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Analyzing Market Power in the Indonesian Cement Industry

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Abstract

This paper aims to analyze market power in the Indonesian cement industry during the period of 1993-2011. The model used to estimate the degree of market power is Bresnahan-Lau's model proposed by Bresnahan (1982) and supported by Lau (1982). This model allows the estimation of market power using the demand and supply function although the marginal cost data in an industry is unavailable. This model would be later reformulated into a dynamic model of error correction model (ECM) framework. The ECM framework adopted here is more based on the theoretical framework because this model could address both statistical problems generated by non-stationary in a time series data and incorporates the important dynamic factors such as habit formation from the demand side and adjustment cost for the producers. In addition, the result of the ECM framework also enables us to analyze the degree of competition in the short and long run equilibrium conditions. Separability test of the variables involving the identification of the degree market power as well as preliminary test such as integration test, co-integration test, and weakly exogenous test is also performed in this paper. The result suggests that the Indonesian cement has some market power of oligopolistic competition both in the short run and in the long run.

Keywords: error correction model; non-stationary; integration test; co-integration test; weakly exogenous; separability test; the Indonesian cement industry
JEL Classifications: D22, L16

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1. Introduction

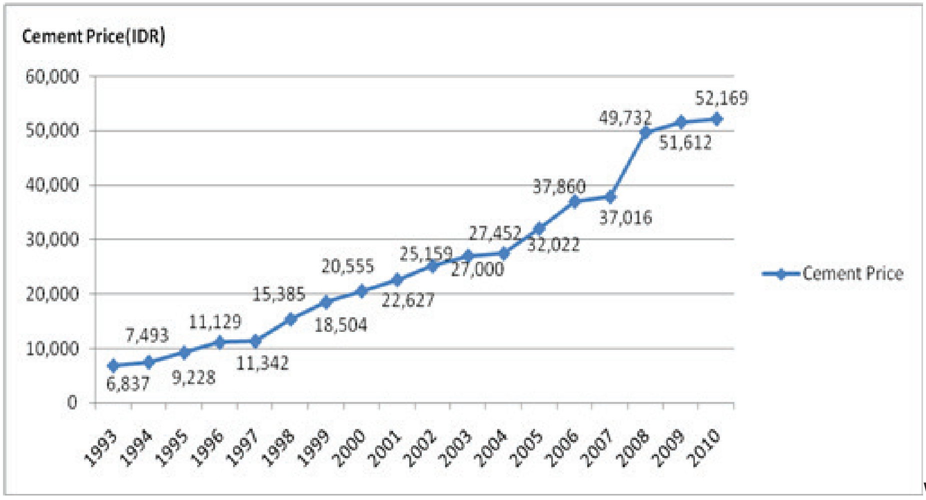
The issues of market power have long been a concern in industrial economics. This is due to the ability of the firm to manipulate price by influencing demand and supply which could create price distortions in a market. At the certain level, the price distortion created by market power enables a firm to alter prices away from competitive price level and close to monopoly level. The high degree of market power in the market will lead the firm to monopolize the industry. In this point, Ivaldi, Jullien, Rey, Seabright, and Tirole (2003, p.4) suggest that competition level may be threatened in a situation in which firms could exert some market power even when none of the firms would be considered individually dominant. Conversely, the low degree of market power exercised by a firm will encourage the industry toward the high level of competition.

In Indonesia, the movement of the cement price has actually become the attention of public both in the pre-deregulation period (before 1998) and in the post-deregulation period (after 1997). In the pre-deregulation period, Plunkett, Morgan, Pomeroy (1997, p.76) described that the Indonesian cement industry has been characterized by seasonal shortage of cement and high prices and it reached the peak of a concern about the shortage in 1994. This condition prompted call for deregulation in the Indonesian cement industry to stabilize the cement price in the market[1]. However, deregulation undertaken by the Indonesian government on the cement industry in the end of 1997 has also boosted on a rise of the cement price paid by consumer in which the increase of the cement price was faster than previous years.

Figure 1 shows the increase of the Indonesian cement price over year since 1993-2010. Until 2010, markup in the Indonesian cement industry has risen almost fivefold since 1997 and almost eight fold since 1993. Due to the increase of the cement price in the post-deregulation period, Nusa Prima Persada International (2010, p.3), a consultant of a limited company suggested that the Indonesian cement industry has seen several large price increases blamed on cost escalation of oil, steel etc. But when these costs declined, there was no subsequent reduction in the Indonesian cement prices. These conditions raise conjecture regarding the existence of market power exerted by firms in the Indonesian cement industry. Hence, the central issues discussed in this paper are to analyze the degree of competition among suppliers in the Indonesian cement industry by estimating market power.

[1] Dowling (2006) suggested that deregulation in connection with financial crisis in year end of 1997. In this deregulation, the Indonesian government omitted monopoly in the Indonesian cement industry.

Figure 1
The Average of Cement Prices Paid by the Indonesian Consumer
During the Period 1993-2010 (IDR/sack)



Source: Biro Pusat Statistik (BPS), calculated by CEIC and Pusdatin, Ministry of trade, Indonesia

2. Literature Review

Conceptually, market power shows the relationship between price and marginal cost. Landes & Posner (1981, p.937), Martin (1994, p.14), Church & Ware (2000, p.10), Hausman & Sidak (2007, p.387), Kutlu & Sickles (2012, p.142) define market power as the ability of firms to charge the price of their product above competition market for a significant period of time. Furthermore, the understanding of market power will be more apparent with comprehending the concept of market structure such as competitive market, oligopoly, and monopoly. Bain (1972) suggested that the price behavior, such as those which is revealed by "Chamberlianian theory"[2], will be different among pure competition, monopolistic competition, oligopoly, and monopoly market. In this case[3], the product price in monopoly market will be higher than the price in competitive market and the oligopoly market and the product price in oligopoly market is also higher than the product price in competitive market. Under this circumstance, market power exerted by firms in an industry does not exist if the product price is equal to marginal cost in the industry.

Recently, there are two amending paradigms to measure the degree of market power namely Structure-Conduct-Performance (SCP) and Neo Empirical Industrial Organization (NEIO) paradigms. The difference of these paradigms in measuring market power is only based on the availability of the marginal cost data. The SCP paradigm proposes Lerner Index

[2] Chamberlianian theory was proposed by Edward Chamberlin (1933). This theory classified market on the basis of number of sellers (many, few, and one) and on basis of degree differentiation of the product.

[3] Let the demand market: $P = A - Q$ where $A > c$ (marginal cost) and total cost (TC), without fixed cost, is denoted by $TC = Q$. Assuming oligopoly market in form of Cournot-Duopoly for homogeneous product then the equilibrium solution using maximization principle will yield price equilibrium, that is, $PPC<PC<PM$ where P is prices and PC, C, M denote perfect competition, Cournot oligopoly, and monopoly market, respectively.

as a model to estimate the degree of market power exerted by firms in an industry. In this index, the estimation of the degree of market power extremely depends on the availability of the marginal cost data. If marginal cost data are available then Lerner index can be directly calculated. However, Landes and Posner (1981, p.941), Corst (1999, p.227) suggested that Lerner index as a measurement of the degree of market power can be difficult in practical because of well-known problems in the measurement of marginal cost at which marginal cost is more hypothetical construct and rarely so easily measured. As a result, Lerner index that is estimated from the hypothetical construction in marginal cost will result upper estimate rather than a precise estimate. This problem has triggered the industrial organization economists to estimate market power exerted by firms without the availability of the marginal cost data.

The emphasis of empirical studies without giving priority on the observation of the marginal cost data directly to estimate market power has adequately evolved in the recent decades. Later, this paradigm is called "New Empirical Industrial Organization or the NEIO paradigm". According to Deodhar and Sheldon (1997, p.78), typically studies in the NEIO paradigm estimate structural econometric models on firm level optimization using time series data from a single industry. Meanwhile, Church and Ware (2000, pp.451-452) noted that the NEIO paradigm has been quite success in establishing the existence of market power in individual markets. This paradigm assesses market power in an industry ignoring the calculation of marginal cost directly. In this case, the analysis of marginal cost was based on theoretical models of oligopoly constructed by the supply relation for the industry.

Historically, the NEIO paradigm can be traced to the work of Bresnahan in 1982 supported by Laurence Lau with an impossibility theorem in the same year. Later, their model was more popular with Bresnahan-Lau's Model. This model identifies the oligopoly solution based on the framework of demand and cost curve representing supply relation, even when the cost or profit data is unavailable. In this framework, the rotation of demand curve can be used to assess market power exerted by a firm in an Industry. Furthermore, according to Bresnahan (1989, p.1012), marginal cost that cannot be directly observed can be analyzed from the firm behavior using difference among the related markets to trace the effects of change in marginal cost or it comes to a quantification of market power without measuring cost at all. In this case, firm and industry behavior is viewed as unknown parameters to be estimated.

3. Empirical Model

Model used to estimate the degree of market power in this paper is the Bresnahan-Lau's model. The Analysis of market power in the Bresnahan-Lau's model is started by defining the demand function and the total cost function in an industry. Bresnahan (1982, p. 88) and Lau (1982, p.93) assume the demand function as the following equation.

$$Q = D\,(P, Y) \qquad (1)$$

Where Q is the quantity demanded in the industry, P is price, and Y is the exogenous variable affecting or shifting the quantity demanded. On the supply function, analysis is started by drawing the total cost function. Suppose that producers have a typical the cost function as follows.

$$C = C\ (Q, W) \tag{2}$$

Where C is the total cost to produce product, Q is the quantity produced in an industry and W is exogenous variable shifting production cost. Based on the demand function and the total cost function, the economic profit in the industry is given by the following equation.

$$\pi = P(Q,Y)D(P,Y)\text{-}C(Q,W) \tag{3}$$

Where π is the profit function, P (Q, Y) x D (P, Y) is the total revenue, and C (Q, W) is the total cost in the industry. If firms in the industry are not price takers, then perceived marginal revenue (MRp), and not price, will be equal to marginal cost (MC). This equalization is obtained by taking first order condition (FOC) with respect to Q in equation (4) and is given by the following equation.

$$\frac{\partial \pi}{\partial Q} = P(Q,Y) + \lambda D(P,Y)\left[\frac{\partial P(Q,Y)}{\partial Q}\right] - \frac{\partial C(Q,W)}{\partial Q} = 0 \tag{4}$$

λ in equation (4) is new parameter describing the degree of market power exerted by firm in the industry. Formally, the equation (4) suggests that perceived marginal revenue :$MR_p = P(Q,Y) + \lambda D(P,Y)\left[\frac{\partial P(Q,Y)}{\partial Q}\right]$ is equal to marginal cost:$MC = \frac{\partial C(Q,W)}{\partial Q} = c(Q,W)$. Equation (4) could be arranged as follows.

$$P(Q,Y) = -\lambda D(P,Y)\left[\frac{\partial P(Q,Y)}{\partial Q}\right] + \frac{\partial C(Q,W)}{\partial Q} \tag{5}$$

Bresnahan (1982) suggests that equation (5) is supply relation. λ is new parameter describing the degree of market power. If λ = 0, then competitive market will be present since P = MC. If λ = 1 then it displays monopoly market since MR = MC. This principle prevails for a firm producing product in monopoly market and λ = [0, 1] corresponds to oligopoly solution. If λ = 1/n with n is the number of firm in the industry then it shows Cournot-oligopolistic competition.

In fact, the empirical problem faced in equation (5) is that how to estimate λ as parameter describing the degree of market power. Bresnahan (1982) solved this problem by introducing the interaction term between an exogenous variable in demand-side, let the variable Z, with price (P).The main assumption in this case is that Z should interact with P so that the interaction term between P and Z combines elements both rotation and vertical shift in the demand curve. In other words, the exogenous variable (Z) included as an interaction term with price (P) in the demand-side should be capable not only shifting the intercept but also changing (rotation) the slope of demand curve. Without the interaction term, the degree of market power exerted by firms in the industry could not be identified. In addition, Lau (1982, p.93) extended the identification of the conduct parameter proposed by Bresnahan (1982) and showed that the conduct parameter of λ could be identified as long as the aggregate demand is not separable in a vector Z of exogenous variables. In this regard, if at least one exogenous variable interacts with price in the demand-side and the demand function is not separable in Z, then the identification of conduct parameter of market power could be solved because of the interaction term acts as a rotation and vertical shift in demand curve.

To obtain an overview of the model developed by Bresnahan and Lau (1982), let the demand function with the interaction term in equation (1) and the marginal cost function in equation (2) be linear and it is written in an econometric equation as follows.

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 Y + \alpha_3 PZ + \alpha_4 Z + \varepsilon \quad (6)$$

$$MC = \beta_0 + \beta_1 Q + \beta_2 W + \eta \quad (7)$$

Taking the first order condition of equation (6) with respect to Q, obtained the expression for ${dP}/_{dQ}$ as follows.

$$\frac{dP}{dQ} = \frac{1}{\alpha_1 + \alpha_3 Z} \quad (8)$$

Substituting equation (8) and (7)into equation (5), obtained an equation that describes the supply relation with the some degrees of market power as shown in the following equation.

$$P = -\lambda \frac{1}{\alpha_1 + \alpha_3 Z} Q + \beta_0 + \beta_1 Q + \beta_2 W + \pi \quad (9)$$

Equation (9) could also be written as follows.

$$P = -\lambda Q^* + \beta_0 + \beta_1 Q + \beta_2 W + \pi \quad (10)$$

Where $Q^* = \frac{Q}{\alpha_1 + \alpha_3 Z}$ and λ is the estimated conduct parameter to evaluate market power exerted by firms in an industry. This conduct parameter should be negative and span from 0 and 1. Moreover, λ could be estimated by using the aggregate industry data and the econometric methodology because of it could be identified as a coefficient of Q*. Based on the knowledge of λ in the equation (10), its estimation depends on the parameter of α_1 and α_3. Both parameters are known parameter and it is estimated by using the demand function in the equation (6).

Equation (6) and (10) proposed by Bresnahan and Lau (1982) ignore the lagged values of the variables. In this case, the Bresnahan-Lau's model could be biased variance and would not be statistically correct if a time series data used in this model has non-stationary property. Steen & Salvanes (1999, p.147) suggests that dynamic framework could address statistical problem generated by non-stationary in a time series data. In addition, dynamic framework could also incorporate dynamic factors such as habit information from the demand side and adjustment cost for the producers in which the presence of habit information in demand and adjustment cost in supply make static models inadequate. Therefore, this paper will reformulate the Bresnahan-Lau's model into a dynamic framework in which the dynamic model used in this paper is error correction model (ECM).

4. Methodology Research

4.1 Data Construction

Analysis of the degree of market power in this paper will use quarterly data covering the period 1993-2011. Overall, the number of observation in this study is 76 observations. Furthermore, as a manufacturing product, the quantity demanded for cement (QC) could be expressed as a function of own price (PC), the substitute prices, gross domestic product (GDP), and regulation (DC) undertaken by government in the cement industry since the end of 1997. The first three variables could not be denied because it is postulated in the demand theory, stating that the demand for a good is influenced by own price and demand shifters such as income and the substitute price. In this case, Bresnahan (1982) suggested that the variables such as own price and other market shifters will be able to reveal the degree of market power in an industry through both rotation and vertical shift in demand. This is done by formulating the interaction term between price and exogenous variables such as income and the substitute price. Furthermore, associated with the substitute price, the closest substitute for cement is wood for construction materials (PW).Although both products could not be compared in terms of strength and durability, there has been no material yet other than wood for construction materials as a substitute for cement. Therefore, this study uses the wood price for construction materials as the substitute price.

On the other hand, the supply function is affected by the variable costs in producing cement. Gupta & Patel (1976, p.29) suggested that the variable costs in the cement industry are the cost of raw material, energy or fuel, labor, transport, etc. Mabry (1998, p. 402) revealed that energy such as coal and fuel made up the largest part of variable costs in which the price changes in these variable costs will influence the cement supply. Therefore, the variable costs used in this study are the coal price (WCO) and the fuel diesel price (WDF). In addition, this paper also includes deregulation (DC) undertaken by the Indonesian government in the end of 1997 as the exogenous variable in the supply function.

4.2 Econometric Procedure

The estimation of the degree of market power in this paper will reformulate Bresnahan-Lau's model into a dynamic framework of error correction model (ECM) in which the degree of market power in this model is estimated from the demand and supply function. Assuming that the demand function in the Indonesian cement industry is not separable in two interaction terms is that the interaction term between the cement price (PC) and GDP (PCGDP) and the interaction term between the cement price (PC) and the wood price (PW) as the substitute product of cement (PCPW), then the demand function of the Indonesian cement industry could be written in an ECM as the following equation.

$$\begin{aligned}\Delta Q_{Ct} = {} & \alpha_0 + \sum_{i=1}^{k-1} \alpha_{1,i}\,\Delta Q_{c,t-i} + \sum_{i-0}^{k-1} \alpha_{2,i}\,\Delta PC_{t-i} + \sum_{i=0}^{k-1} \alpha_{3,i}\,\Delta GDP_{t-i} \\ & + \sum_{i=0}^{k-1} \alpha_{4,i}\,\Delta PW_{t-i} + \sum_{i=0}^{k-1} \alpha_{5,i}\,\Delta PCGDP_{t-i} + \sum_{i=0}^{k-1} \alpha_{6,i}\Delta\, PCPW_{t-i} \\ & + \gamma_D\big[Q_{C,t-k} - \theta_1 PC_{,t-k} - \theta_2 GDP_{t-k} - \theta_3 PW_{t-k} - \theta_4 PCGDP_{t-k} - \\ & \theta_5 PCPW_{t-k}\big] + \alpha_6 \Delta D_C + \varepsilon_t \end{aligned} \tag{11}$$

Where:

$$\theta_j = \frac{\sum_{i=1}^{k} \alpha_{j,i}}{\gamma}, \text{ for j =1, 2, 3.........k,} \tag{11.1}$$

All variables in equation (11) have been defined in the aforementioned discussion. The summations in equation (11) capture the short run parameters. For instance, α_2 is the parameter of the short run dynamic for the price of cement. Meanwhile, the terms in bracket are the ECM terms which provide the long run parameters or the stationary long run solution. For example, θ_1 is the long run impact of the cement price on demand for cement. Meanwhile, γ_D denotes a parameter for the speed of adjustment. This parameter measures the impact on ΔQ_{Ct} of being away from the long-run target. In addition, separability test will be performed in this function. This test is needed to determine whether the demand function is not separable from the interaction term PCGDP and PCPW. Separability test in this paper will use exclusion test as proposed by Steen & Salvaness (1999, p.159) and Vassilopoulos (2003, p.80). In this case, if the interaction term variable could be excluded from the long run relation, then demand function is separable from the interaction term. If this occurs, then the interaction term could not be used to estimate the conduct parameter of market power.

On the other hand, the ECM framework of the supply function in the Bresnahan-Lau's model involves a variable to estimate the degree of market power. This variable is calculated from the interaction term in the demand function. In this case, the interaction term will determine the variable of Q* used to estimate λ or the degree of market power. Steen & Salvanes (1999, p.152), Vassilopoulos (2003, p.74), Chintrakarn & Jindapon (2012, p. 221) suggested that the natural candidate to calculate the variable of Q* are the long run coefficient of the interaction term in the demand function. In addition, as mentioned in construction data, the supply function is also influenced by the variable costs such as the coal price (WCO) and the diesel fuel price (WDF). Hence, the supply function in the Indonesian cement industry could be written in the ECM framework as follows.

$$\Delta PC_t = \beta_0 + \sum_{i=0}^{k-1} \lambda_{,i}\, \Delta Q^*_{C,t-i} + \sum_{i-1}^{k-1} \beta_{1,i}\, \Delta PC_{t-i} + \sum_{i=0}^{k-1} \beta_{2,i}\, \Delta Q_{C,t-i} + \sum_{i=0}^{k-1} \beta_{3,i}\, \Delta WCO_{,t-i} + \sum_{i=0}^{k-1} \beta_{4,i} \Delta WDF_{,t-i} + \gamma_S [PC_{,t-k} - \mu_1 Q_{C,t-k} - \mu_2 WCO_{,t-k} - \mu_3 WDF_{,t-k} - \varphi_C Q^*_{C,t-k}] + \beta_6 \Delta D_c + \pi_t \quad (12)$$

Where:

$$Q^*_{C,t} = \frac{Q_C}{\theta_1 + \theta_4\, GDP + \theta_5 P_W} \quad (12.1)$$

$$\mu_j = \frac{\sum_{i=1}^{k} \beta_{j,i}}{\gamma_S} \text{ and } \varphi_C = \frac{\sum_{i=1}^{k} \lambda_i}{\gamma_S}, \text{ for j = 1,2,.....k} \quad (12.2)$$

Equation (12) is the ECM framework of the supply relation function. It also consists of estimation for the short run and the long run solutions. The short run parameters are shown by the parameters of the summations while the long run parameters in the ECM terms are identified by the parameters in the brackets. Moreover, the estimation of the degree of market power in the Indonesian cement industry is described by λ and φC. Under this circumstance, λ is an index of market power in the short run and φ_C is an index of market power in the long run.

Furthermore, the estimations of equation (11) and (12) do not provide variance for the long run parameters. Boef & Keele (2008, p.192) suggested that the variance of the long run parameters in the ECM framework could be calculated by the Bärsden's transformation. Banerjee et.al (1983) suggested that Bärsden's transformation involves a calculation of the long run parameter θ_j as nonlinear functions of coefficients in the original regression in which the variance of the long run parameter could be derived by using the following formulation.

$$var(\hat{\theta}_j) = \left[\frac{1}{-\hat{\gamma}}\right]^2 \left[var(\hat{\beta}_{jk}) + (\hat{\theta}_j)^2 var(\hat{\gamma}) + 2\theta_j cov(\hat{\beta}_{jk}, \hat{\gamma})\right] \quad (13)$$

5. Results of Estimation

5.1 Result of the Preliminary Test

Before the estimation of the model in econometric procedure, several preliminary tests such as integration test, co-integration test, and weakly exogenous test were conducted. These tests are performed to ensure the validity of the ECM framework as a measurement of the degree of market power in the Indonesian cement industry. Integration test was performed to examine the stationary of a time series data. This test was conducted by Augmented Dickey-Fuller (ADF). The results showed that the null hypothesis of non-stationary for all variables could not rejected in the level of series, I (0) but it was found to be stationarity in the first differences at reasonable significance levels (see appendix B/table A2 for the results of integration tests). Co-integration test were performed by Johansen's procedure as proposed by Johansen & Juselius (1990). This test is needed to ensure the existence of the long run equilibrium relationship among the economic variables. The result indicated that there was at least one co-integration vector both in the demand function and in the supply relation function and it could be represented as a stationary in the long run relationship (see appendix C for the results of Co-integration tests). Meanwhile, all variables in the demand and supply function are weakly exogenous. Using Likelihood Ratio (LR) test proposed by Johansen (1995), the result of weakly exogenous test showed that the demand and supply relation function in the ECM framework could be reduced as the single equation analysis which provides a clear distinction between the short run and the long run analysis and makes the analysis of ECM more robust (see appendix D for the results of weakly exogenous tests).

In addition, separability tests showed that the null hypotheses of the individual tests for separability in GDP and PW could be rejected at 5 % level of significance while it was not rejected in jointly separability test at any level of significance. The results suggested that demand function was not separable in GDP and PW individually but it was separable and more restrictive if these variables were incorporated as the interaction term to estimate the degree of market power. Hence, the use of the interaction term individually supported this study to explain the conduct parameter of the degree of market power in the Bresnahan-Lau's model (see appendix E for the results of the separability tests).

6. Empirical Results of Market Power in Dynamic Framework

6.1 The Demand Function

Table 1 presented the estimation results in the ECM framework of the demand function. The lag length of 2 was found sufficient in the demand function. The lag length was decided based on Akaike Information Criterion (AIC) and Schwarz Criterion (SC)[4]. Several diagnostic statistics were also performed to support the validity of the demand function. Breusch Godfrey (LM) test as well as Durbin-Watson (DW) test[5] suggested the absence of autocorrelation and serial correlation in the model. RESET test indicated the absence of specification error in regression and ARCH test showed that

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[4] The values of AIC and SC for the lag length of 2 is 29.16 and 29.78, respectively while the values of AIC and SC for the lag length of 1 are 29.62 and 30.01, respectively

[5] For D-W test, it is obtained dL = 1.177 and dU = 1.817 for k =12 and t = 76 at 1 % level of significance. It means that D-W = 2.012 is between dU< D-W < 4-dU, indicating no autocorrelation.

heteroskedasticity in the demand function could be rejected. Finally, Chow test suggested that no evidence of any structural break in the demand function.

Table 1
OLS Estimates of the Dynamic Demand Functions
for the Indonesian Cement Industry, Quarterly Data from 1993 to 2011

Variable	Parameter Estimates	t-Statistic
Dependent Variable : $\Delta QC_{,t}$		
Intercept : α_0	746558.60	0.506
$\Delta QC,_{t-1}$: α_{QC1}	0.58	5.341*
$\Delta PC_{,t}$: α_{PC}	-250.24	-1.456
$\Delta PC_{,t-1}$: α_{PC1}	-472.84	-3.059*
$\Delta GDP_{,t}$: α_{GDP}	-4166.58	-0.417
$\Delta GDP_{,t-1}$: α_{GDP1}	6786.67	0.761
$\Delta PW_{,t}$: α_{PW}	-619.90	-0.035
$\Delta PW_{,t-1}$: α_{PW1}	-60993.33	-3.933*
$\Delta PCGDP_{,t}$: α_{PCGDP}	0.51	1.462
$\Delta PCGDP_{,t-1}$: α_{PCGDP1}	1.09	4.261*
$\Delta PCPW_{,t}$: α_{PCPW}	0.05	0.195
$\Delta PCPW_{,t-1}$: α_{PCPW}	0.43	1.707***
ΔDC : α_{DC}	590131.10	3.558*
γ_D	-0.81	-6.477*
$PC_{,t-2}$: $\alpha_{PC,2}$	57.23	0.837
$GDP_{,t-2}$: $\alpha_{GDP,2}$	9690.54	1.966**
$PW_{,t-2}$: $\alpha_{PW,2}$	13028.89	1.576
$PCGDP_{,t-2}$: $\alpha_{PCGDP,2}$	-0.06	-0.281
$PCPW_{t-2}$: $\alpha_{PCpw,2}$	-0.25	-1.737***
θ_{PC}	71.02	0.865
θ_{GDP}	12025.28	2.165**
θ_{PW}	16167.94	1.569
θ_{PCGDP}	-0.07	-0.283
θ_{PCPW}	-0.31	-1.695***
Diagnostic Test		
R^2	0.71	
D-W	2.012	
LM-Test	0.01	(0.927)
ARCH-Test	0.26	(0.609)
RESET Test	2.19	(0.101)
Chow Test	0.54	(0.468)

Note: - *, **, and *** are significant at 1 %, 5, and 10 % with two-tail test
- Values in parentheses are the p-values and the number of observations is 76
- Standard error for estimating t-statistic is heteroskedasticity-robust which was performed by STATA using variance covariance errors (VCE)
- The estimation of demand function is based on equation (11), their long run equation is based on equation (11.1), and the long run t-statistic is based on equation (13).

Generally, half of independent variables in the demand function were significant at 1%, 5%, and 10% level of significance with the determination coefficient (R^2) of 0.71. Meanwhile, the adjustment coefficient (γ_D) of the ECM in the demand function was consistent with theory, namely negative and significant at 1 % level of significance. The value of 0.81 for the adjustment coefficient indicated that there was an adjustment of 81.0 % after deviation from the long run equilibrium.

Related to economic interpretations, the ECM framework in this study could analyze the variables that affect the demand for cement in the short run and the long run. However, the interpretation of the coefficient was basically similar to the interpretation of the regular regression. As seen in the table 1, in the short run, the cement price (PC), GDP, and the wood price (PW) in current quarter were not statistically significant at any level of significance, suggesting that the changes of PC, GDP, and PW in current quarter have no impact on the change of the cement demand. It is happen because the interaction term with PC, GDP and PW was also included in the demand function. These interaction terms may have accounted the impact of PC, GDP, and PW dampening the level of significance for these variables. However, the lagged values of the left hand side variables such as the cement price (PC) and the wood price (PW) in the demand function have the expected signs and were statistically significant at 1 % level of significance, indicating that changing in PC and PW in the last quarter would affect demand for cement in the current quarter. In addition, the coefficient of deregulation was also significant at 1 % any level of significance toward the change of demand for cement after 1997. This condition indicated that there was difference of the cement quantity demanded by consumer before and after deregulation.

In the long run, the variable of GDP was statistically significant at 5 % level of significance, indicating that an increase in GDP would increase the demand for the cement in the long run, and vice versa. However, variables such as the cement price (PC) and the wood price (PW) were not statistically significant at any level of significance. It means that the change in PC and PW in the long run had no effect on the change of the cement demand. The coefficient associated with PC and PW in the demand function was not statistically significant because the interaction term between PC and PW was also included. As shown in the table 1, the coefficient of PCPW was statistically significant at 10 % level of significance with two-tail test. Therefore, this interaction term may have accounted the impact from PC and PW which affect the level of significance in the coefficient of PC and PW.

In addition, other information provided by the demand function is the estimation of elasticity such as the long run own-price elasticity and income elasticity. The calculations of the long run own-price elasticity and income elasticity are related to the interaction terms of PC, PW, and GDP in the demand side. Hjalmarson (2000, p.21); Chintrakarn & Jindapon (2012, p.222) suggested the long run own-price elasticity could be estimated by using the following formula: $\epsilon_{PP} = (\theta_{PC} + \theta_{PCPW}\overline{PW} + \theta_{PCGDP}\overline{GDP})\left(\frac{\overline{PC}}{\overline{QC}}\right)$ and the long run income elasticity is given by the following formula $\epsilon_{GDP} = (\theta_{GDP} + \theta_{PCGDP}\overline{PC})\left(\frac{\overline{GDP}}{\overline{QC}}\right)$ where $\overline{PC}, \overline{PW}, \overline{GDP},$ and $\overline{QC}$ denote the mean of the cement price (PC), the wood price (PW), Gross Domestic Product (GDP), and the cement quantity (QC), respectively. The mean value of these variables was given by descriptive statistic in appendix A (table A1).

Based on these formulas, the long run own-price elasticity in the Indonesian cement industry was found to be -0.05, i.e., the increase of the cement price about 10 % would only decrease demand for cement about 0.5%. However, this coefficient was not statistically significant at level of significance with t-statistic of -0.816. This result was also in line with what was found in the estimation result of the demand function, namely the long run cement price was not statistically significant at any level of significance. Moreover, the long run income elasticity was 0.56 and statistically significant with t-statistic of 2.619[6]. This was also in line with what was found in the estimation result of the demand function, namely the long run GDP was statistically significant at any level of significance. The value of the long run income elasticity suggests that cement in Indonesia is a normal good which is needed as a main ingredient for housing, infrastructure, and the construction industry.

6.2 The Supply Function

As discuss above, there were two variables used as the interaction term in the demand function namely PCGDP and PCPW. These variables have an important role to calculate Q* used to estimate the degree of market power. Considering separability test, Q* wouldbe calculated separately from these two interaction terms since they were not separable individually in the demand function. Yet, it was separable if they were incorporated each other in the demand function. Q*,calculated from the long run coefficient of PCPW, was not statistically significant both in the long run and the short run. In addition, the null hypothesis of correct regression specification in this supply function could be rejected since the p-value of RESET test was less than 0.05, indicating that this supply function contains misspecification. This problem would cause the irrational estimation result. On the other hand, Q*, calculated from the long run coefficient of PCGDP, more satisfied the diagnostic tests of the econometric analysis. Therefore, this study would use this supply function to analyze the degree of market power in the Indonesian cement industry. Table 2 presents the estimation results of the supply function in which Q* was calculated by the interaction variable of PCGDP.

Furthermore, several diagnostic statistics have also supported the validity of the supply function. Breusch Godfrey LM test suggested that the null hypothesis of no autocorrelation and no serial correlation could be rejected in supply function. This test was also consistent with the DW-test, indicating that the model was absence of autocorrelation problem for both models[7] .The ARCH test indicated that the null hypothesis of no heteroskedasticity could be rejected. RESET test also suggested that the correct specification test could not be rejected for this function supply. Finally, Chow test was also performed to analyze no structural break in the Indonesian cement industry after and before the end of 1997. The p-value of this test was also greater than 0.05, indicating that the null hypothesis of no structural break after and before deregulation could not be rejected or no evidence of any structural break in the supply function.

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[6] The variance of t-statistic in this case was calculated using the formula of weighted sum of variables as follow: $Var(aX + bY+cZ)= a^2Var(x) + b^2Var(Y) + c2Var(Z) + 2ab\,Cov(X,Y) + 2ac\,Cov(X,Z) + 2bc\,Cov(Y,Z)$ for the own-price elasticity and $Var(aX + bY)= a^2Var(x) + b^2Var(Y) + 2ab\,Cov(X,Y)$. Variance and covariance in this case was performed by nlcom-STATA.

[7] The values of D-W test for both models are between $dU< D\text{-}W < 4\text{-}dU$ implying no autocorrelation in the estimated models. In this case, dU = 1.817 for k =12 and T = 76 at 1 % level of significance.

Table 2
OLS Estimates of the Short and Long run Supply Functions
For the Indonesian Cement Industry, Quarterly Data from 1993 to 2011

Variable	Parameter Estimates	t-Statistic
Dependent Variable : $\Delta PC_{,t}$		
Intercept : β_0	-3674.68	-3.120*
$\Delta QC_{,t}$: β_{Qc}	0.002	3.088*
$\Delta QC^*_{,t}$: λ_s	-0.07	-3.210*
$\Delta WCO_{,t}$: β_{WCO}	30.30	2.050**
$\Delta WDF_{,t}$: β_{WDF}	8.60	7.151*
ΔDC : β_{DC}	-297.66	-1.516
ECTS :γ_s	-0.28	-3.657*
$Qc_{,t-1}$: $\beta_{Qc,1}$	0.001	2.943*
$QC^*_{,t-1}$: $\beta_{QC^*,1}$	-0.03	-2.102**
$WCO_{,t-1}$: $\beta_{WCO,1}$	31.25	3.163*
$WDF_{,t-1}$: $\beta_{WDF,1}$	4.74	3.031*
Long Run Parameters		
μ_{QC}	0.01	6.538*
φ_{QC^*}	-0.10	-3.424*
μ_{WCO}	113.10	7.279*
μ_{WDF}	17.17	7.602*
Diagnostic Test		
R^2	0.57	
D-W	2.150	
LM-Test	0.59	(0.443)
ARCH-Test	0.56	(0.456)
Reset Test	1.72	(0.173)
Chow Test	0.03	(0.871)

Note: - *Significant at 1% and **significant at 5 % level of significant at 10% with two tail test and values in theparentheses are the p-values.
- The number of observations is 76.
- Standard error for estimating t-statistic is heteroskedasticity-robust which was performed by STATA program VCE
- The estimation of supply function is based on the equation (12), their long run coefficient is based on the equation (12.2), and t-statistic long run is based on the equation (13).

Similar to the demand function, AIC and SC was also used to determine the lag length in this dynamic supply function. The values of AIC and SC suggested this study to use lag length of 1[8]. Furthermore, the adjustment coefficient (γ_s) was negative and significant at 1 % level of significance. It was consistent with the theory. The estimation of the adjustment coefficient (γ_s) was 0.28, indicating that there was an adjustment of 28 % after deviation from the long run equilibrium.

[8] The values of AIC and SC for the lag length of 1 are 16.67 and 17.01, respectively. These values are slightly less than the values of AIC and SC for the lag length of 2, namely 16.74 and 17.24, respectively.

Related to the level of significance, almost all of the independent variables were statistically significant at 1 % and 5 % level of significance with two-tail test and had correct signs. The coefficients of the variable costs such as coal and diesel fuel were positive and statistically significant at 1 % level of significance both in the short run and the long run. It meant that the rise of the coal and diesel fuel price would increase the Indonesian cement price. The increase in the prices of coal and diesel fuel has been a major problem in the Indonesian cement industry since coal and diesel fuel are the major energy used in production process. According to Indonesian Commercial Newsletter (2006, p. 20), the increase in the price of diesel fuel in 2005 forced PT. Semen Cibinong (Holcim) to stop temporally operation one of its factories which has an annual capacity of 1.5 million tons. This condition has led to disturbance in the smoothness of the Indonesian cement production. Another estimation result in the supply function was the effect of deregulation undertaken by the Indonesian toward the change of the cement price. The coefficient had a positive coefficient but it was not statistically significant at any level of significance, implying that deregulation undertaken by the Indonesian government in the end of 1997 in the cement industry had no impact on the increase of the cement price, i.e. the removal of control in terms of production, distribution area, and fixing price since the end of 1997 could not be viewed as a factor causing the changes in the cement price both before and after deregulation.

The most important information in the estimation result of the supply function is the estimation of the degree of market power both in the short run and the long run. Theoretically, this coefficient should be negative and between 0 and 1. If the degree of market power is found to be zero, then the Indonesian cement industry behaves competitive market and if it is found to be one, then firms exert all potential market power in the Indonesian cement industry. Because of this coefficient is the main focus in this paper, the further discussion of the degree of market power would be presented in the next section.

The Analysis of Market Power in the Indonesian Cement industry

As previously mentioned, the degree of market power was exhibited by the coefficient of λ_s for the short run and φ_{Q*} for the long run. Table 3 reported the estimation results in market power both for the short run and the long run.

Table 3
The Degree of Market Power in the Dynamic Model
In the Indonesian Cement Industry

Model Estimation	**Coefficient**	**t -Statistic**	**Significance Level**
Short Run (λ_s)	0.07	3.210*	Significant at 1 % level
Long Run (φ_{Q*})	0.10	-3.424*	Significant at 1 % level

Sources: table 2

The short run estimation of market power, λ_s, was 0.07, negative, significant at the 1 % level with two-tailed test, and between 0 and 1 as expected. Meanwhile, the long run estimation of market power, φ_{Q*}, was 0.10, statistically significant at the 1 % level of significance with two-tailed test, negative, and between 0 and 1.These results suggested that the Indonesian cement industry has some degree of market power both in the short and the long run.

Crucial question arises with respect to the estimation results in the degree of market power is whether firms in the Indonesian cement industry had or had no market power. To answer this question, it is required to test the null hypotheses of the different market structures such as competitive market, monopoly market, and Cournot-oligopolistic competition. These null hypotheses are tested by using asymptotic test (Wald Test). In this case, the null hypotheses of competitive market, monopoly market, and Cournot-oligopolistic competition in the short run and the long run could be specified by H_0: $\lambda_s=\varphi_{Q*}= 0$ against H_1: $\lambda_s=\varphi_{Q*}> 0$, H_0:$\lambda_s= \varphi_{Q*}= 1$againsH$_0$:$\lambda_s= \varphi_{Q*}=1$, and H_0:$\lambda s= \varphi_{Q*}=0.11$[9] againsH$_0$:$\lambda_s= \varphi_{Q*}\neq 0.11$, respectively. Table 4 presented the results for the null hypotheses of different market structures in the Indonesian cement industry.

The null hypothesis of competitive market could be decisively rejected at any level of confidence, no rejecting the alternative hypothesis of some market power both in the short run and the long run. It meant that competition in the Indonesian cement industry was different from zero, namely competition in perfectly competitive market. This result raised question whether firms in the Indonesian cement industry behaved non-competitive. Hence, to validate this question, it could be investigated the possibility of Cournot-oligopoly and monopoly behavior. Furthermore, the null hypothesis of Cournot- oligopolistic competition was not rejected at any confidence level and rejected the null hypothesis of monopoly market both in the short run and the long run. These results suggested that competition among firms in the Indonesian cement industry could be viewed as Cournot-oligopolistic competition rather than behaving monopoly both in the short run and the long run. In other words, firms in the Indonesian cement industry could enjoy the market power of oligopolistic competition both in the short and the long run.

Table 4
The Existence of Market Power under the Null Hypotheses
of the Different Market Structures

Null Hypothesis	**P-value**
Short Run	
H_0: $\lambda_s= 0$ against H_1: $\lambda_s> 0$	0.002
H_0:$\lambda_s = 0.11$; H_1: $\lambda_s \neq 0.11$	0.136*
H_0: $\lambda_s = 1$;H_1: $\lambda_s<1$	0.000
Long Run	
H_0:$\varphi_{Q*} = 0$; H_1: $\varphi_{Q*}> 0$	0.002
H_0:$\varphi_{Q*} = 0.11$; H_1: $\varphi_{Q*} \neq 0.11$	0.872*
H_0:$\varphi_{Q*}=1$; H_1: $\varphi_{Q*}< 1$	0.000

Note: - The null hypothesis of the different market structures was tested by asymptotic test (Wald-Test). In this case, this study treat the degree of market power for the long run as 1.4 times the degree of market power in the short run since the parameter of market power in long run is 0.10 while the parameter of market power in the short run is 0.07

- *is not rejected the null hypothesis at any level of confidence

[9] As mentioned in the previous section, the degree of market power in the Cournot-oligopolistic competition was specified as $\lambda =1/n$ where n is the number of firm. In the Indonesian cement industry, the number of firms is nine firms. Therefore, λ in Cournot-oligopolistic competition is 0.11

In the most case, oligopolistic competition could give rise to a wide range of different outcomes. Friedman (1983), Kuenne (1992) suggested that oligopolistic competition is strategically linked to one another in which the best policy for one firm is independent the policies being followed by each rival firm in the market. In this situation, without cooperative among them to employ restrictive trade practices such as collusion, market sharing in raising prices, and restrict production among them, competition between firms in an oligopoly could be fierce, with relatively low prices and high production. On contrary, if the firms employ restrictive trade practices, then firms could enjoy market power in the oligopolistic competition since restrictive trade practices could create seasonal shortage in the industry. As a result, the product prices could rise in the industry.

The weakness in this study is that market power under Bresnahan-Lau's model could not identify collusion between firms in the Indonesian cement industry. Corts (1999, pp.244-245) criticized the NEIO models, suggesting that the conduct parameter or the degree of market power estimated in the NEIO paradigm would understate the true conduct parameter if the firms in the industry are efficiently colluding. This is because of there was no simultaneous quantity setting in the demand and supply function used in this model. Yet, the model would be useful to test whether the market behaved competitively ($\lambda = 0$), monopoly ($\lambda = 1$), and Cournot oligopolistic competition ($\lambda = 1/n$ with n is the number of firms on the industry). In addition, Gasove & Mullin (1998, p.370) who investigated conduct and cost in the sugar industry using the NEIO model and direct measure approach found that though the NEIO model underestimatedthe degree of market power, the NEIO model still performed reasonably well to estimate the degree of market power. The estimation results of the degree of market power between the NEIO model and direct measure approach was not significantly different. Furthermore, in the case of the Indonesian cement industry, KPPU, a legal body of the Indonesian antitrust, proved that the accusation of collusion in the Indonesian cement industry was not correctly proven[10]. Hence, this study concludes that Indonesian cement industry has some market power in which the degree of market power in this industry is the market power of the oligopolistic competition. In other words, the estimation results of market power suggested that the Indonesian cement industry behaved oligopolistic competition rather than behaving as competitive market or monopoly market both in the short run and the long run.

One possible explanation for the existence of the market power in the Indonesian cement industry is that the number of firm has not much increased during the period of 1993-2011.Even the number of firm in the Indonesian cement industry was stable namely 9 firms by the average of 83.55% in CR-4 in the period of 1997-2011.This condition enables firms in the Indonesian cement industry to enjoy the market power of the oligopolistic competition both in the short run and the long run since there was no new firm in the Indonesian cement industry affecting the level of competition. In other words, without new firm during the period of 1997-2011, the Indonesian cement market may often have a shortage in the short run and the long run so that firms in the Indonesian cement industry could enjoy seasonal market power when the cement production experience shortage in the market.

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[10] A degree of KPPU No. 01/KPPU-I/2010 explains the accusation of collusion in the Indonesian cement Industry.

7. Conclusion

The Indonesian cement industry has experienced development rapidly in terms of the installed capacity, production, and the share ownership of the cement firms after 1997. However, the development of the Indonesian cement industry after 1997 has also caused the price to rise as in the previous years, even the increase of cement prices has also faster after 1997. This condition raises conjecture regarding the existence of market power exerted by firms in the Indonesian cement industry.

The purpose of this paper has been to analyze the degree of market power in The Indonesian cement industry. This paper applied the reformulation of the Bresnahan-Lau's model in a dynamic analysis of the ECM framework. This model was applied because the ECM framework could address both statistical problems generated by non-stationary in a time series data and incorporates the important dynamic factors such as habit formation from the demand side and adjustment cost for the producers.

Separability test was constructed in this study by using the exclusion test of Jansen Juselius (1990). The test concluded non separability for the interaction variable individually but it was separable if the interaction variable was incorporated in the demand functions to analyze the degree of market power. Some preliminary tests such as integration test, co-integration test, and weakly exogenous test were constructed to obtain the robust coefficient of the ECM framework. Integration test showed that the data was stationary and they were integrated with the order of one, or I (1), co-integration test ensured at least one co-integration vector both in the demand and supply functions, and weakly exogenous tests suggested that demand and supply relation function in the ECM framework could be reduced as the single equation analysis which provides a clear distinction between the short run and the long run analysis and makes the analysis of ECM more robust. The analysis of the ECM framework concluded the existence of market power in oligopolistic competition in the Indonesian cement industry both in the short run and the long run. A possible explanation regarding the existence of market power in the Indonesian cement industry is that the number of firm has not much increased during the period of 1993-2011. During the period of 1997-2011, the number of firm in the Indonesian cement industry was only 9 firms. Therefore, there was no new firm in the Indonesian cement industry enabling firms in the Indonesian cement industry could enjoy some seasonal market power when the cement production has experienced shortage in the market.

Appendices

A. Descriptive Statistic of the Demand and Supply Function

Table A1
Descriptive Statistics of the Used Variables for Measuring Market Power in the Indonesian Cement Industry 1993-2011

Variables	Mean	Std. Dev.	Min	Max
Cement Production (ton)	7,574,351	1,768,583	4,267,982	11,917,215
Retail Cement Price (Rp/Sack)	27,363	15,661	6,887	55,865
GDP (Trillion Rupiah)	417.44	91.34	286.37	624.42
Price of Wood (Index)	175.72	136.75	38.01	487.18
Price of Coal (Index)	112.71	55.38	46.00	229.70
Price of Diesel Fuel (Index)	635.03	601.40	94.88	1,874.60

B. Result of the Integration Test

Table A2
The Augmented Dickey Fuller for Unit Root Test

Variable	I(0)	P-Value (a)	I(1)	P-Value (a)
Cement Quantity (QC)	0.33	0.979	-4.38	0.001*
Cement Price (PC)	0.78	0.993	-7.20	0.000*
Gross Domestic Product (GDP)	1.18	0.998	-2.91	0.049**
Price of Wood (PW)	-1.16	0.910	-4.45	0.004*
Price of Coal (WCO)	0.16	0.969	-8.25	0.000*
Price of Diesel Fuel (WDF)	0.34	0.979	-7.44	0.000*
Deregulation (DC)	-1.68	0.438	-8.60	0.000*

Note: - The test was performed by including intercept only
- (a) Probability is based on MacKinnon one-sided- p values
- *, ** the null hypothesis of non-stationary could be rejected at 1% and 5 % level of significance, respectively since the small p-value

C. Result of the Co-Integration Test

Table A.3
Result of Co-Integration Test

Co-integration Demand Function	Eigen-Value	λ Trace Statistics Value	λ Trace Statistics Critical Value	λ Max Eigen-Statistics Value	λ Max Eigen-Statistics Critical Value
r = 0	0.618	167.84*	139.28	71.20*	49.59
r ≤ 1	0.340	96.64	107.35	30.80	43.42
r ≤ 2	0.294	65.84	79.34	25.77	37.16
r ≤ 3	0.209	40.07	55.25	17.34	30.82
r ≤ 4	0.185	22.73	35.01	15.15	24.25
r ≤ 5	0.076	7.58	18.40	5.82	17.15
r ≤ 6	0.023	1.76	3.84	1.76	3.84
Supply Function					
r = 0	0.603	143.36*	107.35	68.35*	43.42
r ≤ 1	0.356	75.02	79.34	32.60	37.16
r ≤ 2	0.209	42.42	55.25	17.34	30.82
r ≤ 3	0.173	25.08	35.01	14.09	24.25
r ≤ 4	0.137	10.98	18.40	10.86	17.15
r ≤ 5	0.002	0.12	3.84	0.12	3.84

Note: - * shows that λ trace statistic and λ maximum statistic are significant at the 5 % level

D. Result of the Weakly Exogenous Test

Table A4
Weakly Exogenous Test for Demand and Supply Variables
In the Indonesian Cement Industry

Variable	χ^2	p-value	Variable	χ^2	p-value
Demand Function			Supply Function		
QC	0.38	0.827	PC	2.28	0.131
PC	0.61	0.735	QC	1.17	0.280
PW	0.70	0.703	QC*	1.71	0.192
GDP	2.42	0.299	WCO	1.98	0.159
PCGDP	2.40	0.301	WDF	0.35	0.552
PCPW	2.43	0.296	DC	0.07	0.798
DC	0.24	0.887			

Note: This test is asymptotically distributed as X^2 where the degree of freedom equals to the number of co-integration vectors (r). X^2-table with the degree of freedom of r = 1 is 3.84

E. Result of the Separability Test

Table A5
Separability Test for Demand Function

Null Hypothesis	$\chi 2$	p-value
Individual Test		
H_0:β_{PCPW}=0	14.80	0.005*
H_0:β_{PCGD}P=0	15.82	0.003*
Jointly Test		
H_0:β_{PCPW}=β_{PCGDP}=0	2.87	0.580

Note: - * is significant at 1 % level of significance
- In the individual test there are 1 degree of freedom: r(N-s)= 1(7-6)=1, and in the jointly test there are 2 degrees of freedom, which is r(N-s)= 1(7-5)=2
- Critical value's chi-square at 1 degree of freedom is 3.84 at 5 % level of significance and at 2 degrees of freedom is 5.99 at 5 % level of significance

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