Reliability Examination in Horizontal-Merger Price Simulations: An Ex-Post Evaluation of the Gap between Predicted and Observed Prices in the 1998 Hyundai–Kia Merger*

Job Market Paper

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Abstract

Horizontal-merger price simulations, which rely upon pre-merger data to predict post-merger prices, have been proposed and used in antitrust policymaking. However, a dearth of closely observed large mergers in differentiated-product industries makes empirical investigations of simulation performance extremely difficult, and raises many questions regarding the accuracy of simulation performance. Although a handful of previous studies exist, they focus on short-term simulation performances and ignore long-run effects of mergers. This research investigates the long-run simulation performance and long-run pricing effects of merger in the Korean automobile industry for the period 1991–2010. This period saw the merger of Hyundai and Kia Motors in 1998, a merger caused by the Asian economic crisis and which resulted in the conglomeration of 70 percent of the Korean automobile market. By taking Nevo's (2000, 2001) method as a base and measuring its performance against this real-world merger, I find that post-merger prices can be predicted reasonably well in the short term, but that large discrepancies appear in the long-run simulation. To account for this discrepancy, I confirm four further factors that appear essential to move toward a more accurate post-merger price simulation model: change in marginal costs, change in product lines, and change in consumer incomes and preferences. I counterfactually investigate each factor's contribution to price change, confirming their significance. In my investigation I estimate consumer preferences and substitution patterns leading up to the merger, then I calculate marginal costs, and simulate post-merger prices. In addition, I estimate automobile assembly plant-level production functions to evaluate merger synergy effects. By incorporating changes in the four factors I mention, I can account for 61 percent of the long-run price discrepancies.

Keywords and Phrases: Oligopoly, Differentiated Product, Horizontal Merger, Ex-Post Evaluation

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1 Introduction

Horizontal merger policy evaluations have been a central agenda in industrial organization. Not only have they served as an active field of research, but they also play a vital role in supporting antitrust policymaking. Because social welfare losses directly result from poor merger policy decisions, both academic researchers and antitrust agencies have paid significant attention to merger policy evaluations. In line with this social importance, economists have put an enormous amount of research effort into such various aspects as merger incentives, merger synergies, capacity expansions, and simulations for post-merger market consequences from both theoretical and empirical perspectives.

From an academic perspective, the horizontal merger analyses in homogeneous product industries have been a successful area wherein economic researchers have provided rich evaluation tools for both realized and potential mergers. Starting from a simple theoretical Cournot model (Salant, Switzer, and Reynolds, 1983) to a sophisticated dynamic model (Gowrisankaran, 1999), researchers are now well-equipped to investigate diversified aspects of horizontal mergers. In addition, a sizable body of literature represents retrospective studies on observed mergers in homogeneous product industries, including such industries as the US steel industry (Stigler, 1950), the Italian banking industry (Focarelli and Panetta, 2003), the European bottled water industry (Compete, Jenny, and Rey, 2002), and the U.S. feminine hygiene goods industry (Weinberg, 2011)[1].

In contrast, both the theoretical and the empirical literatures on horizontal mergers in differentiated-product industries are scant. In theoretical analysis, researchers inevitably characterize differentiated-product industries using Bertrand price competitions[2]. Since firms choose multiple prices, economic modeling analyses tend to be quite challenging[3]. In empirical analysis, differentiated-product firms tend to be either large-sized firms or firms that are locally concentrated, given their abilities to supply multi-differentiated products. As such, proposed mergers are likely to be challenged and blocked by local antitrust authorities[4][5]. Although researchers have proposed a small number of vital merger-evaluation tools, e.g. Nevo (2000, 2001), the dearth of empirical horizontal-merger observations in large differentiated-product industries inhibits investigation into these proposed tools' performance. The left side of Figure 1 depicts the fundamental difficulty in the empirical horizontal-merger literature. Since researchers cannot observe post-merger market consequences when mergers are blocked, they are unable to investigate the performances of Nevo's simulation method for these mergers[6]. Consequently, there are only a handful

[1] See Werden and Froeb (2008) for more homogeneous industry merger examples.

[2] Cournot quantity competition model cannot well-describe differentiated product industries, as it assumes centralized spot markets (or assumes the existence of market auctioneers) that provide prices for each differentiated product.

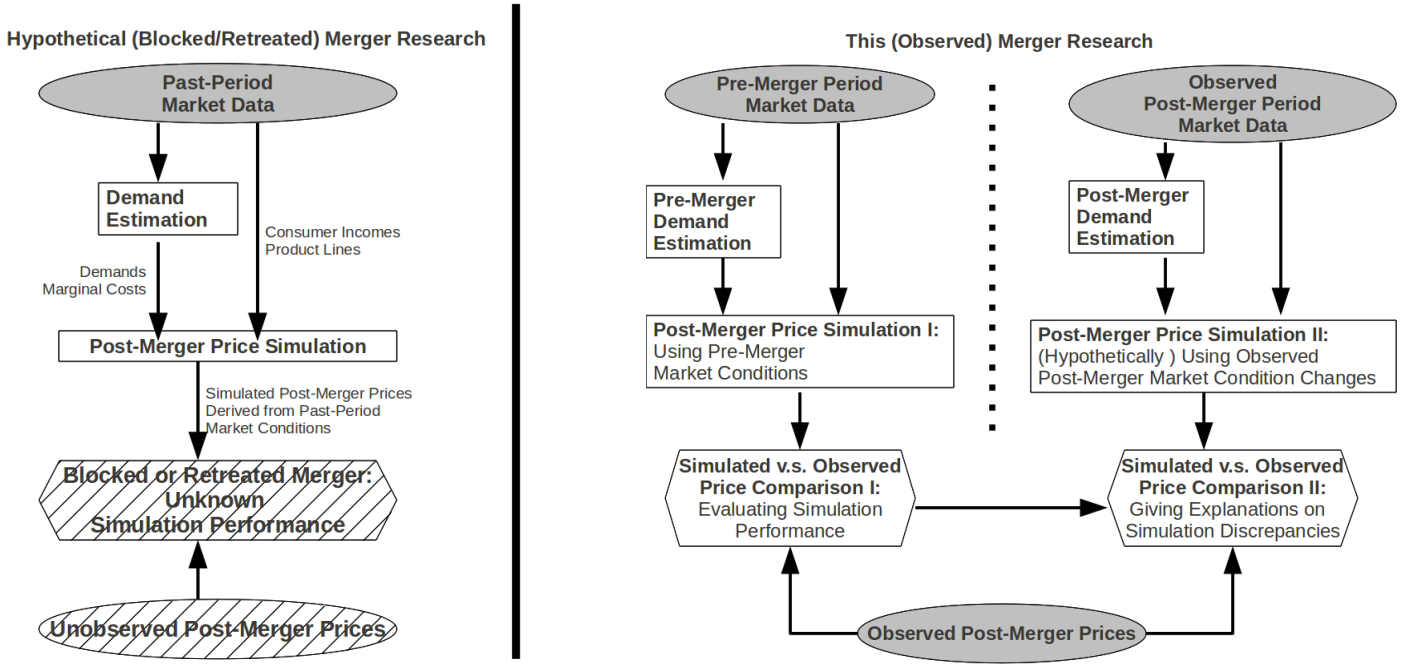
[3] The exception is a static Bertrand model in which researchers can derive first-order necessary conditions. This research relies on such a static Bertrand framework. Dynamic extensions of differentiated-product industry mergers are also challenging due to the emergence of multiple equilibria which compromises the models' policy implications.

[4] Such challenged or blocked merger examples in the United States in recent years include: Rite Ade–Reveco (1996, localized drug store industry), Staples–Office Depot (1997, localized office goods supply industry), Nestle–Dreyer's (2003, ice cream industry), Tenet–Slidell (2003, localized hospital industry), General Mills–Phillsbury (2001, baking ingredient industry), Air Products–L'Air Liquide (2000, industrial gas supplier industry), Fortune Brands–Allied Domecq (2005, premium bourbon industry). See more examples in the *Commentary on the Horizontal Merger Guidelines* by the U.S. Department of Justice and Federal Trade Commission (2006).

[5] Here exists another difficulty: Researchers usually obtain only price data in observed differentiated-product industry mergers. This presents a difficulty for empirical researchers who are unable to implement structural analyses that inevitably require sales quantity data. Empirical researchers try to use price-only data wisely to obtain merger-policy implications. See Ashenfelter, Hosken, and Weinberg (Working Paper) [3] for such use of price-only data.

[6] More precisely, an investigation on the simulation performance inevitably requires following conditions: (1) a merger was realized;

Figure 1: Left figure: Research with a blocked/retreated merger, Right figure: This research (outline)



of realized-merger case studies relating to differentiated-product industries that can be reliably used in antitrust policymaking.

Thus, in order to expand on the available literature regarding differentiated-product horizontal mergers, this paper investigates one specific merge that came from the Asian economic crisis[7]. Using a dataset that includes observations on post-merger market consequences, I evaluate the reliability of and potential improvements to Nevo's (2000, 2001) post-merger price simulation method[8]. In particular, I examine vehicle pricing in the Korean automobile industry for the period 1991–2010. This period saw a large horizontal merger between two differentiated-product firms, Hyundai and Kia Motors (in November 1998), a merger that conglomerated 70 percent of the Korean automobile market. The right side of Figure 1 outlines the framework of this research. First, I estimate consumer preference and substitution patterns leading up to the merger. Second, I calculate marginal costs under a static Bertrand price competition framework. Third, I use these estimated preference and calculated marginal costs to simulate post-merger prices. I find that one can reasonably predict post-merger prices well in the short term[9]; however, large discrepancies appear in the long run. Fourth, I use observed post-merger consumer incomes and preferences, marginal costs, and product lines to account for discrepancies between simulated and observed prices.

(2) both pre-merger and post-merger market data are available; (3) both price and sales quantity data are available; (4) post-merger data are observed for a long period to evaluate long-run impacts of realized merger.

[7] One can recognize the merger investigated in this research as a natural experiment caused by the Asian economic crisis in 1997.

[8] The post-merger price simulation method proposed by Nevo (2000, 2001) has two computational challenges: First, the problem of non-linear minimization search with the nested fixed point algorithms proposed by with Berry, Levinsohn, and Pakes (1995) [5]. The details and severity of this problem are discussed thoroughly by Knittel and Metaxoglou (2011 and working paper) [23] [22]. Second, the large dimensional non-linear simultaneous equation problem associated with post-merger price simulations. I avoid the first challenge by using the instrumental variable nested-logit model estimation in this research.

[9] In this research I avoid using the term "short run" since it generally assumes economic conditions remain unchanged. As explaining soon, the economic conditions (e.g. household income conditions) changed largely after the Hyudai–Kia merger.

It turns out that, by incorporating these observed post-merger information, I can account for 61 percent of long-run price discrepancies. By observing a large fraction of simulation discrepancies which one can account for in the observed post-merger information, this research suggests that when antitrust policy makers apply the results of simulations, they must take into account changes in factors which the simulation model takes as exogenous.

1.1 Literature

The recent literature on differentiated-product horizontal mergers evolves with the development of sophisticated differentiated-product demand estimation methods. Berry (1994) [4] and Berry, Levinsohn, and Pakes (1995, henceforth BLP) [5] propose differentiated product demand estimation methods that can be reliably used for horizontal-merger analysis. Nevo's research (2000, 2001) [31] [32] forms the corner-stone, wherein he proposes a simulation method that emphasizes changes in firm ownership, using the demand-estimation method that BLP proposed a few years earlier. Nevo's method provides the structural framework that enables us to derive post-merger prices using only pre-merger data and information on ownership transitions. Based on this seminal work, several analyses examining blocked mergers followed[10]. However, only two papers have applied Nevo's simulation framework to a differentiated-product industry merger that actually occurred in the real world. Nevo (2000) [31] investigates two mergers in the U.S. cereal industry. His study, however, only uses short-term post-merger data and is unable to investigate the long-run consequences of observed mergers. Peters (2006) [34] investigates five airline mergers observed in the United States during the 1980s, and he faced significant modeling difficulties[11]. By comparing simulated and observed short-term post-merger prices[12], Peters (2006) reports mixed results in simulation performance. In summary, the literature provides only two empirical case studies that investigate the short-term performance of the post-merger price simulation method, and leaving questions of its reliability[13]. This paper contributes to the literature by evaluating simulation reliability both in the short term and in the long run after the merger[14].

1.2 Settings and Organization of Paper

I apply four important settings throughout this paper. First, **all prices used in this research are adjusted for inflation** using Korea's consumer price index[15]. Second, I uniformly applied a **1,000 won = 1 U.S. dollar ex-**

[10] For example, Dube (2005) [12] investigates the attempted but blocked mergers between Coca Cola–Dr. Pepper and Pepsi–7Up. Fan (Working paper) [13] examined a blocked merger in the Minneapolis local newspaper industry. Ivaldi and Verboven (2005) investigate the attempted but blocked merger between heavy truck manufacturers in Europe, Volvo and Scania. Grzybowski and Pereira (2007) studied the attempted merger between the Portuguese mobile telephone service providers, TMN Mobile and Optimus Mobile.

[11] I recognize the difficulty of applying demand estimation and supply-side modeling to the airline industry. Any consumer demand model has to include both hub and spoke airport demands. Any supply-side model must include complicated pricing systems such as mileage points, first versus economy class price differences, and early ticket purchase discounts.

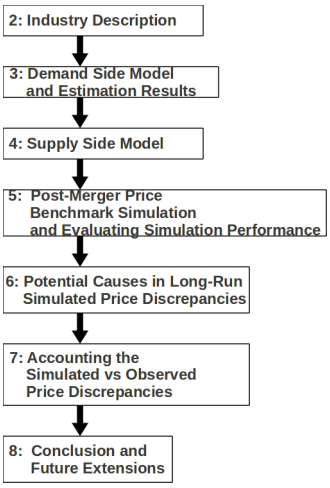
[12] Peters (2006) compares simulated prices and prices that were observed one year after airline mergers.

[13] Specifically, the literature lacks investigations on this simulation's long-run performance.

[14] Potential weaknesses of this paper should be noted here. I do not have panel-market data, and I am unable to use the multi-marke-based instrument variables as suggested by Hausman, Leonard, and Zona (1994) [20]. In my post-merger price simulations, I solve 31 to 37 dimensional simultaneous non-linear system equations and computations tend to be unstable. I have plant-level production and input/output data. However, I do not have brand- (automobile model) level production data, and am unable to recover brand-level production marginal costs from the data available.

[15] I use 2005 as my base year. The consumer price index data come from Statistics Korea (Korea's national bureau of statistics). For U.S. car prices, I also used 2005 as my base year.

Figure 2: Road map of this paper



change rate when representing prices[16] for the sake of easily understandable prices. Third, since the announcement of the Hyunai–Kia merger in November 1998, I define January-1991 through November-1998 as the **pre-merger regime** and December-1998 through December-2010 as the **post-merger regime**[17]. Lastly, I concentrate my research on passenger cars, ignoring trucks[18] and other commercial vehicles such as buses.

I organize the remainder of this paper as follows: Section 2 describes the automobile industry in Korea; Sections 3 and 4 explore the demand- and supply-side models and provide estimation results; Section 5 evaluates the benchmark simulation result and reports long-run simulation discrepancies; Section 6 lists potential causes in long-run simulation discrepancies; Section 7 accounts for long-run price discrepancies by using observed post-merger market data; and Section 8 concludes the study by suggesting future courses of research.

2 Description of the Automobile Market in Korea

Throughout this paper, I define the Korean automobile market as comprising the entirety of South Korea which remains geographically separated from other markets[19][20]. this market is distinct in the following four ways: (1) Korea experienced an economic crisis and sales shares of imported-cars have been extremely small ever since; (2) five Korean domestic manufactures oligopolize the market; (3) the Hyundai–Kia merger occured in November 1998 and conglomerated 70 percent of the market, before which there was only one entry, Samsung Motors (February 1998); and (4) vehicle prices in Korea have been increasing since the Hyundai–Kia merger. In this section, I describe

[16] In general, there are many zeros in prices in Korean won, making it difficult to get a sense of numbers. Although the won-dollar exchange rate is volatile, the long-term average remains close to 1,000 won = 1 U.S. dollar. With this general exchange rate in mind, a Hyundai Sonata price of 20,829,000 won simply becomes U.S. $20,829.

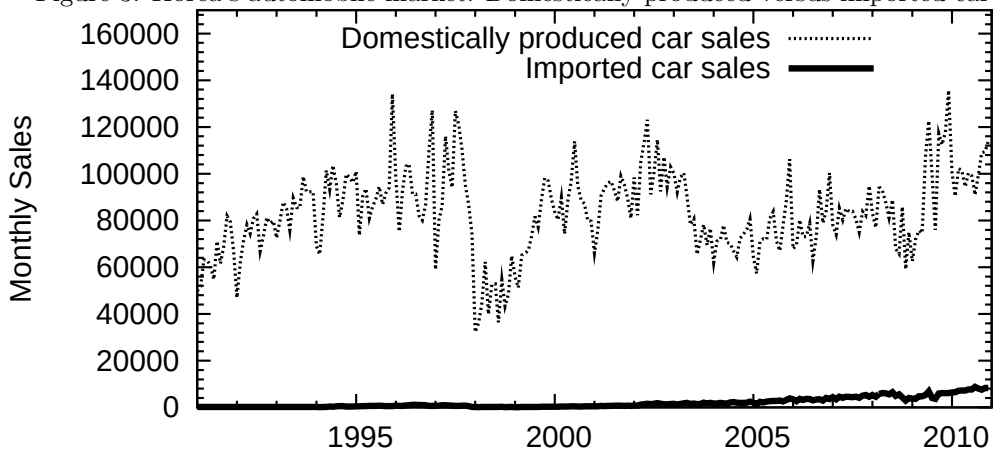
[17] I do not have data from prior to January 1991.

[18] Unlike in the United States, pickup trucks are not popular in Korea.

[19] South Korea (the Republic of Korea), located on the southern half of the Korean peninsula, is geographically separated from trade partners by North Korea and surrounding ocean.

[20] The dataset used in this paper is a single-market dataset, similar to the dataset used in Berry, Levinsohn, and Pake (1995) [5]. I do not have smaller market data such as province-level sales data.

Figure 3: Korea's automobile market: Domestically produced versus imported car sales



Data source: Ward's Automotive Yearbook (domestically produced cars) and KAIDA (imported cars)

the automobile market in Korea with emphasis on these four points, and make connections to estimations and simulations discussed in later sections.

2.1 The Asian Economic Crisis and Imported Car Sales

Figure 3 illustrates the monthly sales of domestically produced cars and imported cars (in number of automobiles sold) in South Korea for 1991–2010. There are two notable findings in Figure 3: First, the market experienced the Asian economic crisis in 1997–1999, during which time automobile sales slumped. This economic crisis led to mergers and acquisitions among Korean domestic automobile manufactures, which I will explain in the latter part of this section. Second, imported car sales shares have remained extremely low, typically less than 2 percent of total sales[21][22], and the majority of Korean automobile buyers have purchased domestically-produced cars. Because of such small shares, I ignore imported car sales in the rest part of this paper.

2.2 Oligopoly with Five Domestic Automobile Manufactures

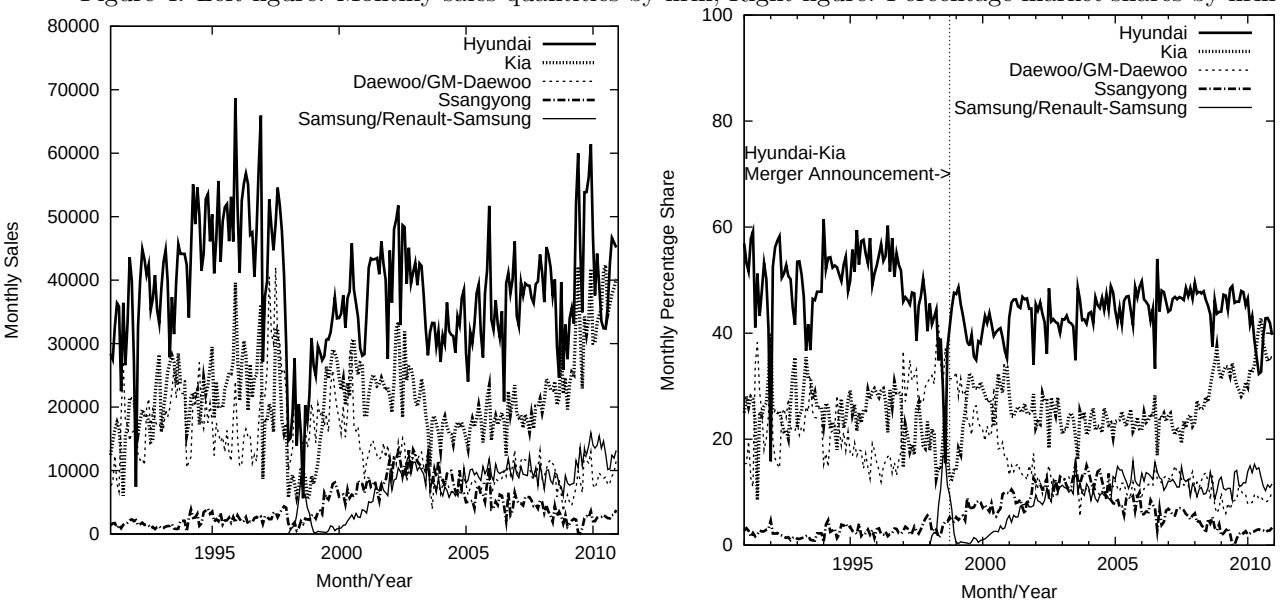
One can describe the Korean automobile market as highly concentrated in a five-firm oligopoly: Hyundai, Kia, (GM-)Daewoo, Ssangyong, and (Renault-)Sumsung Motors. The left side of Figure 4 reports monthly sales by firm. Although monthly sales by firm appear highly volatile[23], Hyundai Motors' sales numbers have been larger than those of any other firm. The right side of Figure 4 illustrates monthly market share. For the period 1991-2010,

[21] Most of the imported cars sold in Korea are German luxury cars such as Audi, BMW, and Mercedes Benz. Note that the Korean Fair Trade Commission suspects collusive pricing among imported car dealers. See: *Korea Times*: `http://www.koreatimes.co.kr/www/news/biz/biz_view.asp?newsIdx=15484&categoryCode=123`.

[22] Of interest, it is important to determine which factors cause these low imported car sales. The tariff on imported cars decreased from 30 percent (in 1988) to 8 percent (in 1995), and since has remained constant at 8 percent. I interviewed several Korean native colleagues and asked the question: "Why do Korean people not buy imported cars?" Their answers were: (1) Imported cars are expensive in Korea, (2) Korean culture does not allow workers to have cars more luxurious than those of their supervisors (Note: Imported cars in Korea are mostly luxury cars), (3) Auto insurance companies charge high premiums on imported cars, and (4) Compared to domestic cars, fewer maintenance dealers are available.

[23] Part of the reason that supports this high volatility in sales quantities is labor strikes.

Figure 4: Left figure: Monthly sales quantities by firm, Right figure: Percentage market shares by firm



Data source: Ward's Automotive Yearbook and KAMA monthly Journal

Hyundai Motor's share has been around 40 to 50 percent; Kia Motors, the second largest automobile manufacture in Korea, holds 25 to 30. The remaining small firms, (GM-)Daewoo, Ssangyong, and (Renault-)Sumsung Motors, hold around 10 percent each. As a whole, Hyundai Motors occupies a larger part of Korea's domestic market share, and this share grew even larger after the Hyundai–Kia merger.

2.3 The Hyundai-Kia Merger (November 1998) and Samsung Motors Entry (February 1998)

The Korean automobile industry experienced substantial ownership changes between 1991 and 2010. Table 1 depicts firm ownership transition information. As would be expected, the Hyundai–Kia merger in November 1998 stands as the most important event during this period. Table 2 lists chronologically the timeline of this merger. One can consider the Hyundai–Kia merger exogenous, since Kia's bankruptcy—a result of the Asian economic crisis—led to the merger[24]. Ford Motors, a 17 percent shareholder of Kia Motors before the bankruptcy, also expressed interest in this acquisition, but Ford retreated[25]. In the simulation section, I simulate a hypothetical scenario of Ford's acquisition of Kia Motors. Also, of particular note is that the merged Hyundai–Kia group has continued to use pre-merger merchandise marks ("Hyundai Motors" and "Kia Motors"), and two networks of retailers (Hyundai and Kia'dealerships)[26]. Although the Korean automobile market is highly concentrated, there has been only one domestic automobile manufacturer entry. Samsung Motors entered the market in February 1998. One may consider Sumsung's entry political due to Korea's presidential policy[27] and I treat this entry as exogenous in this research.

[24] The merger also had political aspects. In 2007, the president of Hyundai Motors, Chung Mong-Koo, was convicted of various bribery activities, potentially including Hyundai's acquisition of Kia Motors. See: *New York Times*: http://www.nytimes.com/2007/02/06/business/06hyundai.html?ref=chungmongkoo

[25] For details about how Ford Motors withdrew from the acquisition, see BBC News: http://news.bbc.co.uk/2/hi/business/196667.stm

[26] Hyundai group initially owned 51 percent of Kia Motors' share. Later, the percentage decreased to 35 percent.

[27] I will sum up the anecdotal political stories related to Samsung Motors' entry. They include the following: (1) It was Kun-Hee Lee's, the president of Samsung group, long-term desire to own an automobile company; (2) Samsung group and Hyundai group are long time

Table 1: Ownership transitions

Firm Trade Name ⇒ Year	(1) **Hyundai Motors**	(2) **Kia Motors**	(3) **(GM-)Daewoo Motors**	(4) **Ssangyong Motors**	(5) **(Renault-)Samsung Motors**
1991	Hyundai	Kia	Daewoo	Ssangyong	——
1992	Hyundai	Kia	Daewoo	Ssangyong	——
1993	Hyundai	Kia	Daewoo	Ssangyong	——
1994	Hyundai	Kia	Daewoo	Ssangyong	(Entry Announcement)
1995	Hyundai	Kia	Daewoo	Ssangyong	——
1996	Hyundai	Kia	Daewoo	Ssangyong	——
1997 (economic crisis)	Hyundai	Kia	Daewoo	Ssangyong	——
1998 (economic crisis)	Hyundai	Kia	Daewoo	Daewoo	Samsung
1999	Hyundai	Hyundai	Daewoo	Daewoo	Samsung
2000	Hyundai	Hyundai	Daewoo	Daewoo	Samsung
2001	Hyundai	Hyundai	Daewoo	Daewoo	Renault-Samsung
2002	Hyundai	Hyundai	Daewoo	Daewoo	Renault-Samsung
2003	Hyundai	Hyundai	GM-Daewoo	Ssangyong	Renault-Samsung
2004	Hyundai	Hyundai	GM-Daewoo	Ssangyong	Renault-Samsung
2005	Hyundai	Hyundai	GM-Daewoo	Ssangyong	Renault-Samsung
2006	Hyundai	Hyundai	GM-Daewoo	Ssangyong	Renault-Samsung
2007	Hyundai	Hyundai	GM-Daewoo	Ssangyong	Renault-Samsung
2008	Hyundai	Hyundai	GM-Daewoo	Ssangyong	Renault-Samsung
2009	Hyundai	Hyundai	GM-Daewoo	Ssangyong	Renault-Samsung
2010	Hyundai	Hyundai	GM-Daewoo	Ssangyong	Renault-Samsung

Note: Cells describe owner firms. For example, in year 2002, Kia Motors was owned by Hyundai Motors.

Data source: Official firm websites and various news paper articles from *The JoongAng Ilbo*, *The Dong-A Ilbo*, and *The Chosun Ilbo*

Table 2: Korean economic crisis, merger, and acquisition timeline

Date		Event
Late 1996	∼ Jun. 1997	Default problems gradually grew in the Korean economy
1997	Jul.	Asian economic crisis, triggered by the collapse of Thai baht
1997	Jul.	Kia Motors announced bankruptcy, triggered Korean economic crisis
		Kia Motors came under creditor bank and court control
1998	Nov.	Creditor banks announced Hyundai Motors' acquisition of Kia Motors
		(Ford Motors,17% shareholder of Kia Motors before the bankruptcy, was also interested in acquisition)
1999	Jun.	Samsung Motors announced bankruptcy, and came under creditor bank and court control
2000	Apr.	Renault group acquired Samsung Motors
2001	∼ 2002	General Motors (GM) gradually proceeded with the acquisition of Daewoo Motors
		(The new firm, GM-Daewoo Motors, was formally established in Nov. 2002)

Data source: Various newspaper articles from *The JoongAng Ilbo*, *The Dong-A Ilbo*, and *The Chosun Ilbo*

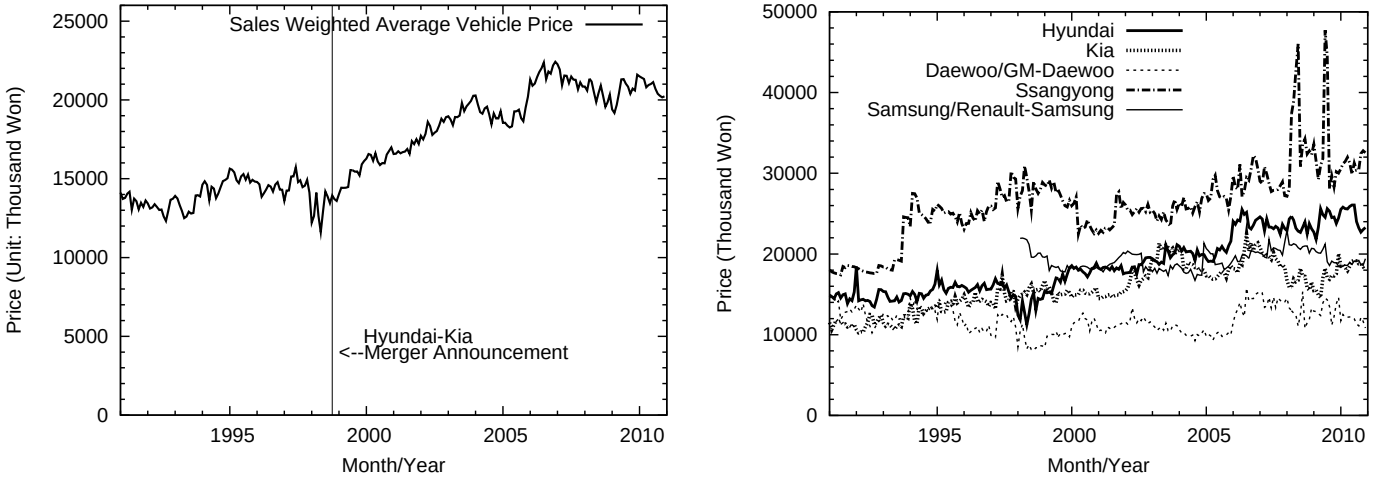
2.4 Post-Merger Vehicle Price Increases

After the Hyundai–Kia merger in November 1998, the market saw significant hikes in vehicle prices. The left side of Figure 9 indicates aggregated (market level) sales-weighted vehicle transaction prices in Korea[28]. The aggregate prices increased after the Hyundai-Kia merger. During the pre-merger regime (1991–1998) the average price was only $13,998; in the post-merger regime (1999–2010) the average price was $19,035, an increase of 35.98 percent ($= \frac{19{,}035}{13{,}998} \times 100 - 100$). The right side of Figure 9 illustrates sales-weighted vehicle transaction prices by firm. These

rivals; (3) Kim Young-Sam (the seventh president of Korea) competed with Jeong Juyeong (the founder of Hyundai group and the owner of Hyundai Motors) in the 1992 Korean presidential election. Kim Young-Sam won the race; (4) After the 1992 presidential election, Kim Young-Sam's administration prosecuted Jeong Juyeong for violations of election law, and Kim Young-Sam's administration and the Hyundai group continued to experience political tensions; (5) Kim Young-Sam had been elected from the Busan area, the second-largest metropolitan area in Korea; (6) Samsung announced its entry into the automobile market in 1994 along with a plan to build an automobile plant in Busan, one and a half years after Kim Young-Sam had been elected president. (7) Samsung Motors began to produce passenger vehicles in the newly constructed Busan plant in February 1998. In the same month, Kim Young-Sam completed his presidential term.

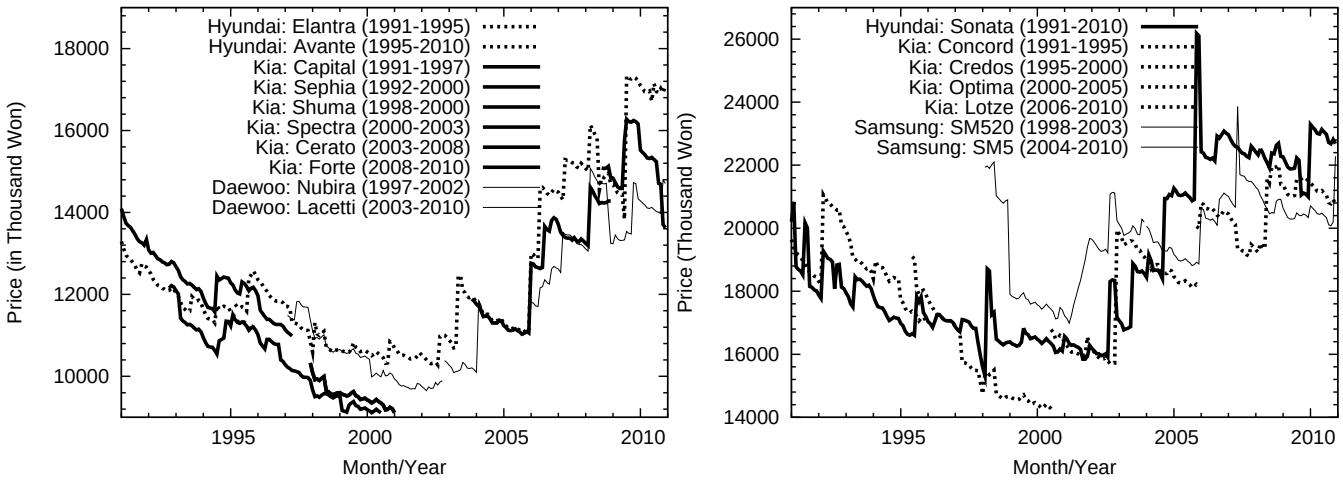
[28] Appendix explains the construction of these aggregate prices. I also calculated the index-weighted aggregate prices.

Figure 5: Left figure: Sales-weighted aggregate price, Right figure: Sales-weighted prices by firm



Data source: Motor Magazine and Carlife Magazine

Figure 6: Left figure: Compact car prices, Right figure: Mid-size car prices



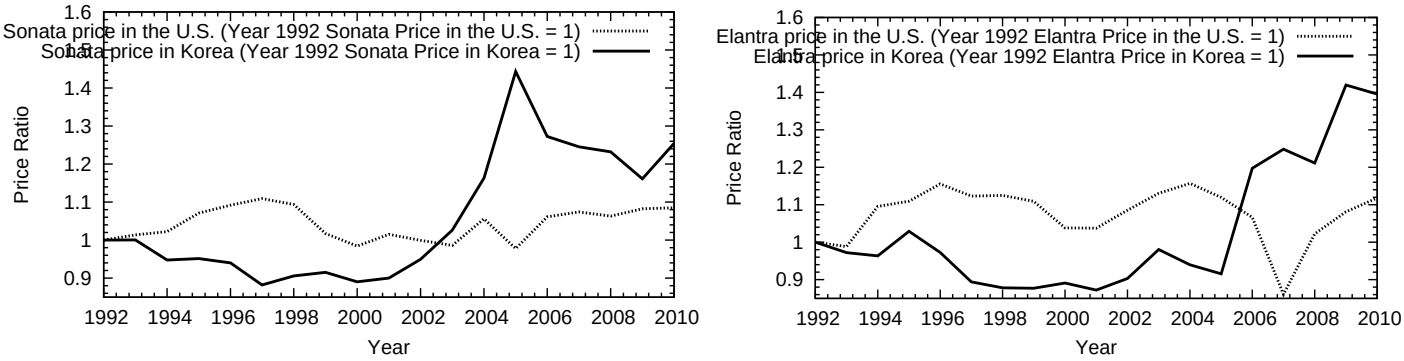
Data source: Motor Magazine and Carlife Magazine

prices show that consumers saw more expensive Hyundai–Kia group cars after the merger. Figure 6 depicts vehicle pricing among compact (left side of Figure 6) and mids-size (right side of Figure 6) class cars[29]. This offers three notable findings. First, vehicle prices had been decreasing before the 1998 Hyundai–Kia merger. Second, although the merger was announced in November 1998, the post-merger price increases did not occur until 2003. During 1999–2003, the merged Hyundai-Kia group refrained from making unilateral price increases[30]. Third, after year

[29] See Appendix for pricing history of other classes of vehicles.

[30] Several reasons explain these non-immediate post-merger price increases: (1) Hyundai–Kia group improved its plant-level productivities, and marginal costs decreased. Appendix contains results from plant-level production function estimations, and I find statistically significant post-merger productivity increases among Hyundai–Kia group plants. (2) The merged firm most likely was concerned about public backlash (mass media and consumer reactions) against any immediate post-merger price increases; (3) The newly merged firm

Figure 7: Left figure: Hyundai Sonata prices in the United States versus in Korea, Right figure: Hyundai Avante/Elantra prices in the United States versus in Korea



Data source: *Ward's Automotive Yearbook* (annual U.S. prices), *Motor Magazine* and *Carlife Magazine* (Korean prices)

Basement prices and ratios are:

Hyundai Sonata price in the United States in 1992 = 1, Hyundai Sonata price in Korea in December 1992 = 1

Hyundai Elantra price in the United States in 1992 = 1, Hyundai Avante/Elantra price in Korea in December 1992 = 1

Note: (1) The Korean won was relatively strong (appreciated) in 1992 (due to the post-Seoul-Olympics boom); (2) I choose 1992 as the base year of comparison as the U.S. prices before 1992 are not available; (3) In Korea, the Hyundai Elantra has been sold under the name Avante since February 1995.

2003, the merged Hyundai-Kia group seems to have adopted unilateral pricing strategies. As a whole, one can clearly observe long-run price increases in Figure 6.

Some may question whether vehicle price increases in Korea were caused by product quality improvements. To investigate this possibility, I compare Hyundai-Sonata and Hyundai-Avante[31] pricing histories in the United States and in Korea. Figure 7 indicates that prices in Korea largely increased after the merger, while prices in the United States increased only moderately. Assuming that market competition conditions in the United States remained unchanged, a quality increase alone could not explain the drastic price increases observed in Korea[32].

2.5 Data Source

I collected data from various sources. First, I compiled monthly passenger vehicle price data from two monthly automobile magazines widely circulated in South Korea, *Carlife Magazine* and *Motor Magazine*. These two monthly

needed time to make management-level integrations.

[31] Hyundai Avante is sold under the name of Elantra in the United States.

[32] Automobile buyers generally perceive that Korean automakers have increased their product quality in recent years. In the United States, Hyudnai-Sonata and Hyundai-Elantra prices have increased about 10 percent, and I attribute these price increases to the quality improvement. Note that the prices of Hyudnai-Sonata and Hyundai-Elantra have increased 26 percent and 38 percent in Korea.

magazines maintain lists of new car prices from the late 1980s[33]. Second, *Ward's Automotive Yearbook 1992–2011*[34] sources the monthly brand-level sales quantities. Since Ward's Automotive Yearbook does not contain brand-level sales quantity data before 1994, I collected the 1991–1994 brand-level monthly sales data from the *Monthly Korean Automotive Industry Journal* published by the Korean Automobile Manufacturers Association (KAMA). Third, I use the two car magazines described above along with the annual report, *Korean Automobile Industry: Annual Version*, released by KAMA, to gather the car specification data. Fourth, I obtained plant-level[35] production output and input data from the *Annual Mining and Manufacturing Survey* conducted by the Statistics Korea[36]. Fifth, I compiled ownership (merger) transition processes and timing information from three Korean newspapers; *The JoongAng Ilbo*[37], *The Dong-A Ilbo*[38], *The Chosun Ilbo*[39], and official company websites. Sixth, price index, demographic (such as numbers of households used as market sizes), worker wage, and bank loan rate data come from the Bank of Korea (BOK) and the Statistics Korea.

3 Demand Side Model and Estimations

This section describes the demand side model and estimation results. I use these estimates to compute substitution patterns in post-merger price simulations in later sections of this paper.

3.1 Demand Model

The demand model builds upon Berry's (1994) instrumental variable (henceforth IV) nested-logit model. For notational simplicity, I denote $t \in \{1, \cdots, T\}$ to index months, $i \in \{1, \cdots, I_t\}$ to index households at time t, $j \in \{1, \cdots, J_t\}$ to represent supplied automobile brand index at time t, $q \in \{1, \cdots, Q\}$ to be quarter dummy, and $g \in \{1, \cdots, G\}$ to be automobile type group index[40]. In particular, g_j indicates the automobile type group to which brand j belongs. The (after taking log) Cobb-Douglas utility function is expressed as

$$u_{ijt} = \sum_{q=2}^{Q} \theta_q d_{q_t} + \alpha p_{jt} + x_{jt}\beta + \xi_{jt} + \zeta_{ig_j} + (1-\sigma)\varepsilon_{ijt} \tag{1}$$

where d_{q_t} is quarter dummy, p_{jt} is brand j's price at time t, x_{jt} is brand j's observable characteristics vector, ξ_{jt} is an unobserved (by researchers) product characteristic. Quarter dummies are included to proxy incomes. Consumer

[33] To collect vehicle prices, the editors of these two magazines call local dealers and gather dealership-level prices. Prices of a specific automobile brand in a specific month listed in these magazines prove close but not identical. Typically, price differences come within $500 of each other. I believe such non-identical prices are a good signal of accuracy, since they seem to reflect dealership-level price heterogeneities.

[34] Berry, Levinsohn, and Pake (1995) [5] also extracted price and sales quantity data for the U.S. automobile industry from these yearbooks.

[35] I could not obtain vehicle brand-level production data. Since a single automobile plant produces multiple vehicle brands, this dataset does not allow me to recover the brand-level production marginal costs. However, I was able to evaluate productivity improvement (merger synergy) after the Hyundai-Kia merger through the production function estimation analysis. See Appendix for details.

[36] http://kostat.go.kr/portal/english/surveyOutlines/6/2/index.static

[37] http://joongangdaily.joins.com/

[38] http://english.donga.com/

[39] http://english.chosun.com/

[40] In the estimation, I categorize automobile brands in to four groups (1) the Small- and Compact-size group, (2) the Mid-size group, (3) the Mid- and Full-size luxury group, and (4) the Jeep, SUV, and Minivan group, according to their price differences and functionalities.

Table 3: Automobile nesting groups for instrumental variable nested-logit estimation

	Nesting group	Price range	Size/Functionalities	Examples:
(i)	Small- & Compact-size group	\$4,000–\$15,000	Small interior, Fuel-efficient, Commuter vehicle	Daewoo-Matiz, Hyundai-Accent Hyundai-Avante, Samsung-SM3
(ii)	Mid-size group	\$16,000–\$29,000	Medium interior Commuter vehicle	Hyundai-Sonata, Kia-Optima Kia-Credos, Samsung-SM5
(iii)	Mid- & Full-size luxury group	\$30,000–\$76,000	Luxury-oriented Commuter vehicle	Hyundai-Grandeur, Hyundai-Equus Kia-Enterprise, Ssangyong-Chairman
(iv)	Jeep, SUV & Minivan group	\$18,000–\$36,000	Large interior, Sports-oriented Family, Commercial use	Hyundai-SantaFe, Kia-Carnival Hyundai-Tucson, Daewoo-Rezzo

See Table 11 in Appendix for details of these group categorizations.

taste parameters $(\{(\theta_2, \cdots \theta_Q), \alpha, \beta, \sigma)\}$ are to be estimated. Note that ζ_{ig_j} captures individual i's taste over group g_j, and $(1-\sigma)\varepsilon_{ijt}$ captures individual i's idiosyncratic taste for product j. Specifically, the parameter $\sigma \in [0,1]$ captures the degree of inside group substitutions. If σ is close to one, consumer i becomes more likely to substitute to products within the same automobile type group. On the other hand, if σ is close to zero, consumer i substitutes across all type groups. Following Berry (1994) [4], I make distributional assumptions. Both ε_{ijt} and $\zeta_{ig_j} + (1-\sigma)\varepsilon_{ijt}$ follow an i.i.d. type I extreme value distribution. By integrating, I obtain the analytic market shares as follows

$$s_{jt} = \frac{\exp\left(\frac{\delta_{jt}}{1-\sigma}\right)}{\sum_{k\in g_j}\exp\left(\frac{\delta_{kt}}{1-\sigma}\right)} \cdot \frac{\left[\sum_{k\in g_j}\exp\left(\frac{\delta_{kt}}{1-\sigma}\right)\right]^{1-\sigma}}{\sum_{g=1,\cdots,G}\left[\sum_{l\in g}\exp\left(\frac{\delta_{lt}}{1-\sigma}\right)\right]^{1-\sigma}}, \tag{2}$$

where I denote a mean utility[41]

$$\delta_{jt} = \sum_{q=2}^{Q}\theta_q d_{q_t} + \alpha p_{jt} + x_{jt}\beta + \xi_{jt}.$$

Berry (1994) [4] inverted the above market share and obtained

$$\ln\left(\frac{s_{jt}}{s_{0t}}\right) = \sum_{q=2}^{Q}\theta_q d_{q_t} + \alpha p_{jt} + x_{jt}\beta + \sigma \ln\left(\frac{s_{jt}}{s_{g_j t}}\right) + \xi_{jt} \tag{3}$$

where s_{0t} is an outside goods (not purchasing cars) share[42] and $s_{g_j t}$ is the market share of group g_j at time t.

3.2 Automobile Brand Nesting Group Categorizations

Table 3 describes the automobile brand group categorization used in this research: (i) Small- and Compact-size, (ii) Mid-size, (iii) Mid- and Full-size luxury, and (iv) Jeep, Sports Utility Vehicle (SUV), and Minivan. I categorize these four groups based on price differences and functionalities. The Small- and Compact-size group cars are priced substantially lower than cars in other groups, and the restrictions on consumer budgets keep substitutions to other groups implausible. The cars in the Mid- and Full-size luxury group are priced higher than cars in the other groups. The Mid-size group and the Jeep, SUV, and Minivan group are divided based on their functionalities. Buyers of

[41] The outside option (not purchasing a car) at time t is $\delta_{0t} = \sum_{q=2}^{Q}\theta_q d_{q_t}$ in this model. I normalize quarter 0 outside option mean utility to be $\delta_{00} = 0$.

[42] I define the market size as the number of households in Korea, extracted from the Korean National Census in 1990, 1995, 2000, 2005, and 2010.

Table 4: Descriptive statistics: Variables in the pre-merger regime (left table), Variables in the post-merger regime (right table)

Pre-merger regime 1991–1998 data (sample size = 2330)				
	Mean	Std. Dev.	Min	Max
s_{jt}	0.0002657	0.0003224	0.0000000735	0.0020515
s_{0t}	0.9934809	0.0018015	0.989058	0.9976192
$\frac{s_{jt}}{s_{g_{jt}}}$	0.1634075	0.1665415	0.0000166	0.9018136
Price	18804.89	12458.19	4044.367	67551.83
Size	11.2441	1.900422	6.52302	16.03113
HP/kg	0.0896633	0.0235246	0.0451411	0.1414791
Km/l	14.07257	3.71396	8	24.1

Post-merger regime 1999–2007 data (sample size = 3729)				
	Mean	Std. Dev.	Min	Max
s_{jt}	0.0001484	0.0001544	0.0000000629	0.0009395
s_{0t}	0.9944497	0.0009979	0.9916624	0.9963381
$\frac{s_{jt}}{s_{g_{jt}}}$	0.1075127	0.1255659	0.0000218	0.7337996
Price	19574.06	11310.8	3877.454	76919.34
Size	12.47808	2.280907	6.52302	18.12583
HP/Kg	0.0909397	0.0188715	0.0514045	0.1599073
Km/l	12.34554	3.397297	7	24.1

the Jeep, SUV, and Minivan group's cars are expected to evaluate large spaces or sports-oriented functionalities, while Mid-size group car buyers do not. Based on these four groups, inside group shares are calculated and used in demand estimations.

3.3 Price Elasticities

The advantage of the instrumental variable nested-logit is its simplicity in computing price elasticities. From equation (2), one can derive own and cross price elasticities,

$$\begin{cases} \frac{\partial s_{jt}}{\partial p_{jt}}\frac{p_{jt}}{s_{jt}} &= \frac{\alpha}{1-\sigma}\left[1-\sigma\left(\frac{s_{jt}}{s_{g_jt}}\right)-(1-\sigma)s_{jt}\right]p_{jt} & & \text{(Own price elasticity)} \\ \frac{\partial s_{kt}}{\partial p_{jt}}\frac{p_{jt}}{s_{kt}} &= \frac{\alpha}{1-\sigma}\left[-\sigma\left(\frac{s_{jt}}{s_{g_jt}}\right)-(1-\sigma)s_{jt}\right]p_{jt} & \text{if } k\in g_j & \text{(Within group cross price elasticity)} \\ \frac{\partial s_{lt}}{\partial p_{jt}}\frac{p_{jt}}{s_{lt}} &= -\alpha s_{jt}p_{jt} & \text{if } l\notin g_j & \text{(Outside group cross price elasticity).} \end{cases} \quad (4)$$

and one can calculate these elasticities based on estimated (α, σ) and observed market shares[43].

3.4 Descriptive Statistics

Table 4 lists descriptive statistics. By comparing pre- and post-merger variables, several notable differences appear. First, the mean of the inflation adjusted vehicle price is higher in the post-merger regime, as a natural consequence of market conglomeration after the Hyundai–Kia merger. Second, the mean size had increased (and mean of Km/l has decreased), since a greater variety of large size cars, SUVs, and minivans became available in 2000s. Third, as numbers of supplied vehicle brands had increases after the Hyundai–Kia merger, the mean of shares (and the mean of in-group share) decreased.

[43] Price derivatives are

$$\begin{cases} \frac{\partial s_{jt}}{\partial p_{jt}} &= \frac{\alpha}{1-\sigma}\left[1-\sigma\left(\frac{s_{jt}}{s_{g_jt}}\right)-(1-\sigma)s_{jt}\right]s_{jt} & & \text{(Own price derivative)} \\ \frac{\partial s_{kt}}{\partial p_{jt}} &= \frac{\alpha}{1-\sigma}\left[-\sigma\left(\frac{s_{jt}}{s_{g_jt}}\right)-(1-\sigma)s_{jt}\right]s_{kt} & \text{if } k\in g_j & \text{(Within group cross price derivative)} \\ \frac{\partial s_{lt}}{\partial p_{jt}} &= -\alpha s_{jt}s_{lt} & \text{if } l\notin g_j & \text{(Outside group cross price derivative).} \end{cases} \quad (5)$$

These derivatives are used for simulations.

3.5 Choice of Instrumental Variables

The major difficulty in estimating equation (3) is the endogeneity in ξ_{jt}. An individual i prefers automobile brands that have large observed characteristics, and firms optimally respond by pricing such brands higher. Therefore, an observed price p_{jt} is positively correlated with an unobserved product characteristic ξ_{jt}, creating positive bias in price coefficient estimations. To solve this endogeneity problem, the literature suggests several specific types of instrumental variables; herein follows the conventional usages of instruments. From, Levinsohn, and Pakes (1995) [5], I use

Instrument Variables:
(1) Cost shifter = (Kilogram of vehicle) × (Importer Price Index)
(2) Within the same class sum of competing firm product size
(3) Within the same class sum of competing firm product horsepower per kilogram
(4) Within the same class sum of competing firm product kilometer per liter

in this research. Since Korea is a natural-resource importing county, and since material costs in the production of one vehicle remain roughly proportional to that vehicle's weight, (1) measures variable material costs in productions[44]. As material costs are positively correlated with price, but unlikely to be correlated with unobserved product characteristics, the above cost shifter becomes a valid instrument. Furthermore, (2)-(4) measure the degree of market competition. The more products other firms offer, the more severe the competition. To measure precisely the degree of competition, I classified the vehicles into nine classes (automobile types), and take summations of each observed product characteristic within each class (see Table 11 in Appendix for details of classifications). Since competition becomes more severe with a larger number of competing products, instruments (2)-(4) are negatively correlated with observed prices. However, instruments (2)-(4) are unlikely to be correlated with unobserved product characteristics ξ_{jt}[45].

3.6 Demand Estimation Results and Estimated Elasticities

Table 5 reports estimation results and calculated own elasticities based on equation (4). In addition to the instrumental variable nested-logit demand model, I also estimate OLS logit and instrumental variable logit demand models for comparisons. I separate the dataset into pre-merger regime data (years 1991–1998) and post-merger regime data (years 1999–2007), since I use only pre-merger regime data for the basement simulation. Price coefficients derived

[44] Because the Korean won historically has highly volatile exchange rates, Korea's Importer Price Index is also volatile. See Figure 10.

[45] I recognize there is a subtle endogenous product line choice concern in this statement. There are at least four possible scenarios of endogeneity:
(A) If ξ_{jt} is large, i.e., product j is attractive
⇒(A-1) competing firms introduce copy-cat products into a market
⇒(A-2) competing firms consider competition with product j difficult, and do not introduce rivaling products
(B) If ξ_{jt} is small (or very negative), i.e. product j is unattractive
⇒(B-1) competing firms consider a profit opportunity, and introduce rivaling products that beat out product j
⇒(B-2) competing firms do not consider producing similar cars profitable, and do not introduce rival products
These four scenarios provide opposite consequences in terms of endogenous product line choices. I believe all of these scenarios are possible and, in general, ξ_{jt} does not correlate to (2)-(4). Berry, Levinsohn, and Pakes (1995) [5] use similar instruments.

Table 5: Estimation results

Variable	Pre-merger OLS logit	Pre-merger IV logit	Pre-merger IV nested-logit	Post-merger OLS logit	Post-merger IV logit	Post-merger IV nested-logit
α :	-0.000068**	-0.000117**	-0.0000820**	-0.0000642**	-0.0001094**	-0.0000582**
Price in thousand won	(0.000004)	(0.0000116)	(0.0000040)	(0.0000257)	(0.0000188)	(0.0000056)
σ :			0.6677716**			0.5403498**
In-group substitution			(0.0793395)			(0.0733306)
β_1 :	0.0321820	0.2328088**	0.0254591	0.2352142**	0.4481224**	0.2457095**
Size in meter^3	(0.0347774)	(0.053974)	(0.0193732)	(0.0148575)	(0.0417942)	(0.0206055)
β_2 :	2.24454	14.26855**	14.92290**	8.752057**	31.59749**	10.07008**
Horsepower per kilogram	(2.662645)	(3.537377)	(1.967729)	(1.653547)	(4.449519)	(2.169522)
β_3 :	-0.0386531**	-0.0501671**	-0.0366461**	0.1540414**	0.0420579*	0.0433083
Kilometer per liter	(0.0152014)	(0.0149092)	(0.0069798)	(0.0098804)	(0.0233517)	(0.010283)
β_0 :	-7.713562**	-9.899668**	-7.07191**	-15.5793**	-16.17454**	-11.45489**
Constant	(.7279814)	(0.8051303)	(0.327289)	(0.3871796)	(0.4878732)	(0.66416)
Measure of fit: R-square	0.22971	-	0.222	0.1016	-	0.629
or Sargan Test (5% value)			(3.84)			(3.84)
First-stage R-square	-	-	0.8190	-	-	0.7379
Sample size	2330	2330	2330	3978	3978	3975
# of inelastic demand (%)	1072 (46.0%)	392 (16.8%)	12 (0.5%)	1576 (39.6%)	695 (17.5%)	478 (12.0%)
Mean own elasticity	-1.291635	-2.199729	-4.127113	-1.256478	-2.070645	-2.322189
Median own elasticity	-1.074259	-1.829523	-3.136359	-1.162262	-1.915378	-2.118278
Min own elasticity	-4.640796	-7.903539	-16.60229	-4.93795	-8.137618	-9.630547
Max own elasticity	-0.2778367	-0.4731717	-0.853698	-0.2489306	-0.4102315	-0.488998

Numbers in parentheses represent standard errors.

** indicates t-statistics are significant within 5 percent.

IV used: IV logit model - Cost-shifter for both pre- and post-merger data (thus, just-identified model).

IV used: IV Nested logit model - (1), (2), and (4) for pre-merger data; (1), (2), and (3) for post-merger data.

Note that in the instrumental variable nested-logit estimations, I removed IV (3) for pre-merger data and IV (4) for post-merger data to avoid over-identifications detected by Sargan statistics.

from each estimation method agree with general findings reported in the automobile literature[46]. Price coefficients from OLS logit estimation suffer from the endogeneity problems, and are positively biased. Instrumental variable logit estimations alleviate endogeneity bias, although estimated elasticities tend to be inelastic[47]. Pre-merger in-

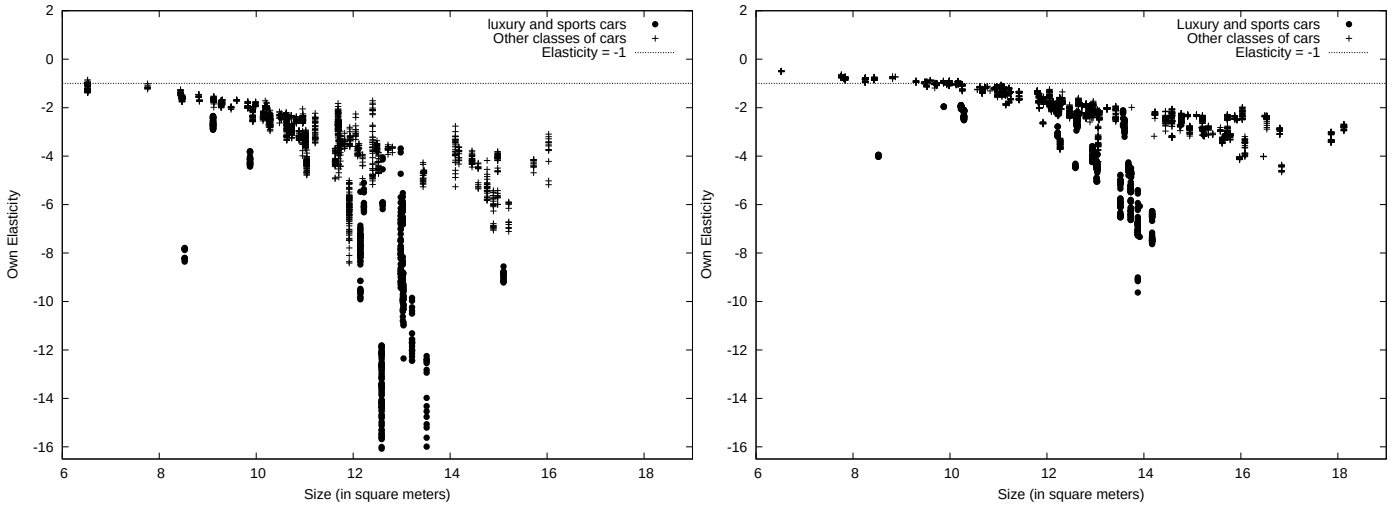
[46] See Table III in Berry, Levinsohn, and Pakes (1995) [5], and Table 4 in Petrin (2002) [35].

[47] Such inelasticities come from own price elasticity equation in the logit demand model. The logit demand model provides elasticity equations

$$\begin{cases} \frac{\partial s_{jt}}{\partial p_{jt}} \frac{p_{jt}}{s_{jt}} &= \alpha(1 - s_{jt})p_{jt} & \text{(Own price elasticity)} \\ \frac{\partial s_{kt}}{\partial p_{jt}} \frac{p_{jt}}{s_{kt}} &= -\alpha s_{jt} p_{jt} & \text{(Cross price elasticity).} \end{cases}$$

In this research, I define market size as all households in Korea, and only tiny portions of the households buy automobiles in any given month. Thus, s_{jt} is close to zero. Then, own price elasticities are almost perfectly proportional to prices. As a result, low-price cars tend to have inelastic demands. This result contradicts our empirical observation that buyers of low price cars are elastic and price

Figure 8: Left figure: Pre-merger regime (1991-1998) own-price elasticities, Right figure: Post-merger regime (1999-2007) own-price elasticities.



strumental variable nested-logit estimation provides reasonable elasticities, and I observe that only 0.5 percent of demands are inelastic[48][49]. I use these pre-merger IV nested-logit estimates in simulations.

This analysis reveals drastic differences between the estimated pre-merger and post-merger regimes' preferences. To understand such drastic preference changes, I briefly note the history of the Korean economy and its motorization. After the 1988 Seoul Olympics, Korea's economy entered a high growth period, and many households obtained their initial opportunity to purchase a vehicle. For their initial car choices, Korean households were mainly concerned about prices and, therefore, this concern compromised other vehicle characteristics. Under such economic circumstances, Korean households mainly bought small[50] and fuel-inefficient but cheap cars in the pre-merger regime (1991–1998). Note that the Organization for Economic Co-operation and Development (OECD) officially endorsed South Korea as a developed country in 1996, although the recession of 1997–1998 set back economic growth[51]. My pre-merger regime estimation results agree closely with this historical observation. Consumers were relatively elastic and preferred non-large-size and fuel-inefficient (but cheap) vehicles in the pre-merger regime (1991–1998). The household environment dramatically changed after the recession. As the economy escaped from the recession and the recovery boom arrived in 2000–2002. Rebounding from recession, banks largely relaxed their credit-inquiry

sensitive. Thus, the logit-demand model remains inappropriate in this research. Note that the nested logit demand model improves this defect by accounting for in-group shares in elasticity calculations.

[48] In Table V of Berry, Levinsohn, and Pakes (1995) [5], they report year 1990 US automobile buyers' elasticities; these are close to my pre-merger elasticities derived from the instrumental variable nested-logit estimation.

[49] Moreover, in Copeland, Dunn, and Hall (2011) [10] Table 5, they report own price elasticities among US automobile buyers during 1999–2004. The their elasticities are [-3.6, -1.5], which is less elastic than the mean elasticity of my pre-merger IV nested-logit model. I recognize that income level difference between United States and Korea causes this discripancy in elasticities. Income in Korea (during 1991–1998) was expected to be lower than that of the United States (during 1999–2004). Note that my post-merger IV nested-logit estimates provide elasticities closer to Copeland, Dunn, and Hall's results.

[50] Note that the coefficient of size is not statistically significant in the instrumental variable nested-logit estimation with pre-merger data.

[51] During the Korean recession (1997–1998), the majority of vehicles bought in Korea were small- and compact-size cars.

requirements[52], and households obtained generous loan opportunities, including auto loans. They also began to replace their initial cars, and households typically chose more expensive cars than the cars they had initially purchased. After 2002, the Korean economy has continued to grow without serious economic stagnation (the average worker wage increased 30 percent compared to that of pre-merger regime, see Table 7), and more and more expensive cars became affordable to Korean households. Post-merger regime estimation results agree with these observations. Korean automobile buyers became relatively inelastic with higher wages and more access to auto loans. In addition, they preferred larger size cars, and they also evaluated fuel-efficiency in the post-merger regime. These estimated preferences reflect the introduction of a number of SUVs into the Korean domestic market and the continued rise of gasoline prices during the 2000s.

Figure 8 plots the relations between calculated elasticities and vehicle sizes (in square meter) in both pre- and post-merger regimes. I observe that luxury and sports cars have large (in absolute value) elasticities. This occurs because elasticities in nested-logit demand are roughly linear in price[53], and luxury and sports cars have higher prices. I recognize elasticities among those cars are likely to be inflated, although these cars have relatively tiny market shares, and inflated elasticities have limited effects in this research[54].

4 Supply Side Model

In this section, I describe the supply side model used to recover marginal costs and post-merger price simulations. Here, I strictly follow the simulation framework proposed by Nevo (2000) [31] and Nevo (2001) [32].

4.1 Firms' Optimization Problem

I assume firms engage in static Bertrand competitions. The Bertrand price competition model is especially suitable for describing the Korean automobile market for the following three reasons. First, Korean automobile dealers explicitly post price tags on cars in their dealerships. Second, brochures available in dealerships explicitly list prices. Third, widely circulated automobile magazines, containing lists of automobile prices, have been available since the late 1980s, and automobile buyers have been well-informed about automobile prices. Other forms of competition, such as competition through choosing sales quantities, are highly unlikely to reflect these three observed facts. As some may argue over my choice of the static competition model, I will return to this point in a later portion of this paper. Firms that choose automobile band prices maximize profits as follows:

$$\Pi_{ft} = \sum_{j \in \mathbf{F}_{ft}} (p_{jt} - mc_{jt}) \cdot s_{jt}(p_t) \cdot M_t - C_{ft}$$

where $f \in [1, \cdots, F]$ represents a firm, $\mathbf{F}_{ft}$ is a set of products which firm f supplies to the market at time t, mc_{jt} is the marginal cost of product j, p_t is a price vector and its dimension is equal to the number of total products available at time t, M_t is the number of households in Korea, and C_{ft} is fixed cost. The first-order necessary condition can be derived as

$$p_t - mc_t = \{\Omega_t \times \mathbf{S}_t(p_t)\}^{-1} s_t(p_t) \tag{6}$$

[52] A credit-card boom was observed during 2000–2003 in Korea.

[53] Note that Berry, Levinsohn, and Pakes (1995) [5], who use the logit demand model as their basis, also have this linear-in-price problem.

[54] In simulations, I fixed full-size luxury and sports car shares to alleviate computational difficulties.

Table 6: Recovered markups and marginal costs in pre-merger regime (January 1991–November 1998)

Manufacturer	Band	Class Category	Average of pre-merger observed prices: p_{jt}	Average of pre-merger markups: $p_{jt} - mc_{jt}$	Average of pre-merger marginal costs: mc_{jt}	Markup Percentage	Post-merger brand termination status (Termination during Dec 1998 - Nov 2003)
Hyundai	Atoz	City/Small	$ 6,316	$ 523	$ 5,796	8.28%	Terminated (in Dec 2002)
Kia	Pride	City/Small	$ 6,965	$ 782	$ 6,182	11.22%	Terminated (in Feb 2000)
Hyundai	Accent	Sub-compact	$ 8,194	$ 991	$ 7,203	12.09%	Terminated (in Oct 1999)
Kia	Avella	Sub-compact	$ 7,929	$ 667	$ 7,262	8.41%	Terminated (in Feb 2000)
Hyundai	Avente	Compact	$11,517	$2,037	$ 9,480	17.69%	Not terminated
Kia	Sephia	Compact	$10,709	$1,023	$ 9,686	9.55%	Terminated (in Jul 2000)
Kia	Shuma	Compact	$ 9,821	$ 853	$ 8,967	8.40%	Terminated (in Jan 2001)
Hyundai	Sonata	Mid-size	$17,593	$3,311	$14,282	18.82%	Not terminated
Kia	Credos	Mid-size	$16,471	$1,529	$14,941	9.28%	Terminated (in Aug 2000)
Kia	Retona	Compact Jeep	$12,041	$ 874	$11,167	7.26%	Terminated (in Dec 2000)
Hyundai	Gallopper	Jeep	$21,721	$2,302	$19,419	10.60%	Not terminated
Kia	Sportage	Compact crossover SUV	$17,746	$1,790	$15,956	10.09%	Terminated (in Dec 2002)
Hyundai	Santamo	Minivan	$19,395	$1,624	$17,771	8.37%	Terminated (in Dec 2002)
Kia	Carnival	Minivan	$19,884	$2,336	$17,547	11.75%	Not terminated

Hyundai and Kia Motors brands supplied in Nov 1998 (merger announcement month).
1000 won = 1 United States dollar exchange rate applied for prices listed on this table
Note: Kia Sportage was brought back in Aug. 2004

where Ω_t and $\mathbf{S}_t(p_t)$ are a square product ownership and substitution matrices with (m, n) entries are (m: row index and n: column index)

$$\Omega_{t,mn} = \begin{cases} 1 & \text{if product } m \text{ and } n \text{ are supplied by the same firm} \\ 0 & \text{otherwise} \end{cases}$$

$$\mathbf{S}_{t,mn} = -\frac{\partial s_{nt}}{\partial p_{mt}}$$

and $\times$ is the entry-by-entry multiplication. All of the right-hand side variables in equation (6) are observed or estimated; Ω_t is observed in data, $\mathbf{S}_t$ can be calculated from equation (5) with estimated parameters, and s_t is observed market share. Therefore, one can calculate markups from observed data and estimated parameters. Furthermore, by subtracting markups from observed prices, we can also calculate marginal costs. Table 6 contains calculated markups and marginal costs for brands that were supplied in November 1998 (merger announcement month). Since the calculated markups and marginal costs fluctuate month to month, I take the averages over months in the pre-merger regime. Recovered markups roughly agree with those reported in BLP (1995) and calculated marginal costs are used for post-merger price simulations.

5 Post-Merger Price Benchmark Simulation

In this section, I describe the post-merger price simulation framework, benchmark simulation assumptions, and benchmark simulation results. I use the simulation framework explained in this section throughout the rest of this

paper, although I will change simulation assumptions.

5.1 Simulation Framework

The post-merger price simulation follows the framework suggested by Nevo (2000, 2001) [31] [32]. The simulation process comprises the inverse operation of calculating markups and marginal costs. Rewriting the firms' profit maximizing first-order condition equation (6) with slight notational modifications,

$$\left[\Omega^{\text{post-merger}} \times \mathbf{S}(p)\right](p - \overline{\hat{mc}}) - s(p) = 0 \tag{7}$$

where $\overline{\hat{mc}}$ is the vector of estimated pre-merger marginal cost (averaged out over the pre-merger period) and $\Omega^{\text{post-merger}}$ is the post-merger ownership matrix. A vector of prices $p = [p_1, p_2, \cdots, p_J]$ solves this system of non-linear equations.

5.2 Benchmark (Conventional) Simulation Assumptions

Here, I list the assumptions for a post-merger price simulation, which are conventionally assumed in the differentiated-product industry horizontal-merger literature. These assumptions are de-facto standard assumptions in such post-merger price simulation analyses as Nevo (2000) [55], [31] Dube (2005) [12], and Peters (2006) [34].

Benchmark (Conventional) Assumptions:

(I-1) Consumer income conditions will remain the same after a merger

(II-1) Consumer preferences (including unobserved product characteristics) will remain the same after a merger

(III-1) Marginal costs will remain the same after a merger

(IV-1) Product line will remain the same after a merger

In the benchmark simulation computation, I materialize the above (I-1)-(IV-4) by using,

Benchmark (Conventional) Assumptions: Implementations

(I-2) Applying the average of pre-merger quarter dummies (which are income proxies), $\overline{\hat{\theta}_{q_t}}$

(II-2) Applying pre-merger consumer preference $(\hat{\alpha}, \hat{\beta}, \hat{\sigma})$ and average of pre-merger unobserved characteristics $\overline{\hat{\xi}_{jt}}$

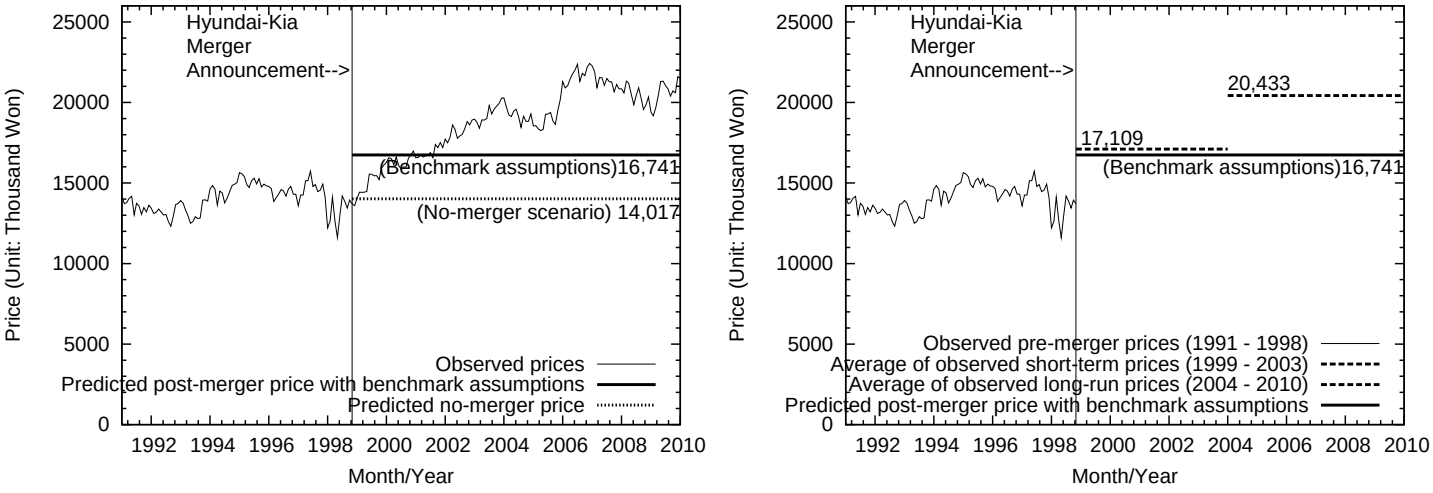
(III-2) Applying the average of pre-merger marginal costs $\overline{\hat{mc}_{jt}}$

(IV-2) Using the pre-merger product line (product line supplied in Nov. 1998, the merger announcement month)

One should recognize these assumptions as averaged pre-merger information. By using them, I am explicitly assuming that market conditions of (I-2)-(IV-2) will not change after the merger. In the next section, I re-compute observed changes in each of (I-2)-(IV-2) with other factors fixed (*Ceteris Paribus* approach).

[55] Note that Nevo (2000) [31], the inventor of this simulation method, clearly expressed his concerns about these simulation assumptions, "*However, this approach is not consistent with firms changing their strategies in other dimensions [than price dimension] that may influence demand. For example, if as a result of the merger the level of advertising changes, and advertising influences price sensitivity, then the estimate of the post-merger equilibrium price based on [simulation equation] will be wrong. In addition. this implies that characteristics, observed and unobserved, and the value of the outside good are assumed to stay the same pre- and post-merger. Therefore, I am implicitly assuming that the price of the outside good is exogenous and does not change in response to the merger.*" See (p.403) of his paper.

Figure 9: Left figure: Merger simulations versus observed prices, Right figure: Merger simulation versus average of observed prices (Short term 1999–2003, and Long run 2004–2010)



Note: All prices in these figures are sales weighted aggregate (market level) prices.

5.3 Benchmark Simulation Results

The simulated post-merger aggregate price is obtained as follows. I first obtain simulated prices for all vehicle brands by solving the non-linear simultaneous equation (7). Then, using the equation (2), I calculate market shares for each vehicle brand, and sales weighted aggregate market prices are calculated. Figure 9 reports the simulation results with benchmark assumptions. I find that the simulation with conventional assumptions can well-predict post-merger short-term (1999–2003) prices[56]. The averaged observed short-term (1999–2003) sales weighted price is \$17,109, and the simulation predicts \$16,741. The short-term price difference gap is \$368 (= \$17,109 - \$16,741), and the simulation only under-predicts by 2.15 percent ($= \frac{17{,}109-16{,}741}{17{,}109} \cdot 100$). However, the simulation, in large part, under-predicts long-run prices. The averaged observed long-run (2004–2010) sales weighted price is \$20,433, while the simulation predicts only \$16,741. The long-run price difference gap is \$3,692(= \$20,433 - \$16,741), and the simulation under-predicts by 18.07 percent ($= \frac{20{,}433-16{,}741}{20{,}433} \cdot 100$). There are several potential reasons for this long-run price discrepancy, and I will investigate them in the next section[57].

[56] This result should be interpreted with the following strong cautions. First, even in the short-term, market conditions changed significantly. Consumer incomes conditions (including automobile loan opportunities), supply side marginal costs, and product lines changed greatly as I will explain in the next section. Second, the merged Hyundai–Kia group seemed to refrain from making unilateral price increases until the end of 2002. Thus, the benchmark simulation assumptions (I-2)-(IV-2) did not hold even in the short term, and the simulated price is close to the observed price almost by coincidence.

[57] Another notable finding is that it took two and-a-half years from the time the merger was announced for market participants to reach predicted post-merger prices. In theoretical merger models, if a merger happened yesterday, a merged firm increases its product prices today (and rival firms also increase prices today). In reality, the effect of a merger does not appear immediately because of many real-world conditions such as (1) a merged firm needs time to be organizationally reconciled, (2) menu costs, or (3) fear of consumers and media backlash in the wake of price increases.

Table 7: Average monthly wage Korea (1991-2010)

Period	Average monthly wage	Change
Pre-merger (1991-1998)	\$1,891	—
Post-merger short term (1999-2003)	\$2,024	+7.1%
Post-merger long run (2004-2010)	\$2,475	+30.9%

6 Potential Causes in Long-Run Simulation Discrepancies

There are several possible reasons for long-run price discrepancies. In this section, I list potential causes using observed post-merger data. These causes become the basis for the simulated price discrepancy analysis discussed in the next section.

I: Post-Merger Changes in Consumer Income

The first factor to review is the change in consumer (household) income. Table 7 lists the average monthly wage in Korea for 1991–2010. I observe that wages steadily increased in the post-merger regime (1999–2010). Compared to the pre-merger regime average wage, workers in Korea are 7.1 percent wealthier in the short term (1999–2003), and 30.9 percent wealthier in the long–run (2004–2010). In the demand side of the model, one can expect that the quarter dummies (income proxies) of consumers' utility function in equation (1) increase with these increases in wages. Given this increase in wages, and given other factors remain unchanged, it is optimal for firms to charge prices higher than pre-merger regime prices. Therefore, changes in wages (incomes) are part of the explanation for price increases.

II: Post-Merger Changes in Consumer Preferences

Changes in consumer preferences constitute the second and largest factor. Table 5 indicates that automobile buyers in Korea had become price inelastic in the post-merger regime. The mean elasticity with instrumental variable nested-logit model in pre-merger regime is -4.13, while it is -2.32 in the post-merger regime. Given that other factors remain unchanged, firms can charge higher vehicle prices without losing much demand with this estimated post-merger preference. Thus, one can expect that the non-trivial portions of price increases can be explained by preference changes.

Table 8: Pre- and Post-merger marginal cost comparison

Manufacturer-Brand	Class	Pre-merger average price	Pre-merger average markup	**Pre-merger average mc**	Pre-merger mc/price ratio	Post-merger average price price	Post-merge average markup	**Post-merger average mc**	Post-merger mc/price ratio
Hyundai-Avante	Sub-compact	$11,517	$2,037	$ 9,489	0.82	$12,806	$2,614	$10,192	0.80
Hyundai-Sonata	Mid-size	$17,593	$3,311	$14,282	0.81	$19,746	$4,453	$15,293	0.77
Hyundai-Grandeur	Mids-size luxury	$37,205	$4,898	$32,325	0.86	$28,593	$5,114	$23,979	0.84
Kia-Carnival	Minivan	$19,884	$2,336	$17,547	0.88	$21,850	$2,954	$18,896	0.86
Ssangyong-Chairman	Large-size Luxury	$60,863	$6,064	$54,799	0.90	$48,050	$4,368	$43,682	0.91

Note: Post-merger marginal costs are derived with IV nested-logit post-merger demand estimation results that use post-merger data. Only five brands listed above were consistently sold from December 1999 through December 2010 without brand terminations.

III: Post-Merger Changes in Marginal Costs

Reductions in marginal costs forms the third dimension of post-merger change[58]. One can expect that, once merged, the new Hyundai–Kia would improve productivity due to merger synergy[59]. Unfortunately, since Korean automobile manufactures frequently changed their product lines both before and after the merger, direct marginal cost comparisons are difficult. Table 8 compares the marginal costs in both pre- and post-merger regimes among brands that had been continuously sold without brand terminations. Note that I recover these marginal costs from estimated demand elasticities, observed shares, and observed prices by using equation (6). I observe that both prices and marginal costs increased in the post-merger regime, while the $(\frac{\text{marginal cost}}{\text{price}})$ ratio decreased.

Since direct comparisons of vehicles' pre- and post-merger marginal costs are difficult due to frequent brand terminations, I use the plant-level input/output data to measure marginal cost improvement. In Appendix, I implement value-added-base production function estimations, and observe the statistically significant merger synergy effects among Hyundai–Kia group plants. Thus, the (value-added basis) marginal production costs of Hyundai–Kia group cars decreased after the merger, and affected post-merger vehicle prices.

IV: Post-Merger Changes in Product Lines

Product lines make up the fourth factor of post-merger change. For a merged firm, terminating intra-firm competing products would seem to be one f the optimal strategies for increase profits. Table 9 demonstrates that a significant number of Hyundai–Kia groups' vehicle bands were terminated between November 1998 and November 2003 (a period of 5 years after the merger announcement). The merged company primarily terminated brands of former Kia Motors, and one can observe significant changes in the product line. In particular, Kia's small- to mid-size luxury car line underwent drastic changes, including the elimination of some of its best-selling brands. In addition, terminated brands coincide with low-markup percentage brands in Table 6. I view these brand terminations as the merged Hyundai–Kia groups' differentiated product organization. In other words, a merged firm has an incentive to terminate intra-firm competing brands to maximize profit[60].

[58] Post-merger marginal cost reductions, called merger synergy, are heavily debated in the homogeneous product industry merger literature. See Gowrisankaran (1999) [17] for the literature review.

[59] I had a chance to interview a former Kia Motors worker. He mentioned that Kia Motors had better large-size engine production technologies (for SUVs and Minivans) than Hyundai did before the merger, whereas Hyundai held advantages in sedan production.

[60] This topic relates to endogenous product choices (product positioning). Although I do not model endogenous differentiated-product positioning in this paper, in the conclusion section, I will mention future extensions of this project that would examine the dynamics of

Table 9: Left figure: Bands supplied by Hyundai and Kia Motors in November 1998 (merger announcement month), Right figure: Brands supplied by Hyundai-Kia groups in Nov. 2003 (five years after merger)

Observed pre-merger product line: Brands supplied by Hyundai and Kia Motors in Nov.1998		
Class	Hyundai	Kia
City/Small	Atoz	Pride (5)
City/Small		
Sub-Compact	Accent (12)	Avella (40)
Sub-Compact		
Sub-Compact		
Compact	Avante (2)	
Compact		Sephia (8)
Compact		Shuma
Compact		
Mid-Size	Sonata (1)	Credos (22)
Mid-Size		
Mid-Size Luxury	Grandeur (3)	Potentia
Full-Size Luxury	Dynasty	Enterprise
Full-Size Luxury		
Sports		Elan
Sports	Tiburon	
Compact SUV/Jeep		(Asia-)Retona
SUV/Jeep	Gallopper (21)	
Compact Crossover SUV		Sportage (17)
Crossover SUV		
Minivan/MPV	Santamo	Carnival (15)
Minivan/MPV		
Compact Minivan/MPV		

Observed post-merger product line: Brands supplied by Hyundai-Kia groups in Nov.2003		
Class	Hyundai	Kia
City/Small	~~Atoz~~	~~Pride (5)~~
City/Small		Visto
Sub-Compact	~~Accent (12)~~	~~Avella (40)~~
Sub-Compact	Click	Rio
Sub-Compact	Verna (27)	
Compact	Avante (2)	Cerato
Compact		~~Sephia (8)~~
Compact		~~Shuma~~
Compact		Spectra
Mid-Size	Sonata (1)	~~Credos (22)~~
Mid-Size		Optima (30)
Mid-Size Luxury	Grandeur (3)	~~Potentia~~
Full-Size Luxury	Dynasty	~~Enterprise~~
Full-Size Luxury	Equus (39)	Opirus
Sports	Tuscani	~~Elan~~
Sports	~~Tiburon~~	
Compact SUV/Jeep		(Asia-)Retona
SUV/Jeep	Gallopper (21)	
Compact Crossover SUV	Terracan	~~Sportage (17)~~
Crossover SUV	SantaFe (7)	Sorento (19)
Minivan/MPV	~~Santamo~~	Carnival (15)
Minivan/MPV	Trajet (32)	
Compact Minivan/MPV	Lavita	Carens (14)

A brand name with a strike-thorough indicates a brand terminated at some point during December 1998 - November 2003.

Parentheses indicate 1991–2010 top 40 sales statuses and rank.

SUV: Sports Utility Vehicle, with off-road driving ability, Minvan = MPV: Multiple Purpose Vehicle

Crossover SUV: Mixture of SUV and MPV

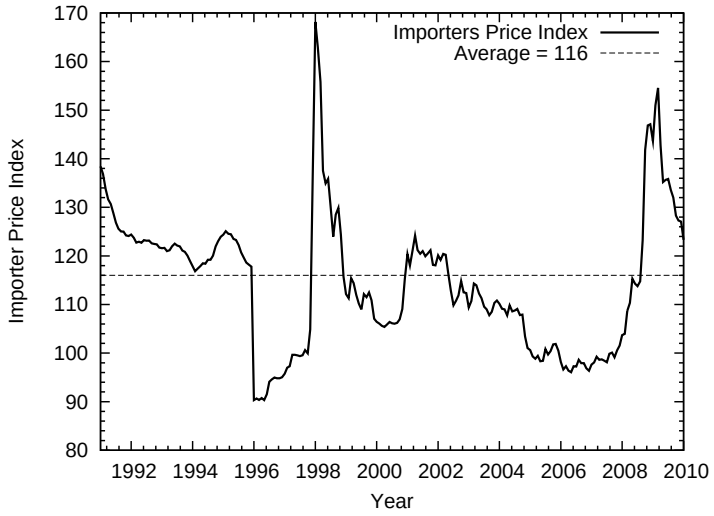
V: Post-Merger Product Quality Improvements

Another potential reason for vehicle price increases is product quality improvement. Although Korean automobile manufactures suffered from a reputation for low quality during the 1980s and early 1990s, today's automobile consumers (both in Korea and in the United States) generally recognize Korean cars to have undergone substantial quality improvements during the late 1990s to 2000s[61]. Figure 7 illustrates that, since 1992, Hyundai Sonata's price in the United States increased about 8 percent and Hyundai Elantra's price increased about 11 percent. Given the assumption that competition status in the United States' automobile market has remained unchanged, one might interpret such price increases as increases in quality. Thus, one could potentially attribute a portion of the price increases in Korea to improvements in product quality. However, such quality improvements cannot be measured

product positioning.

[61] Hyundai Sonata and Genesis were named Green Car Journal's Car of The Year in 2011 and 2009.

Figure 10: Material Cost Proxy: Importer Price Index in Korea (inflation adjusted)



as a numerical variable in this research, and are not included in the subsequent analysis in this paper[62].

VI: Post-Merger Changes in Material Costs

An increase in material costs could be a major cause of price increases. Figure 10 depicts the inflation-adjusted Importer Price Index during 1991–2010, which roughly measures imported material costs[63]. I observe two spikes, first in 1998 and then during 2008–2009. The spikes are due to the devaluation of the Korean won (in 1998 and 2009) and global material cost increases (in 2008). This figure indicates that increases in material cost could cause rises in vehicle prices during 2008–2009. However, the effects of material cost increases (on vehicle prices) were limited to the 2008–2009 period.

VII: Post-Merger Changes in Supply Side Competition

Change in the forms of supply side competition might contribute to long-run price deviations. The benchmark (conventional) simulation assumes a static Bertrand price competition. However, since the merged Hyundai-Kia group took about 70 percent of the domestic market's share in Korea, it remains possible that firms engaged in other forms of competition, such as leader-follower or dynamic price competitions. By observing price transitions in each vehicle type category (see Figures 6, 14, and 15), fringe/small-scale firms (GM-Daewoo, Samsung, and Ssangyong Motors) seem to follow Hyundai-Kia group's prices, especially during 2006–2010[64]. These observations suggest that

[62] Note that unobserved product characteristics, ξ_{jt}'s, are not direct measures of product quality. Rather, ξ_{jt}'s are recovered as residuals in equation (3), and depend on other products supplied in the market. In general, researchers rarely observe quality improvements in data in numerical forms. A notable exception is Leslie and Jin (2003), wherein restaurant hygiene scores (measures of restaurant qualities) are observed and policy impacts of newly introduced hygiene grade cards are investigated.

[63] Since Korea is not rich in natural resources, Korean manufacturing industries import materials from abroad.

[64] I observe that fringe (small-scale) firms raised their vehicle prices about 2 to 6 months after the Hyundai-Kia group raised its prices. The Edgeworth price cycle model, suggested by Maskin and Tirole (1998) and empirically analyzed by Noel (2007, 2008, 2009, 2010) and Lewis (working paper) with gasoline industry data, may capture such price movements. In addition, these observations decrease the likelihood of industry-wide collusion, as firms raise prices simultaneously in a situation of perfect collusion. Furthermore, dynamic price

part of the long-run simulation price discrepancy can be explained by the changes in supply side competition.

In summary, all of the changes described above (and numerous other changes not discussed here[65]) are likely to have occurred simultaneously in the post-merger regime, and thus to have contributed to vehicle prices in Korea. In the next section, I break down the changes in consumer incomes, preferences, marginal costs, and product lines, and investigate their contributions to discrepancies between observed and simulated prices.

7 Counterfactuals: Accounting for Long-Run Post-Merger Price Discrepancies, A Partial Contribution Approach

In this section, I account for the long-run price simulation discrepancies by taking into account observed post-merger market conditions in simulations. I realize that post-merger information is not available at the time merger policy decisions are made, and that simulation results reported here are completely hypothetical. However, these hypothetical simulations enable us to detect the sources of long-run simulated price discrepancies. Detected sources provide useful information for future antitrust policymaking in which antitrust policymakers can debate factors that should be included in post-merger price simulations. Note that the basement simulation, which uses only the pre-merger data, relies crucially on the strong assumptions (I-1)-(IV-1). In general, one cannot expect that such strong assumptions will hold after the merger, especially in the long run. In particular, I change the basement assumption by using the following observed (or estimated) post-merger data.

Using Observed Post-Merger Conditions in Simulations:

(I-3) Observed post-merger consumer incomes

(II-3) Observed post-merger consumer preferences

(III-3) Observed post-merger marginal costs

(IV-3) Observed post-merger product lines

Herein I take the partial contribution (ceteris paribus) approach. In other words, I investigate contributions of each (I-3)-(IV-3), given other factors fixed to the benchmark simulation assumptions[66]. In this way, I numerically evaluate effects of each (I-3)-(IV-3) separately with the goal of contributing to future horizontal-merger policymaking. In particular, I materialize post-merger information (I-3)-(IV-3) under the following conditions:

Using Observed Post-Merger Market Conditions in Simulations: Implementations

(I-4) Applying the 30.9 percent increase in quarter dummy (income proxy)

(II-4) Substituting the estimated post-merger preference parameters $(\hat{\alpha}, \hat{\beta}, \hat{\sigma})$, with using pre-merger $\overline{\xi_{jt}}$ values

(III-4) Applying a uniform 5 percent post-merger marginal cost reduction among Hyundai-Kia group's brands

(IV-4) Applying the observed November 2007 product lines, with post-merger $\overline{x_{jt}}$, $\overline{\xi_{jt}}$ and $\overline{\hat{mc}_{jt}}$ values

competitions, put forth by Rotemberg and Saloner (1986) [36] who suggest high prices during a recession, are not likely to describe this specific industry, since I do not observe high prices during the global recession (2008-2009).

[65] Such as the abilities of CEOs and effective advertisements through mass media.

[66] For example, when I use (II-3), I also apply (I-1), (III-1), and (IV-1) for a post-merger price simulation.

Table 10: **Using observed post-merger changes in simulation**: Partial (ceteris paribus) and total contributions on price discrepancies

Type of post-merger projection (given other projections un-applied, except last row)	Partial (or total) contribution for simulated post-merger aggregate prices	Simulated post-merger aggregate price	Notes:
(I-4): Using only post-merger **consumer income change**	+$ 933 (+25.26%)	$17,674	30.9% increase in average of pre-merger quarter dummies
(II-4): Using only post-merger **consumer preference change**	+$2,192 (+59.36%)	$18,933	Unobserved product characteristics, $\overline{\hat{\xi}_{jt}}$'s, unchanged
(III-4): Using only post-merger **marginal costs changes**	-$ 499 (-13.52%)	$16,242	Uniform 5% reduction in $\overline{\hat{mc}_{jt}}$'s among Hyundai-Kia vehicles
(IV-4): Using only post-merger **product line changes**	$ 269 (-7.31%)	$17,011	Using product lines in Nov. 2007 with recovered post-merger $\overline{\hat{\xi}_{jt}}$'s
Using (I-4), (II-4), and (III-4) **Simultaneously (multiple changes)**	+$ 2,260 (+61.25%)	$19,002	Simultaneously applying (I-4) - (III-4)

1000 won =1 US dollar exchange rate applied

Simulated prices with benchmark (conventional) assumptions (I-1)-(IV-1) is $16,741

Second column represents changes in comparison with benchmark simulated price

Percentages in the second column indicate contributions to reduce (observed long run minus simulated) price discrepancy = $3,692 (= $20,433 - $16,741). For example (I-4) contributes $\frac{933}{3,692} \times 100 = 25.26$ percent.

Average of observed long-run (1999–2003) prices = $17,109

Average of observed long-run (2004–2010) prices = $20,433

Note that, in general, changes in consumer preference and supply-side changes in product lines are not separable. Consumer's preference over unobserved product characteristics ξ_{jt} depends on available products that automobile manufactures determine to supply[67][68]. To alleviate this non-separability problem, I have chosen the pre-merger $\overline{\xi_{jt}}$ values used in (II-4) and post-merger $\overline{\xi_{jt}}$ values used in (IV-4).

7.1 A Ceteris Paribus (Partial Contribution) Evaluation in Post-Merger Changes

Table 10 lists the results of each partial contribution of the post-merger changes for improving (average of observed long run minus basement simulation) price discrepancy, given other changes unapplied. I observe that consumer income increased 30.9 percent after the Hyundai–Kia merger (see Table 7). Applying (I-4), which increases average of pre-merger quarter dummies (income proxy) by 30.9 percent, results in a reduction of the outside goods (non-purchase) share and a $933 increase in post-merger aggregate price. (II-4) enables an investigation on the effect of

[67] I observe that more and more SUVs became available in the post-merger regime. Technically, one can decision-theoretically debate the relationship between consumer preference and choice sets, although such discussions are not within the scope of this research.

[68] I recognize product lines are endogenously determined given consumer incomes and preferences. I am currently working on another research project that analyzes firms' endogenous dynamic choices of differentiated products (product lines) given the perfect foresights on consumer income and preferences.

preference change. By substituting the estimated post-merger preferences $(\hat{\alpha}, \hat{\beta}, \hat{\sigma})$, the aggregate price increases by \$2,192. The post-merger changes in preference comprise the largest observable source of simulation discrepancy. (III-4), a uniform 5 percent reduction in marginal costs among Hyundai-Kia vehicles[69], investigates the consequences of post-merger marginal cost improvements from the merger synergy. The simulation results indicate that these marginal cost improvements result in an aggregate price reduction of \$499[70]. Finally, (IV-4) investigates the impact of product line changes. I substitute the observed November 2007 product lines, their product characteristics (both observable and unobservable), and marginal costs. The result indicates that such product line changes increase the aggregate price by \$269. A strong caveat is required for interpreting this number. Given consumer incomes and preferences, the product lines were endogenously determined by firms. As I discussed in the section 6, the merged Hyundai-Kia group avoided intra-firm product competitions, and terminated some intra-firm competing products. Such product-line organization results in the increase in aggregate price. These simulation results indicate that changes in consumer income and preference had a substantial impact on post-merger price hikes, although supply side changes in marginal costs and product lines also had sizable impacts.

More importantly, these post-merger changes in (I-4)-(III-4) can be applied simultaneously[71], and such a simulation with simultaneous factor changes may have practical value in antitrust policymaking. With this motive in mind, I simulate post-merger prices using (I-4)-(III-4) simultaneously. The result is a 61.24 percent (\$ 2,260) discrepancy reduction, and more than half of the discrepancy can be explained by incorporating (I-4)-(III-4). This simulation result from simultaneous post-merger changes indicates that antitrust policy makers can benefit from incorporating potential changes in relevant exogenous[72] factors into the simulation model[73].

Lastly, there remains an unexplained portion of simulation discrepancy. However, note that such post-merger changes as product quality improvements and changes of supply side competition could explain the remaining simulation discrepancy. In particular, unobserved product quality improvements are likely to be the major component. A consensus exists among automobile industry specialists that Korean automobile manufactures improved their product quality throughout the 2000s[74]. Such quality improvements ideally should be observed and incorporated in simulations. However, product quality improvements are, unfortunately, not numerically observed in this research and thus remain in the unexplained discrepancy.

[69] The uniform 5 percent marginal cost reductions are temporarily assumed. I am currently working on production function estimations and recovering marginal costs using observed wage and rental rate data. Using recovered marginal production costs, I will attempt to investigate the merger synergy effect (TFP improvement) after the Hyundai-Kia merger.

[70] This result marks a contrast to the marginal cost reduction seen in perfectly substitutable homogeneous goods markets. In a homogeneous product market with Bertrand price competition and given that marginal costs are identical, one expect a 5 percent market price decrease with a 5 percent marginal cost reduction. In a differentiated-product market, the effects of marginal cost reductions are weakened by imperfect substitutions.

[71] Since both (IV-4) and (III-4) change marginal costs, (IV-4) cannot be applied with (III-4).

[72] Exogenous to the simulation model.

[73] In this case study, post-merger preference changes play the most significant role in creating long-run simulation discrepancy. However, in other cases such as a horizontal merger in the cereal industry, post-merger supply side changes in marginal cost and product lines could play substantial roles.

[74] GM-Daewoo Motors and Renault-Samsung Motors had also improved product qualities by introducing General Motors and Renault vehicle based automobile brands. General Motors and Renault Motors were also likely to carry over production technologies.

Figure 11: Left figure: Applying post-merger income, Right figure: Applying post-merger preference

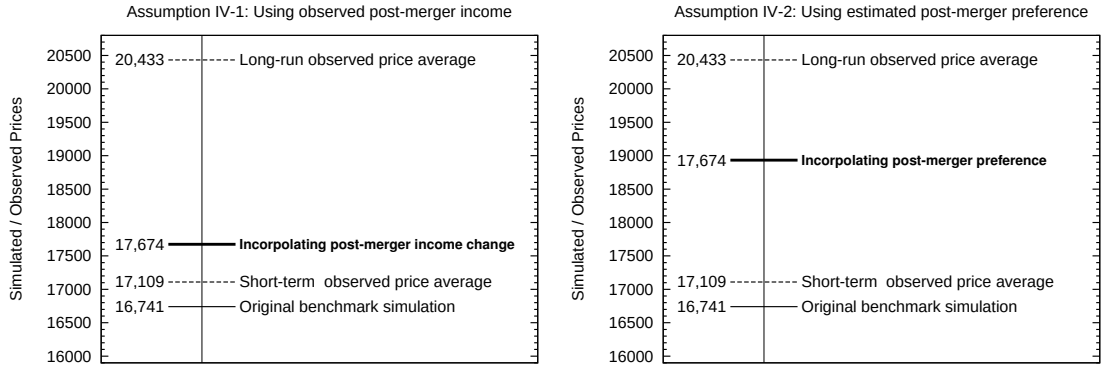
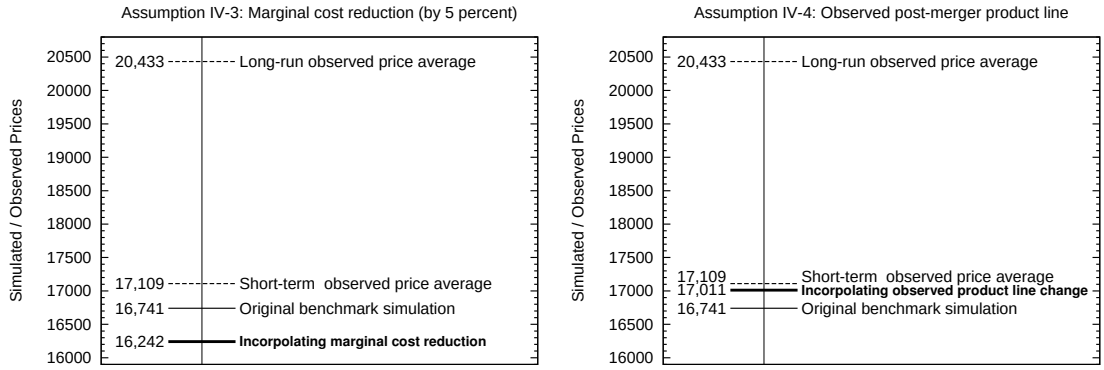


Figure 12: Left figure: Applying marginal cost reduction, Right figure: Applying post-merger product line



8 Conclusion and Future Extensions

This paper demonstrates empirically that the post-merger price simulation method proposed by Nevo (2000, 2001) [31] [31] can offer reasonable performance in predicting shot-term post-merger prices, although, in this case study, some of the simulation assumptions changed even in the short term. Nonetheless, using this simulation reveals significant long-run discrepancies between observed and simulated prices. This research also investigates counterfactual simulations, which take into account observed post-merger changes in the market. Counterfactual simulations exemplify that changes in consumer incomes and preferences, and marginal costs can explain the majority of simulation discrepancies. This ex-post evaluation of simulation performance suggests that, when antitrust policymakers apply the results of post-merger price simulations, they must take into account possible changes in factors that the simulation model takes as exogenous.

One can expand this research in two important directions. The first direction involves modeling supply-side endogenous product positioning[75], a currently active research area in the empirical industrial organization literature.

[75] E.g.: Such differentiated-product firms as magazine publishers or beer manufactures dynamically allocate their products on the product space. They organize their product positioning to correspond to changes in costs, government regulations, and consumer tastes. Importantly, the effect of such policy changes as tighter environmental regulations or tax increases depends on how firms react to new market conditions by reallocating their differentiate products. For example, market effects of the currently debated "sugar tax" depend on how quickly food (or soda) manufacturers react to the sugar tax by changing their product lines.

Although endogenous product-positioning[76] serves as an important component of antitrust policymaking, only a limited number of empirical investigations are currently available, especially regarding the dynamics of differentiated-product positioning[77]. Sweeting (working paper) [39] stands as the pioneering researcher in this area. Due to simple market characteristics, the Korean automobile market is advantageous when it comes to investigating supply-side product choice dynamics.

Investigating Williamson's trade-off with internationally competing firms serves as the second direction of possible research extension. The core of the antitrust merger debate lies in whether consumer-side welfare-reducing price effects can be compensated for supply-side welfare-increasing productivity gains, when looked at from a perspective of enhancing social surplus. This Williamson trade-off framework becomes extremely challenging considering the existence of firms that engage in both domestic and international competitions, and also invest in quality improvements. The trade-off problem would then become whether one can view welfare losses among domestic consumers (that result from high the post-merger domestic market concentration) as necessary sacrifices for the productivity (and quality) increase (and subsequent welfare gains) of globally operating domestic firms. In particular, the Hyundai–Kia group, which has extracted consumer surplus since the merger, has—at the same time—heavily invested in quality, design, and manufacturing improvements[78] and, furthermore, has expanded global sales[79]. If one takes the social surplus maximizing point of view, post-merger welfare losses among Korean domestic automobile buyers could be offset by Hyundai–Kia group's global sales expansions, made possible by the improvements in productivity and product quality[80]. Although I am unable to provide answers to this important social question, my conjecture is that the merger between Hyundai and Kia Motors enhanced Korea's overall welfare, thanks to the large expansion of exports by the merged Hyundai-Kia group.

[76] See Gandhi, Froeb, Tachantz, and Werden (2008) [16] for the theoretical frame work of post-merger differentiated-product space organizations.

[77] See Draganska, Mazzeo, and Seim (working paper) for their literature review on endogenous product choice by firms.

[78] See Hyundai Motors' financial reports: http://worldwide.hyundai.com/company-overview/investor-relations/financial-information-statements-audited-report.html.

[79] As of December 2010, Hyundai-Kia group is the forth-largest automobile manufacture in the world, following GM, Toyota, and Volkswagen groups.

[80] Hyundai Motors' famous "10 years or 100,000 miles" warranty in North America began in 1999, right after the Hyundai-Kia merger.

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Appendix 1: Data Construction Details

8.1 Categorizations for Estimation and Construction of Instrumental Variables

Based on Berry, Levinsohn, and Pakes (1995) [5], I construct and use following instrumental variables.

(1) Cost shifter = kilogram × (Importer Price Index)

(2) Sum of within same class competing firm products' size

(3) Sum of within same class competing firm products' horsepower-per-kilogram

(4) Sum of within same class competing firm products' kilometer-per-litter

Brand classes are listed on the table 11 [81][82].

[81] Since SUVs, Crossover-SUVs, and Minivans have complicated classifications, I categorize them into the single category.

[82] Berry, Levinsohn, and Pakes (1995) also use the sum of the characteristics of other products offered by the same firm. I do not use such instruments in this research due to concerns about endogenous product characteristic choices.

Table 11: Automobile brand classifications by firm

Class	Hyundai	Kia	(GM-)Daewoo	Ssangyong	(Renault-)Samsung	IV Nested-logit group categorization
City/Small	Atoz	Morning (16)	Matiz (4)			(i) Small- & Compact-size group
City/Small		Visto	Tico (11)			(i) Small- & Compact-size group
City/Small		Pride (5)				(i) Small- & Compact-size group
Sub-Compact	Accent (12)	Avella (40)	Ciero			(i) Small- & Compact-size group
Sub-Compact	Click	Rio	Gentra			(i) Small- & Compact-size group
Sub-Compact	Excel (10)		GentraX			(i) Small- & Compact-size group
Sub-Compact	Verna (27)		Kalos			(i) Small- & Compact-size group
Sub-Compact			Lanos (37)			(i) Small- & Compact-size group
Sub-Compact			LeMans (29)			(i) Small- & Compact-size group
Compact	Avante (2)	Capital (38)	Lacetti (31)		SM3 (23)	(i) Small- & Compact-size group
Compact	Elantra (6)	Cerato	Nubira (28)			(i) Small- & Compact-size group
Compact	i30	Forte				(i) Small- & Compact-size group
Compact	Stellar	Sephia (8)				(i) Small- & Compact-size group
Compact		Shuma				(i) Small- & Compact-size group
Compact		Spectra				(i) Small- & Compact-size group
Mid-Size	Sonata (1)	Concord	Espero (20)		SM5 (9)	(ii) Mid-size group
Mid-Size		Credos (22)	Leganza (33)		SM518	(ii) Mid-size group
Mid-Size		K5	Magnus		SM520 (24)	(ii) Mid-size group
Mid-Size		Lotze (34)	Tosca		SM525	(ii) Mid-size group
Mid-Size		Optima (30)				(ii) Mid-size group
Mid-Size Luxury	Grandeur (3)	K7	Arcadia		SM7	(iii) luxury group
Mid-Size Luxury			Brougham			(iii) luxury group
Mid-Size Luxury			Imperial			(iii) luxury group
Mid-Size Luxury			Prince (13)			(iii) luxury group
Mid-Size Luxury			Salon			(iii) luxury group
Full-Size Luxury	Dynasty	Enterprise		Chairman		(iii) luxury group
Full-Size Luxury	Equus (39)	Opirus		ChairmanW		(iii) luxury group
Full-Size Luxury	Genesis	Potentia				(iii) luxury group
Sports	Scoupe	Elan				(ii) Mid-size group
Sports	Tiburon					(ii) Mid-size group
Sports	Tuscani					(ii) Mid-size group
Compact SUV/Jeep		(Asia-)Retona		Family		(iv) Jeep, SUV, Minivan group
Compact SUV/Jeep		(Asia-)Rocsta		Korando (25)		(iv) Jeep, SUV, Minivan group
SUV/Jeep	Gallopper (21)			Musso (18)		(iv) Jeep, SUV, Minivan group
Compact Crossover SUV	Terracan	Sportage (17)	Winstorm	Actyon	QM5	(iv) Jeep, SUV, Minivan group
Compact Crossover SUV	Tuscon (26)			Kyron		(iv) Jeep, SUV, Minivan group
Crossover SUV	SantaFe (7)	Sorento (19)		Rexton (36)		(iv) Jeep, SUV, Minivan group
Crossover SUV Luxury	Veracruz	Mohave				(iv) Jeep, SUV, Minivan group
Minivan/MPV	Santamo	Carnival (15)		Rodius		(iv) Jeep, SUV, Minivan group
Minivan/MPV	Trajet (32)	Grand Carnival				(iv) Jeep, SUV, Minivan group
Compact Minivan/MPV	Lavita	Carens (14)	Rezzo (35)			(iv) Jeep, SUV, Minivan group
Compact Minivan/MPV		Carstar				(iv) Jeep, SUV, Minivan group
Compact Minivan/MPV		Soul				(iv) Jeep, SUV, Minivan group

Parentheses indicate 1991-2010 top 40 sales status and rank

SUV: Sports Utility Vehicle, with off-road driving ability, MPV: Multiple Purpose Vehicle equivalent to Minivan

Crossover SUV: Mixture of SUV and MPV

Appendix 2: Constructions of Aggregate Prices

In this appendix, I describe the construction of aggregated prices. I use two objective criteria for creating representative prices and denoting P as aggregated price or price by firm, p as observed price, and q as observed sales quantity.

Sales Weighted Prices

The definition of sales weighted prices:

(1-1) Sales weighted aggregate prices

$$P_{\text{aggregate},t} = \sum_{j \in \text{all brands supplied at time } t} \left[p_{j,t} \cdot \frac{q_{j,t}}{\sum_{j \in \text{all brands supplied at time } t} q_{j,t}} \right]$$

(1-2) Sales weighted prices by firm (ex: Hyundai Motors)

$$P_{\text{Hyundai},t} = \sum_{j \in \text{all Hyundai brands supplied at time } t} \left[p_{j,t} \cdot \frac{q_{j,t}}{\sum_{j \in \text{all Hyundai brands supplied at time } t} q_{j,t}} \right]$$

These prices are plotted on 9.

Indexed Prices

Index weight are defined as

$$w_{j,\text{period}} = \frac{\text{Sales quantity of brand } j \text{ in a specific period}}{\text{Total sales quantity in a specific period}}.$$

I specify the periods as (i) 1991–1995, (ii) 1996–2000, (iii) 2001–2005, (iv) 2006–2010.

I define indexed prices as:

(2-1) Indexed aggregate prices

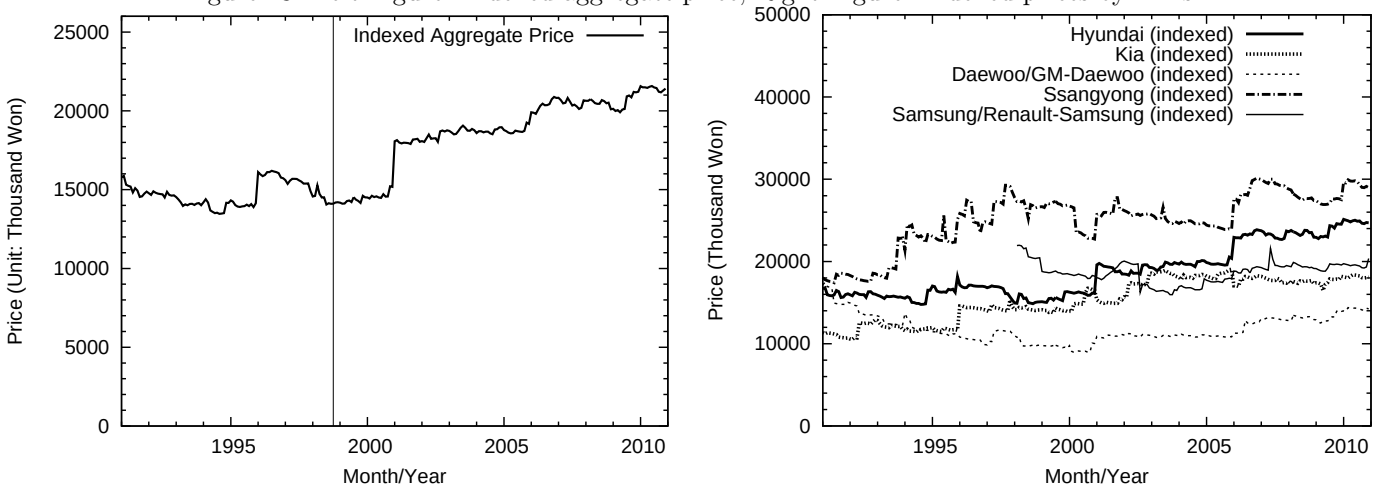
$$P_{\text{aggrregate},t} = \sum_{j \in \text{all brands supplied at time } t} p_{j,t} \cdot w_{j,\text{perod}}$$

(2-2) Indexed prices by firm (ex: Hyundai Motors)

$$P_{\text{Hyundai},t} = \sum_{j \in \text{all Hyundai brands supplied at time } t} p_{j,t} \cdot w_{j,\text{perod}}$$

I plot the indexed prices in Figure 13. Unfortunately, the prices have "jumps" at Januaries of 1996, 2001, and 2006, however, long-run post-merger prices are clearly observed.

Figure 13: Left Figure: Indexed aggregate price, Right Figure: Indexed prices by firms



Data source: Motor Magazine and Carlife Magazine (prices in Korea)

Appendix 3: Supplemental Figures

In this section, I post supplemental figures which are not posted in the main body of the paper.

Vehicle Price Transitions

Figure 14, 15, and 16 show that vehicle prices categorized by class. There are two notable findings among these figures:

(1) Prices did not increase immediately after the Hyundai–Kia merger in November 1998.

(2) Prices significantly increased in 2006.

(1) is caused by the following reason. In the production function estimations, I observe statistically significant Total Factor Productivity (TFP) improvements. Thus, newly merged Hyundai-Kia group' plants obtained merger synergy (TFP improvement), and improved (decreased) their marginal costs. Improved marginal cost prevents Hyundai-Kia group from increasing their vehicle prices after the merger.

Figure 14: Left figure: City-/Small-size car prices, Right figure: Subcompact car prices

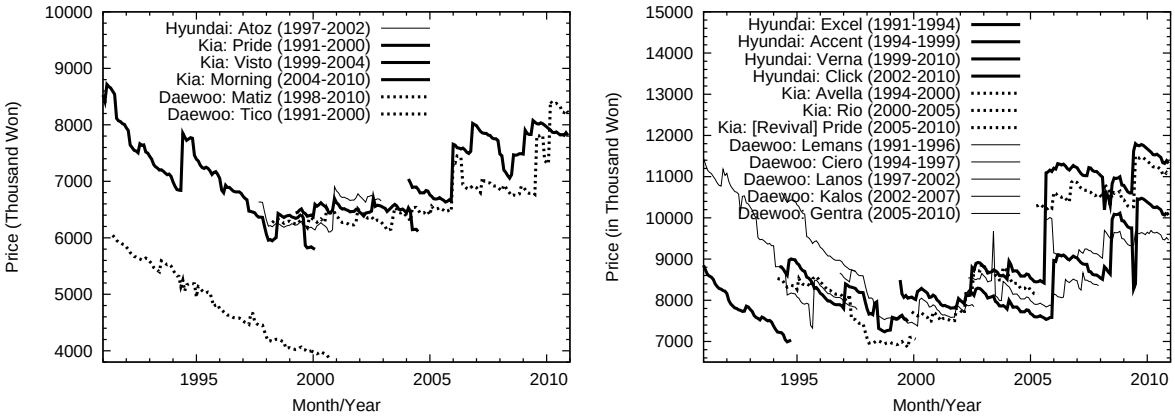


Figure 15: Left figure: Compact crossover SUV prices, Right figure: Crossover SUV prices

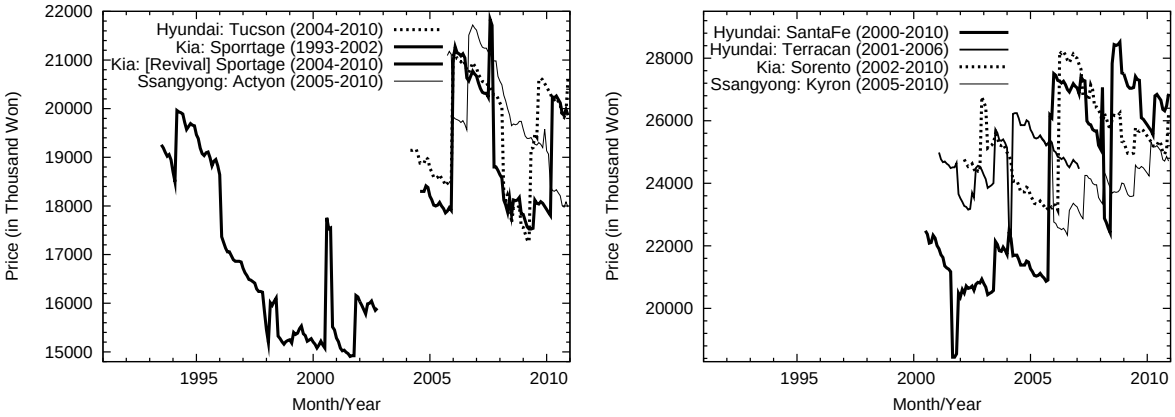
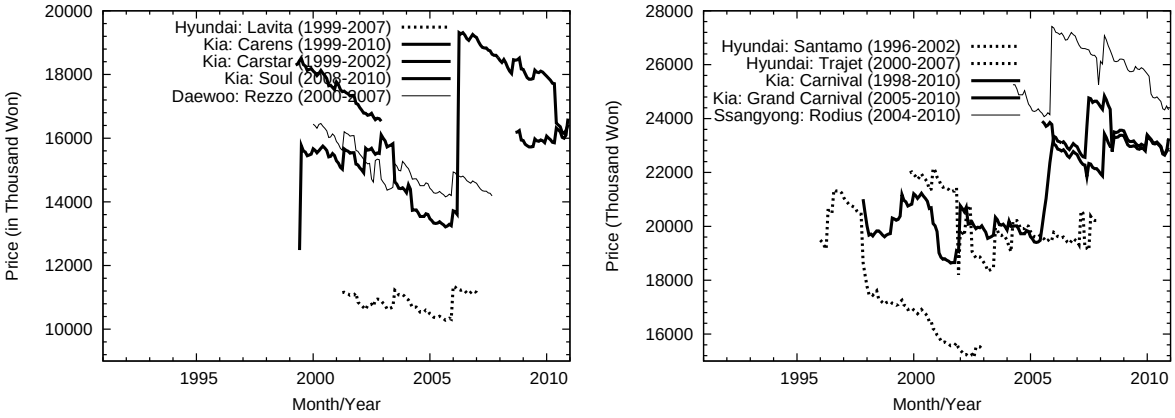


Figure 16: Left figure: Compact-minivan prices, Right figure: Minivan prices



Appendix 5: Simple Example of Nevo's Ownership Matrix Method, and Simulation Computation

Example: Two firms and three brands. Firm A supplies goods 1 and 2 and firm B supplies good 3. Profits for each firm are

$$\begin{aligned}\Pi_A &= (p_1 - mc_1)s_1(p)M + (p_2 - mc_2)s_2(p)M - C_A \\ \Pi_B &= (p_3 - mc_3)s_3(p)M - C_B.\end{aligned}$$

First order necessary conditions are

$$\begin{aligned}s_1(p) + (p_1 - mc_1)\frac{\partial s_1(p)}{\partial p_1} + (p_2 - mc_2)\frac{\partial s_2(p)}{\partial p_1} &= 0 \\ (p_1 - mc_1)\frac{\partial s_1(p)}{\partial p_2} + s_2(p) + (p_2 - mc_2)\frac{\partial s_2(p)}{\partial p_2} &= 0 \\ s_3(p) + (p_3 - mc_3)\frac{\partial s_3(p)}{\partial p_3} &= 0\end{aligned}$$

and

$$\begin{bmatrix} -\frac{\partial s_1(p)}{\partial p_1} & -\frac{\partial s_2(p)}{\partial p_1} & 0 \\ -\frac{\partial s_1(p)}{\partial p_2} & -\frac{\partial s_2(p)}{\partial p_2} & 0 \\ 0 & 0 & -\frac{\partial s_3(p)}{\partial p_3} \end{bmatrix} \begin{bmatrix} p_1 - mc_1 \\ p_2 - mc_2 \\ p_3 - mc_3 \end{bmatrix} = \begin{bmatrix} s_1(p) \\ s_2(p) \\ s_3(p) \end{bmatrix}.$$

Then, we obtain

$$\begin{bmatrix} p_1 - mc_1 \\ p_2 - mc_2 \\ p_3 - mc_3 \end{bmatrix} = \left\{ \begin{bmatrix} 1 & 1 & 0 \\ 1 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \times \begin{bmatrix} -\frac{\partial s_1(p)}{\partial p_1} & -\frac{\partial s_2(p)}{\partial p_1} & -\frac{\partial s_3(p)}{\partial p_1} \\ -\frac{\partial s_1(p)}{\partial p_2} & -\frac{\partial s_2(p)}{\partial p_2} & -\frac{\partial s_3(p)}{\partial p_2} \\ -\frac{\partial s_1(p)}{\partial p_3} & -\frac{\partial s_2(p)}{\partial p_3} & -\frac{\partial s_3(p)}{\partial p_3} \end{bmatrix} \right\}^{-1} \begin{bmatrix} s_1(p) \\ s_2(p) \\ s_3(p) \end{bmatrix}.$$

In the paper, I solve/simulate 18 to 41 dimensional versions of this problem (since the number of supplied automobile brands changes over time, dimensions vary).

Appendix 6: Sales Rankings

Table 12: Top 40 Sales of Domestically-Produced Automobiles (Korea, 1991-2010)

Sales Ranking	Firm	Brand	Classification	Sales Units
(1)	Hyundai	Sonata	Mid-Size	2,605,467
(2)	Hyundai	Avante	Compact	1,611,615
(3)	Hyundai	Grandeur	Mid-Size Luxury	922,587
(4)	Daewoo	Matiz	City/Small	695,707
(5)	Kia	Pride	Sub-Compact	622,416
(6)	Hyundai	Elantra	Compact	580,396
(7)	Hyundai	SantaFe	Crossover SUV	580,368
(8)	Kia	Sephia	Compact	539,333
(9)	Samsung	SM5	Mid-Size	458,776
(10)	Hyundai	Excel	Sub-Compact	416,273
(11)	Daewoo	Tico	Citi/Small	415,096
(12)	Hyundai	Accent	Sub-Compact	406,960
(13)	Daewoo	Prince	Mid-Size Luxury	392,454
(14)	Kia	Carens	Compact Minivan/MPV	388,042
(15)	Kia	Carnival	Minivan/MPV	383,575
(16)	Kia	Morning	City/Small	371,513
(17)	Kia	Sportage	Compact Crossover SUV	345,148
(18)	Ssangyong	Musso	SUV/Jeep	326,968
(19)	Kia	Sorento	Crossover SUV	321,001
(20)	Daewoo	Espero	Mid-Size	306,941
(21)	Hyundai	Galloper	Compact SUV/Jeep	306,596
(22)	Kia	Credos	Mid-size	275,958
(23)	Samsung	SM3	Compact	275,817
(24)	Samsung	SM520	Mid-Size	272,851
(25)	Ssanyong	Korando	Compact SUV/Jeep	271,229
(26)	Hyundai	Tucson	Compact Crossover SUV	255,510
(27)	Hyundai	Verna	Sub-Compact	253,494
(28)	Daewoo	Nubira	Compact	243,718
(29)	Daewoo	LeMans	Sub-Compact	238,527
(30)	Kia	Optima	Mid-Size	218,665
(31)	Daewoo	Lacetti	Compact	193,286
(32)	Hyundai	Trajet	Minivan/MPV	191,767
(33)	Daewoo	Leganza	Mid-Size	189,380
(34)	Kia	Lotze	Mid-Sise	188,236
(35)	Daewoo	Rezzo	Compact Minivan/MPV	180,463
(36)	Ssangyong	Rexton	Crossover SUV	172,386
(37)	Daewoo	Lanos	Sub-Compact	166,032
(38)	Kia	Capital	Compact	153,090
(39)	Hyundai	Equus	Full-Size Luxury	150,171
(40)	Kia	Avella	Sub-Compact	138,099

Appendix 4: Measuring Merger Synergy by Estimating a Production Function and Recovering Production Marginal Costs

In this appendix, I estimate a automobile-plant-level production function and examine the Hyudai-Kia merger's synergy. As mentioned in the paper, the direct comparisons of pre- and post-merger marginal costs are difficult because Korean automobile manufactures changed their product lines largely. Alternatively, I directly measure the Total Factor Productivity (henceforth TFP) changes before and after the Hyundai-Kia merger.

Plant Level Data

Production and cost functions are estimated with data from *Korean Annual Mining and Manufacturing Survey* which contains annual plant level data[83]. The plant information is summarized in Table 13.

Firms' Cost Minimization Problem

I assume a production function has the Cobb-Douglas form $Y = f(K, L) = AK^{\alpha_k}L^{\alpha_l}$ where Y is a value added, A is a TFP, K is a value of capital equipment (includes building, structure, machine, vessels and vehicles, etc), and L is the number of total labor hours. Given an amount of production Y, a firm solves the cost minimization problem

$$\min_{K,L} \{rK + wL\} \quad \text{s.t.} \quad Y = AK^{\alpha_k}L^{\alpha_l}.$$

[83] The data is available from http://kostat.go.kr. Unfortunately, this dataset does not have plant id indicators. However, because of small number of automobile assembling plants in South Korea, I was able to pin down plants' identities by matching their province/city locations, plant establishment years, and end/beginning of year number of labors. Xu also use the same survey data (for Electric Motor Industry) to construct his technology diffusion model.

Table 13: List of automobile plants in Korea

Plant Number	Plant ownership	Location	Sampling years	produced brand (in the calendar year of 2004)
1	Daewoo→GM Daewoo	Incheon-Greater-City	1992 - 2009	Cielo, Lanos, Leganza
2	Daewoo→GM Daewoo	Gusan, Jeolla-Buk-Province	1997 - 2009	Magnus, Nubira, Rezzo
3	Daewoo Truck→Tata Daewoo	Gunsan, Jeolla-Buk-Province	1995 - 2009	Commercial Truck
4	Daewoo→GM Daewoo	Changwon, Gyeong-San-Nam-Province	1992 - 2009	Matiz, Tico
5	Hyundai	Ulsan-Greater-City	1992 - 2009	Atoz, Avante, Dynasty, Equus, Galloper, Grandeur, Santa-Fe, Santamo, Sonata, Sportage, Tiburon, Verna, Visto, Kia-Carstar
6	Hyundai	Asan, Chung-Cheon-Nam-Province	1996 - 2009	Dynasty, Equus, Grandeur, Tiburon
7	Hyundai	Jeonju, Jeolla-Buk-Province	1995 - 2009	Buses, Commercial Trucks
8	Kia	Hwaseong, Gyeong-Di-Province	1992 - 2009	Shuma, Optima, Carens, Sephia, Sorento, Opirus
9	Kia	Gwangju Greater-City	1992 - 2008	N.A.
10	Asia→Kia	Gwangju-Greater-City	1992 - 2009	Commercial Trucks
11	Kia	Sohari, Gyeong-Gi-Province	1992 - 2009	Carnival, Rio
12	Samsung	Busan-Greater-City	1998 - 2009	SM3, SM5, SM7
13	Samsung	Daegu-Greater-City	1998 - 2000	Commercial Trucks
14	Ssangyong	Pyeongteak, Gyong-Gi-Do	1992 - 2009	Chairman, Korando, Musso, Rexton

Data Source: Firm websites (ownership), Korea Mining and Manufacturing Survey (location and sampling years), Ward's Automotive Yearbook (produced vehicle brand)

Table 14: Production function estimation results

(Sample size = 211)	Fixed-effect	Random-effect	Olley-Pakes
Hyundai-Kia merger synergy dummy	**0.5288425****	**0.7764618****	
	(0.1629887)	(0.1305422)	
Log of capitals: k_{jpT}	0.2493353**	0.2768914**	
	(0.0686254)	(0.0667296)	
Log of labor hours: l_{jpT}	0.7767417**	0.7786819**	
	(0.073964)	(0.0733462)	
Year 1994-1995 dummy	0.1845082	0.1720114	
	(0.2199425)	(0.2265514)	
Year 1996-1997 dummy	0.6856387**	0.7152682**	
	(0.2069489)	(0.2129984)	
Year 1998-1999 dummy	0.0691629	0.0380033	
	(0.2149192)	(0.2195961)	
Year 2000-2001 dummy	0.3862698*	0.3030461	
	(0.2245226)	(0.2238168)	
Year 2002-2003 dummy	0.9488245**	0.8473274	
	(0.2300275)	(0.2310227)	
Year 2004-2005 dummy	0.8188824**	0.716725**	
	(0.226336)	(0.2262378)	
Year 2006-2007 dummy	1.413632**	1.443058**	
	(0.2067615)	(0.2128381)	
Year 2008-2009 dummy	1.276235**	1.307849**	
	(0.2081042)	(0.2141733)	
Constant	-3.818104**	-4.230903**	
	(0.5081779)	(0.500086)	

Note: Basement years for dummy variables are 1991-1992. Random effect model is rejected by the Hausman test

It is trivial that this minimization problem provides the following well-known Cobb-Douglas cost and marginal cost functions

$$\begin{aligned} C(r,w,Y) &= \left(\frac{Y}{A}\right)^{\frac{1}{\alpha_k+\alpha_l}} \cdot \left[\left(\frac{\alpha_k}{\alpha_l}\right)^{\frac{\alpha_l}{\alpha_k+\alpha_l}} + \left(\frac{\alpha_l}{\alpha_k}\right)^{\frac{\alpha_k}{\alpha_k+\alpha_l}}\right] \cdot r^{\frac{\alpha_k}{\alpha_k+\alpha_l}} \cdot w^{\frac{\alpha_w}{\alpha_k+\alpha_l}} \\ MC(r,w,Y) &= \frac{1}{\alpha_k+\alpha_l} \cdot \frac{1}{Y} \cdot C(r,w,Y) \end{aligned}$$

Production Function Estimation

For estimation, we assume the production function is

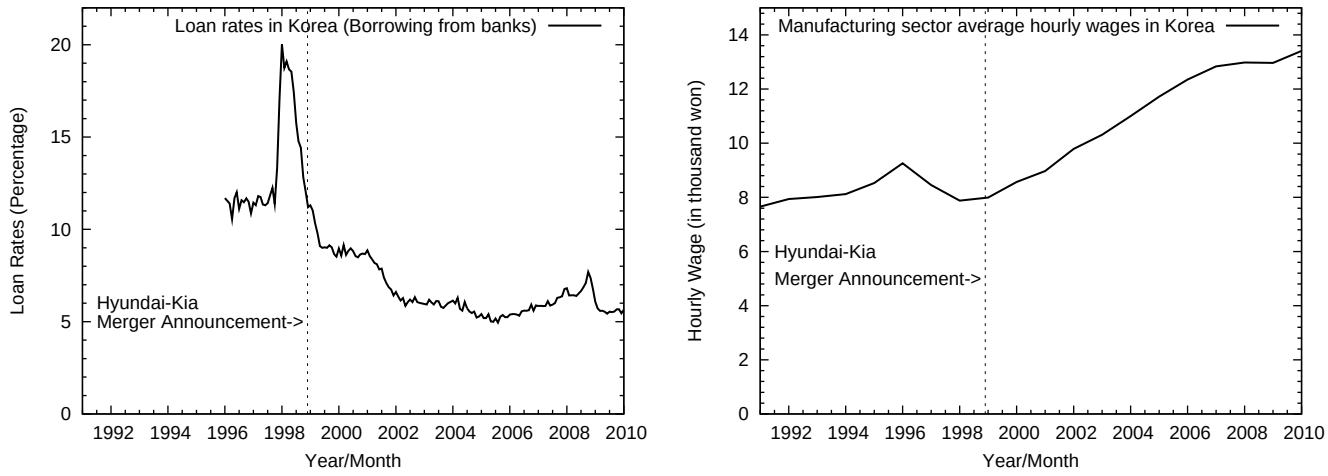
$$Y_{jpT} = A_j K_{jpT}^{\alpha_k} L_{jpT}^{\alpha_l} \exp(\varepsilon_{jpT})$$

By taking natural logarithm, we have

$$y_{jpT} = a_j + \alpha_k k_{jpT} + \alpha_l l_{jpT} + \varepsilon_{jpT}$$

where I define $y_{jpT} = \log Y_{jpT}$, $a_{jpT} = \log A_j$, $k_{jpT} = \log K_{jpT}$, $l_{jpT} = \log L_{jpT}$. Note that I use firm level heterogeneity term a_j which is different from plant level heterogeneity. It is ideal to estimate both firm and plant level heterogeneities, although the small sample size restricts such possibilities.

Figure 17: Left figure: Bank-to-firm loan rates in Korea, Right figure: Manufacturing sector hourly wage in Korea



Data Source: Bank of Korea, Statistics Korea (Korea's national bureaus of statistics)

Table14 shows estimation results[84]. I confirmed significant merger synergy (increase in TFP) after the Hyundai-Kia merger. Potential causes of this merger synergy are (1) technology diffusions among merged Hyunai-Kia group plants, (2) reallocations of capital resources, (3) sharing vehicle parts, and (4) organizational improvements in production systems.

Loan Rates and Worker Wages

Table 17 contains bank-to-firm loan rates and manufacturing sector worker wage in Korea (hourly wages). Loan rates decreased after the Hyundai-Kia merger, while hourly wages have kept increasing.

[84] I am currently working on organizing plant-level investment data to implement the production function estimation method proposed by Olley-Pakes [33].