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Spatial Price Competition in the Korean Retail Gasoline Market

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ABSTRACT : This paper analyzes competition among service stations in the Korean gasoline market. We consider spatial differentiation as a source of product differentiation as well as the characteristics of the stations and vertical contracts between refiners and retailers as factors causing changes in equilibrium prices in the Korean gasoline retail market. The effect of the government's price disclosure policy on the retail market competition is also analyzed. Moran's I test indicates that the prices of neighboring gas stations are spatially correlated in the market. It is also found that gasoline prices for vertically integrated stations are much lower than those for independent stations. In addition, unbranded stations charge lower prices than branded stations but also induce branded stations to price more competitively. Meanwhile, the government's price disclosure policy did intensify price competition in the retail gasoline market. It is inferred that the price disclosure policy contributed to retailers gaining more bargain power in price negotiation with refiners, causing an eventual increase in retail prices.

Keywords : Spatial competition, Vertical integration, Unbranded stations, Price disclosure policy

JEL 분류 : L42, L44, L13, L8

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한국 휘발유 소매시장에서의 공간 가격경쟁

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요 약 : 이 논문은 한국의 휘발유 시장에서 주유소 간의 경쟁에 대하여 분석하였다. 한국 휘발유 소매시장에서 균형가격 변화에 영향을 미치는 요인으로 주유소의 특성 및 정유사와 주유소 간의 수직계약구조를 고려했을 뿐 아니라 공간적 차별화를 제품차별화의 방식의 일환으로 고려하여 분석을 수행하였다. 본 연구에서는 또한 2009년 5월부터 시행한 정부의 소매시장에서 주유소가격공시정책이 주유소 간 경쟁에 갖는 효과를 분석하였다. 수직통합된 주유소의 가격이 독립주유소보다 낮은 것으로 나타났으며 자가폴주유소가 폴주유소에 비해 낮은 가격을 책정할 뿐 아니라 인근 자가폴주유소는 폴주유소로 하여금 가격을 더 낮게 책정하도록 하는 효과가 있는 것으로 나타났다. 정부의 가격공시정책은 소매시장에서 가격경쟁을 강화시키는 방향으로 작용, 소매가격을 떨어뜨리는 것으로 나타났다.

주제어 : 공간경쟁, 수직통합, 자가폴주유소, 가격공시정책

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I. Introduction

Gasoline is considered a perfectly homogeneous good with respect to its physical and chemical properties. For this reason, firms differentiate their products through the provision of ancillary services, such as car washes and repair shops, to mitigate price competition. Competition in the gasoline market is highly localized, and firms have close geographical competitors (Van Meerbeeck, 2003; Benson et al., 1992). Competition is also influenced by the contractual structure of service stations vis-a-vis refiners. Service stations may be “branded”, meaning that they sell gasoline under the brand name of refiners. Branded service stations can be operated under a variety of contractual agreements: they may be owned and operated by the refiner (company operated) they may be owned by the refiner but leased to the station manager (lessee dealers) or they may be owned by a manager who contracts to carry the refiner’s brand (contract dealers). There are also independent sellers that own stations and sell unbranded gasoline. Unbranded stations typically compete with other stations by offering the lowest prices with little product differentiation. The effect of independent stations on the market has been controversial and not fully examined in empirical literature. Hastings (2004) reported that when an independent retail gasoline chain (Thrifty) was purchased by ARCO in Southern California, converting independent stations to branded stations, stations that had competed with Thrifty significantly increased their prices because of the loss of an independent, unbranded competitor. This suggests that independent, unbranded stations drive up price competition and that increasing their market share may be an efficient solution to promote competition in gasoline markets. Netz and Taylor (2002) investigated the relationship between spatial differentiation and location pattern for retail stations in Southern California. They found a positive relationship between the share of independent stations and the degree of spatial differentiation among stations, indicating that independent stations increase price competition to a larger extent than branded stations. Therefore, branded stations have an incentive to maximize spatial product differentiation in the presence of independent stations to minimize price competition. Pennerstorfer (2009) found that independent gasoline retailers generally heighten price competition, given that they charge significantly lower prices. However, at the same time, they reduce price competition for branded, as consumers might consider gasoline sold at unbranded stations to be of inferior quality. Consequently, independent unbranded stations have only a small influence on prices charged by branded stations.

To analyze competition in the Seoul gasoline market, we employ station-level monthly prices and estimate a spatial econometric model. As the market is characterized by spatial competition, we introduce a spatial lag in the price reaction function to avoid model misspecification. For the estimation of the model, we collected data from all gas stations operating in Seoul, Korea. The data contains station-level monthly prices and station characteristics such as the provision of charger, wash, and repair services. Unlike Pinkse et al. (2002) and Pennerstorfer (2009), who used cross-sectional data for their analyses, we used panel data to obtain both the inter-station and intertemporal variations of the variables. One distinctive feature of the data is that they reflect both before and after of the price disclosure policy implemented by the Korean Government. This policy requires refiners to disclose their wholesale prices to provide transparent price information to retailers and consumers.[1] The reporting of wholesale prices by refiners allows retailers to reduce the search cost of finding cheaper sources of gasoline supply and facilitates price competition between refiners as they try to extend their market share via price reduction strategies (see Stigler, 1961; OECD 2001, for example). On the other hand, wholesale price disclosure may facilitate price coordination by refiners, causing an overall increase in retail prices. Price transparency can help ease the reaching of

1) Two types of price disclosure measures have been carried out recently. Price disclosure at the retail level has been implemented since April 2008 via OPINET, a price comparison website. At the wholesale price level, each refiner has disclosed prices since May 2009 via OPINET. On OPINET, consumers can check an individual station's retail price for different products against all Korean gasoline markets and wholesale prices charged by refiners. The retail prices are updated daily, and wholesale prices are updated weekly.

agreements and can reduce the incentive to cheat by reducing the time before cheating is detected. Therefore, price transparency is one of the factors required to reach a collusive understanding and ensure its sustainability over time, particularly in highly concentrated markets (See OECD 2010; Mollgaard and Overgaard, 2006; Phlips, 1988). Thus, our data provides us with an excellent opportunity to evaluate the role of price transparency as a collusive or competitive factor in this market.

We find that the prices of neighboring gas stations are spatially correlated and are affected by spatial competition among gas stations located within a certain geographical region (neighborhood). Results indicate that gasoline prices of vertically integrated stations are much lower than those of independent stations, possibly due to lower management costs. In addition, unbranded stations charge lower prices than branded stations, inducing branded stations to price more competitively. We also find that the price disclosure policy did intensify price competition in downstream markets. Controlling for other factors that may affect retail gasoline prices, retail gasoline prices decreased after the policy was implemented. It is inferred that price disclosure contributed to retailers gaining more bargain power in price negotiations with refiners and promoting eater price competition.

The rest of the paper is organized as follows. In section II, we describe the Korean gasoline market. In section III, we specify the estimation model and explain the data used in the paper. In section IV, we explain the results. We conclude the paper in section V.

II. Korean Gasoline Market

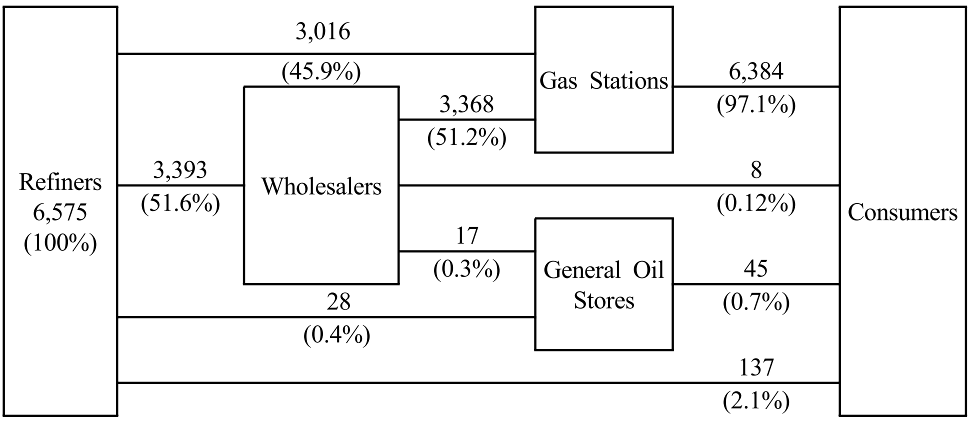
Broadly, the oil industry is composed of two sectors: an upstream sector related to the exploration and development of crude oil and a downstream sector that includes the refining and sales of petroleum. Unlike other major gasoline markets, Korea has no vertically integrated oil company that combines both upstream and downstream businesses, despite the country's large consumption volume and refining capacity.

Although SK Energy and GS Galtex, Korean oil companies, have recently invested in upstream projects, their volume of crude oil production is not yet significant. Therefore, the Korean gasoline market can be described as having only three different distribution levels: refining, wholesaling, and retailing. Figure 1 displays the distribution channel, from refiners to final consumers, for gasoline sold in the Korean market as of 2010. As shown in the figure, about 97% of gasoline was sold to end consumers through two main distribution channels the channel passing through wholesalers and retailers accounted for about 51% of total consumption, while the channel passing through only gas stations accounted for about 46% of total consumption. About 2.1% of gasoline sales were made to end consumers directly from refiners, and 0.7% of gasoline was sold at "general oil stores" that do not have gasoline pumps.[2)]

Since 1995, Korean refineries have produced gasoline outstripping total domestic market demand; therefore, the export volume of gasoline has gradually increased. In 2011, refineries exported about 43% of the gasoline they produced, which amounted to roughly 53 million barrels. Due to the surfeit of domestic gasoline production, there have been no gasoline imports since 2006. Therefore, all gasoline distributed and consumed in the Korean market is supplied by four private refining companies: SK Energy (SKE), GS Galtex (GSC), Hyundai Oilbank (HDO), and S-Oil (SOL). SKE had the largest market share in terms of sales volume (about 37% of total gasoline sales), and GSC had the second largest market share (about 31% of total gasoline sales). HDO and SOL had 18% and 14% of market share, respectively in 2011. These four majors have sustained their stable market share since gasoline imports ceased in 2006. Importers were not competitive in the domestic market, as domestic refiners were producing more efficiently utilizing economies of scale.

2) A "general oil store" is a retail store that deals with oil products unlike a gas station, it does not have a pump and therefore puts more weight on the delivery/sale of heating oil and diesel than on the sale of gasoline.

〈Figure 1〉 Gasoline Distribution Channel (Unit: 10,000 B, %, as of 2010)



〈Table 1〉 Korea's Gasoline Supply and Demand (Unit: 1,000 B, %)

Supply		Demand	
Domestic production	Import	Domestic demand	Export
123,494(100%)	0	69,574(56.9%)	53,519(43.3%)

〈Table 2〉 Volume and Market Share by Market Producer (Unit: 1,000 B, %)

Category		SKE	GSC	HDO	SOL	Others	Total
2009	Volume	25,639	21,104	10,095	8,726	307	65,872
	Market Share	38.9%	32.0%	15.3%	13.2%	0.5%	100.0%
2010	Volume	26,083	21,868	11,116	9,519	244	68,931
	Market Share	37.8%	31.7%	16.1%	13.8%	0.5%	100.0%
2011	Volume	25,633	21,506	12,154	9,855	426	69,574
	Market Share	36.8%	30.9%	17.5%	14.2%	0.6%	100.0%

〈Table 3〉 Ownership Structure of Gas Stations (%)

Brand	SKE		GSC		HDO		SOL	
	Vertically Integrated	Indepen -dent	Vertically Integrated	Indepen -dent	Vertically Integrated	Indepen -dent	Vertically Integrated	Indepen -dent
Number of Gas stations	810 (18.6)	3,539 (81.4)	590 (17.7)	2,636 (82.3)	257 (10.9)	2,098 (89.1)	143 (7.3)	1,800 (92.7)
	4,349 (100)		3,326 (100)		2,355 (100)		1,943 (100)	

Source: Korea Oil Station Association (2012)

The oligopolistic market structure of the refining industry is transmitted into gasoline retail markets via vertical contracts between refiners and service stations. In the retail market, there were about 12,830 service stations operating in 2012; 93% of stations were selling gasoline under the brands of the four majors. In addition, more than 90% of branded gas stations had an exclusive dealing contract with one of the four majors. Independent gas stations that were selling unbranded gasoline and were not tied to refiners through an exclusive dealing contract or ownership accounted for about 7% of the gas stations operating in the Korean market. Regarding ownership structure, about 16% of stations selling branded gasoline were owned by one of the four refiners and operated directly by the company or by lessee dealers. Table 3 shows the proportion of vertically integrated stations and independent gas stations operating in the market.

III. Model Specification and Data

1. Model Specification

Several theoretical approaches have been used to analyze the oligopolistic interdependence in gasoline markets. Slade (1986, 1991) estimated the intertemporal reaction function to analyze competition in the Vancouver gasoline market. Pinkse et al. (2002) developed a spatial price competition model for differentiated products and analyzed the U.S. wholesale gasoline market. Pennerstorfer (2009) used a model similar to that of Pinkse et al. (2002) to investigate the influence of unbranded stations on the Austrian gasoline market. Manuszak (2009) estimated a demand model for gasoline products that reflects the possibility of product differentiation arising, in part, from the locations of gas stations in the Hawaiian retail gasoline industry. Recently, Houde (2012) developed an empirical model of spatial competition where spatial differentiation depends on the structure of the road network and the direction of traffic flows. We followed and extended the methodological example of Pinkse et al. (2002) by using panel data for the modeling of price competition in the Seoul gasoline market.

1) Demand

Let us assume that there are n gas stations, $i = 1, 2, \cdots, n$, selling a differentiated product. Let $\overline{p}_{it}$ denote the nominal price of the gas station i at time t. We assume that there is an outside good that is sold at $\overline{p}_{0t}$. Let $\overline{y}_{kt}$ present the income of consumer k at time t. Then, consumer k purchases a vector of $q_{kt} = (q_{1kt}, q_{2kt}, \ldots, q_{nkt})'$ of the spatially differentiated gasoline, taking into account transportation costs or search costs. Assuming a normalized-quadratic indirect-utility function, where the prices of the differentiated gasoline, as well as incomes, are normalized by the price of the outside good, we can derive aggregate-demand equations for gas stations, as follows:

$$q_{it} = \alpha_i + \sum_j \gamma_{ij} p_{jt} - \delta_j y_t \tag{1}$$

Here, $\Delta = [\gamma_{ij}]$ is an arbitrary $n \times n$ matrix that is symmetric and negative semi-definite. The prices and incomes are normalized as $p_{it} = \overline{p}_{0t}^{-1} \overline{p}_{it}$ and $y_{kt} = \overline{p}_{0t}^{-1} \overline{y}_{kt}$. The incomes are aggregated by $y_t = \sum_k y_{kt}$. Because equation (1) has too many parameters to be estimated, it is assumed that the brand level intercept α_i is a function of the characteristics of brand i, i.e., product and market characteristics, x_{it} and

y_t. Therefore, it is assumed that consumers demand the characteristics of brands rather than brands themselves.

2) Pricing Relationship: Price reaction function

Let us assume that a gas station chooses p_{it} to solve the following profit maximization problem:

$$\max_{p_{it}} \pi_i = (p_{it} - c_{it})(\alpha_i + \gamma_{ii} p_{it} + \sum_{i \neq j} \gamma_{ij} p_{jt} - \delta_i y_t) - F_{it} \quad (2)$$

Here, c_{it} and F_{it} represent a service station i's marginal cost and fixed cost. Then the first-order condition for the profit maximization produces station i's price reaction function or best-response function, as follows:

$$p_{it} = R_{it}(p_{-it}) = -\frac{1}{2\gamma_{ii}}(\alpha_i - \gamma_{ii} c_{it} + \sum_{i \neq j} \gamma_{ii} p_{jt} - \delta_i y_t), i = 1, 2, \ldots, n \quad (3)$$

In equation (3), p_{-it} represents the set of prices other than that of station i, i.e., $p_{-} = (p_{1t}, p_{2t}, p_{(i-1)t}, p_{(i+1)t}, \ldots, p_{nt})$. The parameter γ_{ii} determines the own-price elasticities and is assumed to be a function of the local market structure and product characteristics. The slope of the reaction function, $\frac{\gamma_{ij}}{-\gamma_{ii}}$ is called the diversion ratio between stations, i and j, which is defined as the share of station i's lost consumers due to an increase of price i, p_i, who switch to station j. It is likely that the ratio depends on a measure of the distance between i and j. In this paper, we assume that it depends on the Euclidean distance between i and j and that it decreases the farther apart are i and j. Then, assuming that X represents the matrix of observed brand and market characteristics and that there are unobserved brand and market characteristics u, we can rewrite equation (3) in the following matrix form:

$$p = R(p) = \alpha + X\beta + Dp + u \quad (4)$$

In the equation, the matrix $D = (d_{ij})$ has zero diagonal elements, $d_{ii} = 0$, and off-diagonal elements, $d_{ij} = g(\cdot)$, should be estimated. In this paper, we assume that the function is modeled as a function of the geographical distance, following Netz and Taylor (2002) and Kalnins (2003); it depends on the Euclidean distance between i and j. Then equation (4) can be rewritten as follows:

$$p = R(p) = \alpha + X\beta + \rho Wp + u \quad (5)$$

In equation (5), W represents the spatial weighting matrix that contains the spatial information among stations. After row-normalization, Wp is the spatially weighted average price charged by the competitors and ρ is the spatial autoregressive coefficient. The error is normally distributed with $u \sim N(0, \Omega)$. The spatial weighting matrix W contains elements, $w_{ij} = 1/Dist(i,j)$, where $Dist(i,j)$ is the Euclidean distance between i and j. In this paper, we use the row-normalized matrix, $\widetilde{W} = w_{ij} / \sum_{j=1} w_{ij}$. Equation (5) is autoregressive in that price is regressed on the lagged prices, where lags represent spatial distances rather than time differences. One may attempt to estimate the model using ordinary least squares (OLS), which is generally applied to time series autoregressive models, provided that the regressors are strictly exogenous. However, regardless of the properties of the error terms, the OLS does not give us a consistent estimator due to the interdependence in price decisions among different stations. The multidirectional dependence among prices induces the correlation between spatially lagged explanatory variables and error terms, which violates the OLS assumptions for consistency. Such a problem can be avoided by using the maximum likelihood estimation (MLE) technique. Note that the above equation can be rewritten as:

$$v = \Omega^{-\frac{1}{2}}((I-\rho W)p - X\beta) := f(p, X, \theta) \tag{6}$$

where $v \sim N(0, I)$ and $\theta = (\rho, \beta)$. The log-likelihood function is constructed based on the joint distribution of the error terms, and the consistency of the estimator does not depend on the uncorrelatedness between the spatially lagged explanatory variable and error terms. The transformation shown above is essentially what distinguishes MLE from OLS in estimating a spatially autoregressive model. We specify our estimation model as follows:

$$\begin{aligned} p_{it} &= \alpha + \beta_1 SKE_i + \beta_2 SOL_i + \beta_3 HDO_i + \beta_4 UBR_i + \sum_{j=1}^{8} \gamma_j Char\,Var_{ijt} + \theta_1 No500m_{it} + \theta_2 No1km_{it} \\ &+ \theta_3 No2km_{it} + \vartheta_1 \%UBR500m_{it} + \vartheta_2 \%UBR1km_{it} + \vartheta_3 \%UBR2km_{it} + \delta_1 BR_{it} \times \%UBR500m_{it} \\ &+ \delta_2 BR_{it} \times \%UBR1km_{it} + \delta_3 BR_{it} \times \%UBR2km_{it} + \rho \sum_{k \neq i}^{n} w_k p_{kt} + \sigma OilP_t + \pi May2009_t \\ &+ \varphi_1 t + \varphi_2 t^2 + \varepsilon_{it} \end{aligned} \tag{7}$$

where p_{it} is station i's price of gasoline at time t; SKE_i, SOL_i, HDO_i are the brand dummies and UBR_i is an indicator for an unbranded station. $No500m_{it}$, $No1km_{it}$ and $No2km_{it}$ represent the number of gas stations within a radius of 500 m, 1 km, and a 2 km from station i, respectively. In addition, $\%UBR500m_{it}$, $\%UBR1km_{it}$, and $\%UBR2km_{it}$ denote the percentages of unbranded stations in the neighborhood (defined by the distances of 500 m, 1 km, and 2 km) of station i. $BR_{it} \times \%UBR1km_{it}$ is an interaction term between the indicator for a branded station and the percentage of unbranded stations competing within these three specified proximities. The rest of the interaction terms can be defined in a similar way. The term $\sum_{k \neq i}^{n} w_k p_{kt}$ is a spatially lagged price at time t, and $OilP_t$ denotes the oil (Dubai crude) price at time t. $May2009_t$ is a dummy variable for the period after May 2009, when price disclosure became mandatory. The quadratic time trend term, $\varphi_1 t + \varphi_2 t^2$, is included to control for the persistent time trend of gasoline price. In addition, ε_{it} is an error term.

2. Data

Seoul is a city located in the center of the Korean peninsula, surrounded by Gyeonggi province and transected by the Han River (Figure a1). As of 2011, a total 10.4 million people were living in the 25 districts of Seoul (Figure a2), and the total number of service stations operating in Seoul was 717. Among them, 291 stations used SKE brand name gasoline, and 211 stations sold gasoline under the GSC brand. HDO and SOL accounted for 101 and 85 stations, respectively (Table a1). Independent, unbranded stations totaled 29. Our sample includes all of these stations. The data are monthly and range from April 2008 through February 2011. During the sample period, the number of gas stations in Seoul increased from 448 to 717. Table 4 shows the descriptive statistics of the sample, including ownership structure and station services such as washing, repair, and charging. Examined characteristics also include having a convenience store, selling premium gasoline, and providing bonus points and gift certificates. The dummy variable for a self-service station was included, as well. We find that the branded stations provide ancillary services more intensively than unbranded stations (UBR). Table 5 shows the number of stations within 500 m, 1 km, and 2 km of a station. On average, there was approximately one competing gas station located within a 500 m radius of a station. Within 1 km and 2 km, there were on average 4 and 15 gas stations operating in Seoul, respectively. Table 6 shows the proportion of stations selling unbranded gasoline within a radius of 500 m, 1 km, and 2 km. Within a 500 m neighborhood radius, about 2.8% of stations were selling unbranded gasoline; within 1 km and 2 km, the proportion increased to 3.5% and 3.8%, respectively. The proportion of unbranded stations in Seoul is much lower than the national average of 7%; it is not easy for an unbranded gas station to operate in Seoul due to the relatively high operational costs.

〈Table 4〉 Summary Characteristics by Brand (February 2011)

Character variable/ Number of stations	GSC	SKE	SOL	HDO	UBR
Directly owned	33(15.6)	86(29.6)	1(1.2)	26(25.7)	0(0.0)
Car wash	101(47.9)	180(61.9)	38(44.7)	45(44.6)	5(17.2)
Charger	2(1.0)	27(9.3)	0(0.0)	3(3.0)	0(0.0)
Repair	39(18.5)	97(33.3)	16(18.8)	19(18.8)	2(6.9)
Convenience store	32(15.2)	51(17.5)	2(2.35)	2(2.0)	1(3.5)
Premium gasoline	90(42.7)	129(44.3)	11(12.9)	12(11.9)	0(0.0)
Bonus point	181(85.8)	0(0.0)	70(82.3)	83(82.2)	1(3.5)
Gift card	56(26.5)	47(16.2)	1(1.2)	63(62.4)	0(0.0)
Self	21(10.0)	15(5.2)	1(1.2)	3(3.0)	0(0.0)

Note: The numbers in parentheses represent the percentage of stations that provide ancillary services for each brand.

〈Table 5〉 Number of Stations in the Neighborhood

Number of stations within	GSC	SKE	SOL	HDO	UBR
500m radius	1.19	1.09	0.86	1.19	0.80
1km radius	4.29	4.28	3.79	4.14	3.97
2km radius	15.42	15.60	13.88	14.99	15.07

Note: Average over the data sample period

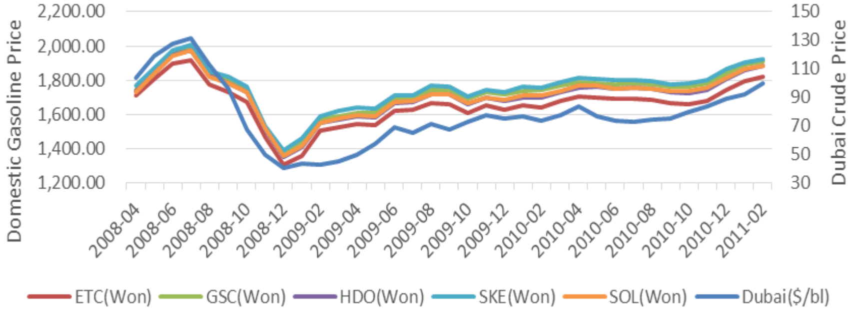
〈Table 6〉 Percentage of Unbranded Stations in the Neighborhood

% of unbranded stations within	Total	GSC	SKE	SOL	HDO	UBR
500m radius	2.77	0.95	3.05	2.75	4.29	8.05
1km radius	3.47	2.98	2.96	4.05	3.19	11.58
2km radius	3.79	3.28	2.94	5.26	3.77	11.91

Note: Average over the data sample period

Figure 2 represents the average monthly gasoline pricing for gas stations under different brand names. It also includes the trend of the Dubai crude oil price in U.S dollar per barrel[3)]. There was a dip during the recent financial crisis at the end of 2008. Since then, prices have been increasing. It is clear from the data that the SKE brand represents the highest gasoline price, and independent, unbranded gasoline sellers charged the lowest retail prices. Detailed monthly average prices and standard deviation per refiner are reported in Table a2.

〈Figure 2〉 Trend of Monthly Gasoline Prices by Brand



One thing we want to verify prior to the estimation of our model is the spatial correlation of retail prices. Equation (5) suggests that an individual station’s prices depend on the neighboring stations' prices, or the degree of local competition, which implies spatial correlations in gasoline prices. Therefore, we wish to find evidence that the prices of neighboring gas stations are, in fact, spatially correlated. With this evidence, we can justify our model specification, i.e., the best response function (5). For this purpose, we use Moran’s coefficient (or Moran’s I), a simple statistic that is based on the sample correlation coefficient between a random variable and its nearest geographical neighbors. More specifically, Moran’s I is defined as:

$$I = \frac{N}{\sum_i \sum_k \tilde{w}_{ij}} \cdot \frac{\sum_i \sum_j \tilde{w}_{ij}(p_i - \overline{p})(p_j - \overline{p})}{\sum_i (p_i - \overline{p})^2} \tag{8}$$

3) The average of the Dubai crude oil price was 77.17 with the standard deviation of 22.74.

where $\overline{p}$ is the mean of p and $\widetilde{w}_{ij} = \dfrac{w_{ij}}{\sum_j w_{ij}}$ which is the $(i,j)^{\text{th}}$ element of a spatial weight matrix $\widetilde{W}$.

$$E[I] = \frac{N}{\sum_i \sum_j \widetilde{w}_{ij}} \cdot E\left[\frac{\sum_i \sum_j \widetilde{w}_{ij}(p_i - \overline{p})(p_j - \overline{p})}{\sum_i (p_i - \overline{p})^2}\right] = -\frac{1}{N-1} \tag{9}$$

Under the null, the expectation of the statistic is given by the above. Thus, this expectation approaches zero as the sample size gets larger. The second moment of I under the null can also be obtained as follows:

$$E[I^2] = \frac{N((N^2 - 3N + 3)T_1 - NT_2 + 3T_0^2) - K((N^2 - N)T_1 - 2NT_2 + 6T_0^2)}{(N-1)(N-2)(N-3)T_0} \tag{10}$$

where $T_0 = \sum_i \sum_j w_{ij}$, $T_1 = \frac{1}{2}\sum_i \sum_j (w_{ij} + wji)^2$, $T_2 = \sum_i (w_{i\cdot} + w_{\cdot i})^2$ and $K = \left[\frac{1}{N}\sum_i (p_i - \overline{p})^4\right] / \left[\frac{1}{N}\sum_i (p_i - \overline{p})^2\right]^2$. Thus, we can calculate the variance of I under the null. A properly normalized test statistic is known to be normally distributed namely, the test statistic

$$Z = \frac{I - E[I]}{Var[I]^{\frac{1}{2}}} \tag{11}$$

follows a standard normal distribution.

The results of Moran's coefficient and z-scores are presented in Table 7. As is clear in the above equation, the moments of I depend on weights, w_{ij}. Because we use three different weighting matrices for estimation, the test statistics are also calculated in three different ways based on the weights—in other words, based on the distance that defines the geographic "proximity." In all three cases, the null hypothesis of no evidence for spatial correlation is rejected. A Moran's coefficient close to +1 indicates a strong positive spatial correlation, and -1 indicates a strong negative correlation. The calculated Moran's coefficient for the 500 m, 1 km, and 2 km weighting matrices had modestly strong positive correlations: 0.6280, 0.5818, and 0.4258, respectively. The z-score gives a formal test that provides evidence of spatial correlation at the 1% significance level for all three cases.

〈Table 7〉 Test Statistics for Spatial Correlation in Prices

Null: no spatial correlation	500 m	1 km	2 km
Moran's I	0.6280	0.5818	0.4258
Expected value under the null	- 0.0001	- 0.0001	- 0.0001
Standard deviation of I under the null	0.0121	0.0067	0.0037
z-score	52.0051	86.9569	115.4288
p-value	-	-	-

IV. Results

Tables 8-10 show results of the various specifications of the model (7). First, in Table 8, we consider station characteristics, lagged price, oil price, and the price disclosure dummy as the variables. We also include the number of stations in a certain geographic area (neighborhood) as a measure of competition intensity. Overall, the table displays results from the four different estimated models. The pooled OLS shows the result of a reduced form model and does not consider spatial effect. The other three models display results of spatial models where lagged prices were constructed under the assumption that gas stations compete within a geographical radius of 500 m, 1 km, and 2 km, respectively. In the table, SKE, SOL, and HDO represent the brand dummies that capture average price differences against the baseline brand, GSC. Results indicated that gas stations selling unbranded gasoline (UBR) charge much lower prices than branded gas stations. Unbranded stations purchase gasoline from any refiner or distributor that charge slower prices rather than contract with particular refiners for gasoline supply. They reduce management costs by minimizing the provision of ancillary services, which are typically used by branded stations as a means of product differentiation, to focus on price competitiveness. The variable "Directly Owned" has a negative coefficient and is statistically significant. Directly owned stations are owned and operated by refiners.[4)] Thus, vertically integrated stations charged 10 won per liter less than vertically independent gas stations. In company-operated stations, retail prices are decided directly by refiners. Lessee dealers, however, set retail prices while contracting with refiners for wholesale prices, leasing fees, volume discounts, and other regulations related to the operation of stations. In the case of contract dealers, managers own stations and set retail prices but are constrained by various forms of vertical contracts, such as exclusive dealings with refiners. There are numerous efficiency-enhancing motives for vertical integration, such as elimination of double-marginalization and reductions in transaction costs.[5)] In particular, the elimination of double markup may be most easily resolved via refiner ownership of retail outlets. There could also be alternative contractual agreements between refiners and retailers (such as two-part tariffs), but these agreements could be imperfect substitutes for vertical integration (Tirole, 1988, p.176).

Our results are consistent with the empirical results of gasoline divorcement laws reported in the literature.[6)] Barron and Umbeck (1984) compared pre- and post-

4) Nahm and Oh (2010) investigated the effect of vertical integration on price competition in the retail gasoline market in Seoul but did not produce statistically significant results, possibly due to the lack of sufficient information they only used 6 days' worth of data between October 2008 and November 2008.

5) See Spengler (1950) and Rey and Stiglitz (1995) for examples related to double marginalization and Coase (1937) for transaction costs.

6) Gasoline divorcement laws restrict or proscribe the vertical integration of gasoline refiners and gasoline retailers. In the U.S., divorcement laws have been imposed in six states and one territory: Hawaii, Connecticut, Delaware, Maryland, Nevada, Virginia, and the District of Columbia.

divorcement gasoline prices in Maryland and found that prices increased 6.7 cents at full-service stations and 1.4 cents at self-service stations relative to the average U.S price increase after the enactment of divorcement.[7] Shepard (1983) found that company-owned stations charged lower prices than their nonintegrated counterparts, with a price differential ranging from 1.35 cents to 10 cents per gallon.[8] Vita (2000) used state-level data from the mid-1990s and found that divorcement regulations increased the retail price of unleaded regular gasoline by more than 2.6 cents per gallon, reducing consumer surplus by over $100 million annually. Bello and Cavero (2008) indicated that vertically integrated stations with the same brand charged lower prices than vertically separated ones in order to compete more aggressively with independent, unbranded service stations in the Spanish gasoline market. It was also found that stations that provide ancillary services such as car washes, bonus cards, and gift cards tended to charge higher prices than counterparts without such services. For example, car wash services are usually provided at a discounted price or for free if gasoline is purchased. Thus, part of the service charge is transferred to higher gasoline retail prices. The same rationale can be applied to gift and bonus card services. Car repair services, however, are additional businesses that are not directly related to petroleum sales. Therefore, incentives still exist for stations to lower gasoline prices to attract customers. As expected, stations selling premium gasoline charged about 40 won per liter higher than other stations, and the price of self-service stations was about 81 won per liter lower than that of other types of gas stations.

The lagged price variable has a positive coefficient and is statistically significant at the 1% level, suggesting that prices are strategic complements to gas stations. This also

7) The Maryland state legislature in 1974 passed a divorcement law that prohibited direct refiner control of gasoline stations. After the law was passed, most stations affected by the law converted to franchise operations. The prohibition of refiner-controlled operations involves a reassignment from refiner to franchisee of the right to set operating hours and gasoline prices. See Barron and Umbeck (1984) for details.

8) The data Shepard used include all gasoline stations in a four-county area in eastern Massachusetts over a 12-week period in the first quarter of 1987.

suggests that a structural model (such as ours) better represents the behavior of stations than reduced form models; therefore, the pooled OLS model can produce omitted-variable bias, which may affectc the size of the estimated coefficients. The price disclosure dummy coefficient is negative and significant. The Korean government implemented the price disclosure policy in May 2009, and the policy required that refiners reveal their weekly wholesale prices to the public to promote market competition through transparency. Our result suggests that the policy was effectively implemented: retail prices decreased by about 39 won per liter after it was implemented. Other model specifications in Table 8 and Table 9 produced similar results regarding the impact of the price disclosure policy. The number of gas stations within 50 m, 1 km, and 2 km geographical radii had negative and statistically significant effects on price level. This suggests that an increase in the number of gas stations heightens the overall degree of competition. Crude oil price (OIL PRICE) has a positive effect on retail gasoline price, as expected. In Table 9, we used the percentage of unbranded stations as a measure of competition; the other variables used are the same as those in Table 8. It was found that an increase in the proportion of stations selling unbranded gasoline lowered gasoline price within a radius of market competition. Thus, given the same number of stations within a certain geographical boundary, the composition of stations can affect their pricing behavior. The results of the other variables in the model are very similar to those in Table 8. The impact of ownership structure and station characteristics is quite robust to model specifications. In Table 10, we used an interaction term between the proportions of unbranded stations with the branded station dummy variable to investigate how the proportion of unbranded stations influences the pricing behavior of branded stations. The interaction term's coefficient is negative and statistically significant. Hence, the pricing of branded stations becomes more aggressive as unbranded stations become more densely distributed within a certain geographical radius forming the competition boundary.

〈Table 8〉 Empirical Results: Specification 1

Variable	Pooled OLS	Spatial 500 m	Spatial 1 km	Spatial 2 km
Constant	1,088.80 (6.87)***	1,092.15 (6.79)***	1,089.90 (6.85)***	1,062.39 (7.21)***
SKE	28.20 (2.89)***	23.82 (2.51)***	19.43 (2.89)***	34.61 (3.39)***
SOL	-18.40 (3.38)***	-21.86 (2.56)***	-14.65 (3.34)***	-5.31 (4.39)
HDO	-15.20 (3.37)***	-28.22 (2.48)***	-13.37 (3.33)***	-2.28 (3.93)
UBR	-70.80 (6.06)***	-70.91 (5.22)***	-70.22 (4.06)***	-49.13 (6.85)***
Directly owned	-14.60 (1.61)***	-14.70 (1.61)***	-11.55 (1.60)***	-13.08 (1.61)***
Car wash	18.30 (1.26)***	17.17 (1.26)***	15.59 (1.26)***	16.95 (1.26)***
Charging station	-3.30 (2.42)	-2.91 (2.42)	-6.54 (2.40)***	-4.14 (2.42)*
Repair service	-5.40 (1.32)***	-5.16 (1.32)***	-4.29 (1.30)***	-4.42 (1.31)***
Convenience store	-5.20 (1.78)	-0.55 (1.77)	-4.32 (1.76)**	-2.87 (1.77)
Premium gasoline	45.90 (1.29)***	44.72 (1.29)***	40.60 (1.30)***	42.88 (1.30)***
Bonus card	16.40 (2.39)***	5.78 (2.26)**	2.95 (2.44)	18.93 (2.42)***
Gift card	21.70 (1.65)***	20.42 (1.64)***	20.22 (1.63)***	21.07 (1.65)***
Self	-56.10 (2.40)***	-56.21 (2.39)***	-57.06 (2.38)***	-56.96 (2.39)***
No of stations within a 500 m radius	-	-12.06 (0.98)***	-	-
No of stations within a 1 km radius	-2.90 (0.43)***	-	-4.99 (0.43)***	-
No of stations within a 2 km radius	-	-	-	-1.08 (0.16)***
Lagged Price	-	0.01 (0.001)***	0.03 (0.001)***	0.03 (0.002)***
Oil Price	6.10 (0.03)***	6.05 (0.04)***	5.96 (0.04)***	5.93 (0.05)***
Price Disclosure (May 2009 and on)	-39.50 (3.17)***	-39.37 (3.16)***	-38.85 (3.13)***	-38.57 (3.16)***
t	16.80 (0.56)***	16.73 (0.56)***	16.38 (0.55)***	16.30 (0.56)***
t^2	-0.30 (0.01)***	-0.31 (0.01)***	-0.30 (0.01)***	-0.30 (0.01)***

Note: (1) The numbers in parentheses are p-values. (2) * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

〈Table 9〉 Estimation Results: Specification 2

Variable	Pooled OLS	Spatial 500 m	Spatial 1 km	Spatial 2 km
Constant	1,089.90 (6.68)***	1,084.35 (6.77)***	1,089.04 (6.69)***	1,091.75 (6.66)***
SKE	25.60 (2.29)***	25.56 (2.33)***	17.16 (2.38)***	24.94 (2.29)***
SOL	-11.20 (1.96)***	-9.15 (1.99)***	-10.43 (1.96)***	-7.34 (1.95)***
HDO	-23.00 (1.96)***	-20.72 (1.98)***	-22.57 (1.96)***	-21.87 (1.94)***
UBR	-43.70 (3.89)***	-54.40 (3.90)***	-50.35 (3.90)***	-37.38 (3.88)***
Directly owned	-15.30 (1.59)***	-15.38 (1.60)***	-14.20 (1.59)***	-13.35 (1.58)***
Car wash	16.60 (1.24)***	17.01 (1.26)***	14.51 (1.25)***	16.21 (1.23)***
Charging station	-5.50 (2.40)**	-4.54 (2.42)*	-7.94 (2.39)**	-4.45 (2.37)*
Repair service	-4.40 (1.30)***	-5.83 (1.32)***	-4.54 (1.29)***	-5.25 (1.29)***
Convenience store	-1.00 (1.76)	-0.18 (1.77)	-1.59 (1.75)	-1.25 (1.74)
Premium gasoline	42.40 (1.29)***	43.44 (1.30)***	39.59 (1.30)***	39.37 (1.28)***
Bonus card	8.30 (2.18)***	7.11 (2.23)***	-2.04 (2.31)	6.63 (2.18)***
Gift card	21.60 (1.63)***	21.83 (1.64)***	20.41 (1.63)***	23.46 (1.62)***
Self	-55.80 (2.38)***	-57.39 (2.40)***	-56.20 (2.37)***	-55.90 (2.36)***
% of unbranded within a 500 m radius	-	-0.60 (0.04)***	-	-
% of unbranded within a 1 km radius	-1.20 (0.05)***	-	-1.17 (0.05)***	-
% of unbranded within a 2 km radius	-	-	-	-2.37 (0.08)***
Lagged Price	-	0.01 (0.001)***	0.01 (0.001)***	0.02 (0.002)***
Oil Price	6.10 (0.04)***	6.07 (0.04)***	6.01 (0.04)***	6.08 (0.04)***
Price Disclosure (May 2009 and on)	-39.50 (3.14)***	-39.36 (3.17)***	-39.14 (3.13)***	-39.65 (3.11)***
t	16.70 (0.56)***	16.72 (0.56)***	16.53 (0.55)***	16.75 (0.55)***
t^2	-0.30 (0.01)***	-0.30 (0.01)***	-0.30 (0.01)***	-0.30 (0.01)***

Note: (1) The numbers in parentheses are. (2) * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

〈Table 10〉 Estimation Results: Specification 3

Variable	Pooled OLS	Spatial 500 m	Spatial 1 km	Spatial 2 km
Constant	1,088.40 (6.75)***	1,088.17 (6.77)***	1,090.96 (6.72)***	1,067.67 (6.77)***
SKE	30.60 (2.36)***	24.46 (2.33)***	19.90 (2.39)***	33.19 (2.36)***
SOL	-11.50 (1.98)***	-10.35 (1.98)***	-10.93 (1.96)***	-8.49 (1.97)***
HDO	-22.40 (1.98)***	-20.30 (1.98)***	-22.32 (1.96)***	-20.56 (1.97)***
UBR	-79.60 (7.17)***	-67.03 (5.19)***	-71.36 (7.09)***	-48.54 (8.25)***
Directly owned	-14.90 (1.61)***	-13.72 (1.61)***	-11.86 (1.59)***	-12.92 (1.59)***
Car wash	18.40 (1.26)***	17.00 (1.26)***	15.55 (1.25)***	17.11 (1.25)***
Charging station	-3.20 (2.42)	-3.39 (2.42)	-6.53 (2.39)***	-3.49 (2.41)
Repair service	-5.10 (1.32)	-4.81 (1.32)***	-4.16 (1.30)***	-4.40 (1.31)***
Convenience store	-2.30 (1.78)	-2.18 (1.77)	-3.98 (1.76)**	-2.44 (1.76)
Premium gasoline	46.10 (1.29)***	44.43 (1.30)***	40.73 (1.30)***	43.40 (1.29)***
Bonus card	14.70 (2.27)***	8.06 (2.23)***	1.61 (2.33)	16.32 (2.27)***
Gift card	21.30 (1.65)***	20.00 (1.64)***	20.02 (1.63)***	20.15 (1.64)***
Self	-55.80 (2.40)***	-57.27 (2.50)***	-56.79 (2.37)***	-56.25 (2.39)***
% unbranded stations within 500 m * branded	-	-9.51 (0.65)***	-	-
% unbranded stations within 1 km * branded	-2.50 (0.22)***	-	-5.02 (0.24)***	-
% unbranded stations within 2 km * branded	-	-	-	-1.26 (0.08)***
Lagged Price	-	0.01 (0.001)***	0.02 (0.001)***	0.03 (0.001)***
Oil Price	6.10 (0.04)***	6.05 (0.05)***	5.96 (0.04)***	5.93 (0.03)***
Price Disclosure (May 2009 and on)	-39.50 (3.17)***	-39.31 (3.16)***	-38.87 (3.14)***	-38.64 (3.16)***

Note: (1) The numbers in parentheses are standard errors. (2) * significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

V. Conclusion

In this paper, we analyze competition among service stations in the Seoul gasoline market. For this purpose, we consider spatial differentiation as a source of product differentiation and introduce a spatial lag in the price reaction function to avoid misspecification. We also analyze the structure of vertical relationships between refiners and service stations and the impact of service stations characteristics on market competition. Our results indicate that vertically integrated stations charged lower prices than nonintegrated stations. From the perspective of competition policy, the efficiency of vertical integration should not be underestimated, despite the possibility that integrated stations may play an exclusive role for potential entrants in retail markets. Results indicate that unbranded stations not only price more competitively but also induce branded stations to charge more competitive prices. It is inferred that gasoline consumers are more sensitive to prices than toother gasoline characteristics. Therefore, the proliferation of unbranded stations can contribute to increasing competition in gasoline markets. Regarding the government's price disclosure policy, we determine that it did meet its original intent to promote greater market competition, given that the retail price of gasoline decreased following the implementation of the policy. It is difficult to judge whether price transparency can ultimately play a role in promoting competition or collusion, but in our case, it contributed to retailers gaining more bargaining power in price negotiation with refiners, causing an eventual increase in retail prices.

[References]

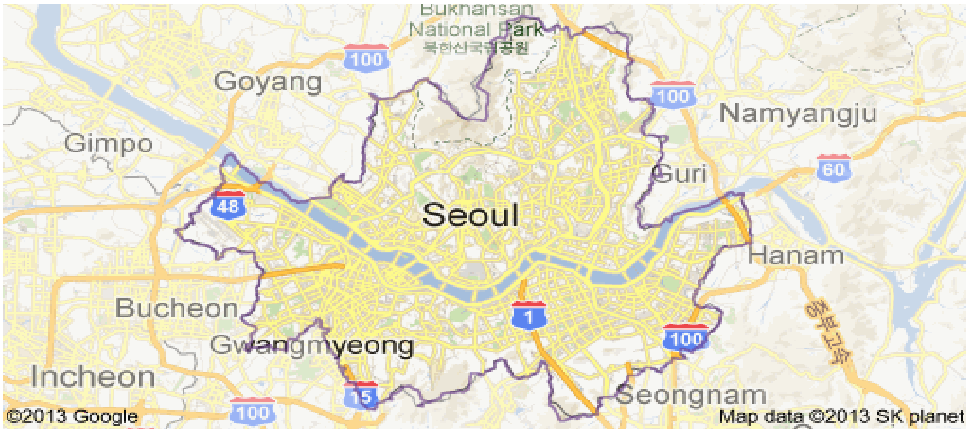
1. Barron, J. and J. Umbeck, 1984, *The Effects of Different Contractual Arrangements: The Case of Retail Gasoline Markets*. Journal of Law & Economics, Vol. 27, pp. 313 ~28.

2. Bello, A. and Sandra Cavero, 2008, *The Spanish retail petroleum market: New Patterns of Competition Since the Liberalization of the Industry*. Economic Policy Vol. 36, pp. 612～626.
3. Clemenz, G. and K. Gugler, 2006*, Locational Choice and Price Competition: Some Empirical Results for the Austrian Retail Gasoline Market*. Empirical Economics, Vol. 31, pp. 291～312.
4. Houde, Jean-Francois, 2012, *Spatial Differentiation and Vertical Mergers in Retail Markets for Gasoline*. American Economic Review, Vol. 102, No. 5, pp. 2147～2182.
5. Kalnins, Arturs, 2003, *Hamburger Prices and Spatial Econometrics.* Journal of Economics and Management Strategy, Vol. 12, No. 4, pp. 591～616.
6. Manuszak, Mark D., 2010, *Predicting the Impact of Upstream Mergers on Downstream Markets with and Application to the Retail Gasoline Industry*. Industrial Journal of Industrial Organization, Vol. 28, pp. 99～111.
7. Mollgaard and Overgaard, 2006. *Transparency and Competition Policy, in Pros and Cons of Information Sharing.* Stockholm, Swedish Competition Authority.
8. Nahm, J. H. and S. A. Oh, *The Effects of Vertical Relation on Price Competition in Retail Gasoline Markets in Seoul*. Korean Journal of Industrial Organization, Vol. 18, No. 2, pp. 19～41.
9. Netz, Janet S. and Beck A.Taylor, 2002, *Maximum or Minimum Differentiation?: Location Patterns of Retail Outlets*. Review of Economics and Statistics, Vol. 84, No. 1, pp. 162～175.
10. OECD, 2001, *Report on Price Transparency*. Paris.
11. OECD, 2010, *Report on Information Exchange between Competitors Under Competition Law*. Paris.
12. Pennerstorfer Dieter, 2009, *Spatial Price Competitionin Retail Gasoline Markets: Evidence from Austria*. Annals of Regional Science, Vol. 43, pp. 133～158.
13. Pinkse, Joris and Margaret E. Slade, 2004, *Mergers, Brand Competition, and the Price of a Pint*. European Economic Review, Vol. 48, pp. 617～643.
14. Pinkse, Joris, Margaret E. Slade, and Craig Brett, 2002, *Spatial Price Competition: A Semiparametric Approach*. Econometrica, Vol. 70, pp. 1111～1153.
15. Phlips, Louis, 1988, *The Economics of Imperfect Information*. Cambridge University Press.

16. Shepard, Andrea, 1993, *Contractual form, retail price, and asset characteristics in gasoline retailing*. Rand Journal of Economics, Vol. 24, No. 1, Spring pp. 58～77.
17. Slade, M., 1987, *Interfirm Rivaly in a Repeated Game: An Empirical Test of Collusion*. Journal of Industrial Economics, Vol. 35, pp. 499～516.
18. Slade, M., 1992, *Vancouver's Gasoline-Price Wars: An Empirical Exercise in Uncovering Supergame Strategies*. Review of Economic Studies, Vol. 59, pp. 257～276.
19. Slade, M., 1996, *Multitask Agency and Contractual Choice: An Empirical Exploration*. International Economic Review, Vol. 37, pp. 456～486.
20. Spengler, J., 1950, *Vertical Integration and Antitrust Policy*. Journal of Political Economy, Vol. 58, pp. 347～52.
21. Tirole, J., 1988, *The Theory of Industrial Organization*. Cambridge: MIT Press.
22. Vita, M. G., 2000, *Regulatory Restrictions on Vertical Integration and Control: The Competitive Impact of Gasoline Divorcement Policies*. Journal of Regulatory Policies, Vol. 18, No. 3, pp. 217～233.

[Appendice]

〈Figure a1〉 Map of Seoul Metropolitan Area



〈Figure a2〉 Districts in Seoul

〈Table a1〉 Number of Service Stations

Year	Month	Total	GSC	SKE	SOL	HDO	ETC
2008	4	448	114	225	38	65	6
2008	5	448	110	227	40	64	7
2008	6	453	112	231	38	65	7
2008	7	461	121	230	38	64	8
2008	8	472	122	233	42	67	8
2008	9	474	125	232	42	67	8
2008	10	478	128	235	40	67	8
2008	11	478	128	235	40	67	8
2008	12	477	128	235	39	67	8
2009	1	488	132	237	41	70	8
2009	2	494	131	241	43	70	9
2009	3	495	132	239	45	70	9
2009	4	497	131	240	47	70	9
2009	5	507	132	246	49	70	10
2009	6	509	132	246	51	70	10
2009	7	530	141	253	54	72	10
2009	8	537	144	254	56	73	10
2009	9	544	146	257	56	75	10
2009	10	546	146	257	57	76	10
2009	11	557	150	261	58	77	11
2009	12	561	150	261	59	78	13
2010	1	564	150	262	61	78	13
2010	2	572	151	262	64	80	15
2010	3	579	154	263	65	81	16
2010	4	584	156	263	65	81	19
2010	5	587	156	265	65	81	20
2010	6	602	159	270	69	84	20
2010	7	628	175	275	70	87	21
2010	8	638	180	277	74	85	22
2010	9	641	184	275	73	86	23
2010	10	651	187	277	75	88	24
2010	11	669	193	280	79	93	24
2010	12	689	201	283	82	98	25
2011	1	707	208	286	85	101	27
2011	2	717	211	291	85	101	29

〈Table a2〉 Monthly Averages of Gasoline Prices (Won/Liter)

Year	Month	GSC	SKE	SOL	HDO	ETC
2008	4	1745.4	1767.5	1734.4	1738.2	1715.1
2008	5	1853.6	1869.6	1842.7	1842.5	1807.3
2008	6	1957.1	1974.8	1943.9	1948	1897.3
2008	7	1992.8	2007.5	1973.9	1978.2	1919.5
2008	8	1838.7	1854.8	1819	1824.4	1773.5
2008	9	1805	1820.4	1785.8	1784.4	1732.7
2008	10	1750.8	1762.4	1731.8	1734.5	1673.6
2008	11	1526.5	1534.7	1517.2	1515.9	1467
2008	12	1373.9	1389.3	1358.4	1355.5	1308.1
2009	1	1443.9	1463.6	1415.9	1412.4	1361.7
2009	2	1579	1593	1554.7	1550.6	1505.9
2009	3	1591.5	1619.4	1577.9	1570.5	1525
2009	4	1607.9	1638.8	1594.5	1590.8	1543.1
2009	5	1608.2	1635.3	1589	1586.8	1540.1
2009	6	1694.1	1712.7	1675.7	1667.5	1625.1
2009	7	1698.6	1712.3	1682.3	1675.7	1630.7
2009	8	1746.8	1768.7	1720.4	1719.5	1665.1
2009	9	1745.1	1764.1	1721	1719.7	1658
2009	10	1691.3	1704.5	1665.1	1659.1	1607.2
2009	11	1732.4	1745.5	1701.1	1696.3	1651.3
2009	12	1716.9	1732.2	1689.2	1678.6	1626.1
2010	1	1740.5	1762	1713.1	1701.9	1652.8
2010	2	1741.2	1757.1	1713.5	1700.8	1644
2010	3	1768.4	1790.3	1740.9	1729.4	1680.2
2010	4	1791.1	1816.9	1770	1759.8	1702.9
2010	5	1785.2	1805.8	1768.1	1760.4	1699.6
2010	6	1776.3	1800.6	1751	1748.8	1692.6
2010	7	1782.8	1801.5	1759.6	1754.1	1696
2010	8	1779.4	1797.2	1751.6	1750.4	1686.8
2010	9	1763	1778.7	1736.8	1732.7	1664.6
2010	10	1766.2	1781.8	1737.2	1727.8	1660.1
2010	11	1783.9	1799.1	1753.8	1742.9	1682.5
2010	12	1842.8	1863.6	1814.1	1807.2	1745.8
2011	1	1888.9	1906	1863	1857.1	1798.6
2011	2	1907.7	1925.5	1885.3	1882.3	1819.7
Average Price (standard deviation)	-	1744.52 (139.1)	1758.76 (143.0)	1726.80 (133.7)	1716.53 (138.0)	1676.88 (112.21)