

Reform in a Differentiated-Product Industry: The Case of the Korean Cigarette Manufacturing Industry

Heechul Min*

This paper explores the ramifications of privatization and deregulation in a differentiated-product industry. The analysis focuses on the change in firms' product portfolio and pricing policy. Using product-level data on the Korean cigarette manufacturing industry, which underwent major reform recently, a random-coefficient discrete choice model is estimated to approximate substitution patterns among cigarette products. The findings are as follows. First, in the post-reform period, new products are significantly less price-elastic than existing ones; however, no such relationship is found in the pre-reform period. Second, data in the pre-reform period is not consistent with firm-level profit maximization mainly due to the failure to internalize within-firm substitution. In the post-reform period, however, partial evidence supports the view that pricing of new products is compatible with firm-level profit maximization. Overall, the analysis suggests that firm efficiency improves in the post-reform period through the introduction of profitable products and the proper pricing of these products.

JEL Classification: D43, L13, L33

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I. Introduction

Economic literature provides plenty of evidence stating that privately owned firms are more efficient and more profitable than comparable state-owned firms. Megginson and Netter (2001) report an extensive survey of empirical papers comparing both types of ownership. Dewenter and Malatesta (2001) find that, in terms of return on assets, state-owned enterprises listed among 500 largest non-US firms are less profitable than private firms on the same list. Megginson, Nash, and van Randenborgh (1994) compare the pre- and post-privatization financial

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* Department of Economics, Hansung University, 389 Samseon-dong 3-ga, Seongbuk-gu, Seoul 136-792, Korea. E-mail: hmin@hansung.ac.kr. This research was financially supported by Hansung University. I am indebted to two anonymous referees for their valuable comments and suggestions. However, I retain responsibility for any remaining errors.

performances of 61 companies from 18 countries and document strong performance improvements. Based on Korean case studies, Min (2009) investigates the effects of the privatization program on firm profitability and finds that privatization improves return on assets. Literature on privatization is mostly concerned with financial performance and largely ignores implications in a differentiated-product industry.

Product differentiation raises two significant issues. One is the welfare effect of product variety. If consumers value product variety, privatization may benefit consumers further by making more diverse products available through new entries (Anderson, de Palma, and Thisse 1997). In addition, the welfare of consumers may improve or deteriorate depending on the quality change. The other issue is evaluating market competitiveness or firm conduct. Privatization usually comes with other policies of promoting competition. Privatized firms often used to be a monopoly protected by law, and would exist as private monopolies without concurrent competition-enhancing policies. In addition, competition facilitates monitoring possibilities that serve as incentives for productive efficiency (Vickers and Yarrow 1991). However, evaluating the market power in a post-privatized industry becomes more subtle because of product differentiation. In a differentiated industry, not all price-cost margins are attributed to collusive behavior. This means that high price-cost margin may not be due to the lack of price competition but due to consumers' willingness to pay for their favorite brands as well as to pricing decisions made by firms that take into account substitution between their own brands (Nevo 2001). Thus, ignoring product differentiation understates the competitiveness of the privatized industry.

Both welfare effects and firm conduct are essential elements in policy discussions on privatization and deregulation. However, this paper does not discuss the welfare change following the reform, which can be viewed as a limitation. The estimated consumer choice model can be used to compute a change in the consumer welfare measure, such as compensating variations. However, the welfare measure can be misleading unless the negative externalities from smoking are properly taken into account. Furthermore, the concept of social welfare is deemed highly controversial in the case of cigarettes given that many experts view the product as "demerit good" or simply as "bads." Therefore, this paper focuses on drawing implications regarding firm behavior after privatization and deregulation.

Cigarette manufacturing in the Republic of Korea (hereafter Korea) is a good example through which to examine privatization and deregulation in a differentiated industry. The Korean cigarette manufacturing industry features many differentiated brands and has recently experienced a series of reform policies. The reform program includes privatizing the state-owned monopoly, deregulating prices, and allowing the local production of foreign manufacturers. Although such reform programs are conceptually different, it is difficult to separately investigate each of the concurrent policies with only a single industry case. Therefore, this paper looks

into the overall effects of reform policies. It is also possible that the change between the pre- and the post-reform periods results from sources other than privatization and deregulation. Although these are the most prominent events of the industry during the sample period, the possibility that other factors are in operation cannot be completely ruled out. Such limitation comes from the fact that this paper compares the pre- and the post-reform outcomes in a single industry.

This paper examines the change in firms' product portfolios and the pricing policy in the post-reform period. It aims to show that firms adjust their product lines and pricing decisions in a way that enhances firm efficiencies. The analysis compares quantities of interest before and after reform. The challenge herein lies in estimating a large number of substitution parameters implied by many products in the cigarette industry. This challenge is addressed by adopting a random-coefficient discrete choice model proposed by Berry, Levinsohn and Pakes (hereafter BLP 1995), which allows flexible substitution patterns among products. Demands for cigarette products are estimated using the annual data on prices, quantities, and characteristics of cigarette products from 1997 to 2005. Based on the estimated model, own- and cross-elasticities are computed and compared among product groups. Newly-added products are significantly less price-elastic than the existing products in the post-reform period. However, in the pre-reform period, the difference is not statistically significant. The pattern implies that the firms begin to introduce more profitable products only after undergoing reform.

Next, in order to compare alternative assumptions of pricing behavior, a model selection test proposed by Rivers and Vuong (2002) is utilized in the process of choosing non-nested competing models. Firm-level profit maximization is rejected in favor of a hypothesis stating that firms price each product as if it is a single-product firm. The results also implicitly reveal that cigarette makers in the Korean market price their products while largely ignoring the within-firm substitution. However, partial evidence is presented, indicating that firms also consider within-firm substitution in pricing new products in the post-reform period.

The present paper adds to the literature by exploring the implications of privatization and deregulation in a differentiated-product industry, which are largely ignored in existing literature. This paper shows that both product mix and pricing behavior are important aspects of a firm's response to privatization and deregulation, and that the accompanying changes are consistent with increased efficiency. Therefore, a product differentiation is introduced in the analysis, along with the mechanisms through which firm efficiency improves as documented in the literature. This paper is organized as follows. Section II provides a brief institutional overview of the cigarette manufacturing industry of Korea. Section III details the data set and the empirical model. Results are presented and discussed and robustness is checked in Section IV. Section V concludes the paper.

II. Cigarette Manufacturing in Korea

According to a previous study, 99.7% of tobacco is consumed as filter-tipped cigarettes in Korea (Park 2009). The other types of tobacco products, such as cigars, pipes and smokeless tobacco, are very rare in the market, and can be omitted when analyzing demands for cigarettes in Korea.

Domestic consumption of cigarettes reached US\$ 94 billion in 2005 and approximately US \$10 billion in terms of retail value. The Korean cigarette market is deemed as one of the most lucrative in the world due to its high smoking incidence and to the local market's growing preference for "premium" brands.¹ According to Shafey, Eriksen, Ross and Mackay (2009), the male smoking prevalence in Korea is 53.3%, placing the country as the 19th out of 164 countries whose data are available. The "premium" brand segment, which takes up 68.5% of the domestic market in 2005,² explains the high level of market engagement by international makers.

Originally a state-owned monopoly, KT&G has long dominated the national market. However, it was not until the late 1990s that the industry witnessed significant changes in the competition environments. In 1999, KT&G was listed in the stock market and became fully privatized in 2002 when the government sold its remaining shares. In 2001, the Tobacco Business Act was amended, granting local production licenses to any company that meets predetermined conditions, effectively abolishing the monopoly of KT&G. Accordingly, British American Tobacco (BAT) and Philip Morris (PM) established local factories and distribution systems. Japan Tobacco International (JTI), by contract, began to sell locally manufactured cigarette products. As a result, the combined market share of foreign makers rose from 6.5% in 1999 to 27.0% in 2005.

In addition, the amended act no longer allows the government to authorize cigarette prices, resulting in the official deregulation of cigarette prices. However, the deregulation seemed to produce only gradual effects. High-priced products were being introduced, whereas the (after-tax) prices of existing products remained largely unchanged. Of course, the government can still influence cigarette prices through its tax policies even after deregulation. The price of a typical product is 2,500 Won, of which 1,543 Won go to taxes of a sort or another. In 2006, the aggregate revenue from tobacco-related taxes amounted to US\$ 680 million, a figure similar to the nation's customs tariff revenue.

This paper analyzes the Korean cigarette market from 1997 to 2005, during which four manufacturers competed, namely, KT&G, BAT, PM, and JTI. One notable characteristic in this period is the growing popularity of low-tar and slim

¹ Tobacco Reporter Magazine, June 2006.

² See KT&G Annual Report, 2006.

cigarettes. In 2005, low-tar products accounted for 35.3% of the domestic market. Interestingly, Korea is one of the few markets in, which slim cigarettes are popular among male smokers. Preference for low-tar and slim cigarettes are partly due to the health concerns among consumers. Korean consumers seem to believe, possibly erroneously, that low-tar or slim cigarettes are less hazardous than regular ones. However, this paper is in no position to discuss whether or not there are any grounds for such belief. It is only clear that consumers regard cigarettes as differentiated products.

III. Model and Data

3.1. Model

A standard random-coefficient utility model is used to approximate substitution patterns among cigarette products. Consumers are assumed to choose one product among alternatives, including an outside option $j=0$. The conditional indirect utility of consumer i from product $j \in \{1, 2, \dots, J\}$ is given by:

$$U_{ij} = \alpha \log(y_i - p_j) + \sum_{k=1}^K \beta_k x_{jk} + \xi_j + \sum_{k=1}^K \sigma_k x_{jk} V_{ik} + \varepsilon_{ij}, \quad (1)$$

where x_{jk} is the observable characteristic k of product j , p_j is the price of product, ξ_j is the mean valuation of unobservable product characteristics, and ε_{ij} is a love-of-variety error term assumed to be independently and identically distributed across products and consumers. In addition, β_k and σ_k are the mean and the standard deviations, respectively, of the marginal utilities associated with characteristic k . A consumer chooses the outside option when she decides not to purchase any of the cigarette products.³ The consumer's utility from choosing the outside option is given by:

$$U_{i0} = \alpha \log(y_0) + \xi_0 + \sigma_0 V_{i0} + \varepsilon_{i0}. \quad (2)$$

Observed characteristics include tar concentration and cigarette diameter. With the increasing popularity of low-tar and slim cigarettes, those two characteristics served as the key dimensions of product differentiation with a highly strategic importance.

³ The mean utility of the outside option, ξ_0 , is not identified from the intercept in the utility function for the inside goods. Moreover, σ_0 is not separately identified from a random coefficient on the constant term for the inside goods. Thus, both are normalized to zero.

Both y_i and v_i are random variables capturing consumer heterogeneity. Following BLP (1995), y_i is interpreted as income and is assumed to have a log-normal distribution. The distribution parameters are estimated using household income per member in the Korea Labor and Income Panel Study (KLIPS). Here, v_i denotes consumers' heterogeneous taste, whose distribution is assumed to follow a standard normal truncated between 2.5% and 97.5% so that the distribution is bounded above and below.⁴

Some would challenge the validity of the assumption that consumers choose only one unit when they, in fact, choose multiple brands and consume continuously. The assumption of one-unit consumption can be partly defended by defining an appropriate choice-period (Nevo 2000). It is reasonable to presume that consuming multiple brands is only rare in the case of cigarettes. Yet, quantities of cigarette consumption among consumers may vary, making it difficult to accommodate the "multiple-discreteness" in the empirical model using only product-level data. Therefore, the current model is admittedly an approximation of the true consumer behavior.

The estimation method follows a standard procedure of estimating demands in a differentiated-product market. The data consists of the market shares, product characteristics, and prices. Given the data and the parameter, $\theta = (\alpha, \beta, \sigma)$, the fixed point algorithm, ξ_j , the mean valuation of unobservable characteristics for each product, j , is calculated. This is done so that the implied market shares are the same as the actual shares. Given that ξ_j is assumed to be uncorrelated with observed variables of cigarette products except for price, the optimal GMM estimator takes the form:

$$\hat{\theta} = \arg \min_{\theta} \xi(\theta)' Z \Psi^{-1} Z' \xi(\theta), \quad (3)$$

where Z is a set of instruments, and Ψ is a consistent estimate of $E(Z' \xi \xi' Z)$. BLP (1995) is used as basis to construct the instruments. Except for price, product j 's own characteristics are valid instruments, including tar concentration, a dummy for slim cigarettes, a dummy for ultra slim cigarettes, and a constant. The sum of the characteristic across rival firms and the sum of the characteristic k across other own-firm products are also included. Those instruments are derived from the fact that the pricing of product j is affected by the product's proximity in characteristic space to competing products and to its own-firm products. Hence, a total of 12 instruments are constructed.

Some studies, e.g., BLP (1995) and Petrin (2002), estimate the demand function jointly with the supply relation, similar to the one described above. This is possible because joint estimation enables the estimates to be more accurate with the help of

⁴ See Petrin (2002) for similar assumptions on consumer tastes.

additional moment conditions and cross restrictions on parameters. However, the advantage comes at the risk of assuming a wrong competition model. As long as the demand function is precisely estimated, estimates without an assumed specific model of supply is preferred. In Section IV, however, the joint estimation is used to compare the appropriateness of assumptions on the firm's pricing behavior. This approach is comparable to that used by Nevo (2001). The only difference lies on the preferred statistical test used to distinguish behavioral hypotheses.

3.2. Data

The data required to estimate the above model include market shares, prices, and product characteristics. Price and annual sales data from KT&G for products marketed in Korea, including foreign brands, during the period of 1997 to 2005 are used as basis. The data document tar concentration and cigarette thickness. The original data do not include prices of foreign brands before 2002 and are, therefore, complemented with information from government press releases and daily newspapers. With the exception of some unpopular brands, necessary information is retrieved. The difference between published prices and actual retail prices is not much of a concern because the law requires retailers to charge pre-determined prices but not perform any price-related promotion. Cross-sectional variation in prices is effectively removed.

The size of the market for cigarettes must be appropriately defined to compute market shares accurately. As Nevo (2000) points out, defining the market size is often tricky depending on the context and the specifics of the problem. The potential market size is assumed as one pack of cigarettes per day for an adult aged 15 and over. An alternative definition of the market size is drafted and the results, which do not present significant changes, are reported in Section VI.

Negligible brands with annual sales of 1,000 packs and below as well as a brand named Pine Tree of KT&G were excluded from the sample because prices of the negligible products were deemed unobtainable. In addition, during the sample period, the Pine Tree brand was supplied mainly in low-income and rural areas at a highly discounted price, presumably for policy considerations. The combined share of the selected sample, consisting of 91 brands and 407 brand-year pairs, ranged from 94.6% to 99.8% of the national market over the years. Thus, the sample is a fair representation of the Korean market.

Table 1 reports the summary statistics of key variables of the sample. Prices were adjusted for inflation using year 2005 CPI. The mean price was set to 1,895 Won, while the maximum and the minimum prices were 3,000 and 1,093 Won, respectively. As can be seen, there exists considerable variation in quantities sold across brands with the average of 107,000 packs and the standard deviation of 268,000 packs. The tar concentration also varies greatly across brands ranging from

1.0 to 10.0 mg. The thickness of cigarettes is classified into normal, slim, and ultra slim. The prevalence of slim-type cigarettes is notable, although its significance is exaggerated because the shares are not weighted by sales.

[Table 1] Summary statistics

Variables	Summary Statistics			
	Mean	Std. dev.	Min	Max
Price (1,000 Won)	1.895	0.406	1.093	3
Quantity sold (1,000 packs)	107	268	1	2,621
Tar (mg)	5.6	2	1	10
Thickness	Frequency (relative frequency)			
	Normal: 61 (15.0%),			
	Slim: 290 (71.3%),			
	Ultra slim: 56 (13.8%)			
No. of observations	407 brand-year pairs (91 brands)			

Change in product portfolio after privatization and deregulation was summarized using descriptive statistics. Table 2 illustrates a general trend of product characteristics over the sample period. The number of products more than doubled from 1997 to 2005, increasing steeply after 2001. Mean tar concentration fell, while its standard error went up, most notably after 2002. Such trends indicate that more diverse brands in terms of tar concentration are supplied, while low-tar products become dominant in the market. A similar pattern is found with regard to the cigarette diameter, but this is less noticeable than tar concentration.

[Table 2] Trends in brand characteristics

Year	# of Brands	Tar (mg)		Diameter (mm)	
		Mean	Std. dev.	Mean	Std. dev.
1997	32	6.35	1.16	7.66	0.17
1998	33	6.25	0.92	7.64	0.22
1999	33	6.15	0.84	7.56	0.35
2000	39	6.05	0.75	7.47	0.49
2001	41	5.97	0.82	7.37	0.65
2002	47	5.86	0.88	7.27	0.83
2003	54	5.15	2.26	7.17	0.97
2004	62	4.31	3.87	7.12	1.05
2005	66	4.13	4.44	7.11	1.05

Table 3 reports the share of products in a given year that have been introduced to the market during the last 4 years, both in terms of quantities and the number of products. The share of recently added products is quite considerable, suggesting an

active change in product mix. Notably, the share in product numbers rose from 29.3% in 2001 to 59.1% in 2005, and the share in quantities more than doubled from 22.6% in 2001 to 52.1% in 2005.

[Table 3] Share of products added during the last 4 years

Year (t)	Quantities	# of Products
2001	22.6	29.3
2005	52.1	59.1

Taken together, Tables 2 and 3 show that the product characteristics and the share of newly added products changed sharply around 2002. It is noticeable that the period also coincided with the privatization and deregulation of the market. This indicates that the change in policy seemed to have a deep impact on the way the cigarette manufacturers competed in the Korean market at that time.

IV. Results

4.1. Estimation

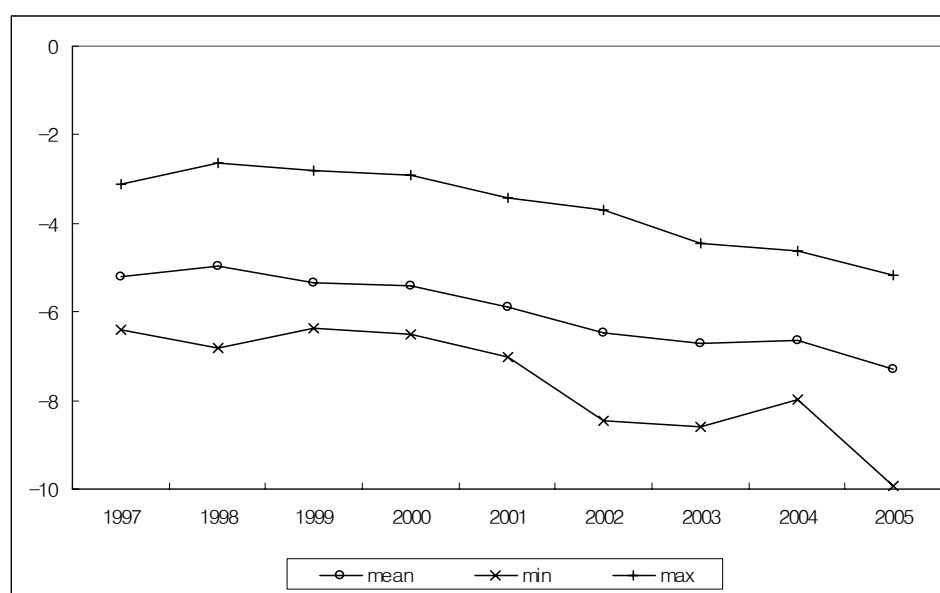
Table 4 reports the results for three different demand specifications, namely, MAIN, IV-Logit, and OLS. MAIN is the main empirical model described in the previous section and is estimated using Equation (3). Standard errors in the MAIN model due to the simulation process are corrected (BLP 1995). OLS has regressed $\log(\text{share})$ on independent variables; in addition, IV-Logit takes price as endogenous and uses the same instruments as MAIN. Moving from OLS to IV-Logit, sensitivity to price almost doubles, implying the considerable endogeneity of prices. The MAIN model is quite precisely estimated, such that most coefficient estimates are twice larger than the standard errors. Parameter estimates suggest that the average consumer considers tar as “bads” whereas 25% of consumers think otherwise. On the other hand, most consumers seem to prefer slimmer cigarettes with varying degrees. The J-statistic is 7.73 with a p-value of 0.17. Thus, the over-identification restrictions under a typical significance level cannot be rejected.

Figure 1 illustrates own-elasticities implied by the MAIN model. Individual products became more elastic over the sample period, thereby reflecting the intensified competition among brands. It might be interpreted as evidence for the merit of reform. The estimated own-elasticities range from -3 to -10. The present evidence is not consistent with most empirical studies stating that the demand for cigarette is inelastic (Chaloupka and Warner 2000). Naturally, the demand for an individual product is much more elastic than the industry demand.

[Table 4] Estimation result

		MAIN		IV-Logit		OLS	
		Estimate	Std. err.	Estimate	Std. err.	Estimate	Std. err.
α	Log(y-price)	98.48	19.41				
β	Price			-2.02	0.27	-1.14	0.22
	Tar	-0.78	0.36	-0.14	0.04	-0.07	0.04
	Diameter	-0.50	0.19	-0.30	0.10	-0.18	0.10
	Constant	9.01	2.42	0.76	1.16	-2.19	1.00
σ	Tar	1.17	0.44				
	Diameter	0.18	0.56				
	Constant	1.25	3.71				
J-statistic		7.73 (0.17)					

[Figure 1] Trends in own-elasticities



4.2. Restructuring Product-Mix

This subsection investigates how newly-added products differ from the existing ones in terms of own-elasticities, based on the estimated model in the previous subsection. The discussion aims to demonstrate the change in firms' strategies toward product mix.

Panel A of Table 5 compares own-elasticities of existing products and new products in each year. Products are defined as new if they appear in the sample for the first time in that year. Thus, the comparison is not available in 1997, which is

the first year in the sample. The first row (A) lists the average own-elasticities among the existing products, and the second row (B) has the average own-elasticities among new products. The differences between new and existing products are reported in the third row. The fourth row has the standard errors of the difference. Standard errors were computed after drawing 100 times from the estimated joint distribution of parameters, using a parametric bootstrap first reported in Nevo (2001). In most years, the difference is negative, indicating that new products, on average, have less elastic demands than existing ones. However, the difference is not statistically significant before 2002. The statistical significance is stronger from 2002 to 2003 (10% significance level) and from 2004 to 2005 (5% significance level).

Panel B compares about-to-exit products with remaining products in a similar way. A product is defined as about-to-exit if it appears in the sample for the last time in that year. No about-to-exit products are found in 1997 and 1999, and such products cannot be appropriately defined in 2005. The difference between remaining products and about-to-exit products is positive except in 2002. This indicates that about-to-exit products have relatively elastic demands. However, the difference is not statistically significant, except in 2002.

[Table 5] Comparing own-elasticities

PANEL A: New Products vs. Existing Products									
Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Existing(A)	na	-5.01	-5.36	-5.40	-5.91	-6.70	-6.88	-6.83	-7.48
New(B)	na	-4.38	-5.03	-5.45	-5.65	-5.53	-5.95	-6.01	-6.43
Diff (A-B)	na	-0.63	-0.33	0.05	-0.26	-1.17	-0.94	-0.82	-1.05
Std. err.	na	0.47	0.26	0.30	0.44	0.64*	0.54*	0.41**	0.48**
PANEL B: About-to-exit Products vs. Remaining Products									
Year	1997	1998	1999	2000	2001	2002	2003	2004	2005
Remain(A)	-5.20	-4.96	-5.34	-5.37	-5.84	-6.49	-6.62	-6.59	na
Exit(B)	-	-5.07	-	-6.07	-6.45	-6.17	-7.56	-7.07	na
Diff (A-B)	-	0.10	-	0.71	0.61	-0.32	0.94	0.48	na
Std. err.	-	0.18	-	0.38*	0.39	0.30	1.23	0.47	na

The above discussion shows the specific way, by which cigarette makers restructure their respective product mixes in response to recent reforms, although the pattern is more evident in new products than in about-to-exit ones. In an increasingly competitive market, firms naturally try to differentiate their products and maintain “customer loyalty.” One way to achieve such goal is to introduce price-inelastic brands and phase out price-elastic ones.⁵ In other words, firms must

⁵ Notice that products became more elastic over the sample period as shown in Figure 1; this reflects

continuously introduce profitable products into the market and retire the unprofitable ones. Such product portfolio strategy is reflected in the following quote from the 2003 annual report of KT&G: “We will continue to introduce differentiated brands that offer high profit margins and meet consumer demand for high quality products. Moreover, the restructuring of our product portfolio to focus on strategic brands will include the gradual phasing out of non-profitable brands. (...) Furthermore, we will be responsive to market demands, and continue to develop brands that meet consumers’ increasing preference for low-tar and slim-type cigarettes.” The empirical result strongly suggests that firms actively bring price-inelastic brands into the market; however, less compelling evidence is found with regards the retirement of price-elastic brands.

4.3. Pricing Behavior

This subsection compares the appropriateness of alternative models of supply conduct. The general strategies include the repeated joint estimations of the demand functions with each of the alternative supply models and the completion of a model selection test proposed by Rivers and Vuong (2002). They developed a general framework for choosing between possibly non-nested competing models. The test statistic is given by $N(r, s) = \sqrt{J}(F_r - F_s) / \hat{\sigma}$, where F_r and F_s are the GMM minimands for models r and s , respectively, and $\hat{\sigma}$ is the estimated standard error of the numerator.⁶ The test statistic follows the standard normal distribution under the null hypothesis stating that two models are equally distant from the true model. Model s is preferred to model r if $N(r, s)$ is sufficiently large, and vice versa.

Prior to presenting the test result, a brief explanation is provided regarding the process of pricing equations being jointly estimated with demand. Following BLP (1995), the following after-tax profit function of firm is considered:

$$\Pi_f = \sum_{j \in F_f} (\tilde{p}_j - mc_j) S_j(p, x, \xi, \theta) M,$$

the intensified competition. Therefore, introducing inelastic brands and phasing out elastic ones is compared to running faster to stay in the same place. On the other hand, product restructuring has ambiguous effects on consumers. It contributes to product variety but harms some consumers who prefer the retired brands.

⁶ Here, $\hat{\sigma}$ is computed from the following formula:

$$\hat{\sigma}^2 = 4 \left\{ \bar{m}(r)' Q \left(\frac{1}{J} \sum m_j(r) m_j(r)' \right) Q \bar{m}(r)' + \bar{m}(s)' Q \left(\frac{1}{J} \sum m_j(s) m_j(s)' \right) Q \bar{m}(s)' \right. \\ \left. - 2 \bar{m}(r)' Q \left(\frac{1}{J} \sum m_j(r) m_j(s)' \right) Q \bar{m}(s)' \right\},$$

where $m(i)$ is a vector of moments for model i , and Q is a weighting matrix.

where F_j is a set of products produced by firm f , \tilde{p}_j is a after-tax price of product j , mc_j is the marginal cost of product j , S_j is the market share of product j , and M is the market size. The marginal cost of product j is assumed to be written as $\log(mc_j) = T_j\gamma + \omega_j$, where T_j is a vector of observable cost-shifters. Then, the first order condition in a vector notation is given by:

$$S(p, x, \xi, \theta) - \Phi \Lambda (\tilde{p} - mc) = 0,$$

where Λ is a $J \times J$ matrix whose (j, r) element is $\Lambda_{jr} = -\partial S_r / \partial \tilde{p}_j$, and Φ is a $J \times J$ matrix corresponding to alternative assumptions on pricing behavior. The first order condition implies a pricing equation: $\log(\tilde{p} - (\Phi \Lambda)^{-1} S(p, x, \xi, \theta)) = T\gamma + \omega$. Moment conditions, in addition to the demand moments, are obtained given that ω is assumed to be uncorrelated with the instruments.

Note that by taking a different matrix Φ , a different pricing behavior is imposed on the model. Suppose, for example, that $\Phi_{jr} = 1$ if both products j and r are produced by the same firm; otherwise, $\Phi_{jr} = 0$. In this case, firms compete in the usual Bertrand-Nash fashion and maximize firm-level profits. If Φ is an identity matrix, it means that firms set the price of each product as if it is a single-product firm without considering substitution between their own products; as a result, such firms fail to maximize firm-level profits. If Φ is a matrix whose elements are all ones, then it means that the firms maximize the industry's joint profit.

First, three hypotheses are considered in terms of pricing behaviors: M1, M2, and M3. M1 is the hypothesis stating that firms acting as single-product firms fail to maximize firm-level profits. M2 means firm-level profit maximization. M3 describes a pricing behavior wherein firms maximize joint profits, corresponding to perfect collusion.

[Table 6] Specification test

	M1	M2	M3	M4	M5	GMM obj
M1						0.147
M2	5.42 (0.00)					343.250
M3	4.39 (0.00)	-3.55 (0.00)				151.709
M4	5.23 (0.00)	-5.37 (0.00)	-4.13 (0.00)			10.663
M5	0.81 (0.40)	-5.42 (0.00)	-4.39 (0.00)	-5.23 (0.00)		0.150
M6	4.88 (0.00)	-5.38 (0.00)	-4.11 (0.00)	0.90 (0.37)	4.79 (0.00)	11.097

Table 6 reports the test statistics and p-values following Rivers and Vuong (2002). At the far right column, the GMM minimand is also reported. The statistic in the r th row and j th column is $N(r, s) = \sqrt{J}(F_r - F_s) / \hat{\sigma}$, which compares model r against model s . A negative value in the table means the column model, r , is

preferred to the row model, s ; meanwhile, a positive statistic means the row model s is preferred. M1 is found to be superior to M2 and M3 because $N(M2, M1) = 5.416$ and $N(M3, M1) = 4.389$ with p-values smaller than 0.001. It is notable that the data reject the firm-level profit maximization M2 in favor of M1. Specifically, firms do not seem to take into account within-firm substitution. Ignoring within-firm substitution implies setting lower prices as can be shown using the first order condition in Equation (5). Therefore, prices are not high enough to be consistent with profit maximization, even less with the industry's joint profit maximization. This can be partly attributed to the fact that the sample included data from the pre-reform period, during which the prices of KT&G were officially regulated.⁷ The following discussion addresses refined assumptions on pricing.

The supply model is allowed to differ after 2002, during which a series of reform policies was completed. Thus, whether or not pricing behavior switched during the sample period can be tested. Two additional hypotheses on pricing behavior were considered: M4 and M5. M4 assumes that firms set prices as if they are single-product firms until 2002 and then engage in firm-level profit maximization after 2002, that is, M1 until 2002 and M2 after 2002. Table 6 shows that M1 is overwhelmingly preferred over M4 with $N(M4, M1) = 5.229$ and a p-value less than 0.001, thus rejecting the conjecture that deregulating prices may lead to firm-level profit maximization. Puzzling as it is, firms hardly re-price their existing cigarette products. According to Park (2009), cigarette makers change the prices of existing products for no other reason than of the regular increase in excise tax rates. The after-tax prices of existing products remained largely unchanged over the product's life cycle, even after prices were deregulated. Although cigarette makers seemed reluctant to mark up the price of existing products, they introduced high-priced new products instead. It is not clear whether such pricing is the result of the government's unofficial intervention or the firms' rational strategy in a more sophisticated demand specification.

Given the above discussion, it is natural to check whether price deregulation influences only new products in the post-reform period. M5 summarizes that idea, M2 is assumed for the products introduced after 2002, and M1 is assumed for other products. Table 6 reports that M5 is definitely superior to M2, M3, and M4 because the test statistics are -5.416, -4.389 and -5.227, respectively. All p-values are less than 0.001. The table also shows that $N(M5, M1) = 0.806$ and p-value is 0.420. Although the statistic is positive, a model cannot be rejected in favor of another. Therefore, M5 is statistically indistinguishable from M1, which is the most preferred pricing behavior thus far. Given that the comparison is indeterminate, M5 cannot be claimed as the most appropriate description of firms' pricing behavior. However, the

⁷ The Law states that cigarette makers should have its prices authorized by the government, but it is not clear how regulated prices are determined.

result partially supports the claim that firms began to rationalize pricing of new products after privatization and deregulation; during this time, cigarette makers introduced high-priced new products as a response to price-deregulation, and the pricing of new products was more consistent with firm-level profit maximization.

Finally, a hypothesis is added involving asymmetry among firms. All hypotheses from M1 to M5 treat the incumbent KT&G and foreign competitors equally. Given that KT&G was a state-owned enterprise until 2002, the incumbent may have had more restrictions on pricing behavior. M6 summarizes this idea and assumes that pricing behavior follows M1 only for KT&G until 2002 and M2 otherwise. Table 6 shows that M6 is not preferred over M1 or M5. No significant asymmetry is found in pricing behavior between the incumbent and foreign competitors.

4.4. Robustness

This subsection provides robustness checks, and explores whether parameter estimates are sensitive to different specifications. Column A in Table 7 allows $\beta_{constant}$ to change over years by including a dummy for the years 2000–2002 and another dummy for the years 2003–2005. This has been done so that the average preference for all cigarette products may change over time. Some would argue that the consumer preference for cigarette products waned over the sample period. Anti-smoking campaign would make consumers more conscious about tobacco's damage to health. In addition, non-tax policies, such as establishing smoke free zones, could effectively raise the cost of smoking, which would translate into high $\beta_{constant}$ in the model. The result in column A, however, shows that such argument does not change the estimation result significantly, because the coefficient estimates on year dummies are statistically insignificant.

Most BLP models do not include brand dummy variables or even firm dummies (BLP 1995, Petrin 2002).⁸ Brand dummies and firm dummies greatly weaken identification because the instruments are based on brand and firm identity. After estimating a model with firm dummies in order to control for unobserved characteristics unique to each manufacturer, we find that all the estimated coefficients for firm dummies are statistically insignificant, as shown in column B. In addition, the other estimates are comparable to the baseline estimates, although statistical significance has reduced.

Column C estimates the same demand function, but only with data from 1997 to 2003 rather than the full sample from 1997 to 2005. In the beginning of year 2005, the Korean government increased taxes on cigarettes by 500 Won, about 25% of the average current price. Some would argue that data in 2004 and 2005 were tainted by

⁸ Nevo's (2001) method is a rare exception with the help of three-way panel (over time, across products, and across cities) rather than the typical two-way panel.

stock-piling because the policy change was announced to the public in advance. Column C shows that even without data in 2004 and 2005, most parameter estimates are very similar to those generated by the MAIN model in Table 2.

Finally, column D reports the same demand estimation but with an alternative definition of market shares. Thus far, the potential market size has been assumed as one pack of cigarettes per day for each adult aged 15 and over. As Nevo (2000) suggest, it is advisable to check the sensitivity to alternative definitions. The difficulty of defining the market size often comes from computing the share of an outside good. In the case of cigarettes, however, the ratio of non-smokers may be used as a proxy for the share of an outside good. Thus, the market share of each product is calculated as $s_j = (q_j / \sum_r q_r) \times (1 - s_0)$, where s_0 is the ratio of non-smokers among the adult population. The estimation result using a new definition of the market share is reported in column D. The result is also very similar to that of the MAIN model shown in Table 2.

[Table 7] Robustness Checks

		A		B	
		Estimate	Std. err.	Estimate	Std. err.
α	Log(y-price)	97.45	31.68	89.27	44.10
β	Tar	-0.86	0.32	-0.72	0.82
	Diameter	-0.60	0.28	-0.58	0.47
	Constant	8.90	2.73	10.27	10.92
	Year00_02	0.54	0.48		
	Year03_05	0.44	0.84		
	Firm1			-1.49	4.12
	Firm2			-3.70	8.23
	Firm3			-1.06	2.30
σ	Tar	1.24	0.40	1.09	1.01
	Diameter	0.11	0.62	0.20	0.86
	Constant	1.45	4.23	1.37	7.40
J-statistic		5.53 (0.14)		6.62 (0.04)	

		C		D	
		Estimate	Std. err.	Estimate	Std. err.
α	Log(y-price)	84.15	21.00	88.84	37.31
β	Tar	-0.95	0.65	-0.90	1.31
	Diameter	-0.74	0.25	-0.60	0.28
	Constant	9.65	3.40	8.67	4.86
σ	Tar	1.32	0.63	1.30	1.24
	Diameter	0.10	0.49	0.10	0.69
	Constant	2.42	5.64	2.76	14.02
J-statistic		6.10 (0.30)		8.40 (0.14)	

V. Conclusion

This paper explores the ramifications of privatization and deregulation in a differentiated-product industry. Specifically, the analysis focuses on the change in firms' product portfolios and pricing policies induced by market liberalization. Economic literature provides much evidence stating that privately owned firms are more efficient and profitable than comparable state-owned firms. However, not much attention has been given to the implications in a differentiated-product industry. Ignoring product differentiation in the analysis of privatization is well-justified in some cases; however, this can be problematic in others. This paper demonstrates that privatization and deregulation induce firms in a differentiated industry to change product lines and pricing decisions in a way that enhances their efficiency.

Firms restructure their product portfolio after privatization and deregulation mainly by introducing price-inelastic new brands to the market. Low-tar and slim-type cigarettes are such products in the case of the Korean cigarette industry. In addition, pricing behavior does not internalize the within-firm substitution effects in the pre-reform period, although firms increasingly adopt more rational pricing for newly introduced products in the post-reform period. Taken together, the findings imply that firm efficiency is improved in the post-reform period through the introduction of profitable products and proper pricing of such products.

Two notable limitations found in this paper can be explored in future research. First, the welfare effects of privatization and deregulation are not discussed. This is mainly because measuring social welfare is very controversial given that cigarettes are believed to be "bads" that generate negative externalities. Welfare effects can be appropriately studied with more innocuous products. Second, the outcomes of a single industry before and after the reform are compared. Although privatization and deregulation are the most notable changes in the industry, the role of other concurrent factors cannot be ruled out completely. Thus, it would be helpful to extend analysis to other privatized industries.

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