *tariff* is a dummy variable that is zero when the import duty rate is zero, and equals 1, otherwise; α, β_i, δ_i, γ_i, λ_i, φ_i, σ_i, μ_1, μ_2, μ_3, and are parameters to be estimated; and is a white noise residual. The lag length (k, l, m, n, p, q) included in the estimation corresponds to the shortest lag length that will generate

[6] To be sure, a finding of asymmetry in some periods and symmetry in others is not uncommon. For example, Kirchgässner and Kübler [1992], investigating possible price asymmetries in retail gasoline prices in Germany during the period 1972-1989, reported that for the sample period covering the 1980s, the adjustment in retail prices was symmetric and full to changes in spot crude oil prices, whereas there was asymmetry in the 1970s.

[7] For example, Deltas [2004] tested if the model that he used that showed asymmetry generates good predictions not only for "in sample" but also "out-of-sample" data.

[8] The pump price (PP) net of 12 percent VAT and excise tax is estimated as follows:

$$NPP = P/1.12 - excise\_tax(0.9).$$

white-noise residuals, as indicated by the Ljung-Box Q statistic at 5 percent level of significance. The three terms, $\mu_1\Delta MOPS_{t\text{-}1} + \mu_2 NPP_{t\text{-}1} + \mu_3 ER_{t\text{-}1}$, on the right-hand side of equation (1), comprise the error correction term, so called because it provides a mean reversion effect by pushing *NPP* toward the level implied by its long-run relationship with *MOPS* and *ER*.[9] Price asymmetry is indicated if the null hypothesis that the λ_i's, the φ_i's and the σ_i's are jointly equal to zero is rejected.[10]

A variant of equation (1) specifies the same variables in levels instead of changes:

$$NPP_t = \alpha + \sum_{i=0}^{k}\beta_i MOPS_{t\text{-}i} + \sum_{i=1}^{l}\delta_i NPP_{t\text{-}i} + \sum_{i=0}^{m}\gamma_i ER_{t\text{-}i} + \sum_{i=0}^{n}\lambda_i C_{t\text{-}i} MOPS_{t\text{-}i} + \sum_{i=1}^{p}\varphi_i D_{t\text{-}i} NPP_{t\text{-}i} + \sum_{i=0}^{q}\sigma_i F_{t\text{-}i} ER_{t\text{-}i} + v\ tariff + \mu_t \qquad (2)$$

It is not unusual for different model specifications to produce conflicting findings especially if there is no economic principle driving their differences. When this is the case, no one specification can be considered superior a priori. Hence, when one specification generates evidence of pervasive and significant

---

[9] The error correction term is computed based on the following long-run equilibrium relationship between pump price, mops, and exchange rate:

$$NPP_t = \kappa_0 + \kappa_0 MOPS_t + \kappa_2 + v_t$$

where v_t is white noise. The error correction term is then defined as:

$$EC = NPP_{t-1} - \kappa_0 - \kappa_1 MOPS_{t-1} - \kappa_2 ER_{t-1}$$

The retail price adjustment with error correction term becomes:

$$\Delta NPP_t = \alpha + \sum_{i=0}^{k}\beta_i \Delta MOPS_{t\text{-}i} + \sum_{i=1}^{l}\delta_i \Delta NPP_{t\text{-}i} + \sum_{i=0}^{m}\gamma_i \Delta ER_{t\text{-}i} + \sum_{i=0}^{n}\lambda_i C_{t\text{-}i}\Delta MOPS_{t\text{-}i} + \sum_{i=1}^{p}\varphi_i D_{t\text{-}i}\Delta NPP_{t\text{-}i} + \sum_{i=1}^{q}\sigma_i F_{t\text{-}i}\Delta ER_{t\text{-}i} + \theta(NPP_{t\text{-}1} + \kappa_1 MOPS_{t\text{-}1} + \kappa_2 ER_{t\text{-}1} + v\ tariff + \mu_t$$

If the long-run restrictions implied by the error correction process on the coefficients of the levels variable (namely κ_1 and κ_2) are ignored, then the above equation is estimated without restrictions on the coefficients of the level variables.

[10] Another variant of equation (1), following Balke et al. allows for asymmetry in the levels of the error correction variables:

$$\Delta NPP_t = \alpha + \sum_{i=0}^{k}\beta_i \Delta MOPS_{t\text{-}i} + \sum_{i=1}^{l}\delta_i \Delta NPP_{t\text{-}i} + \sum_{i=0}^{m}\gamma_i \Delta ER_{t\text{-}i} + \sum_{i=0}^{n}\lambda_i C_{t\text{-}i}\Delta MOPS_{t\text{-}i} + \sum_{i=1}^{p}\varphi_i D_{t\text{-}i}\Delta NPP_{t\text{-}i} + \sum_{i=1}^{q}\sigma_i F_{t\text{-}i}\Delta EXR_{t\text{-}i} + \mu_1 C_{t\text{-}1} MOPS_{t\text{-}1} + \mu_2 D_{t\text{-}1} NPP_{t\text{-}1} + \mu_3 F_{t\text{-}1} ER_{t\text{-}1} + v\ tariff + \mu_t$$

Asymmetry is found if the coefficients λ_i, φ_1, σ_1, μ_1, μ_2 and μ_3 are jointly significantly different from zero.

asymmetry while another shows none, the evidence presented by the model with a better forecasting ability is preferred in the absence of any other criterion to break the impasse. Most tests, however, show that the ECM fits the data better than a level specification. This suggests that the asymmetry applies to the rate of change, not to the level of prices.[11] Moreover, a levels specification often suffers from severe multicollinearity problem due to high correlation between variables.

3.2. Estimation and results

To implement equations (1) and (2), data on MOPS and pump prices at selected fuelling stations were obtained from the DOE. Owing to the terms of DOE's subscription with Platts, the agency could only provide weekly average MOPS (in liter and peso value) between January 2009 and July 2013.

Before discussing the results, it is useful to note that the NPP_t tracks the movement of MOPS_t very closely, but not of ER_t, as shown in the figures below.

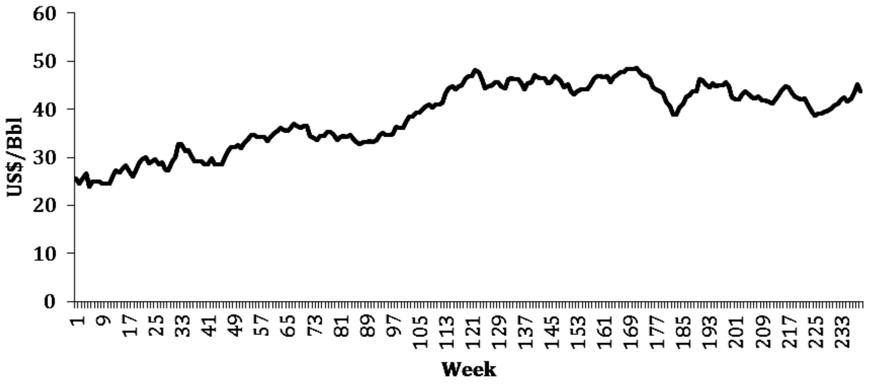

FIGURE 1. Regular gasoline pump prices, net of excise tax and VAT, 1/2009 – 7/2013

[11] For instance, Balke et al. [1998] found small and few cases of asymmetry using the levels specification, but pervasive and large asymmetry using ECM.

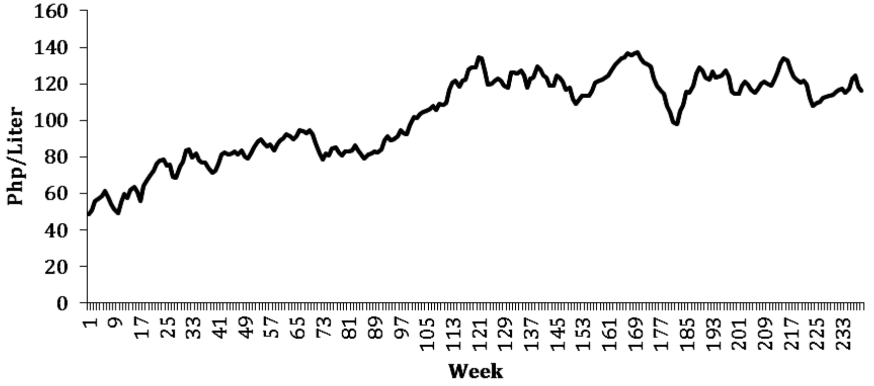

FIGURE 2. MOPS of gasoline prices, 1/2009 – 7/2013

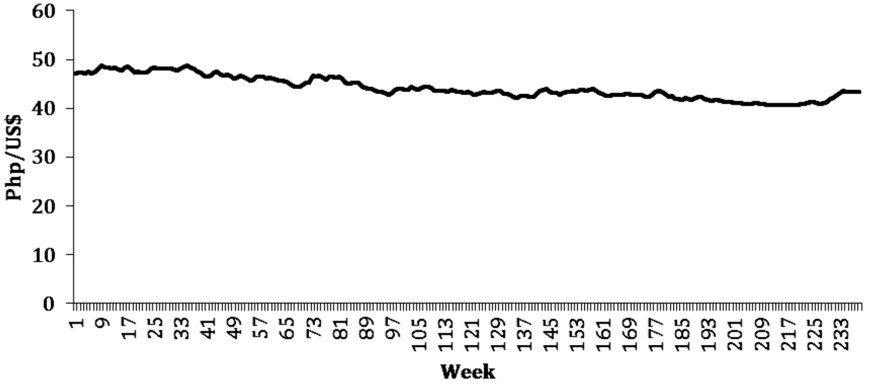

FIGURE 3. Exchange rate, 1/2009 – 7/2013

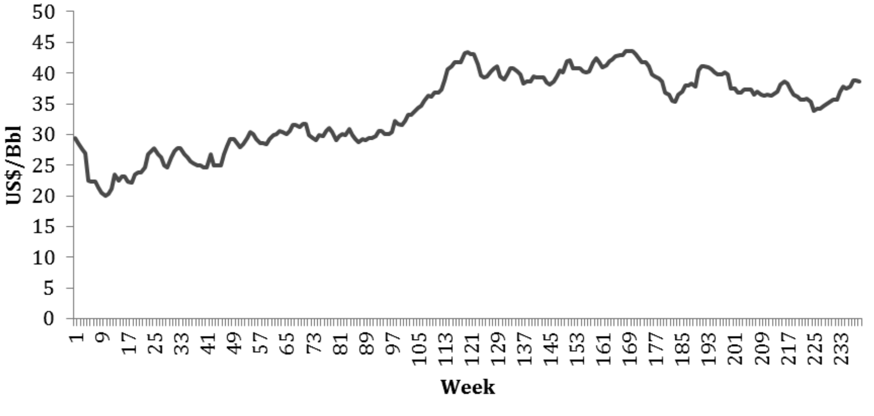

FIGURE 4. Diesel pump prices, net of excise tax and VAT, 1/2009 – 7/2013

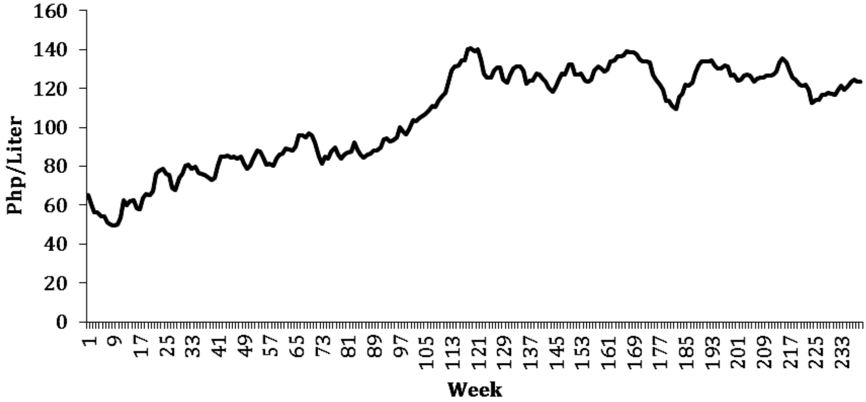

FIGURE 5. MOPS of diesel prices, 1/2009 – 7/2013

3.2.1. Gasoline

As mentioned earlier, equation (2) may have a serious multicollinearity problem. That possibility is suggested by the high correlation coefficients between the regressors which ranged from 0.832 and 0.992. Indeed, the regressors in equation (2) showed extremely high variance inflation factors (VIF). For example, in one regression run, the VIFs ranged from 1.2 to 331.6 with a mean of 97.5. In contrast, the multicollinearity is not a problem in equation (1).

Before estimating equation (1), a test for cointegration is necessary as the ECM requires the series *NPPg* (net pump price for gasoline), *MOPSg* (MOPS for gasoline) and *ER* to be cointegrated. The augmented Dickey-Fuller tests showed that the series *NPPg*, *MOPSg* and *ER* are each integrated of order one. To show that they are cointegrated, we show that the error term, u_t, in the equation

$$NPPg_t = \alpha + \beta MOPSg_t + \gamma ER_t + u_t$$

is stationary. This means that the residual series $\hat{u}$ has no unit root. The augmented Dickey-Fuller test applied on the residuals rejected the null hypothesis that has $\hat{u}$ a unit root; hence $\hat{u}$ is stationary, i.e., *NPPg*, *MOPSg* and *ER* are cointegrated.

Table 1 shows the regression results for equation (1) for gasoline.

TABLE 1. Regression results for changes in prices of gasoline

Variable	Coefficient	Standard Error
$\Delta MOPSg_t$	0.0060	0.0191
$\Delta MOPSg_{t-1}$	0.2342*	0.0213
$\Delta MOPSg_{t-2}$	-0.0198	0.0201
$\Delta MOPSg_{t-3}$	-0.0278	0.0203
$\Delta MOPSg_{t-4}$	0.0135	0.0195
$C_t \Delta MOPSg_t$	-0.0065	0.0313
$C_{t-1} \Delta MOPSg_{t-1}$	-0.0434	0.0315
$C_{t-2} \Delta MOPSg_{t-2}$	0.0432	0.0317
$C_{t-3} \Delta MOPSg_{t-3}$	0.0443	0.0318
$C_{t-4} \Delta MOPSg_{t-4}$	-0.0394	0.0318
ΔER_t	0.2028	0.1963
ΔER_{t-1}	-0.0446	0.1980
ΔER_{t-2}	-0.0779	0.1973
ΔER_{t-3}	0.0563	0.1966
$F_t \Delta ER_t$	-0.1826	0.3123
$F_{t-1} \Delta ER_{t-1}$	0.4578	0.3168
$F_{t-2} \Delta ER_{t-2}$	-0.1014	0.3185
$F_{t-3} \Delta ER_{t-3}$	0.1700	0.3217
$NPPg_{t-1}$	-0.0667*	0.0258
$MOPSg_{t-1}$	0.0217*	0.0087
ER_{t-1}	0.0482	0.0346
Tariff	-0.1044	0.1321
_cons	-1.8120	1.6629

*5 percent significant.

The above results show that $\Delta NPPg_t$ is significantly affected by $\Delta MOPSg_{t-1}$ and error correction terms, $NPPg_{t-1}$ and $MOPSg_{t-1}$. Since none of the dummy interacted variables is significant, the hypothesis of price asymmetry in gasoline prices is rejected.

3.2.2. Diesel

Turning to diesel prices, we also observe the high correlation coefficients among the current and lagged *NPPd* (net pump price for diesel), current and lagged *MOPSd* (MOPS for diesel), and current and lagged *ER* ranging from 0.881 to 0.994. These pose similar multicollinearity problems as those found in gasoline pries. Thus, only the equation in changes (equation (1)) was estimated for diesel prices.

The augmented Dickey-Fuller tests showed that the series of *NPPd, MOPSd* and *ER* are each integrated of order one. As in gasoline prices, the Dickey-Fuller test for cointegration examines the residuals of the equation

$$NPPD_t = \alpha + \beta MOPSd_t + \gamma ER_t + u_t$$

for unit roots. The Dickey-Fuller test showed that the residual series does not have a unit root; hence it is stationary, i.e., *NPPd*, *MOPSd* and *ER* are cointegrated. Table 2 shows the regression results for equation (1) for diesel.

TABLE 2. Regression results for changes in prices of diesel

Variables	Coefficient	Standard Error
$\Delta MOPSd_t$	0.0131	0.0193
$\Delta MOPSd_{t-1}$	0.2217*	0.0217
$\Delta MOPSd_{t-2}$	0.0063	0.0252
$\Delta MOPSd_{t-3}$	0.0030	0.0250
$\Delta MOPSd_{t-4}$	-0.0021	0.0241
$C_t\Delta MOPSd_t$	0.0064	0.0296
$C_{t-1}\Delta MOPSd_{t-1}$	-0.0050	0.0299
$C_{t-2}\Delta MOPSd_{t-2}$	-0.0427	0.0408
$C_{t-3}\Delta MOPSd_{t-3}$	-0.0603	0.0408
$C_{t-4}\Delta MOPSd_{t-4}$	0.0425	0.0411
$\Delta NPPd_{t-1}$	-0.0373	0.0763
$\Delta NPPd_{t-2}$	-0.0102	0.0757
$\Delta NPPd_{t-3}$	-0.0134	0.0745
$D_{t-1}\Delta NPPd_{t-1}$	0.1252	0.1367
$D_{t-2}\Delta NPPd_{t-2}$	0.2185	0.1359
$D_{t-3}\Delta NPPd_{t-3}$	-0.1807	0.1368
ΔER_t	0.1637	0.1745
ΔER_{t-1}	0.0465	0.1755
ΔER_{t-2}	-0.3137	0.1752
ΔER_{t-3}	0.2357	0.1770
ΔER_t	0.0039	0.2776
ΔER_{t-1}	0.3433	0.2816
ΔER_{t-2}	0.2557	0.2842
ΔER_{t-3}	-0.1666	0.2890
$NPPd_{t-1}$	-0.0942*	0.0294
$MOPSd_{t-1}$	0.0297*	0.0090
ER_{t-1}	0.0763*	0.0364
Tariff	-0.0559	0.1182
_cons	-3.3361*	1.6799

*5 percent significant.

As in the gasoline price regression, the only variable significantly affecting changes in diesel prices is the lagged change in MOPS for diesel ($\Delta MOPSd_{t-1}$)

and the error correction terms, ($NPPd_{t-1}$, $MOPSd_{t-1}$and ER_{t-1}). Since none of the dummy interacted variables is statistically significant, price asymmetry in diesel prices is also ruled out.

4. Explaining price asymmetry

While none of the preceding regression results presents evidence of price asymmetry, it is still useful to explain why the perception of asymmetry seems pervasive.

To be sure, asymmetrical price adjustment is not uniquely suspected in the downstream oil markets. Indeed there is a body of literature suggesting that the phenomenon applies to other industries as well. For instance, Hannan and Berger [1991] and Neumark and Sharpe [1992] documented a similar phenomenon in the banking industry, which was subsequently linked by Hannan [1994] and Rosen [2002] to market concentration. Kahn, Pennacchi, and Sopranzetti [2004] investigate the effects of changes in treasury rates to consumer loan rates and confirmed the presence of asymmetric response. Peltzman [2000] provided evidence that asymmetric cost pass-through to consumers applies across a broad range of U.S. manufacturing industries.

In the downstream oil market, the phenomenon has been ascribed to several factors, such as oligopolistic price coordination [Borenstein, Cameron, and Gilbert 1997], exercise of market power by dominant players [Borenstein and Shepard 2002]; [Deltas 2004]; [Polemis 2012], consumer search costs [Borenstein, Cameron, and Gilbert 1997], nature of price shock [Radchenko 2004], inventory management [Radchencko 2010], price cycles [Noel 2009], accounting practices and refinery adjustment costs [Borenstein, Cameron, and Gilbert 1997]. From the standpoint of regulators and policymakers, the main concern is whether the asymmetry signals tacit collusion or exercise of market power by dominant players.

The trigger price coordination model of Green and Porter [1984] explains the link between asymmetric cost pass-through and oligopolistic price coordination. Consider an industry where a few dominant firms are engaged in tacit collusion to maintain high profit margins, but the information concerning upstream prices (e.g., import contract price for crude oil) are imperfect. When upstream (i.e., world crude oil) prices increase, each firm quickly raises its selling price to signal to other firms that it is adhering to the tacit agreement of maintaining profit margins. By contrast, when upstream prices decrease, each firm is reluctant to lower its selling price because of the risk that such action may be interpreted by other firms as an act of price undercutting, and therefore a violation of the tacit agreement. When one firm is perceived by others to have reneged on the agreement, it will trigger retaliation from the other firms and hence lead to the breakdown of the collusive arrangement. As profits are lower under a competitive rather than a collusive regime, each firm behaves cautiously in adjusting its prices downwards in response to lower upstream prices, hence the asymmetry in cost pass-through.

Asymmetric cost pass-through is also possible when one firm has sufficient local market power to ignore the threat of price undercutting from competitors. A firm with local market power (owing, for example, to high search cost of consumers for alternative suppliers) can delay the pass-through to consumers of cost decreases. Similarly, a firm with sufficient local market power can raise its price immediately when its upstream cost increases.

The more benign explanations for asymmetry are just as plausible as the attribution to tacit collusion or market power. For instance, the accounting practice of First In First Out explains how, when the upstream price increases, a firm is likely to reduce its order, which causes its inventory to shrink. Because of smaller inventory and the First In First Out accounting practice, the firm sells the products incorporating the higher upstream price sooner. In the opposite case, when the upstream price decreases, a firm is likely to increase its order, which causes the inventory to pile up. With a larger inventory, a firm will sell the product incorporating the lower upstream price later.

Refiners' adjustment costs complement the accounting practice explanation for asymmetry. Higher upstream price prompts refiners to reduce their outputs, which entails adjustment costs of recalibrating production levels. The adjustment cost of increasing production (when the upstream price decreases) is however higher than the corresponding cost of reducing production (when the upstream price increases). Consequently, refiners will expand their production output levels more gradually than when they contract their production. The asymmetry in the refiners' adjustment costs of changing production levels translates to the observed asymmetry in price adjustment.

The interest of this study lies mainly in the plausibility of a market power explanation. If the asymmetry were proven, it would have been necessary to test if the speed of retail price adjustment, hence degree of asymmetry, depends on the average retail-wholesale margin. Large average margins tend to have more asymmetric and slower adjustment than those with small margins. Since the degree of market power is associated with the size of gross margins, a less competitive market would have larger gross margin and more asymmetric price adjustment.[12] Only a robust link between price asymmetry and profit margin would have established price collusion.

[12] Establishing the link between price asymmetry and market power requires addition of retail-wholesale price margin series in equation (1) or (2), following Deltas [2004].

5. Conclusions

This study assesses the state of market competition in the downstream oil market by way of examining the validity of public perception that domestic oil prices are sticky downwards with respect to changes in world oil prices. If domestic suppliers, principally the oil majors, were able to engage in collusion, this would have manifested in domestic prices adjusting more slowly and less proportionately to declines in world prices. Conversely, domestic prices would have adjusted more quickly and disproportionately larger than increases in world prices.

That the econometric analysis did not bear out this perception suggests that domestic oil suppliers are not coordinating their price adjustments to benefit from price increases in the global markets. Instead, the data suggests that over time, oil suppliers systematically adjust their prices to a one-period lag in changes in world prices. This is true of both suppliers of gasoline and diesel.

If the perception of price asymmetry is not supported by data, why then has suspicion of noncompetitive behavior persisted? A possible explanation is that contrary and convincing evidence has yet to be presented to the public. This study has produced evidence of the absence of price asymmetry. However, it must be emphasized that this does not prove market competition or the absence of market collusion. Put bluntly, this study has only succeeded in proving the absence of price asymmetry. Whether market collusion exists, in other forms, is not refuted. A market competition study is necessary to examine domestic price movements more exhaustively and to assuage public suspicion of conspiracy among oil suppliers.

University of the Philippines School of Economics

References

Al-Gudhea, S., T. Kenc, and S. Dibooglu [2006] "Do retail gasoline prices rise more readily than they fall? A threshold cointegration approach," July, available at http://www.umsl.edu/~dibooglus/personal/gasoline2.pdf.

Anderson, P. L., T. R. Bolema, and I. K. Geckil [2007] "Damages in antitrust cases", *AEG Working Paper* 2007-2, Anderson Economic Group, LLC (East Lansing Chicago).

Australian Competition and Consumer Commission [2007] "Petrol prices and Australian consumers: report of the ACCC inquiry into the price of unleaded petrol", December.

Australian Competition and Consumer Commission [2012] "Monitoring of the Australian petroleum industry: report of the ACCC into the prices, costs and profits of unleaded petrol in Australia".

Baker, J. B. and D. L. Rubinfeld [1999] "Empirical methods in antitrust litigation: review and critique", *American Law and Economics Association*, 386-435.

Balke, N. S., S. P. A. Brown, and M. K. Yucel [1998] "Crude oil and gasoline prices: an asymmetric relationship?", *Economic Review*, Federal Reserve Bank of Dallas, First Quarter, pp. 2-11.

Bolotova, Y., J. M. Connor, and D. J. Miller [2005] "The impact of collusion on price behavior: empirical results from two recent cases", paper presented at the Third Annual International Industrial Organization Conference (Atlanta, Georgia).

Borenstein, S. and J. Bushnell [2005] "Retail policies and competition in the gasoline industry", *Working Paper CSEM WP 144*, Center for the Study of Energy Markets, University of California Energy Institute.

Borenstein, S., A. Colin Cameron, and R. Gilbert [1997] "Do gasoline prices respond asymmetrically to crude oil price changes?", *The Quarterly Journal of Economics* **112**: 305-339.

Borenstein, S., and A. Shepard [2002] "Sticky prices, inventories, and market power in wholesale gasoline markets", *Rand Journal of Economics,* **33**: 116-139.

Cerdá, J., [no date] "Oil pipeline logistics", paper presented at the Pan American Study Institute on Emerging Trends in Process Systems Engineering, 11-21 August, Mar del Plata, Argentina.

Chen, L., M. Finney and K. S. Lai [2005] "A threshold cointegration analysis of asymmetric price transmission from crude oil to gasoline prices", *Economic Letters* **89**: 233-239.

Deltas, G. [2004] "Retail gasoline price dynamics and local market power", *Working Paper*, University of Illinois, Urbana-Champaign, August.

Department of Energy [2012] "The report of the Independent Oil Price Review Committee, pursuant to Department Order No. DO2012-03-004, 1 March.

European Commission [2000] Commission decision of 9 February 2000 declaring a concentration to be compatible with the common market. http://ec.europa.eu/competition/mergers/cases/decisions/m1628_20000209_600_en.pdf .Accessed 15 October 2013.

EU Competition Commission [2000] Commission authorizes TotalFina to take control of Elf Aquitaine subject to substantial changes to the plan originally notified. http://europa.eu/rapid/press-release_IP-00-135_en.htm. Accessed 15 October 2013.

Gholampour, E., M. Mehrara, and G. Emamverdi [2012] "The analysis of asymmetric prices of crude oil and prices of imported gasoline to Iran using TAR model", *Journal of Basic Applied and Scientific Research* **2**(11): 10853-10858.

Green, E. and R. Porter [1984] "Non-cooperative collusion under imperfect price information", *Econometrica* **52**: 387-400.

Hannan, T. [1994] "Asymmetric price rigidity and the responsiveness of customers to price changes: the case of deposit interest rates", *Journal of Financial Services Research* **8**: 257-267.

Hannan, T. and A. Berger [1991] "The rigidity of prices: evidence from the banking industry", *American Economic Review* **81**: 938-945.

Hastings, J. S. [2004] "Vertical relationships and competition in retail gasoline markets: empirical evidence from contract changes in Southern California", *American Economic Review* **94**:1 (March), 317-329.

Kilian, L. [2010] "Explaining fluctuations in gasoline prices: a joint model of the global crude oil market and the U.S. retail gasoline market", *The Energy Journal* **31**(2): 103-128.

Kirchgässner G. and K. Kübler [1992] "Symmetric or asymmetric price adjustment in the oil market", *Energy Economics* **14**: 171–185.

Neumark, D. and S. A. Sharpe [1992] "Market structure and the nature of price rigidity: evidence from the market for consumer deposits", *Quarterly Journal of Economics* **107**: 657-680.

Noel, M. [2009] "Do retail gasoline prices respond asymmetrically to cost shocks? The influence of Edgeworth Cycles", Working Paper, University of California, San Diego, March.

Office of Fair Trading [1998] "Competition in the Supply of Petron in the UK". https://www.gov.uk/government/organisations/office-of-fair-trading, Accessed 26 June 2013.

Organisation for Economic Co-operation and Development (OECD) [2009] *Competition policy for vertical relations in gasoline retailing*, report by the Competition Committee, Directorate for Financial and Enterprise Affairs.

Peltzman, S. [2000] "Prices rise faster than they fall", *Journal of Political Economy* **108**: 466-502.

Polemis, M. L. [2012] "Competition and price asymmetries in the Greek oil sector: an empirical analysis on gasoline market", *Empirical Economics* **43**: 789-817.

Radchenko, S. [2005] "Lags in the response of gasoline prices to changes in crude oil prices: the role of short-term and long-term shocks", *Energy Economics* **27**(4): 573-604.

Radchenko, S. and D. Shapiro [2010] "Anticipated and unanticipated effects of crude oil prices and gasoline inventory changes on gasoline prices", Working Paper, University of North Carolina at Charlotte, October.

Roseman, F. [2005] "The effects of recent volatility in international petroleum markets on Canadian wholesale and retail gasoline prices", a report prepared for the Competition Bureau.

Rosen, R. J. [2002] "What goes up must come down? asymmetries and persistence in bank deposit interest rates", *Journal of Financial Services Research* **25**(2): 37-329.

Wlazlowski, S. [2001] "Petrol and crude oil prices: asymmetric price transmission", MPRA Paper No. 1486, available at http://mpra.ub.uni-muenchen.de/1486/.

ANNEX. IOPRC Model to Detect Price Asymmetry[13]

Working on a larger data set, the third IOPRC estimated a model that determines whether changes in domestic pump prices (*PP*) are aligned with changes in world oil prices, represented by *MOPS*, and whether domestic pricing behavior has changed through different regulatory regimes. Five regulatory periods were identified and regressions were run for each period, namely: (i) regulated years, 1994-1996; (ii) early deregulation, 1999-2004; (iii) period covered by the second IOPRC, 2005-2007; (iv) recent years before the current administration, January 2008 to June 2010; and (v) period under the current administration, July 2010 to May 2012.

For each regulatory period, five separate regressions were implemented where *PP* is regressed on: (i) contemporaneous values of *MOPS* and taxes; (ii) one-period lagged values of *MOPS* and taxes; (iii) two-period lagged values of *MOPS* and taxes; (iv) three-period lagged values of *MOPS* and taxes; and (v) four-period lagged values of *MOPS* and taxes. Specifically, the following were estimated:

$$PP_{t-1} = \alpha_0 + \alpha_1 MOPS_{t-i} + \alpha_2 TAX_{t-i} + \varepsilon_t,\ i = 0\ 1\ ...,\ 4$$

$$\Delta PP_{t-1} = \alpha_0 + \alpha_1 \Delta MOPS_{t-i} + \alpha_2 \Delta TAX_{t-i} + \varepsilon_t,\ i = 0\ 1\ ...,\ 3$$

where $\Delta X_t = X_t - X_{t-1.}$

The regression with the highest R^2 was selected to represent the relationship between *PP* and *MOPS* for the regulatory period. The order of the lag in the selected equation was perceived to be the length of time it takes *PP* to adjust to a change in *MOPS*. It was found that for the most recent regulatory period, the regression involving one-period lagged variables produced the highest R^2. This was considered evidence of *PP* adjusting to a change in *MOPS* after a week. For earlier regulatory periods, however, regressions involving higher lags have higher R^2, suggesting that the adjustment of *PP* was longer during those periods. Based on these results, the IOPRC concluded that domestic prices adjust to changes in world crude oil prices more quickly in recent periods than earlier.

[13] See Technical Paper A, "Testing the Relationship Between Local and World Oil Prices" of the Department of Energy (2012).

To determine if the *PP* response to *MOPS* is asymmetrical, i.e., if domestic prices respond more quickly when world oil prices rise compared to when they fall, the following equation was estimated:

$$\Delta PP_t = \alpha_0 + \alpha_1 \Delta MOPS_{t-i} + \alpha_2 \Delta TAX_{t-i} + \alpha_3 \Delta DUM_{t-i} + \varepsilon_t$$

where *i* depends on the order of lagged *MOPS* in the selected regression representing the regulatory period; and $DUM_{t-i} = 1$ if $\Delta MOPS_{t-i} > 0$, otherwise $DUM_{t-i} = 0$. That α_3 is statistically different from zero is considered an indication of asymmetry. Concretely, when α_3 is positive, the pass-through to consumers of price increases are disproportionately more than of price declines.

The estimated regressions showed positive and significant α_3 for the most recent regulatory period, but not for earlier periods. These results are held to support the committee's observation that price asymmetry is limited only to the most recent period.