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Effects of a Universal Childcare Subsidy on Mothers' Time Allocation†

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This paper examines the effects of a universal childcare subsidy on childcare decisions and mothers' employment by using Korea's policy reform of 2012, which provided a full childcare subsidy to all children aged 0 to 2. I find that the introduction of a universal childcare subsidy increased the use of childcare centers by children aged 0-2, which led to less maternal care compared to that provided to children aged 3-4. However, the expanded subsidy had little effect on mothers' labor supply. Moreover, the policy effects vary by individual and household characteristics. The effects of the expanded subsidy are mainly found in low-income households and less educated mothers. Highly educated mothers and high-income households are likely to focus more on the quality of childcare service. These results imply that a simple reduction in childcare costs would bring only limited effects on mothers' time allocation behavior; thus, more attention should be paid to improving the quality of childcare services.

Key Word: Universal childcare, Childcare subsidy, Quality of care, Mothers' time allocation
JEL Code: J13, J21, J22, I28

I. Introduction

Universal childcare programs are ongoing topics of discussion in Korea. The Korean government started to provide a full subsidy for full-day center-based care to all families with children aged 0-2 and 5, regardless of their income and/or employment status, in 2012 and expanded it to all households with children aged 0-5 in 2013. This universal childcare program was introduced in Korea's context of low fertility and low female labor force participation rate. Korea has one of the

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lowest fertility rates in the world.[1] Also, the female employment rate remains low relative to other OECD countries, and the labor supply of mothers with young children is particularly low.

As a means of solving these problems, a full subsidy for the use of childcare centers has been widely advocated. A childcare subsidy could encourage households to use childcare centers, thus removing some of the childcare burden for women, who have most responsibility for raising children in Korea. However, a lower childcare cost does not necessarily lead to changes in mothers' decisions regarding employment and childcare arrangements, as the decision-making process is affected by various factors instead of only childcare prices.

In this paper, I examine the effects of a universal childcare program on childcare arrangements and mothers' employment by using the policy reform of 2012, which provided a full childcare subsidy to all children aged 0 to 2. In particular, I analyze mothers' time allocation between paid work and childcare. In many economic models, time is usually divided into market work and leisure time, but for mothers, substantial amounts of non-market time are used for childcare. Looking into mothers' time allocation behavior for childcare as well as market work helps to understand policy effects on mother's time use comprehensively. In addition, I study the possibility that the impacts of the full subsidy are heterogeneous across households and mothers. Previous studies of childcare subsidies focused primarily on mean effects, but the policy effects of financial support may differ according to household income distributions and other characteristics.

This paper finds that the introduction of the universal childcare program increased the use of childcare centers by children aged 0-2, which led to less maternal care compared to children aged 3-4. However, I find little effect of the expanded subsidy on mothers' labor supply. Moreover, the policy effects vary significantly by individual and household characteristics. For less-educated women and for low-income households, center-based care has replaced care by parents, but this result is not found among highly educated women and high-income households. This finding suggests that the degree of substitutability between maternal care and center-based care differs according to individual and household characteristics.

To understand the heterogeneous policy effects, I also examine the demand for quality of childcare. Using a questionnaire about willingness to pay for the quality of childcare center, I find that willingness to pay is higher with mothers who are more educated and have higher household incomes. The results imply that the demand for childcare service varies according to individual and household characteristics, possibly leading to different responses to childcare policy changes.

The empirical results have important policy implications. First, the effects of the expanded subsidy are mainly on low-income households and less educated mothers. In the sense, the full subsidy for full-day center-based care that covers high-income households would not be cost-effective compared to the large fiscal burden incurred by the government to cover all income classes. The funds for the subsidy program ultimately come from an increase in the tax burden, which lowers

[1]Korea's average births between 2010 and 2015 are estimated as 1.3 per year, which is the third lowest in the world (UNFPA 2014).

economic efficiency (Havnes and Mogstad 2011). Moreover, highly educated mothers and high-income households are likely to focus more on the quality of childcare service. Thus, a simple reduction in childcare costs would have only limited effects on mothers' decisions regarding their time use and childcare arrangements.

The remainder of this paper is organized as follows. Section II explains the childcare subsidy policy of Korea and predicts the effect of the subsidy on mothers' time allocation behavior and childcare arrangements. Section III presents the empirical model, and Section IV describes the data. Section V shows the results of the estimation and Section VI concludes the paper.

II. Literature Review

A large literature examines the effect of childcare prices on female labor supply decisions. The estimates of the degrees of childcare price elasticity on employment range from 0.04 to –1.26 in the literature (Blau and Currie 2007). Because childcare arrangements and prices are closely correlated with mothers' employment decisions, exclusion restrictions need to be applied to estimate childcare prices. Without appropriate exclusion restrictions, the estimates could be biased (Baker *et al.* 2008; Blau and Currie 2007; Havnes and Mogstad 2011).

Instead, more recent studies use natural experiments that exploit exogenous childcare policy changes. Baker *et al.* (2008) analyze the introduction of a childcare subsidy in Quebec and find a large and positive impact on the labor supply of mothers with children aged 1-5 years. Gelbach (2002) and Berlinski and Galiani (2007) show that the introduction of public kindergarten or pre-primary education increases female labor supply in the United States and Argentina, respectively. On the other hand, Havnes and Mogstad (2011) find that the expansion of subsidized childcare in Norway has little effect on the maternal labor supply and instead crowds out informal care arrangements. Additionally, Lundin *et al.* (2008) study a reduction in childcare costs due to the introduction of a maximum price in Sweden and find no effect on the female labor supply.

These studies using policy changes find that a reduction in childcare prices leads to an increase in childcare center usage but a decrease in informal care usage. However, the findings about policy effects on mothers' employment vary across studies that examine policy changes in different countries. This may have resulted because each country has different childcare culture and labor market conditions that together affect decisions on mothers' labor supply and childcare arrangements.

Beyond focusing on labor supply decisions, Kimmel and Connelly (2007) study mothers' time allocation decisions by categorizing time into market work, childcare, home work, and leisure. They find that maternal care time increases with childcare prices and mothers' wage rates.

In Korea's studies of childcare and female labor supply, the findings differ substantially, too. Choi (2011) examines the effects of the means-tested childcare subsidy of 2007, finding a negative effect on married female labor supply rates. Huh and Suk (2011) also show a negative impact of the means-tested childcare subsidy on female employment and argue that more forms of support for working

mothers are needed in childcare subsidy policies. On the other hand, Kim and Hong (2013) use the 2009 National Childcare Survey and find a positive effect of the childcare subsidy on female labor supply.

To the best of my knowledge, there are two studies which examine exogenous childcare policy changes in the Korean context. Cho (2007) uses the introduction of a basic subsidy for private childcare centers in 2006 and finds an increase in the use of private childcare centers but little effect on mothers' labor supply rates. Because the basic subsidy was provided directly to centers and not households with children and given that it rarely changed the price of childcare center usage, any analysis of the policy effect on mothers' labor supply decisions is limited. Byun and Heo (2014) examine the expansion of the childcare subsidy for low-income and middle-income households between 2004 and 2009 using the Korean Time Use Survey. They find positive but overall minor effects on working hours and negative effects on maternal care time. Due to the limitation of the dataset, i.e., no observation of the age of each child, they compare households with preschool-aged children to those with school-aged children, including high school students.

In my paper, I examine the introduction of the full childcare subsidy in 2012 given to all children aged 0-2 for a comparison with children aged 3-4. As a robustness check, I limit the sample to children aged 2 and 3 in order to compare children at more similar development stages.

III. Background

A. *Childcare Subsidy Policy*

The childcare subsidy has expanded its coverage gradually from low-income households to those at all income levels. In 2007, the subsidy targeted relatively low-income households under the urban worker's average monthly income and the subsidy amounts decreased in household incomes. The income level for subsidy eligibility increased to the lowest 70% in 2010, and a full subsidy was given to eligible households. In 2012, the full childcare subsidy was provided to households with children aged 0-2 and 5 regardless of their income and/or wealth (Table 1).

TABLE 1—POLICY CHANGES REGARDING THE CHILDCARE SUBSIDY

	Children aged 0-2	Children aged 3-4	Children aged 5
2007	Means-tested subsidy; for households whose income is at or less than the urban worker's monthly average		Full subsidy to households whose income is at or less than an urban worker's monthly average
2010	Full subsidy to households whose income is in the lowest 70% bracket		Full subsidy to households whose income is in the lowest 70% bracket
2012	Full subsidy to all households	Full subsidy to households whose income is in the lowest 70% bracket	Full subsidy to all households
2013	Full subsidy to all households		

Note: Recognized income is equal to the sum of the household's monthly income plus converted monthly income from its holdings such as land, housing, financial assets, vehicles, and other assets.

Source: Ministry of Health and Welfare (Various years), *Guideline for Childcare Policy*.

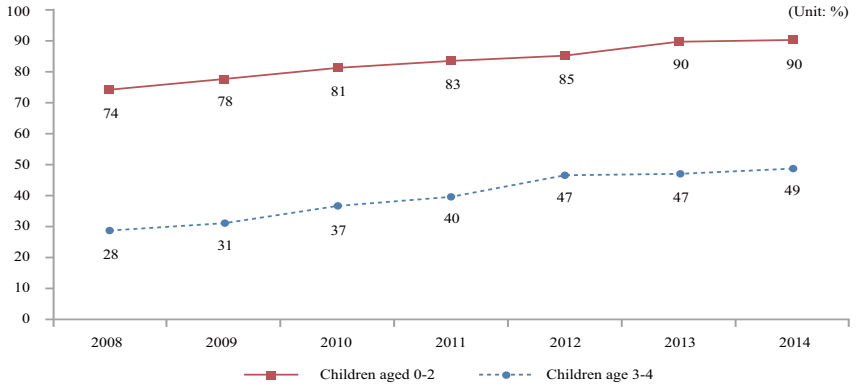

FIGURE 1. USAGE RATE OF CENTER-BASED CARE

Source: Ministry of Health and Welfare (Various years), *Childcare Statistics*; Statistics Korea (Various years), *Vital Statistics Survey*

TABLE 2—CHILDCARE SUBSIDY AMOUNTS OF 2012

Child Age	Subsidy Amount (KRW)
0	394,000
1	347,000
2	286,000
3	197,000
4	177,000
5	177,000

Note: USD 1 = KRW 1,130

Source: Ministry of Health and Welfare (2012), *Guideline for Childcare Policy*

Figure 1 shows that the use of childcare centers has increased, particularly for children aged 0 to 2, who were cared for at home before. As the full subsidy was provided to all households regardless of income with children aged 0 to 2 in 2012, the usage rate of childcare centers increased from 31% to 47% for children aged 0 to 2 between 2009 and 2012. On the other hand, for children aged 3 to 4, the usage rate of center-based care increased by 7%p during the same period from 2009 to 2012. For children aged 3 to 4, the full subsidy was provided to the lowest 70% in 2012 and not to all income classes. Moreover, even if the full subsidy is given to both children aged 0 to 2 and 3 to 4, the subsidy benefits are much larger for younger children. As shown in Table 2, the range of the full subsidy for children aged 0 to 2 is from KRW 394,000 to KRW 286,000 per month, while the subsidy amount for children aged 3 to 4 is from KRW 197,000 to KRW 177,000.

Starting in 2013, children aged 3-4 are entitled to the full subsidy as well, which means that all households with young children aged 0-5 are eligible for the childcare subsidy.[2] Accordingly, the usage rate of childcare centers increased by 5%p for children aged 3 to 4 for 2013, whereas the rate for children aged 0 to 2 remained the same.

[2]The childcare program provided for children aged 3 to 5 is called the "Nuri program."

While coverage for the full subsidy has been expanded to all income households, there has been much policy debate about a universal childcare subsidy. The federal budget for childcare and early childhood education more than doubled from KRW 294 billion in 2009 to nearly KRW 800 billion in 2013 (Yun *et al.* 2013). The subsidy expansion triggered disputes about the financial burden between the central and local governments. Moreover, there is criticism that the subsidy expansion leads to excess demand on the centers, which causes more trouble for working mothers who desperately need center-based care for their children. Also, the usage escalation intensified concerns about the management of childcare facilities and their quality.

B. *Theoretical Framework*

In this section, I present a theoretical model which is used to investigate factors that affect mothers' time allocation and childcare arrangements. Usually, in many economic models, time is divided into market work and leisure time, but for mothers, substantial amounts of non-market time are used for childcare. In addition, mothers' labor force participation decisions are made in conjunction with childcare arrangements. In this sense, I assume that a mother allocates her time to market work, leisure, and childcare in the model, which is extended based on James-Burdumy (2005).

The mothers' total time (T) consists of market work time (T_h), childcare time (T_c), and leisure (T_l).

$$T = T_l + T_h + T_c \tag{1}$$

A mother maximizes her utility that is derived from consumption (C), leisure (T_l), and the quality of her child (Q).

$$max U = U\left(Q, C, T_l\right) \tag{2}$$

To enhance the child's quality, she can invest time and market goods for childcare. As time inputs, she can spend her own time with her child, or arrange childcare by others such as childcare centers and other caregivers. Then, the child's total time (T_{kid}) is spent with mother (T_c), with other individuals including relatives and nannies (T_f), or in a childcare center (T_p).

$$T_{kid} = T_c + T_p + T_f \tag{3}$$

The child's quality is affected by both the quantity and quality of each time input. In a child-quality production function, the child's quality is determined by the maternal care time (T_c) and its quality (Q_c), center-based care time (T_p) and its quality (Q_p), informal care time by other individuals other than parents (T_f) and its quality (Q_f), and market goods (M). The product term of the quantity and quality of

each care time is the input of the child-quality production function, as expressed in Equation (4). The functional form suggests that as a time input is used more, its quality influences the child's quality more. Moreover, even if the child is cared for by different care providers for the same amount of time, the effect of each time input on the child's development would differ according to the quality of the care.

$$Q = Q\left(T_c \cdot Q_c, T_p \cdot Q_p, T_f \cdot Q_f, M\right) \tag{4}$$

The budget constraint is as follows,

$$C + P_p \cdot T_p + P_f \cdot T_f + M = wT_h + N, \tag{5}$$

where w denotes the wage rate of the mother, and P_p and P_f are the prices per hour for center-based care and for informal care by other individuals, respectively. N is other household income excluding mother's earned income. Because I focus on mothers' time allocation behavior, other household incomes, including the husband's income, are assumed to be given in the model.

The mother maximizes her utility with respect to the above budget and time constraints. The demand function for each type of care time can be expressed with the prices and qualities of the care time inputs, the mother's wage, and other household income.

$$T_i = f_i\left(P_p, P_f, w, Q_p, Q_f, Q_c, N\right), \qquad i = c, p, f \tag{6}$$

Using first-order conditions of the above maximization problem, the following equation is derived:

$$\frac{\partial Q / \partial T_c}{\partial Q / \partial T_p} = \frac{Q_p}{Q_c} \cdot \frac{w}{P_p} \tag{7}$$

Childcare policies can affect mothers' time allocation and childcare arrangements by influencing the price of center-based care (P_p) and its quality (Q_p). Suppose that a policy change reduces the price of care at a childcare center (P_p). Holding other variables constant, in order to maximize her utility, the derivative of the child quality function $Q(\cdot)$ with respect to maternal care time ($\partial Q/\partial T_c$) must increase or the derivative with respect to center-based care time ($\partial Q/\partial T_p$) must decrease. Under the assumption that the child-quality production function is concave,[3] this can be satisfied if the maternal care time decreases or the center-based care time increases. The degree of substitution between maternal care and center-based care is affected by the ratio of the center-based care quality to the maternal care quality (Q_p/Q_c), as shown in Equation (7). When the center-based care quality (Q_p) is

[3]The assumption that the production function is concave implies the diminishing marginal product that additional output produced due to one more unit of input decreases as the amount of input increases.

higher and the quality of maternal care (Q_c) is lower, the mother is more likely to replace her maternal care with center-based care.

This simple theoretical model predicts that if the quality of maternal direct care is much better than that of center-based care, the degree of substitution between maternal care and center-based care would be low. In other words, the time spent in maternal care is unlikely to be replaced by center-based care if a child's quality can be more enhanced by the time investment of mothers. Moreover, if parents find it difficult to trust the quality of center care services or to find accurate information regarding the quality level, the rate of substitution would not be high or substitution would not even occur at all, even if the cost becomes low.

IV. Empirical Specification

To estimate the effects of the childcare subsidy expansion, I examine the policy reform which provided a full subsidy for the use of childcare centers to children aged 0-2. I apply a difference-in-difference (DD) approach by comparing children aged 0 to 2 and children aged 3 to 4 before and after the expansion of the childcare subsidy in 2012.

I use children aged 0 to 2 as a treatment group and children aged 3 to 4 as a comparison group. Children aged 0 to 2 are more likely to be affected by the subsidy expansion in two dimensions: eligibility and benefit amounts. Under the policy reform of 2012, only children aged 0 to 2 were eligible for a universal childcare subsidy regardless of household income. Moreover, the full subsidy amounts differed for children 0-2 years old and those 3-4 years old. The subsidy benefits for children aged 0-2 were larger than those for children aged 3-4, as shown in Table 2. Thus, except for households under 120% of the poverty line, who were already eligible for the full subsidy under the means-tested subsidy scheme before the reform, the subsidy expansion was greater for children aged 0 to 2 compared to children aged 3 to 4.

I use a DD framework with the following form,

$$y = \alpha_1 T_{2012} + \alpha_2 K_{0-2} + \alpha_3 \left(T_{2012} \times K_{0-2} \right) + X\beta + \in, \tag{8}$$

where y is the outcome variable of interest. T_{2012} is a dummy variable equal to 1 if the year is 2012 and 0 otherwise. $K_{0\text{-}2}$ indicates whether a child's age is between 0 and 2. $(T_{2012} \times K_{0\text{-}2})$ is an interaction term between T_{2012} and $K_{0\text{-}2}$, and the parameter α_3 reflects the policy effect of the universal childcare subsidy. X is a vector of the variables of mothers' individual and household characteristics. I control for mothers' age and education and for fathers' education. I also control for other household incomes (excluding mothers' earned income), the number of children under age 5, and the numbers of adults and children in the household. I include local unemployment rates and local childcare center supply rates. Year and area dummies are also incorporated.

The identification strategy could raise several concerns. First, children aged 0-2 and 3-4 could have a substantial difference in their development, which could

affect decisions regarding the type of care and the mothers' time allocation. For example, mothers tend to take care of younger children by themselves, but they are more likely to use center-based care for older children. The effect of the childcare subsidy on center-based care use and on mothers' time use for children aged 0-2 could therefore be underestimated compared to children aged 3-4. In this sense, any interpretation of empirical results needs to be made cautiously. To address this concern, I conduct robust checks by comparing children aged 2 and 3, whose ages are much closer.

Another issue is that both the treatment group and the comparison group were affected by the subsidy expansion between 2009 and 2012. In 2009, households with incomes below the urban worker's monthly average income received the means-tested subsidy. In 2012, the full subsidy was provided to households at all income levels with children aged 0 to 2, while for households with children aged 3 to 4, households in the lowest 70% income bracket were eligible for the subsidy. Although children aged 3 to 4 were also affected by the subsidy expansion, they were affected less than children aged 0 to 2 in terms of both the subsidy amounts and benefit coverage. In the estimation, I assess whether the reduction in costs for center-based care use is much larger for children aged 0-2 than that for children aged 3-4.

In particular, low- and middle-income households in the comparison group were affected by the subsidy expansion. Thus, the benefit gap from the expanded subsidy between the treatment and comparison groups is greater as household's incomes are higher. For this reason, the empirical results pertaining to the effects of the universal childcare program may be underestimated for low-income households. However, this does not necessarily imply that the mean effects of empirical results are driven by high-income groups. I address this concern by examining heterogeneous impacts of the expanded subsidy across income groups.

V. Data

I use data from the National Childcare Survey (NCCS), which is conducted every three years to collect data from households with young children and childcare facilities. The dataset contains information on individual and household characteristics and the mode of childcare used for each child. I employ the 2009 and 2012 datasets. The sample period between 2009 and 2012 covers the subsidy expansion to all income households with children aged 0 to 2.

The main outcome variable is mothers' time use for paid work and childcare. The survey includes information about who takes care of a child at each hour for 24 hours. Using this information, I calculate how long parents take care of their child between 7am and 10pm. It is not possible to compare maternal care times directly, as the 2009 dataset does not distinguish childcare by the father and the mother. In Korea, however, most parental childcare is done by mothers. According to the 2012 dataset, which separates care time according to the father and mother, maternal care time is 8.1 hours a day, while the parents' total care time is 8.6 hours. Thus, this paper focuses on mothers' time allocation and their individual

characteristics. As another outcome variable, I use care hours by other individuals other than parents in order to analyze which type of care is replaced in response to the subsidy expansion.

The sample is restricted to households in which parents cohabit with their child excluding children with disabilities or diseases. I focus on the youngest child in a family to separate treatment and control groups, as the youngest child affects the mother's time allocation most. The final sample consists of 4,062 mother-child combinations.

Table 3 shows the changes in costs for the use of center-based care from 2009 to 2012. The monthly regular tuition fee fell sharply from KRW 153,000 in 2009 to KRW 3,000 in 2012, when the full subsidy for children aged 0-2 was initiated. Total childcare costs with other expenses plummeted from KRW 195,000 to KRW 48,000. On the other hand, the childcare costs for children aged 3-4 did not fall as sharply as those for children aged 0-2 show, as the universal subsidy did not cover them until 2012.

TABLE 3—CHANGES IN COSTS FOR CENTER-BASED CARE

(UNIT: KRW 1,000)

	Total costs for the use of childcare centers	Monthly tuition fee	Other expenses (including extra activities, learning materials, meals)
Age 0-2			
2009	195	153	38
2012	48	3	43
Age 3-4			
2009	250	167	77
2012	201	102	95

Note: As of the real amount in 2012.

Source: Ministry of Health and Welfare (2009, 2012), *National Childcare Survey*

TABLE 4— DESCRIPTIVE STATISTICS

Households with a child aged 0-2	2009 (observations: 1,466)		2012 (observations: 1,457)	
	Mean	SD	Mean	SD
Mothers' age	32.00	4.02	32.69	3.75
Mothers' education: higher than high school	0.38	0.48	0.46	0.50
Father's education: higher than high school	0.46	0.50	0.53	0.50
Number of children aged 0-2	1.12	0.32	1.13	0.35
Number of children aged 3-5	0.30	0.49	0.31	0.49
Number of preschoolers	1.63	0.68	1.63	0.67
Number of school-aged children	0.26	0.59	0.22	0.52
Number of adults	2.23	0.61	2.16	0.53
Local unemployment rate	3.46	0.85	2.84	0.83
Local childcare center supply rate	54.17	8.47	65.41	9.65
Usage rate of childcare centers	0.28	0.45	0.44	0.50
Mothers' labor force participation rate	0.24	0.42	0.25	0.44
Mothers' weekly working hours	10.96	19.76	10.42	18.21
Weekday's parental childcare hours	11.12	4.88	10.44	4.54

(CONTINUED)

TABLE 4— DESCRIPTIVE STATISTICS *(CONTINUED)*

Households with a child aged 3-4	2009 (observations: 581)		2012 (observations: 563)	
	Mean	SD	Mean	SD
Mothers' age	34.79	3.81	35.82	3.72
Mothers' education: higher than high school	0.34	0.47	0.42	0.49
Father's education: higher than high school	0.47	0.50	0.51	0.50
Number of children aged 0-2	0.00	0.00	0.00	0.00
Number of children aged 3-5	1.17	0.37	1.16	0.37
Number of preschoolers	1.77	0.62	1.73	0.59
Number of school-aged children	0.69	0.68	0.66	0.67
Number of adults	2.22	0.61	2.16	0.49
Local unemployment rate	3.40	0.90	2.88	0.85
Local childcare center supply rate	54.67	8.69	65.11	9.65
Usage rate of childcare centers	0.93	0.25	0.97	0.17
Mothers' labor force participation rate	0.40	0.49	0.39	0.49
Mothers' weekly working hours	18.23	22.88	16.54	20.82
Weekday parental childcare hours	7.01	3.08	6.86	2.40

Table 4 shows the descriptive statistics of the variables used for children aged 0-2 and 3-4 in 2009 and 2012. Mothers whose youngest children are aged 0-2 are younger than mothers with the youngest children aged 3-4. For children aged 3-4, mothers' working hours are longer and maternal care hours are shorter. Two notable changes between 2009 and 2012 is that the childcare center usage rate by children aged 0-2 increases from 28% to 44% while parents' care hours decrease.[4]

VI. Empirical Results

A. *Overall Effects of the Full Childcare Subsidy*

Table 5 shows the DD estimates for various outcome variables. In columns (1) and (2), I run DD regressions of the costs of childcare centers and the use of these centers, respectively, to check for the direct effect of the universal childcare subsidy on children aged 0 to 2 compared with children aged 3 to 4. The monthly cost for the use of childcare centers for children aged 0-2 is KRW 106,000 lower than that for children aged 3-4 in 2012 compared to the difference in 2009. This decline in the cost is a direct result of the universal childcare subsidy, confirming that the policy change lowered household spending on center-based care for children aged 0 to 2. Accordingly, the usage rate of childcare centers increases by 12.3%p for children aged 0 to 2 compared to those aged 3 to 4.

Columns (3) and (4) present the effects of the full subsidy on the mothers' labor supply. For both labor force participation and working hours, the estimates are not statistically significant. On the other hand, in column (5), the maternal care time

[4]The childcare center usage rates by children aged 3-4 in Table 4 are higher than those in Figure 1. This difference in usage rates primarily stems from different definitions of childcare centers. The childcare centers defined in Table 4 include those for academic or religious purposes, but this is not the case for Figure 1.

TABLE 5—MAIN RESULTS

	(1) Costs for childcare center	(2) Use of childcare center	(3) Labor force participation	(4) Weekly working hours	(5) Daily parental care hours	(6) Daily informal care hours
2012	-46.462***	0.019	0.019	-0.123	-0.175	-0.214
	(13.693)	(0.027)	(0.039)	(1.690)	(0.281)	(0.195)
Child aged 0-2	-32.771*	-0.358***	-0.020	-1.009	1.841***	0.670***
	(18.175)	(0.032)	(0.034)	(1.487)	(0.328)	(0.248)
2012×Child aged 0-2	-106.065***	0.123***	0.015	1.094	-0.566**	-0.196
	(12.748)	(0.022)	(0.033)	(1.431)	(0.235)	(0.171)
Observations	2,132	4,062	4,062	4,062	4,062	4,062
R-squared	0.380	0.334	0.082	0.083	0.191	0.079

Note: This table reports the coefficient estimates from separate regressions of different dependent variables across columns. The list of control variables used is in Section IV. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

decreases by 0.566 hours for children aged 0-2 compared to that for children aged 3-4. If the average 0.566 hour reduction comes from the 12.3%p increase in center-based care usage, the estimates imply that the use of childcare centers leads to a drop in parents' care time by 4.6 hours (=0.566/0.123) a day. Overall, the reduced costs for center-based care through the universal childcare subsidy led to higher childcare center usage and less care by parents themselves for children aged 0-2. However, the labor supply of mothers displays no significant increase in response to the policy change.

B. *Heterogeneous Effects of the Full Childcare Subsidy*

Table 6 shows the effects of the subsidized childcare across mothers' individual and household characteristics.[5] The subjects of the analysis are categorized according to household income, the mothers' education level, and the mothers' employment status, respectively.

In Panel A in Table 6, the sample is split into four sub-samples by household income level: high, mid-high, mid-low, and low-income groups. First, I check the direct results of the full childcare subsidy on childcare costs by income group. The benefit changes from the expanded subsidy are greater as the household income increases. Thus, the results show that the decrease in childcare costs is greater for households with higher incomes – as expected. For the lowest income group, there is no statistically significant decrease in childcare costs, as households with children under age 5 below 120% of the poverty line were already eligible for the full subsidy before the reform. The monthly income level of the low-income sub-sample is less than KRW 1,390,000 per month, which is between 120% of the poverty lines for households with three members (KRW 1,230,000) and four members (KRW 1,510,000). For this low-income group, there is no change in subsidy benefits before and after the policy reform for both children aged 0 to 2

[5]Tables A1 and A2 in the Appendix show descriptive statistics for mothers' working hours and parental care hours across subgroups.

TABLE 6— SUBSAMPLE ESTIMATION RESULTS I

	(1) Costs for childcare center	(2) Use of childcare center	(3) Labor force participation	(4) Weekly working hours	(5) Daily parental care hours	(6) Daily informal care hours
Panel A. Household income						
(1) High	-241.678***	0.158***	-0.054	-3.042	0.493	-1.249**
	(33.633)	(0.047)	(0.061)	(2.677)	(0.508)	(0.507)
(2) Mid-high	-149.108***	0.177***	0.012	0.487	-0.866*	-0.363
	(22.133)	(0.042)	(0.063)	(2.726)	(0.467)	(0.333)
(3) Mid-low	-37.402*	0.151***	0.019	2.445	-1.118***	-0.026
	(19.125)	(0.044)	(0.060)	(2.601)	(0.418)	(0.237)
(4) Low	-22.741	-0.008	0.021	1.367	0.042	0.160
	(14.996)	(0.043)	(0.055)	(2.357)	(0.398)	(0.165)
Panel B. Mothers' education level						
(1) Higher than high school	-164.596***	0.134***	0.014	0.961	-0.149	-0.483
	(25.568)	(0.037)	(0.054)	(2.281)	(0.412)	(0.327)
(2) High school graduate or less	-58.608***	0.114***	0.012	1.053	-0.679**	-0.111
	(13.120)	(0.027)	(0.041)	(1.861)	(0.286)	(0.189)
Panel C. Mothers' employment status						
(1) Working	-137.674***	0.205***			0.107	-1.583***
	(21.410)	(0.036)			(0.297)	(0.426)
(2) Not working	-76.651***	0.072***			-0.360	0.031
	(14.981)	(0.028)			(0.222)	(0.100)

Note: This table reports the DD coefficient estimates from separate regressions of different dependent variables across columns. The list of control variables used is in Section IV. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

and those aged 3 to 4. Thus, for the lowest income group, there are no effects of the 2012 policy reform on other outcome variables as well.

As discussed in Section IV, the reduction of childcare costs from the universal childcare subsidy is larger for high-income households than for low-income households. However, the effect of the universal childcare subsidy on center usage is similarly large across all income groups except for the lowest income group. Childcare center usage increases by 15.1%p for the mid-low group, 17.7%p for the mid-high group, and 15.8%p for the high-income group. Furthermore, maternal care time decreases more as household incomes are lower, except for the lowest income group. The parental care time for children aged 0 to 2 compared to children aged 3 to 4 decreases by 1.118 hours in the mid-low-income group. For high-income households, however, the DD estimate is positive and not statistically significant.

Because the reduction in childcare costs is less for lower income households, the effects of the full subsidy are likely to be underestimated for low-income households. However, the results show that the decrease in maternal care hours is much larger for lower income households. This implies that the overall negative mean effect on parental care time in Table 5 is largely driven by low-income households rather than high-income households, even if high-income households

experience a larger reduction in their childcare costs.

Instead, for the high-income group, the informal care time by other individuals is reduced by 1.249 hours. This suggests that the informal care by individual caregivers such as relatives and nannies is replaced by center-based care for high-income households. Regarding the labor supply, I find no statistically significant results across all income groups.

In Panel B of Table 6, I separate the sample by mothers' education levels, i.e., whether they are higher than high school graduates or not. The reduction in childcare costs is greater for the higher education group. Both the high- and low-education groups increase their use of center-based care in response to the universal childcare subsidy. The rate of center usage by children aged 0-2 increases by 13.4%p compared to that for children aged 3-4 for highly educated mothers and by 11.4%p for less educated mothers.

Similar to the results in Panel A, although the low-education group experiences less of a reduction in their childcare costs, the maternal care time for this group decreases more than it does for the high-education group. The parental care time for children aged 0 to 2 is reduced by 0.679 hours in the low-education group. For the high-education group, however, the DD estimate is not statistically significant and its magnitude is smaller.

In Panel C in Table 6, the sample is divided according to mothers' employment status.[6] Both working and non-working mothers increase their use of center-based care. Working mothers increase childcare center usage by 20.5%p and non-working mothers do so by 7.2%p. For working mothers, center-based care replaces informal care by other individuals such as relatives and nannies, while maternal care time is replaced by the use of childcare centers for non-working mothers.

Because mothers' earned incomes are included in household incomes, households with working mothers are more likely to be classified into the high- and middle-income groups. To address this concern, I divide the sample first by mothers' employment status and split the sub-samples by household incomes again. Table 7 shows results from the sample split by the two criteria of mothers' employment status and household income.

For both working and non-working mothers, the reduced costs of the use of childcare centers are larger as household incomes increase. Also, there is little effect of the policy change on mothers' time use and childcare center usage in the lowest income group, as they were likely to have been eligible previously for the full subsidy before the introduction of the universal childcare subsidy.

In the sample of working mothers, the use of center-based care increases in response to the subsidy expansion and instead, informal care time decreases across all household income levels except for the lowest income group. There is little change on maternal care time for working mothers.

For non-working mothers, on the other hand, the effect of the universal childcare subsidy on center usage is larger for households with lower incomes. As for less-educated, low-income households with non-working mothers, the expanded subsidy

[6]If more mothers participate in the labor force in response to the childcare subsidy expansion, the estimates on the center-based care use and mother's time use could be overestimated for the working mother sample. However, if the subsidy expansion does not affect mother's labor force participation decisions significantly, as in the main results of Table 5, this concern about overestimation is not severe.

TABLE 7—SUBSAMPLE ESTIMATION RESULTS II

	(1) Costs for childcare center	(2) Use of childcare center	(3) Daily parental care hours	(4) Daily informal care hours
Working:				
(1) High income	-247.290***	0.266***	-0.002	-1.595**
	(45.141)	(0.060)	(0.424)	(0.730)
(2) Mid-high income	-84.634***	0.196***	0.333	-1.871**
	(28.074)	(0.069)	(0.592)	(0.773)
(3) Mid-low income	-59.720*	0.185**	-0.374	-1.589*
	(34.032)	(0.092)	(0.761)	(0.907)
(4) Low income	-11.151	0.070	-0.717	0.378
	(38.817)	(0.106)	(0.937)	(0.854)
Not working:				
(1) High income	-225.090***	0.084	-0.220	-0.006
	(56.175)	(0.074)	(0.562)	(0.373)
(2) Mid-high income	-187.092***	0.111*	-0.627	0.063
	(34.854)	(0.058)	(0.451)	(0.195)
(3) Mid-low income	-28.075	0.113**	-0.869**	0.219
	(22.482)	(0.053)	(0.439)	(0.210)
(4) Low income	-17.685	-0.032	0.448	-0.045
	(15.875)	(0.049)	(0.401)	(0.132)

Note: This table reports the DD coefficient estimates from separate regressions of different dependent variables across columns. The list of control variables used is in Section IV. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

substantially increases the use of a childcare center and lowers direct care hours by parents. In contrast, for the highest income group, the increase in childcare center usage by children aged 0-2 compared to that by children aged 3-4 is smaller and not statistically significant. Moreover, there is little change in parents' direct care hours for the high-income group.

C. Robustness Checks

In the main DD specification, children aged 0-2 are the treatment group, which was affected by the universal childcare subsidy, while children aged 3-4 are the comparison group. However, these treatment and comparison groups could be substantially different in terms of the child's development stage, which leads to different decisions regarding the mothers' time allocation behavior. To address this concern, I conduct robust checks by comparing children aged 2 and 3, who are more likely to be at a similar development stage. Given that children up to age 2 were eligible for the 2012 universal childcare subsidy, the policy effects are different for children aged at and above 2.

Also, the analysis with the sample restricted to children aged 2 and 3 can address concerns over the effects of other policy changes during the sample period. A home childcare allowance was introduced for low-income households with children aged less than 36 months during the sample period, and maternal leave benefits were expanded in 2011. These policy changes could affect decisions on childcare and mothers' time allocation, especially for households with younger children. With

TABLE 8—ROBUSTNESS CHECKS – SAMPLE RESTRICTED TO CHILDREN AGED 2 AND 3

	(1) Costs for childcare center	(2) Use of childcare center	(3) Labor force participation	(4) Weekly working hours	(5) Daily parental care hours	(6) Daily informal care hours
Panel A. Overall	-83.196***	0.190***	0.064	2.969	-1.187***	-0.121
	(17.355)	(0.039)	(0.056)	(2.441)	(0.384)	(0.263)
Panel B. Household income						
(1) High	-186.247***	0.277***	0.056	-0.816	-0.268	-1.388*
	(51.677)	(0.087)	(0.103)	(4.459)	(0.831)	(0.792)
(2) Mid-high	-134.942***	0.202**	0.049	1.852	-1.309	-0.344
	(34.164)	(0.083)	(0.115)	(5.249)	(0.822)	(0.570)
(3) Mid-low	-52.966*	0.289***	0.045	5.063	-2.417***	0.206
	(27.930)	(0.079)	(0.101)	(4.457)	(0.711)	(0.360)
(4) Low	-10.835	0.019	-0.017	-0.373	0.130	0.154
	(20.295)	(0.077)	(0.097)	(4.150)	(0.653)	(0.261)
Panel C. Mothers' education level						
(1) Higher than High school	-120.901***	0.203***	0.097	3.668	-1.019	-0.206
	(35.149)	(0.068)	(0.090)	(3.735)	(0.667)	(0.493)
(2) High school graduate or less	-56.304***	0.163***	0.028	2.080	-1.075**	-0.072
	(17.891)	(0.049)	(0.072)	(3.338)	(0.480)	(0.305)

Note: This table reports the DD coefficient estimates from separate regressions of different dependent variables across columns. The list of control variables used is in Section IV. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

these policy changes, the effects of a universal childcare subsidy may be underestimated because the other policy changes could motivate mothers with young children to increase their own care hours and decrease the use of childcare centers. The analysis restricted to children aged 2 and 3 helps to control for the effects of other policy changes because other policies most affect mothers with children aged 0 or 1. In the sample, only one mother with a child aged 2 (1.4%) received home childcare allowance benefits, and no mothers with children aged above 2 did so. Regarding maternal leave, five mothers with children aged 2 (4.7%) used maternal leave, and two mothers with children aged 3 (1.9%) did so in 2012.

Table 8 presents the estimation results with the sample restricted to children aged 2 and 3. In Panel A, I run the DD regression by comparing children aged 2 with children aged 3 before and after the policy change. The estimation results are quite similar to the main results from the full sample. Costs for the use of childcare centers decrease by KRW 83,000 and center usage increases by 19%p for children aged 2 compared to children aged 3. In columns (3) and (4), the effect of the full subsidy on the mothers' labor supply is not statistically significant. However, parents' care hours drop by 1.187 hours for children aged 2 relative to children aged 3.

In Panel B, the sample is divided by household income level. Similar to the main results from the full sample, the reduced cost to use childcare centers is greater as household incomes increase, and the decrease in the cost is not statistically significant in the lowest income group. Childcare center usage increases by more

TABLE 9—ROBUSTNESS CHECKS – ESTIMATION RESULTS ACROSS CHILDREN'S AGES

Dependent variable:	(1) Age 0	(2) Age 1	(3) Age 2	(4) H_0: $\alpha_3(Age0) = \alpha_3(Age1)$	(5) H_0: $\alpha_3(Age1) = \alpha_3(Age2)$
Use of childcare center	0.045***	0.297***	0.219***	[0.0]***	[0.077]*
	(0.033)	(0.033)	(0.035)		
Labor force participation	-0.006	0.063	0.061	[0.055]*	[0.962]
	(0.035)	(0.041)	(0.047)		
Daily parental care hours	0.143	-1.898***	-1.345***	[0.0]***	[0.191]
	(0.282)	(0.341)	(0.334)		

Note: This table reports the DD coefficient estimates from separate regressions of different dependent variables across rows in columns (1), (2), and (3). Columns (4) and (5) report p-values for the hypothesis that the DD coefficient estimates are the same across children's ages. The list of control variables used is in Section IV. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

than 20%p across all income levels, except for the lowest income group. Regarding the mothers' labor supply, the coefficients of labor force participation and working hours are greater than those in the main results in Table 6 but are still not statistically significant. Similarly to the main results, parents' care hours are reduced more for lower income households, except for the lowest income group. The decrease in maternal care hours is the largest in the mid-low-income group.

In Panel C which splits the sample by mothers' education level, as in the main findings of Table 6, both education groups increase their use of center-based care, but the maternal care time decrease is statistically significant only in the less educated group.

Table 9 shows the effects of the childcare subsidy across children's ages. In the analysis, while the control group is still children aged 3 to 4, the treatment group is children aged 0, 1, and 2 in columns (1), (2), and (3), respectively. To check whether the treatment group shows heterogeneous responses across children's ages, I test the hypothesis that the policy effects are identical between children of different ages in columns (4) and (5). Column (4) shows that children aged 0 are quite different from children of different ages in the treatment group. The increase in the use of childcare centers is much smaller for children aged 0 and parental care hours do not decrease in response to the subsidy expansion. In column (5), on the other hand, children aged 1 and 2 show similar responses to the policy changes. The labor supply of mothers and parental care hours do not show significant differences between children aged 1 and 2. The increase in the use of childcare centers is greater for children aged 1 than that of children aged 2, but the difference is statistically significant only at the 10% level.

Lastly, I check whether the findings of this paper stem from different time trends in mothers' time allocation and childcare arrangements across children's ages. Ideally, we can think of a placebo test to compare children aged 3 and 4 under the assumption that both age groups are not affected by the policy reform. This assumption, however, is not valid, as children aged 3 and 4 were also affected by the subsidy expansion, and because the subsidy amounts differed between the two groups. Nonetheless, it is still meaningful to compare the two groups to assess whether they were similar in other aspects.

TABLE 10—ROBUSTNESS CHECKS – SAMPLE RESTRICTED TO CHILDREN AGED 3 AND 4

	(1) Use of childcare center	(2) Labor force participation	(3) Weekly working hours	(4) Daily parental care hours	(5) Daily informal care hours
2012×Child aged 3	0.058**	-0.003	0.171	-0.291	-0.114
	(0.024)	(0.058)	(2.532)	(0.311)	(0.228)

Note: This table reports the DD coefficient estimates from separate regressions of different dependent variables across columns. The list of control variables used is in Section IV. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

As shown in Table 2, the subsidy benefits were larger for children aged 3 than those for children aged 4 for households in the lowest 70% income bracket. Accordingly, Table 10 shows that the increase in childcare center usage rates is greater for children aged 3 compared to children aged 4. For mothers' time allocation, however, the labor supply of mothers and parental care hours do not show any significant differences between children aged 3 and 4 before and after the policy change. Although the analyses is limited, the results indicate that the two age groups show similar patterns in terms of the mothers' labor supply and parental care hours, except for childcare center usage rates, which were likely to be affected by the policy change.

D. *Price and Quality of Childcare Service*

The above DD results show that the effects of the universal childcare subsidy vary according to mothers' individual and household characteristics. Overall, the reduction in childcare costs from the universal childcare subsidy leads to an increase in the use of center-based care and a decrease in maternal care. Especially for less educated and lower income households, parental care is replaced by center-based care. However, such a result is not observed among highly educated and higher income households.

The theoretical model in Section III explains the mothers' decision-making process regarding her investment in her child's quality. A mother would spend her own time caring for her child or would use center-based care. This decision could be affected by the quality of care and the price of the care service. If the quality of mother's direct care is much better than that of center-based care for her child's quality improvement, the degree of substitution between maternal care and center-based care would be low in spite of the reduced cost to use childcare centers. In other words, the demand for quality in childcare service may differ across households, thus affecting mothers' time allocation behavior.

To assess the possibility of different levels of demand for care quality across individual and household characteristics, I examine willingness to pay for the quality of center-based care. The NCCS contains a question which, "How much more would you pay for center-based care with better quality?" Based on the answers to this question, I can calculate willingness to pay for better quality care, i.e., the maximum amount that parents are willing to pay for the quality of childcare.

TABLE 11— ANALYSIS OF THE WILLINGNESS TO PAY FOR THE QUALITY OF CARE

	Coefficient	(SE)
Household incomes (log)	0.146***	(0.036)
Education	0.312**	(0.125)
Age	-0.015	(0.014)
Child's age (reference group: Age 0)		
Age 1	-8.029***	(0.520)
Age 2	-2.818***	(0.278)
Age 3	-1.031***	(0.188)
Age 4	0.118	(0.095)
Age 5	0.257***	(0.083)
Spouse's education	0.283**	(0.123)
Number of children aged 0-2	-0.504**	(0.202)
Number of children aged 3-5	-1.013***	(0.224)
Year: 2012	-0.853***	(0.134)
Observations	4,035	

Note: This table reports the marginal effects of coefficient estimates of the Tobit model. The list of control variables used is in Section VI. D. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Standard errors (SE) are clustered at the household-mother level and are robust to heteroskedasticity.

Table 11 presents the estimation results for the demand for childcare quality. As a dependent variable, I use the total maximum willingness to pay for the care quality. Because willingness to pay is observed only if the value is higher than 0, I employ a Tobit model for this estimation. As explanatory variables, I use mothers' individual characteristic variables, in this case their education and age, and the household's variables of income, spouse's education, the number of children, the number of adults, and dummies for child ages. I also control for year, area, local childcare center supply rates, and the type of childcare center currently used.

In this analysis, the sample contains all children aged 0-5 who use childcare centers. I use standard errors clustered at the household-mother level to control for cases in which a mother has several children in her household.

The results show that households with higher incomes are willing to pay more for the quality of childcare centers. A 1% increase in household income leads to a 0.15% increase in the maximum willingness to pay for the quality care. Also, the education level of the mother affects their willingness to pay for quality when household incomes are controlled. Highly educated mothers' willingness to pay is higher than that of less educated mothers by 31%.

The estimation results suggest that the demand for quality of childcare differs according to the mothers' education levels and household incomes. Households with higher incomes and mothers with more education are willing to pay more for better quality care. Those households may be less responsive to a reduction of the costs incurred to use childcare centers if the quality of care is not guaranteed or satisfactory. This is consistent with main results pertaining to the effects of the universal childcare subsidy, which showed that for low-income households and less educated mothers, the use of center-based care replaces childcare by parents, whereas this is not the case for highly educated mothers and high-income households.

VII. Conclusions

This paper examines the effects of Korea's childcare subsidy reform that provided a full subsidy for full-day center-based care to all households with children aged 0 to 2 regardless of their income and/or employment status in 2012. The results show that the introduction of the universal childcare subsidy increased the use of center-based care by children aged 0-2 as compared to children aged 3-4 while also decreasing maternal care hours. However, there is little effect of the full subsidy on mothers' labor supply. I also find that the effects of the expanded subsidy are highly heterogeneous according to mothers' education and household income levels. The substitution of center-based care by maternal care is found for less-educated mothers and low-income households, but this result is not found among highly educated mothers and high-income households. Rather, highly educated and high-income households are found to have a higher level of demand for quality care service.

According to the Infant Care Act, the expansion of the childcare subsidy was intended to support early childhood development and promote labor force participation of women, who are the primary caregivers in Korea. These policy objectives serve as important criteria for evaluating the effectiveness of the subsidy program. The results of this paper suggest that the effectiveness of financial childcare support varies according to household characteristics. Under the current subsidy, all households with young children can receive the full subsidy for *full-day (12 hours a day)* center-based care regardless of their incomes. However, the effects of the subsidy expansion are mainly on low-income households. The full subsidy for full-day center-based care that covers high-income households would not be cost-effective compared to the large fiscal burden incurred to cover all income classes.

The findings of this paper also imply that financial childcare support alone is not sufficient to affect the time allocation behavior of mothers. In order to influence mothers' time allocation behavior, especially the employment of highly educated women which has been stagnant, the quality of childcare services needs to improve. Focusing on the quality of care would help ease parents' concerns and enhance women's participation in the labor market. Above all, a confirmed quality level of childcare services is of great importance in that the first goal of childcare policy is to develop children's capabilities at the earliest stage of their development.

This paper focuses on short-run effects of the childcare subsidy expansion immediately after the policy changed. Under different policy settings, however, women's decisions regarding their human capital investments and labor market participation may change over time, leading to a change in mothers' time allocation behavior which differs from the findings here (Havnes and Mogstad 2011). Moreover, another limitation of this paper is that the effects of the expanded subsidy on child development are not considered. Previous papers show that human capital investments in the early stages of development have long-run impacts on health, educational attainment, and other adult outcomes (Currie and Almond 2011). In this sense, to evaluate the effectiveness of the childcare subsidy, the long-term effects on child development should be studied concurrently.

APPENDIX

TABLE A1— MEANS OF MOTHERS' WEEKLY WORKING HOURS ACROSS SUBGROUPS

		2009	2012	Differences (2012-2009)
A. Mothers' education				
a. higher than high school:	Age 0-2	13.70	11.81	-1.88
	Age 3-4	20.84	16.99	-3.85
b. high school graduate or less:	Age 0-2	9.31	9.24	-0.06
	Age 3-4	16.87	16.22	-0.65
B. Household's income				
a. high income:	Age 0-2	17.78	17.10	-0.68
	Age 3-4	22.86	21.41	-1.46
b. low income:	Age 0-2	5.19	4.45	-0.73
	Age 3-4	13.19	10.83	-2.35
C. Mothers' employment status				
a. working:				
a-1. high income:	Age 0-2	42.24	39.29	-2.96
	Age 3-4	41.98	39.92	-2.06
a-2. low income:	Age 0-2	42.31	36.88	-5.42
	Age 3-4	42.14	36.44	-5.70

TABLE A2— MEANS OF PARENTS' DAILY CARE HOURS ACROSS SUBGROUPS

		2009	2012	Differences (2012-2009)
A. Mothers' education				
a. higher than high school:	Age 0-2	10.63	10.15	-0.48
	Age 3-4	7.08	6.95	-0.13
b. high school graduate or less:	Age 0-2	11.48	10.68	-0.79
	Age 3-4	6.97	6.79	-0.17
B. Household's income				
a. high income:	Age 0-2	9.82	9.23	-0.59
	Age 3-4	6.60	6.54	-0.07
b. low income:	Age 0-2	12.29	11.52	-0.78
	Age 3-4	7.44	7.23	-0.21
C. Mothers' employment status				
a. working:				
a-1. high income:	Age 0-2	4.42	4.94	0.53
	Age 3-4	4.58	4.95	0.38
a-2. low income:	Age 0-2	5.75	6.01	0.27
	Age 3-4	5.45	5.92	0.47
b. not working:				
b-1. high income:	Age 0-2	13.74	12.53	-1.21
	Age 3-4	9.03	8.37	-0.66
b-2. low income:	Age 0-2	13.17	12.26	-0.91
	Age 3-4	8.35	7.79	-0.56

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Effect of the Introduction of High-speed Trains on Consumer Welfare†

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This paper examines the impact of introducing high-speed trains on consumer welfare, taking the ensuing changes in train schedules into account. Based on the estimated demand model for travel which incorporates consumer's heterogeneous preferences for travel schedules into the standard discrete-choice model, I separately evaluate the impact from adding high-speed trains and that from changes in train schedules. The results indicate that consumers who travel between two cities connected by high-speed trains benefit from the introduction of high-speed trains, while some travelers whose choice set does not include high-speed trains face a reduced frequency of non-high-speed trains, resulting in significant losses.

Key Word: Endogenous product characteristics, New product entry, Consumer surplus, High-speed train, Korea, KTX
JEL Code: L13, L92

I. Introduction

Generally speaking, introducing an additional differentiated product into a market benefits consumers due to the increased number of alternatives if everything else, such as prices, remains the same. However, the effect on consumer welfare is not as simple if producers also change the characteristics of other products and the set of other products offered. This paper considers firms' reactions to the introduction of new products, particularly in cases of altered product characteristics or altered sets of products offered, and analyzes the effects of new products on consumer surplus, taking those reactions into account. The goal of this analysis is to investigate changes in consumer welfare due to the introduction of

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a new product based on available Korean transportation industry data. Specifically, this paper decomposes the effects of the introduction of high-speed trains into the gains or losses attributable to having high-speed trains and those attributable to firms' choices of products to offer across different types of consumers.

This paper contributes to the literature by examining the effects of new product introduction considering firms' choices of product characteristics in response to the new product. The possible effects of new product introduction can be explored by reviewing the considerable amount of literature available (Trajtenberg 1989; Petrin 2002).[1] However, many of the empirical studies of markets with differentiated products primarily address firms' pricing strategies given the characteristics of each product while treating the market structure as exogenous. Moreover, the effects of ensuing changes in product characteristics and the product line after the introduction of a new product have not been discussed substantially in the empirical literature despite the fact that corresponding theories are well documented (Spence 1976; Gabszewicz *et al.* 1986).[2] Berry *et al.* (2006) and Berry and Jia (2010) also emphasize that producers may have an incentive to manipulate product characteristics other than prices.[3] In particular, a rail company in Korea may have a strong incentive to control product characteristics such as train schedules, particularly because with regulation, it has only limited power over pricing. Accordingly, I will treat the choices of train schedules of the rail company as endogenous in all subsequent discussions, and I will account for this by using the instrumental variables in the estimation.

To study the effects of both new product introduction and the ensuing changes in product characteristics on consumer welfare, I estimate consumer demand for travel while explicitly incorporating preference heterogeneity into an otherwise standard discrete-choice model (Koppelman 2006; Train 2009). Heterogeneity is captured in my model through a modification of the concept of the "schedule delay," the difference between a traveler's most preferred time to travel and his or her actual time to travel, suggested in Miller (1972) and Douglas and Miller (1974). Although preference over the travel schedule is an essential factor with regard to travel demand, there has been limited modeling of it in the past due to data constraints. Some research that analyzes travel demand, such as that by Koppelman *et al.* (2008), models departure time preferences, but in general they consider neither potential endogeneity from the schedules nor the heterogeneity of preferences over travel schedules across consumers.

In my subsequent welfare analysis, I separately quantify the gains resulting from the introduction of high-speed trains and the welfare changes resulting from the rail company's schedule adjustments. For the welfare analysis, I utilize the observed set

[1]Trajtenberg (1989) proposes a method with which to measure product innovation, providing an example examination based on the social benefits from the innovation of CT scanners. Petrin (2002) quantifies the effects of the introduction of the minivan.

[2]Spence (1976) demonstrates that firms tend to limit the number of products they offer by not introducing close substitutes for its existing products, leading to ambiguous implications regarding the introduction of new products on consumer welfare. Gabszewicz *et al.* (1986) illustrates how a monopolist would choose product quality if it can only produce a bounded number of products. The lesson to be learned from both of these analyses is that firms can react to the introduction of a new product by manipulating characteristics of the product other than the price.

[3]Bresnanhan also comments on Hausman (1996).

of products offered in the Korean transportation markets before high-speed trains were introduced instead of estimating a model of supply owing to data limitations and ambiguity regarding the objectives of the rail company.

As a result of this research, I found that the introduction of high-speed trains caused sizable increases in consumer surplus in the Korean transportation markets where high-speed trains have been made available. However, due to the losses caused by the changes in the sets of products offered to consumers, the overall change in consumer surplus in the transportation market as a whole after the introduction of high-speed trains is smaller than the increases which resulted from the addition of high-speed trains. I also found that there are significant differences in the magnitude of consumer welfare changes across heterogeneous consumers. The benefits from the new product introduction are somewhat confined to a small number of markets, while the changes in choice sets affect a broader range of consumers.

The differential effects across consumers depend on the availability of high-speed trains. On the surface, consumers who had high-speed trains added to their choice set benefited as a result. However, this group of consumers endured approximately 50% fewer non-high-speed trains after the introduction, which offset the gains from the high-speed trains. Thus, the net gains for that consumer group are not as large as intuitively expected, as the schedule changes caused substantial welfare losses which offset 50% of the gains from having high-speed trains. Consumers who travel between two cities that are not connected by high-speed trains but are located along a high-speed rail line are also subjected to nearly 50% fewer trains owing to the reduced frequency of trains. As a result, that consumer group experienced only a loss in consumer surplus. On the other hand, consumers who travel between two cities which are not located along a high-speed rail line experienced an increased number of trains due to the reallocated conventional trains; thus, they experienced a substantially increased consumer surplus. These changes in train schedules are more noticeable than mere price changes after the introduction of high-speed trains, yielding more significant effects on consumer surplus than those of price changes.

The remainder of this paper is organized as follows: Section II explains the transportation industry in South Korea, and Section III presents the model. Section IV and Section V describe the data used and the estimation procedure and assumptions imposed, respectively. Section VI addresses the procedure used to calculate consumer welfare, and this is followed by a discussion of the results in Section VII. The summary and concluding remarks are offered in Section VIII.

II. Industry Background

Rail service in South Korea is provided by only one company, Korail, which leases railroads from the Korea Rail Network Authority. It currently operates four different types of trains, categorized in terms of speed: KTX, Sae-ma-eul, Mu-gung-hwa and Tong-il. It had been operating the latter three types prior to the introduction of high-speed trains in April of 2004. KTX, the high-speed train introduced in 2004, is the fastest train type available in Korea, making only a few

stops during its trips. Sae-ma-eul is the second fastest train type. It skips small stations, but it stops at a large city in each region. Mu-gung-hwa can be regarded as a local train, stopping even at stations in small cities. In the analysis, only three types of trains are considered because Tong-il covers relatively short distances and is usually used by commuters who live in suburbs that are not reached by subways.

Korail was a governmental organization until 2004, at which time it became a public enterprise financed by the government. Although it became a corporation, its general behavior, such as its pricing strategy, did not change because the government is the only shareholder. It has extremely limited power regarding its pricing. In particular, the fares must only depend on the train type and the traveled distance, and the firm cannot set prices differently for a given destination within the same day. Specifically, Korail determines a "minimum fare" and a "rate per km" for each type of train subject to the maximum rate per kilometer announced by the Ministry of Land, Infrastructure and Transport and approval from the ministry, and calculates fares based on a combination of the train type and distance using what are known as "distance scale rates."[4] Similar to pricing, Korail must also obtain approval from the Ministry of Land, Infrastructure and Transport in order to change its service frequency. However, it has a degree of flexibility regarding its schedule frequency. Whereas Korail must earn the approval to change its frequency for each rail line by more than 10% according to the enforcement decree of the Railroad Enterprise Act, reducing the schedule by less than 10% and changing the composition of train types do not require approval.[5]

This paper takes advantage of these strict regulations on pricing. In the empirical literature, one major econometric issue is potential endogeneity bias caused by prices. That problem does not arise in this paper, as rail pricing is strictly regulated; therefore, prices are assumed to be uncorrelated with unobserved product characteristics. In addition, because the rail fare is identical for a given destination on the same day regardless of the departure time, consumers' observed choices of travel schedule, such as "morning" or "evening," reflect their preferences based solely on schedule without being influenced by price.

Although this paper focuses on the rail industry, it is still important to understand other modes of transit in order to analyze the demand for rail service. In particular, substitution between rail services and other modes of transportation influences the overall effect of the introduction of high-speed trains on consumer surplus. Therefore, it is important to take the market size and outside alternatives into consideration. I define outside alternatives here as traveling by bus, airline or car as well as foregoing travel.[6] There are multiple bus companies operating on each

[4]This means *Fare = Greater value among the Minimum Fare and (Rate per Km)·(Trip Distance)*. However, other types of price discrimination can be still offered to travelers. For example, the fares for weekdays are about 5% lower than those for weekends or holidays. There are also discount offers for group members, students, and senior citizens. Unfortunately, my data neither identifies weekend travelers from weekday travelers nor contains information on individual travelers; thus, any price discount or weekend surcharge would not be addressed throughout this paper.

[5]For the detailed contents of the statutes applied to the Korail, please refer to the Railroad Enterprise Act and the Framework Act on the Development of Railroad Industry, which can be found on the website of the Ministry of Government Legislation (www.moleg.go.kr, *in Korean*) or on that of the Korea Legislation Research Institute (http://elaw.klri.re.kr/eng service/main.do, in English).

[6]Travel by bus accounts for 70% of passenger transit, and air travel comprises only 4% of the market in Korea.

route, and their pricing regulations resemble those of the rail company. Bus fares are calculated using "Distance Scale Rates," and fare changes are similarly subject to governmental approval. There are two major airline and three low-cost carriers. Routes between the mainland and Jeju Island are excluded because rail service does not compete with airlines in these routes. Air fare pricing is much less restrictive than that of rail fares. Fares can be set at the discretion of airline companies as long as they provide public notice in advance. Changes in air fares are rarely observed, however.

III. Model of Empirical Demand

In order to evaluate consumer surpluses resulting from the introduction of high-speed trains, one must analyze the demand that describes how travelers choose a means of transportation, taking into account their preferred travel schedules. I estimated the demand for travel using a discrete-choice model used effectively in the past. (See Berry 1994; Berry *et al.* 2006; Koppelman *et al.* 2008; Berry and Jia 2010; Ho 2006) I also extended the standard multinomial logit model by allowing for heterogeneous travel schedules among consumers.

A. *Notions of Markets, Products and Schedule Delays*

This section describes in detail markets and products as I have conceptualized them in this research.

A "market," as used in this paper, is defined as unidirectional travel from an origin city to a destination city. Each unique market is identified by a unidirectional city pair and a month. Each market has its own set of products offered. A "product" is defined as a specific train operating on a specific route (a unidirectional pair of two stations) within a specific market. Each train, which is identified by a unique ID number, runs from a start-node station to an end-node station, with additional stops made during the trip. This definition of a product therefore implies that a single train connecting cities A, B and C is treated as a different product for the two connections it makes (A to B and B to C) because it operates on two distinct routes. Furthermore, given that each city may have more than one station, multiple routes can exist. Therefore, even within a given market, consumers face product choices depending on route preferences. This implies that a train running route 1 (station A1 in City 1 to station A2 in City 2) and the same train running route 2 (station B1 in City 1 to station B2 in City 2) are treated as different products even if both trains have the same train ID number and both routes are engaged in the same market.

In reality, travelers can transfer from one train to another or change modes of transportation over the course of a single trip. However, my analysis could not reflect travelers' transfer decisions throughout the itinerary because the dataset provided by Korail does not contain information regarding individual passengers' itineraries; therefore, that data could not support a trip-based analysis. I attempt to work around this problem, at least partially, by defining a product as a combination of a route and a train ID rather than as the complete trip an individual traveler conceptualizes. A single rail trip is therefore a series of products, as defined above, in that a traveler

may take different trains for each section of his trip.[7] A traveler who wants to travel from A to C with a transfer at B chooses a product for A-B and another product for B-C. Although the traveler is one person, he or she will be treated as two separate travelers in the model because a city pair from A to B and a pair from B to C are two different markets.

The characteristics of each product are inherited from the respective product's train and that train's routing. The characteristics of a train are its type, fare, traveled distance, and schedule. The characteristics of a train's routing include the distance from the station to the city center and the number of trains scheduled for the route within a day. Those characteristics of a train's routing attempt to explain the convenience of each route in terms of intra-city transportation.

This paper attempts explicitly to incorporate traveler's heterogeneous travel schedule preferences. Because the fares for a given product do not vary on the same day, I assumed that travelers' schedule choices are based entirely on the schedule themselves. This ignores the fact, however, that travelers may need to travel at times other than those they prefer due to train availability.[8] Personal preference is compromised even more if a traveler wants to take a specific type of train because it decreases the likelihood of traveling at a preferred time even further. Thus, the difference between travelers' most preferred travel times and the actual times chosen could cause inconvenience, and this can significantly affect the demand for trains. In order to measure this potential traveler inconvenience, I adopted the notion of schedule delay from Douglas and Miller (1974) and Miller (1972), which define it as the absolute difference between the passenger's most preferred time to travel on 24-hour clock and that of his actual time to travel. Each traveler's schedule delay causes disutility.[9]

This paper assumes that each traveler has a target time in mind for one endpoint of each potential trip that does not vary with mode or schedule choices. In existing literature that discusses preferences over travel schedule, departure time is usually considered instead of arrival time (Douglas and Miller 1974; Koppelman *et al.* 2008). Although it is not common to use preferences over arrival time, this paper adopts arrival time for the travel schedule because a traveler normally chooses a departure time and a mode of transportation with a target arrival time in mind. His preferred departure time therefore depends on how he travels, while his target arrival time remains constant during the selection process. In this context, using preference over arrival time instead of departure time is more consistent.[10]

[7]For example, a traveler may take train 1 from A0 to A5 and transfer to train 2 at A5 to arrive at B7. The product that the traveler purchases is then {(A0→A5,train 1), (A5→B7,train 2)}.

[8]Douglas and Miller (1974) suggest two reasons why people cannot travel at their preferred times: the difference between a traveler's desired departure time and the closest scheduled departure; and delays due to excess demand during a traveler's preferred travel time. This paper focuses more on the first source of compromise, which was referred to as *frequency delay* by Douglas and Miller (1974).

[9]Unlike Douglas and Miller (1974), this paper does not consider capacity constraint as a source of schedule delay, but the train schedules.

[10]I use departure time for a_{jmt}, and adopt preference over departure time instead of arrival time in an alternative specification for the purpose of robustness check. The results are robust.

B. Traveler's Problem

The logit model with traveler's heterogeneous preferences with respect to travel time will be adopted in this paper. A traveler i, whose preferred travel time is h_i, faces a choice problem over products given a city pair m during time period t: he has to choose how to travel.[11] Traveler i will consider all of the products in the market mt to choose a product that yields the highest utility. This paper assumes a linear utility (or disutility); hence, the utility function of traveler i for product j (a train-route combination) is given by

$$U^i_{jmt} = x_{jmt}\beta + \eta_m + \xi_{jmt} + \gamma \cdot d\left(a_{jmt}, h^i\right) + \epsilon^i_{jmt} \tag{1}$$

where vector $x_{j.}$ contains the observed characteristics of each product, including the fare. Because the heterogeneity of city pairs is very large, the model includes a dummy variable for each city pair m - the coefficient on the dummy variable for city pair m is η_m - in the demand to allow for the valuation of inside goods to differ across markets. $\gamma \cdot d\left(a_{jmt}, h^i\right)$ measures the inconvenience caused by a schedule delay, where $\gamma<0$. $d\left(a_{jmt}, h^i\right)$ is the absolute difference between a_{jmt} and h^i, h^i is traveler i's preferred travel time of day, and a_{jmt} is his actual time of day to travel specifically on product j in market mt.[12]

The product-level unobservable ξ_{jmt} accounts for a number of product characteristics which are not observed by econometricians, such as the unobserved characteristics of the routes or trains, the facilities inside each train or in the train stations, and the quality of the train attendants. ϵ^i_{jmt} is an additive error term, specific to product j in market mt, which is assumed to follow an extreme value distribution and to be distributed independently across both consumers and products.[13,14] This error term captures each traveler's idiosyncratic tastes with regard to trains or routes, or possibly his physical location or the purpose of his trip.[15]

I explicitly introduced "outside" alternatives in Section IV, which include traveling by modes of transportation other than trains as well as not traveling. The mean of this utility from the outside alternative is normalized to be zero. The coefficients of city-pair-specific dummy variables (η_m) in the utility of "inside goods" are interpreted as being relative to the outside goods.

Given the utility function (1), each traveler i purchases one unit of a product j that yields the highest utility. That is, conditional on $\left(x_{mt}, \eta_m, \xi_{jmt}, a_{mt}\right)$ and his

[11] As discussed in Section II, he is allowed to choose not to travel at all.

[12] $d\left(x-y\right) = min\{|x-y|, 24-|x-y|\}$

[13] Berry *et al.* (2006) considers this as a factor of the preference of time to travel. I explicitly include the preference for the arrival or departure time in the model.

[14] This model was initially proposed in McFadden (1973).

[15] As discussed in Section III.A, the purpose of the trip can be to transfer to another mode of travel or to another train.

preferred time to travel h^i, he will purchase one unit of j if and only if $U^i_{jmt} > U^i_{kmt}$ $\forall k \in J_{mt} \cup \{0\}, k \neq j$, where J_{mt} is the set of products available in market mt and $\{0\}$ is the set of outside alternatives.

The market share of a product is defined as the percentage of travelers using that product out of all potential passengers. The market size is discussed in Section IV. Based on the assumption of the distribution of ϵ, the probability that traveler i purchases product j conditional on $\left(x_{mt}, \eta_m, \xi_{jmt}, a_{mt}\right)$ and i's preferred time to travel is given by the well-known formula

$$s^i_{jmt}\left(\delta_{mt}, a_{mt}, \gamma, h^i\right) = \frac{exp\left(\delta_{jmt} + \gamma \cdot d\left(a_{jmt}, h^i\right)\right)}{1 + \sum_{q \in J_{mt}} exp\left(\delta_{qmt} + \gamma \cdot d\left(a_{qmt}, h^i\right)\right)}, \tag{2}$$

where $\delta_{jmt} = x_{jmt}\beta + \eta_m + \xi_{jmt}$, and which is shared among all travelers in the market.

If the distribution of h^i is known, the market share for each product can easily be obtained from the expectation of (2) over h^i. This paper assumes the traveler's preferred time of day to travel to be discrete such that each traveler has his preferred "hour" to travel on a 24-hour clock. This allows the model to be a discrete mixture of logit models. In other words, h^i takes an integer between 1 and 24,[16] and its probability mass function is $\text{Prob}\left(h^i = \tau\right) = \phi_{\tau mt}$ $\forall \tau \in B$, where B is the set of support of h^i, the 24 integers between 1 and 24. The overall market share of product j is

$$s_{jmt}(\delta_{mt}, a_{mt}, \gamma, \phi_{mt}) = \sum_{\tau \in B} \phi_{\tau mt} \cdot s^i_{jmt}(\delta_{mt}, a_{mt}, \gamma, \tau),$$

where $\phi_{\tau mt}$ denotes the percentage of travelers out of all potential travelers in market mt whose preferred time to travel is τ.

C. *Distribution of Preferred Times of Travelers*

Although this paper does not contain any random coefficient, the model is similar to the mixture model with random coefficients due to the existence of h^i. Ideally, the variable ϕ_τ, defined as the proportion of travelers whose preferred time is τ, can be estimated from the model; however, it is not practical to estimate a different vector of ϕ for each market. Such a task would be impractical even if it was assumed that the distribution travelers is common across markets, as estimation is difficult and is sensitive to small changes in the specification or instruments, as noted by Berry and Jia (2010).[17]

To sidestep this issue, this paper uses a proxy for the proportion of potential

[16] Although I assume h^i to be an integer, it can be easily generalized to any of the 24 real numbers between 0 and 24.

[17] According to Berry and Jia (2010), a mixture model with more than three types of consumers is difficult to estimate and sensitive to small changes in specifications or instruments.

travelers with preferred travel time τ, as obtained using the following assumptions. First, I assumed that the distribution of travelers' preferred times to travel varies across city pairs but does not vary across time periods. That is, $\{\phi_{\tau mt}\}_{\tau=1}^{24}=\{\phi_{\tau m}\}_{\tau=1}^{24}$, $\forall t$. I also assume that the distribution of h^i is identical across all alternatives. Let $w_{\tau m}$ be a proxy for the proportion of travelers in city pair m whose preferred time to travel is τ. Replacing $\phi_{\tau mt}$ with the proxy $w_{\tau m}$ allows the overall market share for product j to be rewritten as

$$s_{jmt}(\delta_{mt},a_{mt},\gamma)=\sum_{\tau\in B} w_{\tau m}\cdot s^i_{jmt}(\delta_{mt},a_{mt},\gamma,\tau). \tag{3}$$

Next, it is essential to find a proxy for $\{\phi_{\tau m}\}_{\tau=1}^{24}$ for each m which reflects the distribution of travelers' preferred times of day to travel. The process of constructing the proxy is based on the underlying belief that all travelers will travel at times that are close to their most preferred times. This is a plausible assumption because fares do not vary on the same day. Therefore, the preference for a given travel time can be inferred by the number of travelers during that time. Thus, one reasonable candidate for the distribution of h^i is the hourly train ridership in each market as sourced from historical data. This assumes that the company schedules trains to support travelers using their knowledge of the true distribution of consumer preferences with regard to travel schedules; thus, the hourly ridership should reflect travelers' true preferences. I obtained the proportion of travelers in each city pair m who actually travel during time period τ using

$$Q_m^{\tau}=\frac{\sum_t \sum_{j\in J_{mt}^{\tau}} q_{jmt}}{\sum_t \sum_{j\in J_{mt}} q_{jmt}}, \tag{4}$$

where J_{mt}^{τ} is the set of available trains in market mt with schedule τ, and q_{jmt} is the number of passengers purchasing product j.[18] I construct a proxy for $\{\phi_{\tau m}\}_{\tau=1}^{24}$ for each m, smoothing the proportion of travelers in city pair m who actually travel at τ above the using Kernel density estimation.[19]

[18]This paper uses the "hour of the arrival time" for train schedules. The reason for this is discussed in Section III.A, and thus $J_{mt}^{\tau}=\{j\in J_{mt}|a_{jmt}=\tau\}$.

[19]In other words,

$$w_{\tau m}=\int_{\tau-1}^{\tau}\frac{1}{Q_m^n}\sum_{y=1}^{24} Q_m^y\cdot K\left(\frac{x-y}{h}\right)dx,\ \tau=1,2,\cdots 24 \tag{5}$$

where $Q_m=\sum_{y=1}^{24} Q_m^y$ and $K(x)=\frac{1}{\sqrt{2\pi}h}exp\left(-\frac{x^2}{2h^2}\right)$. Figure 1 shows the mean percentage of rail travelers who travel within one hour across city pairs (with bars) and the mean of the proxies (with lines) for the distribution of travelers' preferred travel times to illustrate the distribution of travelers' preferred times.

IV. Data

The main analysis employs three different sets of data. This dataset is self-constructed using raw data provided by Korail, the Korea Airports Corporation (KAC), the Korean Statistical Information Service (KOSIS) and the Statistical Yearbook of Land, Transport & Maritime Affairs. The first dataset pertains to the South Korean railroad industry and consists of market shares and product characteristics for the years 2006 and 2007. The second dataset includes the market size and the market share of outside alternatives. These two datasets, used in the demand estimation, only contain observations during the period after the introduction of high-speed trains. The third dataset contains the characteristics of products offered to travelers in 2002, when high-speed trains were not available. This dataset is used for the calculation of travelers' surplus and the welfare analysis.

The first dataset pertaining to the railroad industry combines three different types of information from the Korean railroad (Korail) - i) the number of train passengers for each route (defined as a directional pair of stations) by train type and departure time of day aggregated monthly; ii) the major characteristics of each route, including fares, travel distances, and distance from a station to a city center; and iii) the train schedules with train types, routes, departure times and arrival times. In all, the dataset covers 6,456 routes throughout the country in existence during the time period of the data, and it contains the monthly aggregate numbers of train passengers for each route by train type and departure hour of day, observed for 12 months between July of 2006 and June of 2007. This dataset also contains the major characteristics of the route-train types of combinations, such as fares, travel distances, distance from a station to a city center, i.e., the key variables in the demand estimation.

The schedule data provides for each train identified by a train identification number, the stations at which stops are made, the train type, and the departure and arrival times. The ideal dataset for my research would include the numbers of train passengers aggregated for each train and for each route to facilitate more robust

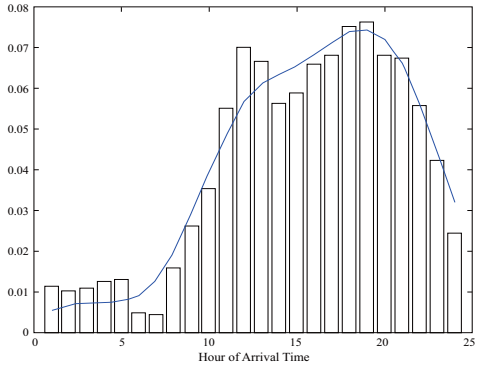

FIGURE 1. HOURLY RIDERSHIP AND DISTRIBUTION USED IN THE ESTIMATION

TABLE 1—SUMMARY STATISTICS

Variable	Mean	STDEV	Median	Min	Max
N=13,347					
Average Population	616,195	724,814	358,772	53,353	7,796,378
Rail, Air, Bus Passengers + Car Ownership	100,172	126,147	56,331	6,874	1,366,424
N=392,459					
Market Share (j)	0.0002	0.0004	0.0001	0.0000	0.0242
Q_j	182	447	49	0	15041
Price (10^3KRW)	8.6	6.7	6.5	1.9	47.0
Distance (Km)	126.0	97.3	96.6	2.9	506.4
N(Own Type Train/Day)	12.5	11.3	9.0	1.0	68.0
N(OtherType Train/Day)	5.7	10.3	1.0	0.0	92.0
Station-City Center (Km)	13.8	9.4	11.4	1.0	82.3

cross-referencing with the schedule of train services.[20] Unfortunately, the available data only summarizes counts by train type and the hour of the departure time; therefore, to infer a train-level dataset, I imposed an assumption on the distribution of train passengers over trains departing within an hour. Each train for each route within a given hour is assumed to have the same number of passengers. Using this assumption, the unit of observation for the combined data is a single train, identified by its train identification (ID) number, running on a specific route over a month. Therefore, my analysis treats a train running on route A and a train running on route B as different observations even if the train ID number is identical.

The second dataset contains the market size and market share of the outside alternatives. "The market" as used herein is defined as a one-way travel choice from an origin to a destination city; hence, I treat a directional city pair and month combination as a separate market. "Travel choice" refers to traveling by rail, bus, car or domestic flight or choosing to forego travel. Potential travelers were estimated rather than observed, however, by assuming that the number of potential travelers is proportional to the geometric average of the populations of the two respective cities constituting a route (Berry *et al.* 2006).

Table 1 summarizes the data used in the demand estimation of this paper, which combines the first and the second datasets. It contains 392,459 products (station pair and train ID combinations) over 1,114 directional city pairs and 12 months. Therefore, the number of city pair and month combinations, which is recognized as a market, is 13,347. I excluded one of four train types, Tong-il, from the first dataset, because this type is usually used by commuters who live in suburbs which are not reached by subways, as discussed in Section II. Thus, it services a demand different from that focused on here. On average, 182 passengers travel on a train-route combination over the period of one month. N(Own Type Train/Day), N(Other Type Train/Day) and Station-City Centers are the variables used to capture the convenience of each route. N(Own Type Train/Day) counts a single type of train scheduled for a particular route within a day. N(Other Type Train/Day) similarly counts the other types of trains. The distance from the city center for a given route is defined as the sum of the distances between the departure and arrival stations from their respective city centers. This variable is meant to capture how conveniently

[20]It is possible for there to be multiple trains departing and arriving within a given hour.

TABLE 2—NUMBER OF PRODUCTS AVAILABLE IN EACH GROUP OF MARKETS

		Data in 2002			Data in 2006		
		(1)	(2)	(3)	(4)	(5)	(6)
		Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
N (City Pairs)		107	330	644	108	330	676
KTX	N	-	-	-	108	-	-
	Mean	-	-	-	14.6	-	-
	Median	-	-	-	8	-	-
	STDEV	-	-	-	19.0	-	-
Sae-ma-eul	N	105	127	257	108	260	246
	Mean	15.9	26.4	4.6	8.4	6.7	7.6
	Median	8	25	4	5	4	5
	STDEV	22.2	18.2	3.4	9.0	8.7	7.3
Mu-gung-hwa	N	107	330	637	107	330	669
	Mean	80.1	62.0	23.3	41.7	31.8	20.5
	Median	50	42	13	32	25	15
	STDEV	76.1	50.9	23.8	33.0	23.1	21.3

Note: 1) N: the number of city pairs in each group where each type of train is available. 2) Group 1: City pairs with a high-speed connection. 3) Group 2: City pairs on high-speed rail lines without available high-speed trains. 4) Group 3: City pairs that are not located along high-speed rail lines.

located departure and arrival stations are in terms of intra-city transportation.

The price variations within a market primarily come from price differences across train types and from routings, as the fares for each route-train type of combination do not vary on the same day or between markets due to the distance-scaled rate system. Another source of price variation is nominal rail fare changes, which were observed twice in my data period. A third dataset is employed to compare travelers' surplus before and after the introduction of high-speed trains. It contains information on the products offered to consumers before high-speed rail was inaugurated. Table 2 compares the number of products offered in 2006 with that in 2002 by train type. Each panel summarizes a specific type of train. The first row of each panel (N) shows the number of city pairs for which the given train type is available, and the next three rows show the mean, median and standard deviation. Each column of the panels summarizes a separate group of markets. In order to compare the train frequencies in 2006 to those of 2002, I partitioned markets into three groups based on high-speed train availability and location. Group 1, containing the city pairs with high-speed connections, is summarized in Columns (1) and (4). Group 2, containing the city pairs which are located along a high-speed rail line but are not connected by a high-speed train, is summarized in Columns (2) and (5). The city pairs that belong to Group 3, which are not on a high-speed rail line (and thus are not connected by high-speed trains), are summarized in Columns (3) and (6).

Each group has been affected differentially by the introduction of high-speed trains. The numbers of Mu-gung-hwa trains offered to Group 1 and Group 2 markets in 2006 were significantly lower than in 2002, while the numbers of Mu-gung-hwa trains offered to markets of Group 3 did not decrease substantially. The panel for Sae-ma-eul reveals two distinctive patterns. First, the numbers of Sae-ma-eul trains offered to Group 1 and Group 2 markets in 2006 also decreased

compared to those in 2002.[21] This change was caused by major reductions in the number of train scheduled for the routes along high-speed rail lines. Second, the panel also reveals that the number of city pairs where Sae-ma-eul trains are available increased from 127 city pairs to 260. This increase occurred because Sae-ma-eul trains stop more frequently and therefore became available in the cities where these additional stops are made. Group 3 experienced only relatively minor changes. In that group, Mu-gung-hwa trains became available between more city pairs despite the average number of Mu-gung-hwa trains slightly decreasing in the group of markets. The average number of Sae-ma-eul trains increased slightly for Group 3.

V. Estimation

To estimate the demand parameters (β,γ), I followed the standard procedure proposed in Berry *et al.* (1995) due to the presence of the unobserved product characteristics ξ, and due to the presence of the heterogeneous travel time preference h^i.[22] Therefore, I inverted the following market share equation for each market to solve for the vector of δ_{mt} as a function of the data and the parameters to be estimated,

$$s_{mt}\left(\delta_{mt}, a_{mt}, \gamma\right) = s_{mt}^{O} \quad \forall \mathrm{m,t}, \tag{6}$$

where $s_{mt}(\delta_{mt},a_{mt},\gamma)$ is a vector of the market shares in market *mt*, as described in (3), and s_{mt}^{O} is a vector of the observed market shares in market *mt*. As in Berry *et al.* (1995), this system of equations is nonlinear with regard to the parameters to be estimated; however, they can be solved numerically by means of contraction mapping.[23] As described in Nevo (2000), I use two-stage least squares, which solve the linear parameters β as a function of the nonlinear parameter γ and limits the nonlinear search in the generalized method of moments to the nonlinear parameter only.

With this assumption, the rail company considers travelers' schedule preferences when determining train schedules; therefore, $E(\xi_{mt})$ could be non-zero. Accordingly, we must include a set of exogenous instrumental variables to identify the parameters. The moment conditions used in the estimation are derived from $E\left(\xi_{mt} \mid z_{mt}\right) = 0$, where z_{mt} is a vector of instruments. For any vector of function $h(\cdot)$, the moment conditions imply $E\left(\xi_{mt} \cdot h\left(z_{mt}\right)\right) = 0$.[24]

[21]The average number of Sae-ma-eul trains offered to the Group 2 city pairs in 2006 is understated because the number of city pairs where Sae-ma-eul trains stop in 2006 is greater than that from 2002. However, it is still significantly decreased because the average number of Sae-ma-eul trains offered in 2006 was 11; this number is not included in Table 2, even if the city pairs are limited to the 127 city pairs where Sae-ma-eul trains have been available since 2002.

[22]Although the model in this paper does not include random coefficients, the existence of heterogeneous tastes for preferred times to travel makes the model similar to those with random coefficients.

[23]I iterated until the maximum difference between each iteration is smaller than $2e^{-25}$.

[24]For this paper, I transformed z_{mt} using a principal component analysis of a given function h(·) to make

Although strict regulations on pricing mitigate the endogeneity problem from prices, the endogeneity from train schedules is of concern in this research. Because a rail company in Korea has only limited power over pricing, it may have a strong incentive to control product characteristics, such as train schedules, instead of fares. As a result, the arrival time of product j, a_{mt} and the schedule delay, $d(a_{jmt},h^i)$ may be endogenously determined by the rail company.[25] Therefore, it is necessary to include valid instruments in order to identify the demand model.

The identification strategy used in this paper searches for the variables that affect the rail company's schedule decisions, but not those that affect consumer demand, exploiting the special circumstances of the railroad industry. Consider, for example, trains running along rail line A with stops at stations between A_0 through A_{N+1} (N intermediate stations). When a rail company determines the schedule for those trains, it would ideally consider the levels of demand for each of the individual routes along the railroad. However, a traveler would care only about the routes on the market in which he travels.[26]

VI. Expected Utility Calculation

The demand estimates provide information about how consumers value each of the product characteristics. These results indicate that consumers experience significant disutility from traveling at a time other than their preferred time to travel. The next step is to quantify the changes in consumer surplus after the introduction of high-speed trains. Because the train schedules changed as a result of the introduction of high-speed trains, I separately considered the changes in consumer surplus caused by train rescheduling and those caused by the introduction of high-speed trains.

The change in consumer welfare can be measured according to the difference between the expected utilities in two different situations. I primarily compared consumers' expected utilities from the set of products offered after the introduction of high-speed trains to those from the products offered before high-speed trains were introduced. To examine the effects of the introduction of high-speed trains separately from other changes, such as train reallocations, I considered consumer surplus with six different sets of products, followed by a stepwise comparison to illustrate the effects of situation changes. It is important to note that the expected utility calculation is based on the observed sets of products and not based on the

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the columns of $h(z_{mt})$ orthogonal.

[25]For example, the rail company could schedule more trains at a popular time; thus, the schedule delay may be small for high-demand products.

[26]For example, consider two cities, City 1 and City 2. Assume the cities have stations, A_{n1} and A_{n2}, respectively, both located on rail line A. Because people who travel from City 1 to City 2 would not care about routes $A_n \rightarrow A_{n'}$, $\forall n,n' \neq n_1$ and $\forall n,n' \neq n_2$, the demand for product j, given train t_1, for $A_n \rightarrow A_{n'}$, $\forall n,n' \neq n_1$ and $\forall n,n' \neq n_2$ constitutes valid instrumental variables for j, with R_{jmt} representing such routes. For example, two of the instrumental variables are $z_{1,jmt} = \sum_{k \in C^1_{jmt}} q_{kmt}$ where

$C^1_{jmt} = \{k \in \cup_m J_{mt} \mid k'\text{strain ID} = j'\text{strain ID \& station pair of } k \in R_{jmt}\}$ and

$C^2_{jmt} = \{k \in \cup_m J_{mt} \mid k'\text{strain ID} \neq j'\text{strain ID \& } a_{kmt} = a_{jmt} \text{ \& station pair of } k \in R_{jmt}\}$.

optimal scheduling choice of the rail company from a supply-side model. The six product sets are defined as follows:

(S1) Train schedules offered to travelers in 2002, before high-speed trains were available, using the prices from 2002
(S2) Train schedules offered in 2002, before high-speed trains were available, using the prices from 2006[27]
(S3) High-speed train schedules offered in 2006, including the other types of trains considered in (S2), using the prices from 2006
(S4) Identical to the product set in (S3), but excluding trains that were no longer part of the 2006 schedule, using the prices from 2006
(S5) Identical to the product set in (S4), but including trains that were newly offered in 2006 versus 2002, using the prices from 2006
(S6) Train schedules offered in 2006, using the prices from 2006

(S1) and (S6) present actual situations, whereas the others present hypothetical situations. The changes from (S1) to (S2) correspond to the effects of price changes between 2002 and 2006. A comparison between (S2) and (S3) provides the effects of the introduction of high-speed trains on travelers' surplus. The changes from (S3) to (S6) corresponds the effects of schedule changes after the introduction of high-speed trains, and the stepwise comparisons from (S3) to (S6) break down those effects into three components: the effects from the elimination of trains ((S3)→(S4)), the effects from the addition of trains ((S4)→(S5)), and the effects from the pure reallocation of existing trains ((S5)→(S6)).

To break down the effect of schedule changes into the three components discussed above, it is necessary to group the trains offered in 2002 into those subsequently removed in 2006 and those still remaining in 2006. Because the systems used to assign identification numbers to trains were different in 2002 and 2006, it was not possible to use the train identification number for the sorting. Thus, this paper exploits the partition of hours, which is defined in Section III.C, by matching Morning trains offered in 2002 to Morning trains offered in 2006 based on the arrival time and the train type. For example, if there were five Mu-gung-hwa trains in the Morning group in 2002 and there were six Mu-gung-hwa trains in the Morning group in 2006, I paired the first offered in 2006 with the five trains offered in 2002 and considered them as trains with "adjusted schedules." The single remaining train was then considered as "an added train." Under this sorting rule, a change in the schedule of a train within time group (B_g) was considered as a reallocation, whereas scheduling a train such that it fell into a different time group ($B_{g'}$, $g' \neq g$) was considered as a removal of that train from the first time group (B_g) and the addition of a new train to the second time group ($B_{g'}$). Using a different sorting rule could result in a different distribution of consumer welfare changes across "removing trains," "adding trains" and "reallocating trains;" however, the total effects of "schedule changes," which consists of all three changes, is invariant across different sorting rules.

To approximate the expected utility given the estimated demand, this paper

[27]This paper uses the fares and the train schedules from November of 2006 for all 2006 pricing.

replaces $\phi_{\tau mt}$, the proportion of travelers whose preferred time to travel is τ, with the proxy $w_{\tau mt}$, as defined in (5). Because ϵ^i_{jmt} in (1) is assumed to have an extreme value distribution, the expected utility can be rewritten as

$$EU_{mt} = \sum_{\tau \in B\phi\tau m} \left[ln \sum_{j \in Jmt} exp\left(V^i_{jmt}\left(\hat{\beta}, \hat{\gamma}, \widehat{\eta_m}, \tau \right) \right) \right] \tag{7}$$

and a monetary measure of the change in travelers' welfare, EV_{mt}, can be constructed according to

$$EV_{mt} = -\frac{M_{mt}}{\beta_p}\left(EU^1_{mt} - EU^0_{mt} \right) \tag{8}$$

where β_p is the price coefficient and M_{mt} is the market size of *mt* (Ben-Akiva 1973; Nevo 2003). EU^1_{mt} and EU^0_{mt} represent the expected utilities of situations with high-speed trains and without these trains, respectively; thus, (8) allows us to compare two different situations with the same demand system.[28]

VII. Results

A. *Travel Demand*

Table 3 shows the results of demand estimations based on the main specification that takes both travelers and non-travelers into consideration. Table 3 shows the estimated parameters, which include the mean utility parameters (β) and the parameter representing the disutility from schedule delay (γ). Column (1) shows the parameters using the main specification, and Column (2) shows the same parameters estimated using the same model without employing the excluded instrumental variables. Column (3) shows the parameters resulting from an OLS estimation of δ_{jmt}.

The mean estimated utility of high-speed trains (KTX) is higher than that of other types of trains for long-distance trips. To be specific, the mean utility values for the KTX are 0.37, 1.81, 3.07 and 4.15, while the mean utility values for Sae-ma-eul trains are 0.3, 0.92, 1.41 and 1.77 for 100 Km, 200 Km, 300 Km, and 400 Km trips, respectively.[29] Schedule delay has a significantly negative impact on demand. In Column (1) of Table 3, the estimated coefficient for schedule delay is -0.311. The most straightforward method of interpreting this coefficient is to compare it to the price coefficient. The price coefficient (-0.115) and the coefficient

[28] While a city pair *m* is observed for multiple periods in the estimation, the products offered in a counterfactual situation are observed for one period; thus, EU^0_m is subscripted only with *m*. I take the mean of EU^1_{mt} over months *t* within city pair *m* to compare it to EU^0_m.

[29] The base category is the Mu-gung-hwa train. The mean utility of high-speed trains (KTX) is -0.41, which is lower than the mean utility of Sae-ma-eul of -0.05 for a 50 Km trip.

TABLE 3—ESTIMATED COEFFICIENT OF THE DEMAND MODEL

	(1) Main Model	(2) Without Instruments	(3) OLS
Schedule Delay (Hour)	-0.311***	-4.613***	-
	(0.004)	(0.474)	-
Price (10^3KRW)	-0.115***	-0.113***	-0.118***
	(0.002)	(0.002)	(0.002)
N(Own Type Train)	0.056***	0.058***	0.056***
	(3.0E-4)	(3.2E-4)	(2.7E-4)
N(Other Type Train)	0.015***	0.017***	0.014***
	(2.4E-4)	(2.8E-4)	(2.8E-4)
Station-City Center	-0.069***	-0.071***	-0.067***
	(2.9E-4)	(3.0E-4)	(2.6E-4)
I(KTX)	-1.240***	-1.262***	-1.204***
	(0.029)	(0.032)	(0.033)
I(Sae-ma-eul)	-0.434***	-0.502***	-0.348***
	(0.017)	(0.018)	(0.018)
I(KTX)*Distance	0.017***	0.015***	0.017***
	(3.4E-4)	(3.8E-4)	(3.8E-4)
I(Sae-ma-eul)*Distance	0.008***	0.007***	0.008***
	(1.7E-4)	(1.8E-4)	(1.9E-4)
I(KTX)*Distance^2	-8.8E-6***	-6.5E-6***	-8.8E-6***
	(8.4E-7)	(9.2E-7)	(9.1E-7)
I(Sae-ma-eul)*Distance^2	-6.2E-6***	-4.5E-6***	-7.1E-6***
	(4.3E-7)	(4.6E-7)	(4.7E-7)
Distance	0.011***	0.010***	0.011***
	(2.4E-4)	(2.4E-4)	(2.2E-4)
Distance^2	-2.1E-5***	-2.1E-5***	-2.1E-5***
	(6.3E-7)	(6.2E-7)	(5.6E-7)
Constant	-8.872***	-7.030***	-9.187***
	(0.036)	(0.029)	(0.020)
R^2	0.578	0.584	0.536
City Pair FE	YES	YES	YES

Note: 1) N=392,459; N(Markets)=13,347; N(City Pairs)=1,114. 2) ***Significant at p=0.01; **Significant at p=0.05; *Significant at p=0.1

for schedule delay imply that travelers are willing to pay as much as (approximately) 2700 KRW to reduce their schedule delays by one hour, holding everything else fixed. The coefficient for price shows that consumers are not sensitive to prices. To be more specific, the probability that they will purchase a product decreases by 9.9% when the price increases by 10%.

The examination of the estimated coefficients of the variables that indicate the convenience of each route, such as N(Own Type Train/Day), N(Other Type Train/Day) and Station-City Center, reveals that routes with more trains scheduled provide higher utility for travelers. In particular, N(Own Type Train/Day) and N(Other Type Train/Day) capture the frequency of the rail service for a given route, and more frequent service for a route implies that the route is more convenient than other routes in the market.[30] The number of a given type of train scheduled on the same day affects a traveler's utility more than the schedules of other types of trains. If the number of a given type of train scheduled on the same day increases by 10%,

[30]If there are two different routes which connect a city pair and one of the routes provides more frequent service, it is likely that the waiting time will be reduced, thereby inducing higher utility when choosing a route with more frequent trains as compared to other routes.

travelers choose corresponding products with a 7% higher probability. On the other hand, a 10% increase in the number of other types of trains scheduled on the same day results in only a 0.8% higher purchase probability. The distance between the station and city center is also an important factor affecting demand based on the estimated parameters. If a given station was relocated 10% farther from its city center, consumers would choose the corresponding products with a 9.5% lower probability.

B. *Consumer Surplus*

I partitioned the markets into three groups based on high-speed train availability in the same manner used in Table 2. This partitioning facilitates an examination of the different effects across heterogeneous consumers. The results for Group 1, which considers consumers in markets with high-speed train stations, are shown in Column (1) of Tables 4, 5 and 6. Group 1 contains 107 million travelers per month across 107 city pairs. Column (2) of Tables 4, 5 and 6 summarize the results for Group 2, which consists of markets that are located along high-speed rail lines without available high-speed trains. Group 2 contains 190.7 million travelers per month across 330 city pairs. The consumers not accounted for in the first two groups belong to Group 3, whose results are shown in Column (3) of Tables 4, 5 and 6. Group 3 covers 615 city pairs with 348.9 million travelers per month. Consumers in Group 1 and Group 2 were expected to experience stronger effects from both the introduction of high-speed trains and the resulting schedule adjustments than consumers in Group 3. I summarized the changes in consumer surplus based on these groups. Tables 4, 5 and 6 reflect the main findings of this paper.

Table 4 summarizes the expected consumer surplus changes per person for each market. Each subpanel in Table 4 displays the change in consumer welfare resulting from each of the five different sources described in Section VI. The "Price Change" panel shows the estimated change in consumer welfare due to price differences between 2002 and 2006. Given that rail fares decreased for 50% of the products available in my dataset, the changes in consumer surplus due to price change are positive. The "Add KTX" panel shows the gains which are attributable to the introduction of high-speed trains into the markets. Considering that high-speed trains became available in the markets of Group 1, only the consumers in Group 1 directly benefited from the new service. The next three subpanels summarize respectively the changes in consumer welfare due to the reduced number of scheduled trains, the scheduling of additional trains, and the rescheduling of existing trains to another time within the same day. The "Total Effect" panel reflects the overall changes in consumer surplus resulting from all sources having an impact.

Each column in Table 4 shows the heterogeneous impacts all normalized to be per person on consumers in each of the three groups, as described above.[31] The

[31]How a group is defined does not affect the demand estimates or the change in consumer surplus. The welfare analysis by group facilitates a clearer understanding of how heterogeneous consumers are differentially affected by the introduction of high-speed trains and the ensuing schedule changes.

TABLE 4—CHANGES OF CONSUMER SURPLUS PER PERSON ACROSS MARKETS (10^3KRW)

		(1) Group 1	(2) Group 2	(3) Group 3
N (City Pairs)		107	330	615
Price change	Mean	0.54	0.33	0.96
	Median	-0.18	-0.39	0.23
	STDEV	1.44	1.42	1.82
Add KTX	Mean	5.64	0.00	0.00
	Median	3.65	0.00	0.00
	STDEV	5.46	0.00	0.00
Remove Trains	Mean	-6.20	-13.81	-1.62
	Median	-5.74	-13.09	-1.66
	STDEV	4.04	8.42	12.42
Add Trains	Mean	1.71	2.47	3.93
	Median	0.87	0.68	2.26
	STDEV	2.16	7.06	11.38
Reallocate Trains	Mean	2.29	2.52	2.16
	Median	1.91	1.40	1.56
	STDEV	3.79	3.87	4.67
Total Effect	Mean	3.98	-8.50	5.43
	Median	3.74	-10.68	3.01
	STDEV	7.81	11.41	8.07

Note: 1) The result is based on the estimates shown in Column (1) in Table 3. 2) Group 1: City pairs with a high-speed connection. 3) Group 2: City pairs on high-speed rail lines without available high-speed trains. 4) Group 3: City pairs that are not located along high-speed rail lines.

median of the expected per-person change in Group 1 resulting from the introduction of high-speed trains is 5,600 KRW, but the expected change resulting from train schedule adjustments is -1,900 KRW, offsetting some of this gain.[32] The median of the expected per-person loss in Group 2 resulting from schedule adjustments after the introduction of high-speed train is approximately 11,140 KRW. This loss occurred because some trains that were available before high-speed trains were introduced became unavailable after they were introduced. Group 3 consumers experienced only minor changes overall compared to consumers in other groups. The median of the expected per-person change in consumer welfare in Group resulting from schedule adjustments after the introduction of high-speed train is about 1,900 KRW. The total effect summarizes the changes in consumer welfare compared to that in 2002. The median of the expected consumer surplus change per person in Group 1 is 4,000 KRW, while that in Group 2 is -8,500 KRW.

Table 5 summarizes the expected consumer surplus changes in each market, taking into consideration market sizes and the magnitudes of the impact per person.[33] The results obtained using the main specification demonstrate that both the introduction of high-speed trains and the ensuing changes in train schedules had substantial effects on consumer welfare, and that the size of the impact varied

[32]The expected change from the schedule adjustment after high-speed trains were introduced is the sum of the changes caused by removing trains, adding trains and rescheduling trains.

[33]Table 5 shows the summary statistics of (The per-person expected surplus changes in each market) × (Market Size).

TABLE 5—CHANGE OF CONSUMER SURPLUS ACROSS MARKETS (10^6 KRW)

		(1)	(2)	(3)
		Group 1	Group 2	Group 3
N (City Pairs)		107	330	615
Price change	Mean	-400.29	120.38	359.80
	Median	-79.15	-65.07	67.78
	STDEV	2136.95	1336.25	1525.64
Add KTX	Mean	9930.24	0.00	0.00
	Median	1359.58	0.00	0.00
	STDEV	22579.08	0.00	0.00
Remove Trains	Mean	-6317.17	-9868.11	-1106.28
	Median	-1879.11	-4427.52	-578.20
	STDEV	11722.20	19636.37	11437.76
Add Trains	Mean	1790.29	1274.05	3079.74
	Median	333.52	217.88	672.13
	STDEV	3870.33	3994.22	12537.64
Reallocate Trains	Mean	-683.35	1333.59	1262.32
	Median	562.99	438.95	455.32
	STDEV	4782.99	2850.51	5191.70
Total Effect	Mean	4319.72	-7140.08	3595.59
	Median	1340.29	-2668.40	833.82
	STDEV	16219.36	19151.81	7673.53

Note: 1) The result is based on the estimates shown in Column (1) in Table 3. 2) Group 1: City pairs with a high-speed connection. 3) Group 2: City pairs on high-speed rail lines without available high-speed trains. 4) Group 3: City pairs that are not located along high-speed rail lines.

TABLE 6—GROSS CHANGE OF CONSUMER SURPLUS IN EACH GROUP OF MARKETS (10^9KRW)

	(1)	(2)	(3)	
	Group 1	Group 2	Group 3	National Gross
N (City Pairs)	107	330	615	1052
Price change	-42.83	39.73	221.28	218.17
Add KTX	1062.54	0.00	0.00	1062.54
Remove Trains	-675.94	-3256.47	-680.36	-4612.77
Add Trains	191.56	420.44	1894.04	2506.04
Reallocate Trains	-73.12	440.08	776.33	1143.30
Total Effect	462.21	-2356.23	2211.29	317.27

Note: 1) The result is based on the estimates shown in Column (1) in Table 3. 2) Group 1: City pairs with a high-speed connection. 2) Group 2: City pairs on high-speed rail lines without available high-speed trains. 3) Group 3: City pairs that are not located along high-speed rail lines.

across consumers. The fact that the median and mean impacts are substantially different suggests that the changes in consumer surplus are heterogeneous across markets. Although the mean of the expected per-person consumer surplus change in Group 1 resulting from the reallocation of trains is positive, the mean calculated per market value is negative. This implies that the losses resulting from reallocating trains occurred in larger markets, which tended also to be more strongly affected by the introduction of high-speed trains directly, while some other markets in Group 1 benefited.

Table 6 summarizes the gross changes in consumer surplus in each of the three groups. As indicated earlier, rail fares decreased for 50% of the products available in my dataset; thus, the overall change in consumer surplus due to a price change

was positive. The second row in each panel shows the gains stemming from the introduction of high-speed trains into the markets. In that high-speed trains became available in the markets of Group 1, only the consumers in Group 1 benefited from the new high-speed rail service. More concretely, the introduction of high-speed trains caused an estimated 10 trillion KRW increase in consumer surplus per month. The net gains for travelers in Group 1 are not as large as superficially anticipated, however, because schedule changes such as the reallocation and reduction of non-high-speed trains caused sizable losses that offset 50% of the direct gains resulting from the introduction of high-speed trains.

The next three rows (rows 3-5) summarize the changes in consumer welfare due to rescheduling trains, such as reducing the number of scheduled trains, scheduling additional trains and reallocating existing trains to another time slot on the same day. The consumer welfare change due to schedule adjustments in Group 1 markets was about -560 billion KRW. Consumers in Group 2 suffered a considerable amount of loss, -2.4 trillion KRW, due to changes in the set of products offered because train schedules in the corresponding markets were reduced by more than 50%. Without any added benefits from new high-speed services, consumers in the markets of Group 2 experienced losses three times higher than the gains of Group 1 resulting from the introduction of high-speed trains. On the other hand, consumer welfare in the markets of Group 3 increased by nearly 2 trillion KRW. Although some trains were removed from the original schedules, the gains resulting from additional non-high-speed trains and from reallocated trains outweighed the losses stemming from the removal of trains. Unlike consumers in Groups 2 and 3, consumers in Group 1 suffered a loss of 73 billion KRW resulting from trains being rescheduled to other time slots, as KTX trains are primarily scheduled at peak times and non-high-speed trains are primarily scheduled away from those times.

Overall, the gains from having high-speed trains are substantial. However, the losses from schedule adjustments that consumers were subjected to in the markets located along high-speed rail lines without high-speed trains scheduled outweighed those gains. Overall changes in consumer surplus were about 317 billion KRW; however, the positive changes are led by the gains from schedule adjustments in the Group 3 markets, but the gains from high-speed trains do not exceed the losses that occurred due to schedule reductions in Group 2 markets.

To summarize, introducing high-speed trains substantially raised consumer surplus in markets where they were actually made available. The changes in the set of products offered to consumers offset 50% of the gains, however. This resulted in greater losses of consumer surplus in markets located along high-speed rail lines but not connected by high-speed trains, and those losses outweighed the gains stemming directly from the introduction of high-speed trains. The overall change in consumer surplus after the introduction of high-speed trains was positive because the gains resulting from schedule adjustments in markets that are not located along high-speed rail lines made up for the losses in markets that are located along high-speed rail lines without available high-speed trains. I also found that there are substantial differences in the magnitudes of consumer welfare changes across heterogeneous consumers. The benefit gained directly from high-speed trains is concentrated in some of the markets, although changes in the choice sets affected a broader range of consumers.

C. *Limitation*

A critical limitation of these results is an implicit assumption of the stability of the demand system. This approach presumes that consumers had identical levels of demand over product characteristics regardless of the existence of the new product. The results are derived based on the estimates of an indirect utility function for the period after the innovation despite the fact that the ex ante and ex post welfare calculations provide quantitatively different measures (Trajtenberg 1989). Given that the estimated demand is only based on the revealed preferences observed for the periods after the introduction, the calculated consumer surplus is valid only if the functional form of the demand is stable as we move away from the center of the data.

A more serious problem arises due to the distribution of travelers' preferred times. First, we cannot guarantee that the distribution of travelers' preferred times is time-invariant. The assumption imposed when the proxy for ϕ is constructed could lead to bias in the results. I used hourly train ridership in each market from the historical data for the proxy, assuming that the train schedule and hourly ridership reflect travelers' true preferences. However, this could lead to a biased result if the preference with regard to travel schedule changed after the introduction because scheduling trains in a different way from that observed in 2006 will result in welfare losses. I believe that this bias is not serious because i) the welfare implication is robust under other distributions, and ii) the proportion of welfare changes due to schedule preferences is relatively small compared to those coming from schedule frequencies.

Lastly, the model adopted in this paper focuses on heterogeneous preferences for travel schedules rather than heterogeneous sensitivity levels to fares and schedule delays. However, in reality, sensitivity would affect a consumer's modal choice together with sensitivity to prices.

VIII. Conclusion

In this paper, I addressed the effect on consumer surplus resulting from the introduction of high-speed trains and the ensuing changes in train schedules. I examined the impacts of introducing high-speed trains on consumer welfare using Korean transportation industry data, taking changes in the product selection offered by the rail company into account. With this data, I estimate a model of travel demand that incorporates consumers' heterogeneous preferences for travel schedules into a standard discrete-choice model and compare the consumer surplus resulting from a set of products offered to consumers before and after the introduction of high-speed trains. My results show that the newly introduced high-speed trains had differential effects on consumers and that the ensuing changes in train schedules also indirectly affected consumer surplus. The changes in consumer surplus within a market depended on the availability of high-speed trains. The overall consumer surplus after the introduction of high-speed trains increased; however, the increase was not nearly as substantial as the gains directly resulting

from the introduction of high-speed trains owing to the losses incurred by groups for which high-speed trains were not available.

My research calls attention to the impact on consumer welfare from cases of new product introduction and the subsequent changes due to the reactions of economic agents in related industries. Although the subsequent changes may have a substantial influence on consumer surplus, the scope of the investigation can easily be restricted to one specific industry or a particular group of consumers, and such a restricted scope can lead to biased results pertaining to welfare implications. This study also provokes a discussion regarding government spending. As expected, the construction of high-speed rail lines was costly and the Korean government allocated an enormous budget, which was levied from all taxpayers. However, the benefits tend to be concentrated in a few markets despite the diffused costs. Therefore, a thorough investigation regarding the benefits of government spending and its wider impact as well as an in-depth discussion are essential for better decisions regarding the government's investments.

APPENDIX

A.1. Alternative Assumption on Market Size

The numbers of airline passengers for each route within a month and the numbers of rail passengers for each route within a month are accurately observed and provided by the Korea Airports Corporation (KAC) and by Korail, respectively. However, I did not observe the number of inter-city bus passengers and auto travelers for each route, which I did for domestic flights. Instead, I took the monthly-aggregated numbers of inter-city bus passengers throughout the country from the Statistical Yearbook of Land, Transport & Maritime Affairs and combined these values with the numbers of households per city from the Korean Statistical Information Service, KOSIS, to infer the number of travelers using inter-city buses or cars. First, to allow disaggregation of the numbers of bus passengers at the city-pair level, I imposed two assumptions: i) inter-city buses are available between all pairs of cities, and ii) the number of passengers is proportional to the geometric average of two respective cities' populations.[34] Assumption (ii) implies that the percentage of travelers using buses among the geometric average of the two cities' populations is constant for all the city pairs.[35] Second, I inferred the number of auto travelers using the geometric averages of the number of cars owned in the two respective cities.

The assumptions discussed above are very limiting, and they may be unrealistic because the geometric averages of populations may not have a strong linear relationship with the respective numbers of bus travelers. It is also true that the proportion of bus travelers in a given market *mt*, among all bus travelers during

[34]Data used in the estimation covers 86 cities, and there are more than 150 bus terminals throughout the country, as obtained from the Korean Statistical Information Service, KOSIS.

[35]Number of travelers using buses in

$$mt = (\text{number of travelers using bus throughout the country in } t) \times \frac{\text{geometric average of two cities population in } mt}{\sum_m \text{geometric average of two cities population in } mt}$$

period *t*, only depends on the populations of the two cities, although other factors such as the distance between the two cities or the convenience of bus connections could also be important. Similarly, the number of cars owned may not have a strong linear relationship with the number of car travelers when considering all routes. I imposed these assumptions and use the sum of the monthly aggregated number of rail and airline passengers for each route, number of bus travelers disaggregated at the city-pair level, and the number of auto travelers as constructed above as the market size for the secondary specification.

A.2. Robustness

Tables A1, A2 and A3 provide the results under alternative assumptions. Table A1 provides the coefficients estimated under the alternative assumptions and Table A3 compares the respective changes in consumer welfare.

In addition to the main analysis that allows travelers to choose to forego travel, I imposed an alternative assumption that does not allow travelers to choose to forego travel. This experiment analyzes how the results vary with the assumption of the market size, and differs from the main analysis in that now the benefits from the introduction of high-speed trains are limited to only travelers, excluding non-travelers. Unlike the definition used in the main specification, the set of outside alternatives is composed of buses, cars and domestic flights. Thus, the market size of outside alternatives is calculated by adding the numbers of rail passengers, airline passengers, bus passengers and auto travelers.[36] Using the inferred market size, I compared the changes in consumer surpluses in this specification to those calculated in the main specification, in which the model allows non-travelers to switch to traveling by trains.

Column (1) of Table A1, Table A2 and Panel A of Table A3 show the results under the assumption of non-travelers not being allowed to travel. Panel A of Table A2 shows the heterogeneous impacts all normalized as per person for consumers in each of the three groups. Panel B of Table A2 summarizes the expected consumer surplus changes in each market, taking into consideration market sizes and the magnitudes of the impact per person. Panel A of Table A3 displays the nationwide total changes in consumer welfare resulting from each of the five different sources. The per-person impacts from each source (shown in Panel A of Table A2) are similar to those shown in Panel A of Table 4 regardless of whether consumers are allowed to forego travel or not. However, the changes in consumer surplus per market reflected in Panel B of Table A2 are different from those in Table 5 despite the similar magnitudes of the per-person impact. Moreover, the nationwide total effect became negative because these results are based on the assumptions that the changes in consumer surplus from the introduction of high-speed trains are limited to travelers and that the estimated changes are understated. One general conclusion to be made regardless of the assumed market size is that the gains from the introduction of high-speed trains are not as substantial as superficially anticipated due to the losses resulting from the reduced schedule frequency in Group 2.

[36] I describe how I calculate these numbers in Section A.1.

TABLE A1—ESTIMATED COEFFICIENTS OF THE DEMAND MODEL UNDER AN ALTERNATIVE DISTRIBUTION OF H^i

	(1)	(2)	(3)	(4)	(5)	(6)
Distribution of h^i	Kernel	Kernel				
N (Time groups)	N\A	N\A	6 Time groups	4 Time groups	4 Time groups	4 Time groups
Within-Group Distribution	N\A	N\A	Uniform	Uniform	Gaussian	Arbitrary
Schedule Delay (Hour)	-0.322***	-0.329***	-0.361***	-0.480***	-0.497***	-0.481***
	(0.004)	(0.004)	(0.005)	(0.008)	(0.009)	(0.008)
Price (10^3KRW)	-0.106***	-0.114***	-0.115***	-0.115***	-0.114***	-0.115***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
N(Own Type Train)	0.057***	0.056***	0.057***	0.057***	0.058***	0.057***
	(3.0E-4)	(3.0E-4)	(3.0E-4)	(3.0E-4)	(3.1E-4)	(3.0E-4)
N(Other Type Train)	0.016***	0.015***	0.015***	0.015***	0.015***	0.015***
	(2.4E-4)	(2.4E-4)	(2.4E-4)	(2.4E-4)	(2.5E-4)	(2.4E-4)
Station-City Center	-0.068***	-0.069***	-0.069***	-0.069***	-0.069***	-0.069***
	(2.9E-4)	(2.9E-4)	(2.9E-4)	(2.9E-4)	(3.0E-4)	(2.9E-4)
I(KTX)	-1.259***	-1.241***	-1.236***	-1.240***	-1.231***	-1.242***
	(0.029)	(0.029)	(0.030)	(0.030)	(0.030)	(0.030)
I(Sae-ma-eul)	-0.466***	-0.435***	-0.417***	-0.408***	-0.369***	-0.406***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.017)
I(KTX)*Distance	0.016***	0.016***	0.016***	0.016***	0.016***	0.016***
	(3.4E-4)	(3.4E-4)	(3.4E-4)	(3.5E-4)	(3.5E-4)	(3.5E-4)
I(Sae-ma-ul)*Distance	0.008***	0.008***	0.008***	0.008***	0.008***	0.008***
	(1.7E-4)	(1.7E-4)	(1.7E-4)	(1.7E-4)	(1.8E-4)	(1.7E-4)
I(KTX)*Distance^2	-9.1E-6***	-8.3E-6***	-8.6E-6***	-8.3E-6***	-7.9E-6***	-8.2E-6***
	(8.2E-7)	(8.3E-7)	(8.4E-7)	(8.4E-7)	(8.6E-7)	(8.4E-7)
I(Sae-ma-eul)*Distance^2	-6.7E-6***	-6.1E-6***	-6.1E-6***	-6.1E-6***	-6.3E-6***	-6.1E-6***
	(4.4E-7)	(4.3E-7)	(4.4E-7)	(4.4E-7)	(4.5E-7)	(4.4E-7)
Distance	0.010***	0.011***	0.011***	0.011***	0.011***	0.011***
	(2.4E-4)	(2.4E-4)	(2.4E-4)	(2.4E-4)	(2.5E-4)	(2.4E-4)
Distance^2	-2.1E-5***	-2.1E-5***	-2.1E-5***	-2.1E-5***	-2.0E-5***	-2.0E-5***
	(6.3E-7)	(6.4E-7)	(6.3E-7)	(6.3E-7)	(6.4E-7)	(6.3E-7)
Constant	-7.306***	-8.834***	-8.750***	-8.476***	-8.440***	-8.472***
	(0.036)	(0.036)	(0.036)	(0.038)	(0.039)	(0.038)
R^2	0.573	0.578	0.580	0.577	0.568	0.575
City Pair FE	YES	YES	YES	YES	YES	YES

Note: 1) In all of the specifications above except (1), the market consists of travelers and non-travelers. 2) In Column (2), this is defined over departure times. 3) N=392,459; N (Markets)=13,347; N (City Pairs)=1,114. 4) ***Significant at p=0.01; **Significant at p=0.05; *Significant at p=0.1

Column (2) of Table A.1 presents the results from the specification that uses the departure time instead of the arrival time. Therefore, the travel time of day a_{jmt} is the hour of product j's departure time, and the preference of travel schedule h^i is also defined over the departure time.

Moreover, I examine how robust my main results are by considering several different distributions of h^i based on several assumptions about the distribution of travelers' preferences over the travel schedule. I am concerned with the possibility that hourly ridership may distort the distribution of h^i due to train schedules. For example, consider a hypothetical situation where a consumer wants to travel at 10 AM using a Sae-ma-eul train, but there is no such train available. Suppose he has the options of waiting until 12 PM or taking a KTX train at a higher price. If he chose to wait until 12 PM instead paying the higher price, he would be counted as a consumer whose preferred time is 12 PM instead of 10 AM. To examine how robust the results are, this paper considers several different distributions of h^i.

TABLE A2—IF NON-TRAVELERS ARE EXCLUDED FROM THE CONSIDERATION

		(1) Group 1	(2) Group 2	(3) Group 3
N (City Pairs)		107	330	615
Panel A: Changes of Consumer Surplus Per-Person Across Markets (10^3KRW)				
Price change	Mean	0.54	0.33	0.96
	Median	-0.18	-0.39	0.23
	STDEV	1.44	1.42	1.82
Add KTX	Mean	6.22	0.00	0.00
	Median	4.03	0.00	0.00
	STDEV	6.03	0.00	0.00
Remove Trains	Mean	-6.79	-15.20	-2.14
	Median	-6.23	-14.36	-1.82
	STDEV	4.43	8.82	11.21
Add Trains	Mean	1.87	2.75	4.66
	Median	0.95	0.75	2.49
	STDEV	2.36	7.21	10.71
Reallocate Trains	Mean	2.41	2.75	2.40
	Median	2.04	1.50	1.73
	STDEV	4.23	4.23	4.72
Total Effect	Mean	4.24	-9.36	5.89
	Median	4.08	-11.83	3.27
	STDEV	8.59	12.49	8.81
Panel B: Changes in Consumer Surplus Across Markets (10^6 KRW)				
Price change	Mean	-57.74	35.09	59.61
	Median	-13.21	-10.39	11.89
	STDEV	310.35	239.03	249.15
Add KTX	Mean	1887.60	0.00	0.00
	Median	236.08	0.00	0.00
	STDEV	4286.02	0.00	0.00
Remove Trains	Mean	-1119.94	-1842.63	-230.97
	Median	-344.91	-804.49	-97.34
	STDEV	2173.30	4066.60	1850.27
Add Trains	Mean	373.02	215.18	494.61
	Median	59.87	35.96	120.20
	STDEV	858.81	687.04	1912.64
Reallocate Trains	Mean	-207.59	219.79	228.43
	Median	85.57	75.17	75.89
	STDEV	1082.54	524.21	840.52
Total Effect	Mean	875.35	-1372.56	551.68
	Median	224.52	-496.24	141.45
	STDEV	3313.28	3978.88	1109.29

Note: 1) Panel A is based on the estimates shown in Column (1) of Table A1. 2) Panel B is based on the estimates shown in Column. (2) of Table A1. 3) Group 1: City pairs with a high-speed connection. 4) Group 2: City pairs on high-speed rail lines without available high-speed trains. 5) Group 3: City pairs that are not located along a high-speed line.

To consider this issue, first I exploit the conjecture that travelers would travel at times around their preferred time of day, after which I combine that with another distributional assumption. Specifically, I partition a set of the 24 numbers (denoted by B) into four groups (denoted by B_g, $g=1,\cdots,4$) that can be interpreted as Morning, Daytime, Evening, and Night.[37,38,39] I construct a proxy for the proportion

[37]Thus, it satisfies $B_g \cap B_{g'} = \emptyset$ for any $g \neq g'$ and $B = \cup_{g=1}^{4} B_g$.

[38]The partition is defined based on the observation of the actual train schedule. The four groups are defined as 6:00-12:00, 12:00-18:00, 18:00-24:00, and 24:00-6:00, respectively.

[39]This paper experiments different partitions with the length of the interval set to four hours instead of six

TABLE A3—CHANGES IN CONSUMER SURPLUS IN EACH GROUP OF MARKETS

(UNIT: 10^9 KRW)

		(1) Group 1	(2) Group 2	(3) Group 3	National Gross
Panel A	Price change	-6.18	11.58	36.66	42.06
	Add KTX	201.97	0.00	0.00	201.97
	Remove Trains	-119.83	-608.07	-142.05	-869.95
	Add Trains	39.91	71.01	304.19	415.11
	Reallocate Trains	-22.21	72.53	140.48	190.80
	Total Effect	93.66	-452.95	339.28	-20.00
Panel B	Price change	-42.74	39.74	220.67	217.68
	Add KTX	1072.59	0.00	0.00	1072.59
	Remove Trains	-681.41	-3299.42	-688.46	-4669.29
	Add Trains	193.48	434.63	1949.32	2577.43
	Reallocate Trains	-72.51	464.37	836.58	1228.44
	Total Effect	469.41	-2360.68	2318.11	426.84
Panel C	Price change	-42.88	39.68	219.18	215.99
	Add KTX	1086.82	0.00	0.00	1086.82
	Remove Trains	-686.53	-3350.46	-718.88	-4755.87
	Add Trains	196.25	467.69	2116.00	2779.94
	Reallocate Trains	-66.38	517.71	915.54	1366.88
	Total Effect	487.29	-2325.38	2531.84	693.75
Panel D	Price change	-42.74	39.65	219.34	216.24
	Add KTX	1079.29	0.00	0.00	1079.29
	Remove Trains	-686.33	-3362.60	-728.49	-4777.42
	Add Trains	198.34	456.26	2126.00	2780.60
	Reallocate Trains	-74.86	489.85	901.31	1316.30
	Total Effect	473.69	-2376.84	2518.16	615.00
Panel E	Price change	-42.93	39.69	218.99	215.75
	Add KTX	1083.39	0.00	0.00	1083.39
	Remove Trains	-684.86	-3344.87	-715.69	-4745.41
	Add Trains	196.15	462.47	2110.71	2769.32
	Reallocate Trains	-66.99	513.11	911.36	1357.48
	Total Effect	484.77	-2329.59	2525.35	680.53

Note: 1) Panel A is based on the estimates shown in Column (1) of Table A1. 2) Panel B is based on the estimates shown in Column (3) of Table A1. 3) Panel C is based on the estimates shown in Column (4) of Table A1. 4) Panel D is based on the estimates shown in Column (5) of Table A1. 5) Panel E is based on the estimates shown in Column (6) of Table A1. 6) Group 1: City pairs with a high-speed connection. 7) Group 2: City pairs on high-speed rail lines without available high-speed trains. 8) Group 3: City pairs that are not located along a high-speed line

of travelers whose preferred time of day belongs to each time group using actual data. Note that this does not violate the assumption that each traveler would travel at a time that is close to their most preferred time, as I used in the main specification.

In order to take the effects of train availability on the distribution into account, and in attempt to reduce those effects, I assumed a uniform distribution within each time group (B_g). By extension, this assumption implies that h^i is uniformly distributed within time group (B_g) but also that the train availability factor induces the observed hourly ridership.[40] Therefore, $Prob(h^i \in B_g) = \sum_{\tau \in B_g} \phi_{\tau m}$ in each city

hours; thus, the 24 numbers are partitioned into the six groups of 3:00-7:00, 7:00-11:00, 11:00-15:00 15:00-19:00 19:00-23:00, and 23:00-3:00.

[40]In addition to a uniform distribution, I apply a Gaussian distribution centered at the median of each time group and a randomly chosen arbitrary distribution.

pair m is replaced with the proportion of rail passengers in city pair m traveling at time $\tau \in B_g$, with the same number of travelers located at each point within B_g according to the assumption. Hence, $\phi_{\tau m}$, the proportion of travelers who prefer to travel at during time period τ, is replaced with $w_{\tau m}$ such that

$$\sum_{\tau \in B_g} w_{\tau m} = \frac{\sum_t \sum_{j \in J_{mt}^{B_g}} q_{jmt}}{\sum_t \sum_{j \in J_{mt}} q_{jmt}} \quad \text{, and} \quad w_{\tau m} = \text{Prob}(h^i = \tau | h^i \in B_g) \cdot \sum_{\tau \in B_g} w_{\tau m}$$

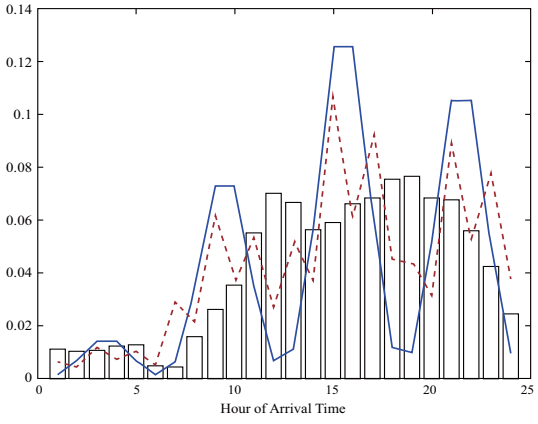
where $J_{mt}^{B_g}$ denotes the set of available trains in market mt whose schedule belongs to B_g, and q_{jmt} is the number of passengers purchasing j.[41] $Prob\left(h^i = \tau \,|\, h^i \in B_g\right)$ is the distributions within the time group.[42]

Figure A1 shows the mean of the percentage of rail travelers who travel within an hour across city pairs (with bars) and the mean of proxies (with lines) for the distribution of travelers' preferred travel times under the different assumptions of the time group distribution. Figures A1(a) and A1(b) show the distribution of h^i based on six time groups and four time groups, respectively, combined with the uniform distribution regarding the within-time-group distributions. Figure A.1(c) displays the mean of two different proxies based on the four time groups, one using a Gaussian (with solid line) and one an arbitrary distribution (with dashed line) for the within-time-group distribution.

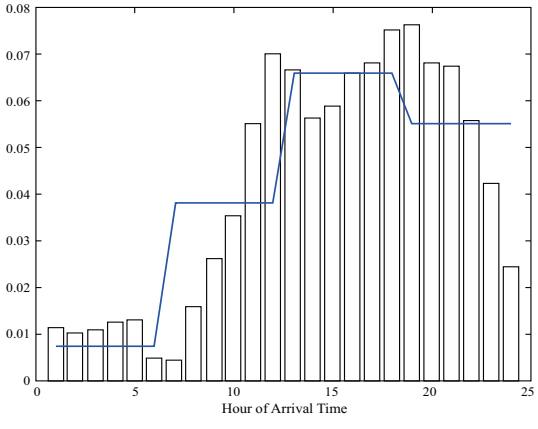
Column (3)-(6) of Table A1 and Panels B-E of Table A3 present the results from the specification that adopts $w_{\tau m}$ shown in (9) as a proxy for the distribution of h^i. Column (3) and Panel B assume that B is partitioned into six time groups with four-hour intervals as defined in Appendix A.2, and that h^i is uniformly distributed within each time group. Columns (4), (5) and (6) and Panels C, D and E assume that B is partitioned into four time groups with six-hour intervals as defined in Appendix A.2 with different within-group distributional assumptions for h^i. Column (4) and Panel C utilize a uniform distribution, and Column (5) and Panel D use a normal distribution centered at the median of each time group. Column (6) and Panel E employ a randomly chosen arbitrary distribution, which is shown in Figure A1(c). Given that most of the losses resulting from schedule changes are due to the reduced number of scheduled trains and not due to reallocations, the implications regarding consumer welfare remain consistent with the findings from the main specification. They are robust across the assumptions regarding the distribution of h^i.

[41] In other words, $J_{mt}^{B_g} = \{j \in J_{mt} \mid a_{jmt} \in B_g\}$.

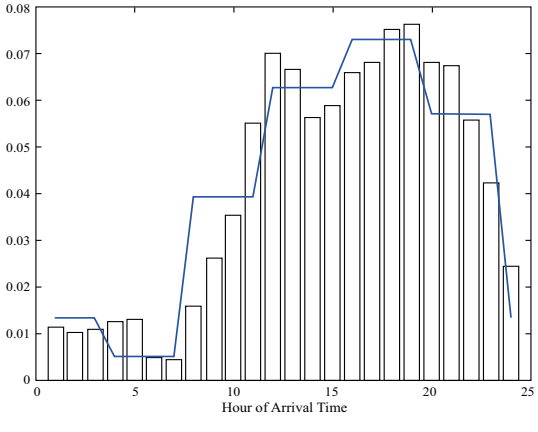
[42] When a uniform distribution is assumed for the distribution within the time group, $Prob\left(h^i = \tau \mid h^i \in B_g\right) = 1/(length\ of\ B_g)$.



a. HOURLY RIDERSHIP AND DISTRIBUTION WITH SIX TIME GROUPS AND A UNIFORM DISTRIBUTION



b. HOURLY RIDERSHIP AND DISTRIBUTION WITH FOUR TIME GROUPS AND A UNIFORM DISTRIBUTION



c. HOURLY RIDERSHIP AND DISTRIBUTION WITH FOUR TIME GROUPS AND A GAUSSIAN, ARBITRARY DISTRIBUTION

FIGURE A1. HOURLY RIDERSHIP AND AN ALTERNATIVE DISTRIBUTION OF TRAVELERS' PREFERRED TIMES

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How Competitive and Stable is the Commercial Banking Industry in China after Bank Reforms?

By KANG H. PARK*

This paper examines market concentration and its effect on competition in the Chinese commercial banking market. This study also investigates how changes in competition have affected the financial stability of Chinese commercial banks. To test the competitive conditions, we obtained the H statistic of the Panzar-Rosse model from a revenue function equation. The degree of financial stability is estimated by the Z-score formula. The Chinese banking industry has become an increasingly less concentrated market with an increased number of banks. Along with a decreased market concentration, competition in the Chinese banking industry has improved moderately. However, its market structure is still far from a competitive market. An individual bank's ability to earn higher markup or charge a higher net interest margin contributes to its financial soundness, although a higher degree of market concentration may have negative effect on the financial stability of the entire banking system.

Key Word: Market concentration, Bank competition, Panzar-Rosse model, Bank stability, Chinese banks
JEL Code: G21, L10

I. Introduction

The last three decades have witnessed a surge in bank mergers. Although firm mergers have occurred for a long time, the mergers during the past twenty years, known collectively as the "fifth merger wave," have been the most remarkable. The banking industry did not escape the merger wave. Banking industries all over the world have experienced a fundamental change in their market structure through rapid consolidation. Financial deregulation and financial

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globalization triggered fierce competition among banks and necessitated consolidation to reduce risk through business diversification and to take advantage of economies of scale.

The Chinese banking system has undergone a different path of structural change, transforming from a mono-bank system to a "several-tiered" banking system over the last 30-plus years. Several measures of financial liberalization and restructuring have been established to improve competitiveness in the commercial banking industry since the 1990s. There have been many bank foreclosures, takeovers and mergers in China, as in many other countries. However, the number of new banks appearing in the Chinese banking market has far exceeded the number of banks which have disappeared.

Until 1978, there was one single bank, the People's Bank of China. Then, as part of its economic reforms, the Chinese government authorized four state-owned commercial banks between 1979 and 1984, with limited competition among them. Since then the Chinese government has allowed many joint-equity banks and private banks in order to mobilize the financial resources needed for economic development. Furthermore, it authorized several policy banks and local (or city) banks as well as joint-equity banks in the 1990s as a measure of financial liberalization in preparation for entry into the World Trade Organization. All of these developments have contributed to a continuous decrease in the degree of market concentration of the Chinese banking industry. It may be worthwhile to examine whether and how much the decreased market concentration in the Chinese banking industry has improved the competitiveness of the banking sector in China.

The purpose of this paper is empirically to investigate whether changes in the concentration of Chinese banks affected the competition and stability of the Chinese commercial banking market for the period of 1992-2008. The degree of competition is estimated by the H statistic of the Panzar-Rosse model, while financial stability is estimated by the Z score formula. This paper is organized as follows. The next section describes developments in the Chinese commercial banking market and analyzes the market concentration trends in the Chinese banking industry. This is followed by a section which reviews the literature on bank competition and financial stability. Section IV discusses the methodology used to assess the degree of competition in the empirical analysis. Section V describes the data and interprets the estimates of the model. Section 6 investigates the relationship between competition and financial stability. The last section provides a summary and conclusion.

II. Developments in the Chinese Banking Industry and Changes in Bank Concentration

Before Deng Xiao Ping's 1978 reforms, China had a single bank, the People's Bank of China, playing both the role of a central bank and those associated with commercial banking, in order to channel funds in accordance with the state plan. With the reforms, four specialized state banks were derived from the People's Bank of China between 1979 and 1984 to form a two-tier banking system in China, leaving the People's Bank of China (PBC) solely functioning as China's central

bank. The four state commercial banks which split from the People's Bank of China are the Bank of China (BOC), the Construction Bank of China (CBC), the Industrial and Commerce Bank of China (ICBC) and the Agricultural Bank of China (ABC). The intention of the creation of these specialized banks was to provide banking services to specific sectors of the economy. For example, the BOC is to specialize in foreign-exchange transactions and trade finance, the CBC is to specialize in medium- to long-term credit for long-term infrastructure projects and urban housing development, the ICBC acts as the major supplier of funds to China's urban areas and manufacturing sector, and the ABC is to specialize in providing financing to China's agricultural sector while also offering wholesale and retail banking services to farmers.

Despite the fact that restrictions on these specialized banks to do business in only their designated areas were removed in 1985, competition among them remained very limited until the mid-1990s. There was a boost to competition when the Chinese government authorized the establishment of three policy banks. These three banks are the China Development Bank (CDB), the Export Import Bank of China (EIBC), and the Agricultural and Development Bank of China (ADBC). The CDB was chartered to provide long-term lending to finance construction projects for infrastructure and leading industries. The EIBC was established to provide loans for the exports and imports of capital goods. The ADBC provides agricultural lending.

To enhance competition in the Chinese commercial banking market, the Chinese government launched a second round of bank reforms in the 1990s. A variety of new bank types were created, including joint-equity banks, local (or city) banks, and foreign banks. This time, 14 joint-equity banks were established, where shares were held by the government, cooperatives and the private sector. These banks are the Bank of Communication, China Merchants Bank, Shenzhen Development Bank, Guangdong Development Bank, Pudong Development Bank, China Everbright Bank, China Minsheng Banking Corporation, Hua Xia Bank, Fuijin Industrial Bank, Hainan Development Bank, China Investment Bank, Yantai Housing Saving Bank and Bengbu Housing Saving Bank. During the mid-1990s, the central government allowed local governments to establish local (or city) banks. The number of banks continuously increased each year. China, with four state-owned commercial megabanks, now runs four of the world's five largest banks as a consequence of the reduced market value of U.S. and other western banks due to the global financial crisis of 2007-2008.

Among the bank reforms in China, the most noteworthy is the joint-equity reform of the four large state-owned banks owing to its impact on the overall economy. A special treasury bond which amounted to US$32.61 billion was issued in 1998 to strengthen the capital requirements of the four banks, raising their equity ratio to 8%. Four asset management corporations were established to purchase the non-performing loans from the four banks, resulting in a reduction of their non-performing loan ratio by 10%. These four banks took measures to improve their operational efficiency by eliminating more than 55,000 branches and laying nearly 363,000 employees off. Over 2003-2005, the BOC, CBC and ICBC received capital injections from the Chinese government in an amount of $62 billion.

Along with the bank reforms, the Chinese government gradually introduced

market-determined interest rates guided by the central bank rate, and the central bank implemented the liberalization of interest rates. The gradual liberalization of interest rates took place in steps: liberalizing the foreign currency interest rate prior to the domestic currency interest rate, liberalizing the lending rate prior to the deposit rate, and liberalizing the large and long-term fund rates prior to the small and short-term fund rates. This type of the gradual interest rate deregulation provided incentives for banks to strengthen their asset and liability management practices and to earn more profits. A nationwide unified inter-bank market had been created by the end of the 1990s, and both the inter-bank lending rate and the inter-bank bond market rate had been liberalized, thus offering financial institutions more of an incentive to adjust the composition of their assets by reducing their excess reserves while increasing the amount of bonds they held as assets. Banks were also given more autonomy to improve their competitiveness by trading in stock markets and making foreign equity investments.

China's joining the WTO had a major impact on the operation of foreign banks in China and on their involvement in the ownership and management of domestic banks. According to China's commitment to the WTO, all restrictions imposed on the ownership and operation of foreign banks, including restrictions on licenses and the number of branches, had to be removed by 2006. Furthermore, foreign banks became entitled to treatment equal to that of Chinese domestic banks, and the Chinese government allowed foreign banks to own up to 25% of domestic banks. By 2008, foreign banks had equity investments in three state-owned commercial banks, nine joint-equity banks and many local (or city) banks.

There are a number of ways to measure the degree of market concentration. The most widely used index is the Herfindahl-Hirschman Index (HHI). This index is applied by the US Department of Justice in its effort to implement its antitrust policies. Another straightforward method is to calculate the share of the industry's output or assets that is owned by a few dominant firms. This top-k firm concentration ratio (CRk) is used by some governments to determine the degree of anti-competition of a proposed merger. Figure 1 presents the HHI and CR4 of the total assets of China. We obtained the HHI and CR4 of three variables, that is, total assets, total loans and total deposits, finding that the correlation coefficients of the HHI and CR4 among the three variables all exceed 0.99. Therefore, only the HHI and CR4 of total assets are shown in Figure 1.

The higher the CR4 and HHI, the more concentrated the market is. Both the CR4 and HHI show a moderately decreasing trend over time; CR4 decreased from 94% in 1992 to 61% in 2008, while the HHI decreased from 2743 in 1992 to 1642 in 2008. This clearly indicates that the market concentration of the Chinese banking market continually decreased for the period of 1992-2008. This change is mostly attributable to changes in banking policies made by the Chinese government, which allowed the establishment of more banks and promoted competition among them. In spite of several mergers of banks in recent years, the number of new banks created far exceeded the number of banks undergoing foreclosure and a merger. The Chinese banking industry, even with the gradual decrease in its market concentration, is still a highly concentrated market compared to those in other countries. Figure 2 shows the HHI of domestic deposits among a few selected countries. China is not included in this sample, but China would be at the high end

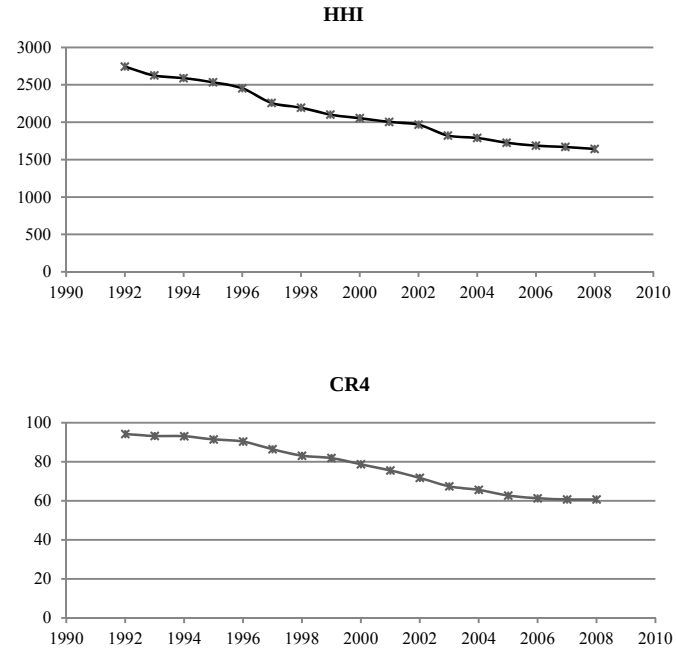

FIGURE 1

Source: 1) HHI is the Herfindahl-Hirschman index and CR_4 is the concentration ratio as measured by the market share of the largest four banks. 2) Total assets are used to calculate CR_4 and HHI. Total assets include assets in both banking accounts and trust accounts.

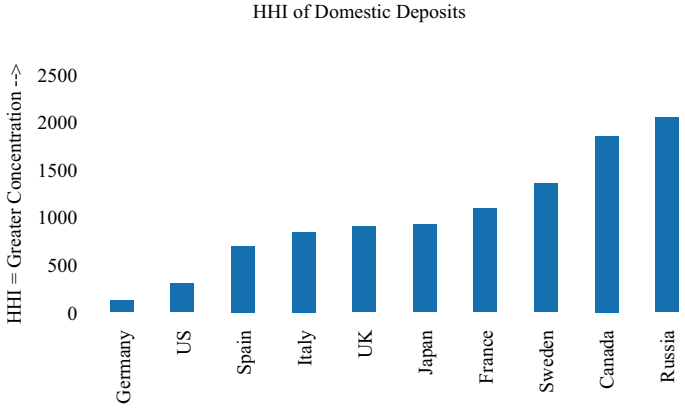

FIGURE 2

Source: Celent analysis, annual report, central banks

of this range, along with Russia and Canada, while Germany and the US are at the low end of the range.

III. Survey of the Literature

In this section, theoretical models and empirical findings pertaining to bank competition are briefly reviewed. Although many studies have been conducted in an effort to investigate the effect of bank consolidation on competition, there is little consensus on an appropriate theoretical framework, and the empirical findings are inconclusive. Gilbert (1984) provides a comprehensive survey of earlier studies and Berger and Humphrey (1992) do so for later studies. The concern about the effect of consolidation on competition arises from the structure-conduct-performance (SCP) paradigm, which dates back to Mason (1939). The SCP model suggests that increasing market concentration leads to less competitive conduct in terms of higher prices and less output and results in higher profits at the expense of lower consumer welfare. This paradigm is the basis of what is termed the "collusion" hypothesis.

Although there is a theoretical basis for these linkages, other equilibrium conditions can lead to different relationships between market concentration and conduct. As long as there are no sunk costs and hit-and-run entry is possible, then market contestability can yield competitive pricing regardless of the number of firms (Baumol *et al.* 1982). The efficient structure hypothesis advances that efficient banks obtain higher profitability and a greater market share due to their efficiency, which will lead to a more concentrated market. Therefore, the association between structure and performance may be spurious unless efficiency is controlled for in the model (Smirlock 1985). Adverse borrower selection may result in spurious empirical SCP linkages as well (Shaffer 2002).

Empirical results on the SCP paradigm are mixed. According to Gilbert (1984), many studies presented a mixed set of results in the aggregate and tended to display various methodological flaws. Weiss (1989) reported that only 21 out of 47 studies support the SCP model. More recent studies find that bank profitability is unrelated or even inversely related to concentration when controlling for efficiency and market share (Berger 1995). Conversely, collusive actions can be found even in non-concentrated markets (Calem and Carlino 1991; Shaffer 1999).

Two empirical methods have been developed to address the shortcomings of the SCP model by testing the conduct directly, without regard to the industry structure. The first of these is the Bresnahan (1982) and Lau (1982) model (B-L model), which estimates the price markup over the marginal cost as a measure of market power. Thus, this method is also termed the markup test. This model is based on two structural equations, an inverse demand equation and a supply equation derived from the first-order condition of profit maximization. The following studies apply the B-L model empirically. Shaffer (1989) rejects the collusive conduct hypothesis with a sample of US banks, and Shaffer (1993) finds that Canadian banks were competitive for the period 1965-1989, even with a relatively concentrated market. Berg and Kim (1994) show that Cournot behavior is rejected in the Norwegian banking system. Fuentes and Sartre (1998) find that bank consolidation in Spain did not weaken the competition level. Gruben and McComb (2003) find regarding Mexican banks before 1995 that marginal prices were set below marginal costs and conclude that the Mexican market is super-competitive.

Another means of overcoming the shortcomings of the SCP model is to use the

Panzar-Rosse (1977) model (P-R model). This model measures the extent to which a change in a vector of input prices is reflected in the gross revenue. Thus, the method is also called the revenue test. If the market is perfectly competitive, the change will then be fully reflected in the revenue. Shaffer (2004) compares and contrasts both methods in detail and discusses their advantages and disadvantages. Numerous studies apply the P-R model empirically, beginning with Shaffer (1983), who finds monopolistic competition with a sample of New York banks in 1979. Nathan and Neave (1989) reject the hypothesis of the monopoly power of Canadian banks. Country-specific empirical studies include Vesala (1995) for Finland, Molyneux *et al.* (1996) for Japan, Coccorese (1998) for Italy, Hondroyiannis (1999) for Greece, and Hempell (2002) for Germany. Molyneux *et al.* (1994) and Bikker and Groeneveld (2000) find monopolistic competition in several European countries. On the other hand, De Bandt and Davis (2000) find monopolistic competition for large banks and monopolies for small banks in Germany and France. Bikker and Haaf (2002) find that the banking industries in 23 OECD countries for the period 1998-1999 are generally characterized by monopolistic competition, with the exception of Australia and Greece. Gelos and Roldos (2002) compare eight European and Latin American countries and find that the bank consolidation process in its early stage does not lower competition.

Molyneux *et al.* (1996) find that the Japanese banking market was under monopoly or conjectural variations of a short-run oligopoly in 1986, though the situation had improved with regard to the level of monopolistic competition by 1988. Uchida and Tsutsui (2005), from long-term Japanese panel data from 1974 to 2000, conclude that market competition improved during the 1970s and 1980s but has worsened since 1997. There are many studies on the efficiency and profitability of Korean banks, including that by Park and Weber (2006a, 2006b). However, very few researchers have studied competition with regard to Korean banks. Lee and Nagano (2008) report that market concentration brought about by bank mergers does not necessarily result in low competition in Japan and Korea. Park (2009) concludes that the Korean banking industry is monopolistically competitive, except during the Asian financial crisis period, from panel data of 1992-2004. Studies of bank competition in China are scant and mostly descriptive rather than analytical. Wong and Wong (2001) describe the trends of bank concentration ratios during the 90s, and Yuan (2006) examines the state of Chinese banking competition for 1996-2000. The present study applies the P-R model to the data of the Chinese banks.

Regarding the relationship between competition and financial stability, there are two opposing schools of thoughts. The competition-fragility school argues that competition drives banks to undertake more risk, while larger banks in concentrated banking systems can reduce their financial fragility by providing more robust capital buffers (Allen and Gale 2004; Boyd *et al.* 2006). The opposing school, believing in the competition-stability linkage, argues that competition leads to more stability. More credit rationing, more competitive lower loan rates and less managerial inefficiency in a less concentrated banking system reduce risk-taking behavior and decrease the probability of bank failure, though banks with more power may engage in more risk-taking behavior (Boyd and DeNicoló 2005; Beck *et al.* 2010; Turk-Ariss 2010). This study will test these opposing models with Chinese bank data.

IV. Model

The P-R model is used to assess the competitive nature of the Chinese banking industry because this model is robust to the extent that market- and bank-level data are available. Let a bank's revenue function be $R = R\ (x, y_1)$, where x is a vector of products and y_1 is a vector of exogenous variables shifting the revenue function, and let a bank's cost function be $C = C\ (x, w, y_2)$, where w is a vector of input prices and y_2 is a vector of exogenous variables shifting the cost function. y_1 and y_2 may have common variables.

Profit maximization by the bank requires that marginal revenue is equal to marginal cost, as $R'(x, y_1) = C'(x, w, y_2)$. Panzar and Rosse (1987) calculate the sum of the elasticities of revenue with respect to input prices from the reduced-form revenue equation and define it as the H-statistic.

$$H = \Sigma\left(\partial R / \partial w_i\right)\left(w_i / R\right) \tag{1}$$

Here, w_i is the i^{th} input price. Panzar and Rosse show from the profit maximization condition that the H-statistic is equal to unity (H=1) in a perfectly competitive market and is less than or equal to zero ($H \leq 0$) under a monopoly. Although the Panzar-Rosse article also shows that $0 < H < 1$ could be consistent with oligopolistic behavior, it is common to regard $0 < H < 1$ as a condition of Chamberlinian monopolistic competition. This interpretation is valid under the assumption that the observations are in long-run equilibrium (Nathan and Neave 1989).

Following Park (2009), we specify the reduced-form revenue equation of a bank as follows,

$$ln\left(R_{it}\right) = \alpha + \beta_1\ ln\left(w_{1,it}\right) + \beta_2\ ln\left(w_{2,it}\right) + \beta_3\ ln\left(w_{3,it}\right) + \gamma_k \Sigma z_k + \varepsilon_{it}, \tag{2}$$

where R_{it} is bank i's revenue at time t, w_1 is the input price of labor, w_2 is the input price of capital, w_3 is the input price of funds, and z_k is a vector of control variables affecting the bank's revenue function. The H-statistic is the sum of β_1, β_2 and β_3. In order to eliminate the manual calculation of $\beta_1 + \beta_2 + \beta_3$ and its standard error, equation (2) can be rearranged as follows.

$$\begin{aligned} ln\left(R_{it}\right) = \alpha &+ \beta_1\left[ln\left(w_{1,it}\right) - ln\left(w_{3,it}\right)\right] + \beta_2\left[ln\left(w_{2,it}\right) - ln\left(w_{3,it}\right)\right] \\ &+ \left(\beta_1 + \beta_2 + \beta_3\right) ln\left(w_{3,it}\right) + \gamma_k \Sigma z_k + \varepsilon_{it} \end{aligned} \tag{3}$$

The H-statistic is estimated by the coefficient of $ln(w_{3,it})$, and its standard error is used to test the significance of this estimate.

The P-R model is constructed under the assumption that the market is in equilibrium. Consequently, following Panzar and Rosse (1977, 1987), Shaffer (1983), Molyneux *et al.* (1996), Claessens and Laeven (2004), and Park (2009), equation (4) is used to test the equilibrium conditions.

$$(4) \qquad ln\left(ROA_{it}\right) = \alpha + \beta_1\ ln\left(w_{1,it}\right) + \beta_2\ ln\left(w_{2,it}\right) + \beta_3\ ln\left(w_{3,it}\right) + \gamma_k\ \Sigma\ z_k + \varepsilon_{it}$$

In equilibrium, rates of return on assets should not be statistically correlated with factor prices (H=0), particularly if the market is perfectly competitive. On the other hand, if the market is in disequilibrium, an increase in factor prices would result in a temporary decline in the rates of return (H<0).

V. Empirical Analysis

Revenue (R_{it}) is typically measured as interest revenue or with its ratio to total assets, presuming that the main function of banks is financial intermediation. However, with the weakening of financial intermediation in recent years and the diversification of bank assets, total revenue or its ratio to total assets is used in some studies. We use both interest revenue (*IR*) and total revenue (*TR*) in this study. ROA is the ratio of net after-tax income to total assets in percentage. The unit labor cost ($w_{1,it}$) is measured by the ratio of personnel expenses to the number of employees, the unit capital cost ($w_{2,it}$) is measured by the ratio of the depreciation allowance and other maintenance costs to the total fixed assets, and the unit funding cost ($w_{3,it}$) is measured by the ratio of interest expenses to the sum of total deposits and borrowings. As personnel expenses are not available in more detail, it is not possible to have differing levels of human capital.

Several control variables are included in the model. Total assets (*ASSET*) are included to observe the size effect and the number of branches (*BRANCH*) is included to account for the effect of the bank network. The ratio of non-performing loans to total loans (*NPL*) is included to control for the credit risk effect. The equity ratio (*EQUITY*) is alternatively used as a control variable for credit market and operational risk. The ratio of non-interest revenue to total revenue (*NINT*) is included to reflect the effect of changing financial intermediation or diversification. The variable BRANCH, representing the bank network, was eventually deleted from the regression estimation due to its high correlation with ASSET. Bikker *et al.* (2006) state that the inclusion of a scale explanatory variable such as ASSET in the Panzar-Rosse model may lead to an overestimation of the level of competition and may distort the tests of monopoly and perfect competition. Therefore, we estimate competitive conditions in both ways, with and without the scale explanatory variable ASSET. However, the H values, regardless of the inclusion or exclusion of ASSET in the model, show similar test results with no indication that the inclusion of a scale explanatory variable causes an overestimation of the level of competition. Thus, in the sections below, we only report the estimation results with the inclusion of ASSET in the model. The fixed-effects model is used for the estimation to reflect bank-specific characteristics and to control for heterogeneity among the banks.

Data used for China are from Bank Scope, the Almanac of Chinese Banking and Finance, and from China Financial Yearbooks. Although China has many banks, only 15 major banks are included in the sample because data availability is limited. A similar sample size is used in Yuan (2006). This limitation of the data tends to

overstate the degree of market concentration. However, any overstatement of HHI would be of a small magnitude, as these 15 banks account for most of the total bank deposits in China, more than 90% in the earlier period and more than 80% in the later period. Furthermore, an overstatement of HHI has no effect on the H statistic, a measure of competition, which is our main concern here. The fifteen Chinese banks are the Bank of China, the China Construction Bank, the Industrial and Commercial Bank of China, the Agricultural Bank of China, the Agricultural Development Bank of China (ADBC), China Development Bank (CDB), the Bank of Communications, China CITIC Bank, China Everbright Bank, China Minsheng Bank, Guangdong Development Bank, Shenzhen Development Bank, China Merchants Bank, Shanghai Pudong Development Bank and Industrial Bank.

A. *Equilibrium Condition Test*

As the P-R model is constructed on the assumption of market equilibrium, the equilibrium condition test is done before the competition condition test. The second column in Table 1 gives the estimation results of equation (4) with the dependent variable, lnROA, for the full sample period. Because the rate of return on assets of some banks can be negative, the dependent variable is actually computed as ln (1+ROA), where ROA is the ratio of net after-tax income to total assets. Several troubled Chinese state and joint-equity banks in their earlier years had negative rates of return on assets. Adding 1 to the ROA before taking the logarithm is arbitrary, but it is a common method used to handle non-positive numbers in logarithmic transformations. Bos and Koetter (2006) point out that adding 1 affects the composition of total error but does not affect the coefficient estimates, which are our main concern.

TABLE 1—TEST OF EQUILIBRIUM CONDITION:
ESTIMATION RESULTS OF EQUATION (4) DEPENDENT VARIABLE: LNROA

	Full Sample Period	Pre-2000 Period	Post-2000 Period
$\ln W_1$	-0.009	0.014	0.002*
	(0.243)	(0.157)	(0.081)
$\ln W_2$	0.007	0.005	0.004
	(0.296)	(0.375)	(0.204)
$\ln W_3$	-0.058**	-0.041	0.008**
	(0.032)	(0.162)	(0.026)
lnASSET	0.022*	0.043**	0.014*
	(0.063)	(0.028)	(0.059)
NINT	0.004	0.002	0.007
	(0.457)	(0.597)	(0.287)
NPL	-0.012**	-0.006	-0.025**
	(0.046)	(0.147)	(0.019)
EQUITY	0.002	0.001	0.005
	(0.186)	(0.285)	(0.139)
ADJ. R^2	0.378	0.342	0.489
Wald test: H=0	5.712**	2.431	1.937
(ρ-value)	(0.017)	(0.121)	(0.194)
Eq. vs. Diseq.	Disequilibrium	Equilibrium	Equilibrium

Source: 1) Estimation results of the fixed-effects model. 2) The coefficients of the constant under the fixed-effects model are not reported here because there are as many as the number of banks. 3) ρ values are shown in parentheses. * and ** indicate significance at the 10% and 5% levels, respectively.

The hypothesis that the market is in equilibrium, that is, H = 0, is rejected for the full sample period at the 2% level of significance. The continuous influx of banks over time and the rapid changes in the structure of the Chinese commercial banking industry may have resulted in a disequilibrium condition. Shaffer (2004) stated that this restriction of the equilibrium condition, that is, H = 0, is necessary only for a case of perfect competition, whereas it is not necessarily required for a case of monopolistic competition. The finding of a disequilibrium condition is not a critical issue, as this paper does not claim that the commercial banking industry in China is perfectly competitive. However, the cause of and solution for the disequilibrium condition are investigated further below.

The Chinese government has introduced many reforms in its financial sectors since year 2000 in an effort to join the WTO (World Trade Organization) and China finally succeeded in joining WTO in December of 2001. Due to several bank reforms and major restructuring in the financial sector during this period, there exist different bank competitive conditions between the pre-2000 period and the post-2000 period. The Chow breakpoint test is used to determine whether there is no significant difference in the estimated equation (4) between the two sub-sample periods, that is, the pre-2000 period and the post-2000 period. The null hypothesis of no structural change is rejected with an F-statistic of 21.38 for the Chow breakpoint test. Therefore, equation (4) is re-estimated for each sub-sample period and its results are reported in the third and fourth columns of Table 1. The hypothesis that the market is in equilibrium, i.e., H = 0, cannot be rejected for each sub-sample period.

B. *Competition Condition Test*

Table 2 presents the estimation results of equation (2) with the dependent variables of lnIR and lnTR along with the H-statistic, which is sum of β_1, β_2 and β_3. According to the Wald test, which is a test for a competition condition, the hypothesis of a monopolistic market structure (H=0) and the hypothesis of a perfectly competitive market structure (H=1) are rejected at the 1% level. We re-estimate equation (2) for each sub-sample period. For the pre-2000 period, the hypothesis of H=1 is rejected, but the hypothesis of H=0 cannot be rejected at the 1% level. For the post-2000 period, both H=0 and H=1 are rejected at the 1% level. These results indicate that there has been a dramatic change in the competition level of the Chinese banking industry over time.

The values of the H statistic for the Chinese banking industry with the full sample are very small regardless of which revenue (lnIR or lnTR) is used as a dependent variable. This result indicates that the Chinese banking market is still far from being a competitive market. It is rather characterized as having an oligopolistic market structure in the earlier period and a monopolistic market structure in the later period. Relatively high adjusted R^2 values indicate the goodness of fit for all of the regressions in Table 2. All coefficients of the input costs, that is, the unit labor cost ($w_{1,it}$), the unit capital cost ($w_{2,it}$) and the unit funding cost ($w_{3,it}$), have positive signs, as expected. However, their coefficient size is small and some coefficients are not statistically significant.

TABLE 2—TEST OF COMPETITION CONDITION: ESTIMATION RESULTS OF EQUATION (2)

	Sample Period		Pre-2000 Period		Post-2000 Period	
	lnIR	lnTR	lnIR	lnTR	lnIR	lnTR
lnW_1	0.116**	0.131**	0.108**	0.112**	0.219**	0.204**
	(0.021)	(0.034)	(0.027)	(0.041)	(0.018)	(0.022)
lnW_2	0.023	0.035	0.029	0.022	0.036*	0.069
	(0.132)	(0.142)	(0.153)	(0.126)	(0.071)	(0.113)
lnW_3	0.078**	0.081**	0.064**	0.072*	0.097**	0.109**
	(0.033)	(0.028)	(0.042)	(0.058)	(0.018)	(0.019)
lnASSET	1.066***	1.009***	1.253***	1.357***	0.938***	0.825***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
NINT	-0.027	0.094	-0.012	0.062	-0.049	0.109
	(0.193)	(0.176)	(0.139)	(0.155)	(0.261)	(0.229)
NPL	-0.004***	-0.006***	-0.002***	-0.004***	-0.005***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
EQUITY	0.013	0.014	0.009	0.008	0.019	0.021
	(0.127)	(0.116)	(0.139)	(0.124)	(0.143)	(0.119)
ADJ. R^2	0.592	0.623	0.504	0.572	0.721	0.698
H statistic	0.233***	0.245***	0.199***	0.208***	0.369***	0.385***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Wald test: H=0,	23.92***	29.32***	3.22*	3.57*	35.33***	39.17***
ρ-value	(0.000)	(0.000)	(0.071)	(0.062)	(0.000)	(0.000)
Wald test: H=1	512.93***	575.62***	714.73***	693.09***	447.28***	419.26***
ρ-value	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Source: 1) lnIR is the natural logarithm of interest revenue while lnTR is the natural logarithm of total revenue. 2) The coefficients of the constant under the fixed-effects model are not reported here because there are as many as the number of banks. 3) ρ values are shown in parentheses. *, ** and *** indicate significance at the 10%, 5% and 1% levels, respectively. 4) H statistic and its ρ value are obtained by estimating Equation 3.

The significant and positive sign of ASSET indicates the strong presence of a size effect. NINT (the ratio of non-interest revenue to total revenue) has no significant effect on either interest revenue or total revenue. The dominant source of Chinese banks' revenue is still interest revenue, indicating no sign of weakening of the financial intermediary function of banks in China, in contrast to the trend of the weakening financial intermediary function of banks in Japan and Korea. Only recently have certain Chinese banks expanded their business into non-loan-related activities. While NPL has a significant negative effect on lnIR or lnTR, as expected, equity ratio does not have a significant positive effect on them. According to the signal theory (Berger 1995), banks that expect to have better performance in terms of profitability credibly transmit this information through a higher equity ratio. There appears to be no strong signaling effect of the equity ratio on profitability in China. In other words, higher profit probability of Chinese banks has not been signaled through a higher equity ratio.

C. *Trend of the H Value over Time*

To determine how the values of the H static changed over time, this statistic is estimated for moving three-year time periods, that is, 1992-1994, 1993-1995, 1994-1996 and so on. The estimation results of the H statistic are reported together with HHI in Table 3.

Market concentration as measured by HHI declined continuously from 2743 in

TABLE 3—MARKET CONCENTRATION AND COMPETITION LEVEL OVER TIME

Year	HHI - Total Assets	H-statistic with lnIR	H-statistic with lnTR
1992-1994	2652	0.136	0.149
1993-1995	2583	0.164	0.174
1994-1996	2525	0.182	0.192
1995-1997	2415	0.207	0.228
1996-1998	2301	0.215	0.247
1997-1999	2184	0.233	0.269
1998-2000	2116	0.259	0.278
1999-2001	2053	0.271	0.299
2000-2002	2008	0.298	0.321
2001-2003	1931	0.302	0.343
2002-2004	1859	0.342	0.338
2003-2005	1779	0.365	0.376
2004-2006	1734	0.389	0.402
2005-2007	1694	0.405	0.427
2006-2008	1666	0.426	0.449

1992 to 1642 in 2008. The H statistic with both lnIR and lnTR increased gradually over the same time period, from less than .15 in the earlier period to more than .4 in the later period. Hence, these two variables exhibit a high negative correlation. The correlation coefficient between HHI and the H statistic with lnIR is -0.974, while the correlation coefficient between HHI and the H statistic with lnTR is -0.976. The decrease in the market concentration of the Chinese banking sector unquestionably contributed to an improvement in the banking competition level in China, although the effect may be mild.

D. *Comparison between Korea and China*

Contrary to the increasing trend of market concentration in the Korean banking industry, the Chinese banking system has experienced a continually decreasing market concentration. According to Park (2009), the Korean banking industry experienced an increase in the HHI of assets from 876 in 1992 to 1325 in 2004. This study finds that the HHI of assets in China decreased from 2743 in 1994 to 1642 in 2008. Bank merger activities and the creation of a few megabanks in Korea contributed to the increasing trend of banking market concentration. On the other hand, the financial liberalization policy of the Chinese government has increased the creation of new banks year after year, contributing to the decreasing trend of banking market concentration.

The H-statistic sheds light on the differences in the market structures between Korea and China. Park (2009), in his study on Korean banking, reports that the H-statistic value for either interest revenue or total revenue ranges from .511 to .659 during the stable period, which excludes the Asian financial crisis period. This indicates that the Korean banking market is monopolistically competitive. On the other hand, this study finds that the H-statistic value for either interest revenue or total revenue ranges from .211 to .385, implying a market structure closer to an oligopoly in the Chinese commercial banking market.

VI. Effect on Financial Stability

In this section, we investigate how bank competition affects the financial stability of Chinese banks. While competition among banks influences bank stability, bank competition may also be affected by the degree of financial stability, as banks may utilize a different competition strategy depending on the stability condition, causing the endogeneity problem of competition variables. Following Boyd *et al.* (2006) and Beck *et al.* (2010), we deployed lagged variables of the explanatory variables in the following estimation equation to address this endogeneity problem.

$$Z_{it} = \alpha + \beta_k \ \Sigma \ C_{k,i\ t-1} + \gamma_k \ \Sigma \ X_{k,i\ t-1} + \delta_k \ \Sigma \ Y_{k,t-1} + \varepsilon_{it} \tag{5}$$

In this equation, Z_{it} represents the Z score of bank i at time t; $C_{k,i\ t-1}$ are variables indicating the competitiveness of bank i at time $t-1$, such as the net interest margin and the Lerner index; $X_{k,i\ t-1}$ are bank-specific variables of bank i at time $t-1$, such as the equity ratio, the share of non-performing loans and the number of branches; and $Y_{k,t-1}$ are macroeconomic variables such as the economic growth rate, the inflation rate at time $t-1$ and two dummy variables, one representing the crisis period and another representing the post-2000 period. The Z score is calculated as the sum of a bank's asset returns and the capital-to-assets ratio divided by the standard deviation of asset returns. Therefore, the Z score can be interpreted as the number of standard deviations that a bank's return on assets has to drop below its expected value before equity is depleted and the bank becomes insolvent. A higher Z score indicates that a bank is more stable and thus has less probability of failing.

We use two variables, the Lerner index and the net interest margin, as our measure of bank competition, with HHI as a measure of market concentration. While the H statistic shows the degree of competition for the entire banking industry, it does not show individual banks' levels of competitiveness. Accordingly, the Leaner index and the net interest margin instead of the H statistic are used to determine how individual banks' competitiveness levels affect bank stability. The Lerner index, which measures the mark-up of prices over marginal costs, indicates the degree of market power. It is calculated as

$$L_{it} = \left(P_{it} - MC_{it} \right) / P_{it},$$

where P_{it} is the price of total assets of bank i at time t, measured by the ratio of total revenues to total assets; MC_{it} is the marginal cost of bank i at time t. Following Turk-Ariss (2010), the marginal cost of bank i at time t is calculated as follows,

$$MC = TC / Q\left[\alpha + \beta \ ln \ Q + \Sigma \varphi_k \ ln \ W_k + \delta \ T \right], \tag{6}$$

where TC denotes total expenses, Q is total assets, and W_k represents the three input prices of labor, fixed capital and funding. T (Trend) is used to capture technical

TABLE 4—ESTIMATION RESULTS OF EQUATION (5), DEPENDENT VARIABLE: LN Z SCORE

Category	Variable	Model 1	Model 2
Competition Variables	Lerner Index	1.031**	
		(0.001)	
	Net Interest Margin		0.121**
			(0.003)
Concentration Variable	HHI (Assets)	-0.238*	-0.306*
		(0.046)	(0.049)
Bank-Specific Variables	Loans/ Assets	-0.137*	-0.148*
		(0.046)	(0.038)
	ln Branch	0.264*	0.314*
		(0.037)	(0.032)
	NPL	-0.061**	-0.053**
		(0.007)	(0.008)
Macroeconomic Variables	GDP Growth Rate	0.069	0.125
		(0.144)	(0.123)
	Inflation Rate	-0.102	-0.088
		(0.197)	(0.156)
Dummy Variables	CRISIS	-0.057	-0.062
		(0.115)	(0.157)
	Post-2000	0.129*	0.152*
		(0.032)	(0.040)
Adj. R^2		0.842	0.827

Source: 1) Estimation results of fixed-effects model. The coefficients of the constant under the fixed-effects model are not reported here. 2) ρ values are shown in parentheses. * and ** indicate significance at the 5% and 1% levels, respectively.

changes in the cost function over time. Equation (6) is scaled by the unit labor cost (*ln W3*) to account for heteroscedasticity.

Table 4 reports the estimation results of equation (5) for Chinese commercial banks. All independent and control variables are lagged by one year. The Lerner index and the net interest margin are highly correlated such that they enter the regression model separately in model 1 and model 2. HHI is negatively related to financial soundness, while both the Lerner index and net interest margin have positive and significant effects on the Z score. Our interpretation of the results is that while the higher degree of market concentration may have a negative effect on the financial stability of the entire banking system, an individual bank's ability to earn higher markups or charge a higher net interest margin contributes to its financial soundness.

Among the bank-specific variables, the loan-to-asset ratio has a negative effect on the Z-score, whereas larger banks or banks with more branches tend to be financially more stable than smaller banks. The ratio of non-performing loans to total loans (NPL) is negatively and significantly linked to the degree of financial stability. None of the macroeconomic variables are statistically significant. The GDP growth rate has a positive effect, while the inflation rate has a negative effect on the Z score, though neither is statistically significant. A dummy variable, CRISIS, has a negative but insignificant effect on the Z-score, which indicates that Chinese banks were not affected as much by the Asian financial crisis of 1997-1998 as the banks of many other Asian countries. The second dummy variable, Post-2000, distinguishing the pre-2000 period and the post-2000 period, is positive and significant.

VII. Summary and Conclusion

Worldwide financial liberalization and financial globalization caused fierce competition among banks all over the world. This necessitated bank mergers and consolidation within a country and across countries to achieve scale efficiency so as to take advantage of diversification or simply to survive. The bank merger wave began in the U.S.A. and spread to Europe, Japan and Korea. However, this wave has not yet hit the Chinese banking market owing to its restricted financial openness and the stringent government regulations on banking. Bank mergers in China were typically initiated by the government rather than originating in the market.

In this study, we examined the effect of market concentration on bank competition in China. The competitive conditions of the Chinese banking industry have definitely improved over time. The Chinese banking system progressed from a one-bank system to a four-bank system of state banks in the 1980s, transforming to a system with more than 20 banks, including joint-equity commercial banks, in the 1990s to a system with several hundred banks at the present time. This study finds that in spite of a drastic decrease in market concentration of the Chinese banking industry, its competition conditions are far from those of a competitive market, as evidenced by the small H statistic values. It appears that bank reforms have a small effect on the competitiveness of Chinese commercial banking. The sheer number of banks does not guarantee a competitive market. Lowering entry barriers for private banks and foreign banks would further facilitate competition. Institutional changes and lifting government regulations on banking are also necessary to speed up competitive behaviors in the Chinese banking market.

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Student Academic Performance, Dropout Decisions and Loan Defaults: Evidence from the Government College Loan Program

By SUNG MIN HAN*

This paper examines the effect of the government college loan program in Korea on student academic performance, dropout decisions and loan defaults. While fairness in educational opportunities has been guaranteed to some degree through this program, which started in 2009, there has been a great deal of controversy over its effectiveness. Empirical findings suggest that recipients of general student loan (GSL) lower academic performance than those who received income contingent loan (ICL). Moreover, for students attending private universities, a higher number of loans received increased the probability of a dropout decision, and students from middle-income households had a higher probability of being overdue than students from low-income households. These findings indicate that expanding the ICL program within the allowance of the government budget is necessary. Furthermore, providing opportunities for students to find various jobs and introducing a rating system for defaulters are two necessary tasks.

Key Word: Government College Loan Program, Student Academic Performance, Dropout Decision, Loan Default
JEL Code: H52, I22, I23

I. Introduction

Most high school graduates intend to obtain a tertiary education, as the social environment of Korea does not make it easy for them to have stable lives without a university degree. They have trouble in finding a quality job without a university degree, indeed finding it difficult to land any job. Moreover, promotions are rare without a degree for those who already have a job. In short, a university degree has become an essential condition for living in Korea.

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It has become common for any high school student in Korea to consider going to university, and the progression rate of high school graduates going to university has reached a fairly high level compared to other countries. The average progression rate[1] to university in Korea was 71% in 2008, which was at that time 15% point higher than the average for all OECD countries. This high university progression rate of Korea is due to the social environment and changes in the education policy made by the Korean government.

First, high school graduates go on to university due to social pressure, considering a university degree to be essential. If students enter universities to develop themselves or to satisfy their academic curiosity, it would have a positive impact on both personal and national development.[2] However, we should not overlook the current situation, in which they decide to go to university not out of any initial desire but mostly due to the social environment and pressure. It was also thought that the non-pecuniary cost[3] is the critical factor determining the entry of students into the higher education market, considering also that the opportunity cost of not going to university will be high.

Other main causes of the higher university progression rate were changes in the education policy of the government. The government introduced the Government-Guaranteed Student Loan program in 2005, the General Student Loan program in 2009, the Income-Contingent Loan program in 2010, and government scholarships (offering tuition assistance depending on students' income levels) in 2012 to address the issue of students from low-income families not continuing on to higher education for financial reasons. If students from low-income households do not go to universities out of economic reasons, there would be no choice for them but to advance to the job market after graduating from high school. A student without sufficient expertise will have a difficult time finding a job and, even if he or she finds a job, will be more likely to have a low-quality job. This will create a vicious circle, trapping the person in poverty. For this reason, the government introduced a tuition aid program, a mixture of scholarships and student loans, in order to mitigate these students' problems so as to help those not otherwise able to receive a higher education. The program definitely helped students with financial need to undertake higher education, and it improved the fairness of opportunities in education. On the other hand, it also increased the university progression rate. Furthermore, we have observed side effects of the program; threats to government finances due to excessive government support and increases in payments overdue owing to financial difficulties in the repayment of the student loans.

This is reasonable considering the effort to solve a market failure of the type that can occur in a credit market, in which a program supports students with financial need to ensure the fairness of educational opportunities. However, considerable government funding is needed to run such a program. Therefore, rigorous discussions are necessary to determine if the student loan program started in 2005

[1]This is calculated according to the ratio of the number of high school graduates per year entering university that year to the number of high school graduates of the same year.

[2]The theory of economic development argues that educated people have higher productivity and that a country can achieve sustainable economic development through them. Other benefits of education are a decrease in both crime rates and unemployment rates, as well as an improvement in public health overall.

[3]The major portion of the non-pecuniary cost is the stigma effect, meaning that members of a society consider a person without a university diploma as an inferior human being.

has been efficiently operated. Moreover, it should be determined if the objectives of the program have been fully met. Fairness in educational opportunities not only refers to the possibility for students to receive a higher education but ensuring an environment that allows students to focus fully on their studies continually. The validity of the program is only ensured when it helps students while they are in school while also allowing them to enter university.

Numerous studies have evaluated the effectiveness of student loan programs. Most focused on the effects of student loan programs on the enrollment rate, academic performance, dropout rate, and graduation rate, particularly considering income levels. They found that the effects of student loans varied according to the income class of the students, and they emphasized the need for active support of students from the low-income classes. Specifically, they suggested that students from the low-income classes need scholarships or other types of financial aid (Kim *et al*. 2008a; Kim *et al.* 2009b).

There has been growing interest in the effects of loan programs on the enrollment rate. Students' ability is positively correlated with the university enrollment rate, which increases with income (Lochner *et al*. 2011). Kim *et al*. (2008b) also argue that students from the low-income class have a higher potential for longer enrollment durations due to economic reasons, and a higher percentage of them took out student loans. They claim that a financial aid program in accordance with income should be implemented. A strong correlation between household income and university enrollment was shown after analyzing the data in the late 1990s and early 2000s (Belley and Lochner 2007). Moreover, it was reported that a student loan program operating at private Mexican universities raises university enrollment by approximately 24% and that loan beneficiaries show higher academic performance by 3% than non-beneficiaries (Canton and Blom 2004; Rau *et al*. 2013). In contrast, Cameron and Heckman (1998) report after analyzing data in the 1980s in the United States that household income scarcely influences university enrollment when the effects of the students' home environments, AFQT scores, and degrees of unobservable heterogeneity are excluded.

Kim *et al*. (2009a) analyze the effects of scholarships and student loans on students' grades by income level using KEEP data (2005-2007). They report that scholarships are an effective means of improving students' grades for those in the medium-income classes. In addition, the effects of student loans on students' grades for students from the low-income class were significantly weaker than those from the upper-income classes.

In addition, much of the work on the impact of student loan programs has focused on dropout decisions. Stress from school life affects the dropout decisions of students from the low-income class more than credit constraints does. However, stress from school life is closely related to economic issues and, consequently, financial problems are associated with the dropout rate (Stinebrickner *et al*. 2007). Rau *et al*. (2013) analyze the State Guaranteed Loan (SGL) program of Chile using a sequential schooling decision model and report that the SGL program decreases the dropout rate. Furthermore, they show that it is especially effective in reducing the dropout rate of unskilled students from low-income families.

Graduation rates can vary according to students' income levels, and students

from top income quartile have a higher graduation rate by 40% than those from the bottom income quartile (Haveman and Wilson 2007). Students receiving financial aid finish their degrees more rapidly than students without support, but the study duration is not shortened with more financial support. However, there is a higher probability of successfully finishing a degree with more financial aid (Glocker 2011).

Studies of student labor market outcomes show that students with higher student loan amounts tend to find employment quicker with a greater potential of holding a low-wage job than students with lower student loan amounts (Kim *et al*. 2012). They report that these results indicate the possibility of worsening income inequality after they enter the labor market, considering that students with higher student loan amounts would financially be in a harsher condition. A beneficiary of the State Guaranteed Loan (SGL) program has a higher probability of holding a low-wage job in the labor market, which raises a question about the quality of education (Rau *et al*. 2013).

Previous domestic studies analyze how the student loan system affects the enrollment rate, student performance, continuity of academic study, and employment. However, there is a limitation when evaluating the effectiveness of widely employed government student loan programs, as analyses are not conducted according to the loan type. Moreover, research has not examined the factor of overdue payments; therefore, there is no evidence pertaining to the sustainability of the program. Although many in-depth analyses have evaluated various effects of student loan programs in other countries, it is challenging directly to apply these results to Korean loan programs due to the many differences among these student loan programs.

There are two channels through which a student loan program affects student academic performance. The majority of the student loan is to pay for tuition. In the absence of a student loan program, students likely will have to hold a part-time job. However, if students have access to a loan program, it allows them to spend more time studying instead of working. This can reduce the probability of them taking a leave of absence or dropping out of school. Furthermore, it may improve their GPA and let them graduate on time.

On the other hand, if a student has received a student loan and has decided to take a part-time job to pay for the loan (principal and/or interest), the student will have less time to study. However, if the student works as a teaching assistant or research assistant, it would be difficult to conclude that working always has negative effects on academic performance. A problematic situation is when a student is forced to work in a job unrelated to school because he or she needs money for living expenses. Working to pay an urgent debt can cause students to underperform in classrooms or to drop out of school owing to a lack of studying hours and due to the psychological and economic burden.[4] Therefore, it is important to analyze if student loans influence academic performance and dropout decisions as part of the effort to improve the program.

[4]Another negative effect of student loans occurs when recipients hold low-quality jobs and must pay the loan quickly, starting the job with existing debt (Kim et al. 2012). However, the ICL will lower the potential that students must take low-quality jobs as compared to the GSL given its use of a grace period until they are hired.

In addition, this study takes into account reductions of overdue payments by considering the characteristics of delinquent students, which is a factor threatening the sustainability of the program. The amount of student loans overdue increased from 304.6 billion won in 2010 to 504.4 billion won in 2012. Once the ICL type enters into repayment, the government financial burden will be worsened due to the increased unemployment under the currently harsh global economic conditions. This can directly affect the sustainability of the program. For this reason, an analysis of this issue will be important.

In conclusion, this study aims to evaluate the impacts of government college loan programs on students' academic performance levels and dropout decisions. Academic performance and dropout decisions are chosen as the elements to analyze because they are closely related to the learning environment.

The remainder of this study is organized as follows. Chapter II introduces the history of the government college loan programs, and a theoretical analysis based on the human capital model is presented in Chapter III. Chapter IV discusses the data and empirical strategy. Chapter V presents the empirical findings regarding the impact of the college loan programs. Chapter VI finally concludes this study and presents policy implications.

II. Background of the Government College Loan Programs in Korea

The Korean government instigated the GSL during the second semester of 2009 and the ICL during the first semester of 2010 to provide equal higher education opportunities regardless of income and to ensure that students could fully concentrate on studying. The main difference between these two programs is the repayment time. The ICL does not require repayment until students enter the labor market and have an adequate level of earnings to pay back the loan. However, GSL recipients are supposed to pay the loan back from the time they receive it. The GSL program supports tuition and living expenses up to 2 million won per year at an fixed interest rate of 2.9% per year to university students from households in the top 20% by income and who are younger than 56, took more than 12 credits in the previous semester, and have a GPA higher than a C (70/100). Students freely set the grace period and payment term and pay the monthly interest (principal and interest) from the time they receive the loan. Meanwhile, the ICL program provides tuition and living expenses up to 3 million won per year at a variable interest rate starting at 2.9% per year to university students from the bottom 80% of households in terms of income who are also younger than 35, took more than 12 credits during the previous semester, and have a GPA higher than a C (70/100).

The government also introduced a government scholarship program in 2012 in addition to these two loan programs. It provides various amounts of financial aid to students depending on their income level. It only supports students below the 80% mark in terms of income. From 2014, it provided full tuition (4.5 million won) to students from households in the lower 20% group in terms of income and a portion of tuition (approximately 675 thousand won) to students from households in the 70 to 80% income level bracket. That is, the GSL, the ICL and government scholarship program support students differently depending on their GPA and income level.

TABLE 1— CURRENT STATUS OF THE GENERAL STUDENT LOAN AND INCOME-CONTINGENT LOAN PROGRAMS BY YEAR

(UNIT: 100 MILLION WON, PERSON)

		Amount of Loan	Number of Recipients
2009	General Student Loan	12,014	331,470
	Income-Contingent Loan	8,456	232,448
2010	General Student Loan	19,205	528,943
	Subtotal	27,661	761,391
2011	Income-Contingent Loan	10,873	303,792
	General Student Loan	15,980	429,742
	Subtotal	26,853	733,534
2012	Income-Contingent Loan	15,150	510,052
	General Student Loan	8,115	217,615
	Subtotal	23,265	727,667
2013	Income-Contingent Loan	17,811	590,746
	General Student Loan	7,709	194,054
	Subtotal	25,520	784,800

Note: A student from a household with three children or more can receive an ICL regardless of income level.

Although students from almost all income levels except the top income classes can receive scholarships, the amounts vary among them. This program allows students to receive loans as well as scholarships simultaneously. However, it is not enough for some students to cover their full tuition, and they are forced to take out a loan to cover the difference.

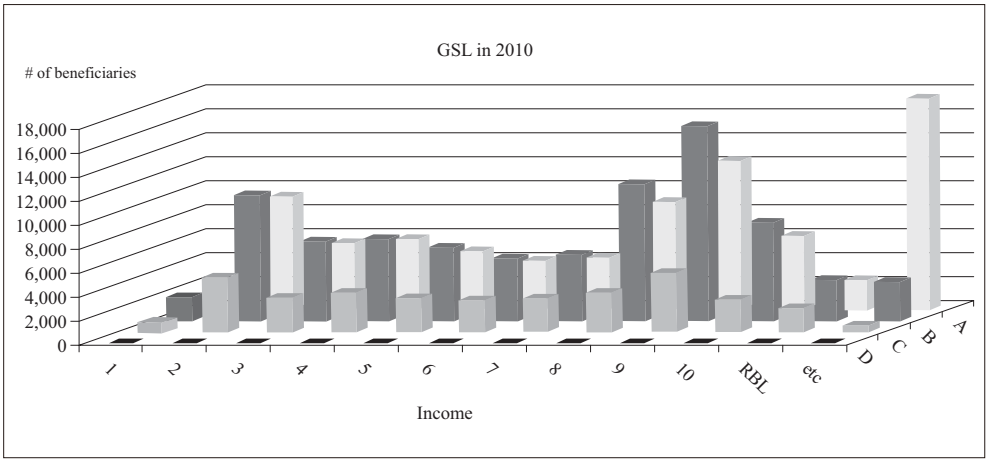
The student loan amounts and the number of recipients by year are shown in Table 1. The ICL started by lending 850 billion won in 2010 and had continuously more borrowers – nearly 600 thousand people borrowed about 1.78 trillion won in 2013. In contrast, the amounts and number of recipients for the GSL continuously decreased from 330 thousand and 1.2 trillion won in 2009 to 190 thousand and 770 billion in 2013. Considering the slight changes in the total number of beneficiaries during these years, it can be concluded that students who used the GSL program converted to the ICL program.

Figure 1 shows the number of beneficiaries of the GSL and ICL programs by income and academic performance for the first semester of 2010 and the second semester of 2012. Although the ICL was launched in 2010, it was not fully advertised to the public. Therefore, many students utilized the GSL program and most borrowers had GPAs higher than a B. The majority of ICL beneficiaries were students from households in the lower 70% in terms of income level, and most of them had GPAs higher than a B. Students with a GPA of C mainly used the GSL program at the early stage of the ICL, although the GPA cutline for the ICL was a C. This suggests that students did not have a good understanding of the loan programs.[5]

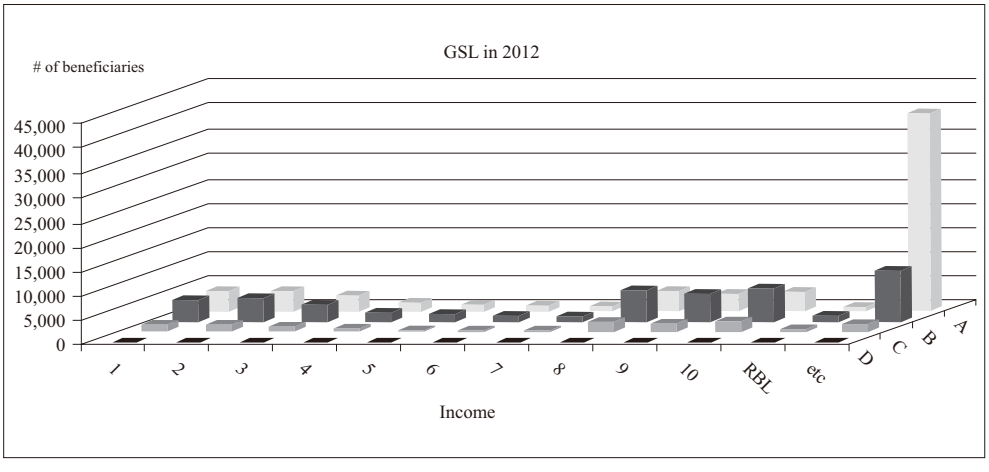
The number of ICL beneficiaries greatly exceeded that of GSL beneficiaries in

[5]Nam (2012) reports a positive correlation between the level of understanding of the ICL and use of the program.

2012. Particularly, students with a GPA at the C level increasingly used the ICL program instead of the GSL program. Students from low-income families (households with income levels in the bottom 30%) mainly used the ICL program. However, the number of GSL beneficiaries during the second semester of 2012 shows that students from lower 70% of households in terms of income often received this type. This may have occurred because a student from a household with three or more children can utilize the ICL program regardless of income.



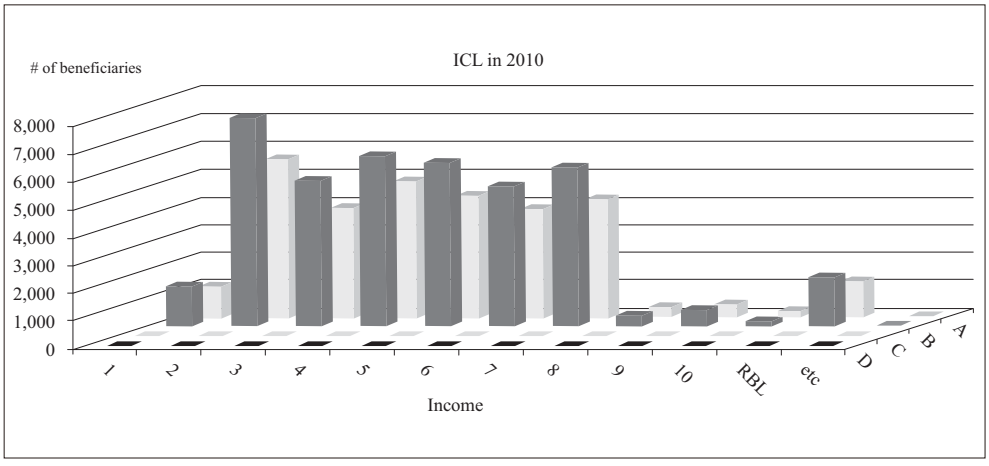
Note: RBL represents recipients of basic living costs. A, B, C and D indicate students' grades during each semester, and income level is divided into deciles.



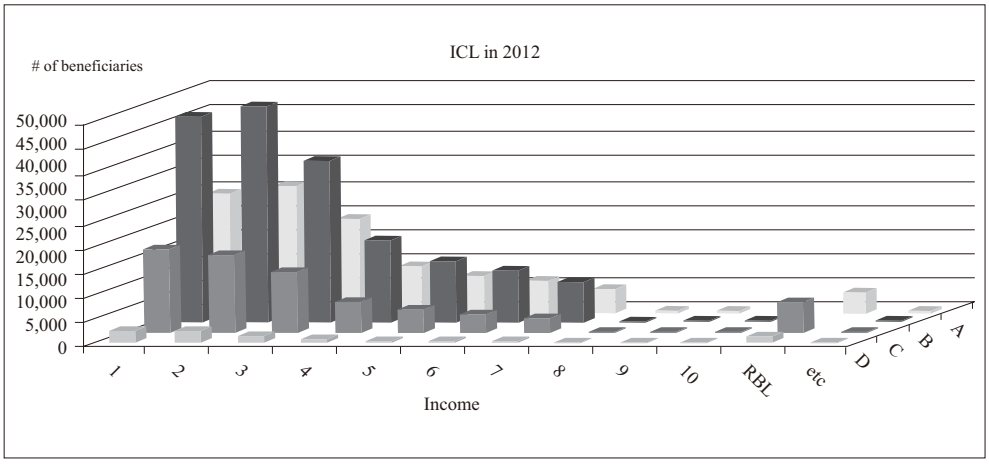
Note: RBL represents recipients of basic living costs. A, B, C and D indicate students' grades during each semester, and income level is divided into deciles.

FIGURE 1. THE NUMBER OF BENEFICIARIES FOR THE GSL AND ICL PROGRAMS BY INCOME AND ACADEMIC PERFORMANCE

(CONTINUED)



Note: RBL represents recipients of basic living costs. A, B, C and D indicate students' grades during each semester, and income level is divided into deciles.



Note: RBL represents recipients of basic living costs. A, B, C and D indicate students' grades during each semester, and income level is divided into deciles.

FIGURE 1. THE NUMBER OF BENEFICIARIES FOR THE GSL AND ICL PROGRAMS BY INCOME AND ACADEMIC PERFORMANCE *(CONTINUED)*

III. Theoretical Framework

According to human capital investment theory, borrowing constraints may alter an individual's investment decision. Essentially, without borrowing constraints, individuals invest human capital regardless of their wealth. Meanwhile, they invest human capital less in the presence of borrowing constraints. Thus, it is critical to determine whether the level of human capital investment differs according to the existence of borrowing constraints. There exists a limit to the amount of loans

available, up to tuition and living expenses in the ICL and GSL programs. Therefore, this section investigates whether the level of human capital investment differs in these cases.[6] To assess this, the general human capital investment model proposed by Lochner *et al*. (2011) is used, and a simple two-period-lived individual model is applied, as described below.

Individuals invest in schooling and work during the first and second periods, respectively. Their utilities are then expressed as

$$\mathcal{U} = u(c_0) + \beta u(c_1) \tag{1}$$

where c_t denotes consumption during period t ($t = 0$ or 1); $\beta > 0$ is a discount factor; and $u(\cdot)$ is a positive, strictly increasing, strictly concave, and twice continuously differentiable function. Each individual is endowed with financial wealth w ($w > 0$) and ability a ($a > 0$). He invests in human capital to increase his future labor earnings, and labor earnings (y) at $t = 1$ are equal to $af(h)$. Here, h is human capital investment and $f(\cdot)$ is a positive, strictly increasing, strictly concave, and twice continuously differentiable function that satisfies Inada conditions. He can borrow money d ($d < 0$) to pay his tuition during school with a gross interest rate of, R(>1). If an individual is not restricted by borrowing constraints, he maximizes his utility (1) under the consumption levels in each period.

$$\begin{aligned} C_0 &= w + d - h \\ C_1 &= af(h) - Rd \end{aligned} \tag{2}$$

Then, the condition to determine the optimal level of human capital investment in order to maximize the present value of net lifetime income is as follows,

$$\frac{u'(c_0)}{\beta u'(c_1)} = af'(h^u) = R, \tag{3}$$

Where h^u indicates the optimal level of human capital investment without borrowing constraints.

For the ICL program, there exists only one borrowing constraint. There is a limit to the loan amount that a student can receive (up to tuition and living expenses). At this point, we consider a fixed upper limit on the amount of debt. The constraints for the ICL program are then as follows:

[6]Suppose that a student cannot borrow money in a financial market due to credit constraints. In such a case, it is clear that if the student receives funds from the ICL or GSL program, he or she can invest human capital more compared to when credit constraints exist. Nonetheless, because this study places emphasis on comparing the level of human capital investment depending on the difference between the upper limit of the loan amount and the repayment method, the case without credit constraints is compared.

$$C_O = w + d - h$$
$$C_1 = af(h) - Rd$$
$$d \le d_{max} \quad (4)$$

The condition to determine the optimal level of human capital investment is expressed as shown below.

$$af'(h^i) = R + \lambda^* \left(\lambda^* = \frac{\lambda}{\beta u'(c_1)}\right) \quad (5)$$

In this equation, λ is the LaGrange multiplier; it is strictly positive when the constraint binds and is $\lambda = 0$ otherwise. Here, h^i indicates the optimal level of human capital investment in the ICL program.

For the GSL program, there are two borrowing constraints. Once students borrow money during period 0, they should repay the money during period 0, with the rest of the money to be reimbursed during period 1. As above, another restriction is that there exists a fixed upper limit to the loan amount. Therefore, the constraints can be expressed as

$$C_0 = w + d - h - rd$$
$$C_1 = af(h) - (1-r)Rd$$
$$d \le d_{max} \quad (6)$$

where $r\,(0 < r < 1)$ is the ratio of the repayment to the total amount students must pay back. Under these constraints, the optimization problem is as follows,

$$af'(h^g) = R + \lambda^{**} \left(\lambda^{**} = \frac{\lambda}{(1-r)\beta u'(c_1)}\right), \quad (7)$$

where h^g indicates the optimal level of human capital investment in the case of the GSL program.

Based on the optimal level of human capital investment in each case, this study considers how borrowing constraints affect human capital investment. In a comparison of (3) and (5), (5) is found to be greater because λ is positive and $f(\cdot)$ is strictly concave and increasing. Therefore, h^u is greater than h^i.

$$af'(h^i) - af'(h^u) = \lambda^* > 0$$
$$h^u > h^i \quad (8)$$

Next, when comparing (5) and (7), (7) is found to be greater because r is less than 1 and $f(\cdot)$ is strictly concave and increasing. Therefore, h^i is greater than h^g.

$$af'(h^g) - af'(h^i) = \lambda^{(**)} - \lambda^* > 0$$

(9) $$h^i > h^g$$

Finally, the optimal levels of human capital investment are ordered as follows:

(10) $$h^u > h^i > h^g$$

In short, once borrowing constraints concerning the upper limit of the loan amount and the repayment method are lifted, the optimal level of human capital investment may be reduced. Comparing the two different loan programs, the optimal level of human capital investment in the GSL program is lower than that in the ICL program. This can be explained according to the difference in the repayment time. While a GSL should be partly repaid during period 0, an ICL is repaid during period 1. For the GSL program, students need to pay the principal or interest while they are in school. However, if they cannot afford this, they may choose to work. If this is the case, the time to study can be reduced, which can negatively affect their academic performance. Under the assumption that students allocate time for study and work, their repayment burden may be reduced when accumulating human capital investment.

IV. Data and Estimation Strategy

A. *Administrative Data*

This study uses two different datasets to observe the effects of government student loan programs on academic performance, dropout decisions and to analyze the characteristics of those who default in relation to the programs. First, unique data supported by the Ministry of Education is used to determine the relative effects of the programs on academic achievement and to assess the characteristics of those in default in the programs. While it is impossible to compare students receiving loans with those not receiving them because the administrative data only contains information about recipients, it is possible to analyze the relative effects of different loan programs by comparing GSL recipients to ICL recipients. Nonetheless, because these two programs have different repayment methods, an analysis of the relative effect of academic performance is useful to measure which system is more effective at improving academic performance. This dataset contains information on students who received a GSL or ICL from the second semester of 2009 to the second semester of 2012. There were 917,509 students who received a loan, and the total number of observations is 1,563,554. Table 2 describes the descriptive statistics of this dataset.

In Table 2, female students received a loan slightly more often, and the average age of a recipient is 22 years. The recipients' scores were found to be between 80 and 90. Once they are converted to the 4.5 point scale, the result is approximately 3.69 points. Students attending private universities received loans more often than

TABLE 2— DESCRIPTIVE STATISTICS OF ADMINISTRATIVE DATA

(UNIT: MONTH, WON)

Variables		No. of obs	Mean	Std. dev	Min	Max
Sex		1,563,554	0.552	0.497	0	1
Age		1,563,554	22.274	3.620	14	57
Grade		1,563,554	2.199	0.694	0	3
Private University		1,563,554	0.873	0.333	0	1
Income Deciles		1,563,554	4.658	2.966	0	10
The loan amount received		1,563,554	3,261,175	1,160,740	100,000	24,200,000
The repayment amount		1,563,554	495,795	1,041,388	0	23,200,000
Overdue period		58,165	15	22.8	2	59
Overdue amount		58,133	3,015,649	1,209,098	1,694	9,976,500
GSL	Tuition	599,785	3,227,698	976,518	100,000	24,200,000
	Living expenses	20,678	1,118,846	848,461	500,000	15,000,000
	Tuition and living expenses	189,028	3,878,549	1,045,651	508,000	11,000,000
ICL	Tuition	295,050	3,029,577	1,014,538	100,000	24,200,000
	Living expenses	65,316	1,573,564	1,349,743	500,000	23,700,000
	Tuition and living expenses	393,697	3,578,123	1,112,757	600,000	15,900,000

Note: Grade is provided with an interval. The intervals of less than 70, 70~80, 80~90 and over 90 are defined as 0, 1, 2 and 3. The 0 income decile represents beneficiaries of basic living costs.

those attending public universities. This reflects the fact that the tuition at private universities is much higher than that at public universities. The main advantage of using this data is that it provides information about the income deciles for students who received a loan as well as those who default on their payments. The income decile of students who received a loan is 4.7, and the loan amount is around 3 million won, on average. In addition, the overdue period of those in default is 15 months, and the amount due is approximately 3 million won.

Using the administrative data, the following equation is used to determine the relative effect of the programs on academic performance. The regression equation is expressed below,

$$GPA_{it}=\alpha Loan_{it}+\beta X_{it}+c_i+y_t+\varepsilon_{it}\,, \tag{11}$$

where i indicates the student, t is the year, and GPA represents the grade point average achieved. Loan equals 1 if a student receives a GSL and is 0 otherwise, and X is a control variable which influences a student's academic performance. These can include sex, age, type of school (public university or private university), income, school region, total loan amount, payment, overdue period, and overdue amount. c_i represents a student's unobservable characteristics, y_t denotes the year effects, and e_{it} is an error term. In this data set, the GPA is provided with a range. Thus, it is represented as follows: below 70 is 0, above 70 and below 80 is 1, above 80 and below 90 is 2, and over 90 is 3. Year effects of variables influencing academic performance were considered for a longitudinal analysis, and a fixed-effect model analysis was conducted to control for unobservable characteristics.

In addition, continuous efforts should be made to lower the overdue rate, as large

amounts which are overdue can threaten the sustainability of the loan system. This study considers a means of lowering the overdue rate and helping delinquent borrowers by analyzing the characteristics of delinquency and determining the income classes most likely to be delinquent. To achieve this goal, the following equation is devised,

$$Default_{it}=\alpha IncDec_{it}+\beta X_{it}+c_i+y_t+\varepsilon_{it}, \quad (12)$$

where i indicates the student, t is the year, and Default is a dummy variable indicating whether a payment is overdue. $IncDec$ is the income decile of the student. X is a control variable which affects the probability of default. It can represent gender, age, the loan balance, the type of school (public university or private university), the school region and the total loan amount.

B. *Korean Education and Employment Panel (KEEP) Data*

The Korean Education and Employment Panel (KEEP) was launched in 2004 to provide basic data for establishing national human resources development policy, education policy and labor market policy. KEEP data traces 2,000 middle school seniors, 2,000 high school seniors and 2,000 occupational high school seniors yearly since 2004. In 2014, the ninth follow-up survey was carried out, containing a wealth of information regarding the educational experiences, grades and jobs of the participants. This data is used to determine how loans interact with dropout decisions. For this purpose, data were collected from 2011 to 2012 and were formulated into panel data after merging with each student's identification code. Descriptive statistics from the KEEP data are shown in Table 3.

3,468 students were used in the analysis of dropout decisions, and there were 6,935 observations for the two years. 58% of the data is from female students, and the school entrance year is 2006 on average. The proportion of those experiencing

TABLE 3— DESCRIPTIVE STATISTICS OF KEEP DATA

(UNIT: %)

Variables	Number of observations	Mean	Std. dev	Min	Max
Sex	6,935	0.579	0	0	1
Entrance year	6,935	2006.7	1.422	2005	2012
Dropout decision	6,935	0.245	0.430	0	1
Number of loans received	6,895	2.026	0.537	1	3
Job	6,929	0.484	0.500	0	1
Monthly income(ten thousand won)	6,255	130.017	313.894	0	4000
Existence of debt	6,780	0.204	0.403	0	1
Major	6,931	3.773	1.788	1	9
School region	6,935	7.007	4.579	1	17
Public school	6,882	0.781	0.414	0	1
Scholarship received at a previous year	6,935	0.117	0.322	0	1

a dropout among the sample is approximately 24.5%, and students received loans two times on average during the period. 20% and 11.7% of students among the sample are in debt and scholarship recipients, respectively. Contrary to the administrative data, 78% of students attend a public school. The tuition for private university is in general two times higher than that for public university. Thus, it would be interesting to determine if the type of school affects dropout decisions.

Regarding the dropout decision analysis, students who experienced a dropout are compared with students who did not. A logit model regression analysis is applied with using dropout experience as a dependent variable and variables influencing dropout decisions as independent variables. The type of school (public university or private university), the major, the location of the school, the presence of an on-campus job, monthly income, the existence of debt, and number of loans are considered as control variables affecting a leave of absence. Year effects of variables influencing a dropout decision are considered for a longitudinal analysis, and a fixed-effects model analysis is conducted to control unobservable characteristics. The regression equation is given below.

$$Dropout_{it}=\alpha NoL_{it}+\beta X_{it}+c_i+y_t+\varepsilon_{it} \quad (13)$$

Here, i indicates a student, t is the year and NoL is the number of loans received. X are control variables which affect the probability of default, such as the type of school (public university or private university), the major, the location of the school, the presence of an on-campus job, monthly income, wealth, and the existence of debt.

V. Results

A. *Impact of College Loan Programs on Academic Performance*

The administrative data with the information for the GSL and ICL is used to determine the relative effect between these two loan programs. Table 4 shows the relative effects of the student loan programs on academic performance.

Pooled regression for column 1 is conducted without controls, region or year effects. The findings indicate that the grades of GSL recipients are lower than those of ICL recipients. The more the loan amount increases, the more the grade decreases. The loan balance, overdue period and overdue amount all have negative effects on academic performance. Though control and region variables are added, the results in column 2 are similar to those in column 1. Lastly, the fixed-effects model is used to control unobservable characteristics in column 3.

The results in column 3 do not differ greatly from those in columns 1 and 2, but the magnitudes of the coefficients are different. GSL recipients show lower academic performance than ICL recipients, and the average grade of the GSL recipients is 3.63 points (out of a total of 100 points) lower than that of the ICL recipients. As the loan amount increases by 1 million won, this value decreases by 1.22 points. In addition, as the overdue amount increases by 1 million won, the

TABLE 4—RESULTS FOR THE EFFECT OF DIFFERENT COLLEGE LOAN PROGRAMS ON ACADEMIC PERFORMANCE ACCORDING TO ADMINISTRATIVE DATA

(UNIT: MIL WON, MONTH)

Variables	(1)	(2)	(3)
GSL	-0.193***	-0.239***	-0.363***
	(0.001)	(0.003)	(0.003)
Loan amount	-0.64***	-1.12***	-1.22***
	(0.01)	(0.01)	(0.01)
Loan balance	-0.49***	-0.51***	-0.20***
	(0.01)	(0.01)	(0.01)
Overdue period	-0.002***	-0.002***	-0.003
	(0.000)	(0.000)	(0.000)
Overdue amount	-0.58***	-0.61***	-0.15***
	(0.01)	(0.01)	(0.01)
Controls	no	yes	yes
Region	no	yes	yes
Year effect	no	no	yes
N	1,563,554	1,563,554	1,563,554

Note: 1) Sex, age, school, region, total loan amount, payment, overdue period, and overdue amounts are included as controls. 2) Robust standard errors are in parentheses. 3) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

grade decreases by 0.15.

From the evidence derived by the analysis of the administrative data, it is concluded that the GSL program has a negative effect on academic performance, which is consistent with the evidence presented in Section III.

B. *Impact of the College Loan Programs on Dropout Decision*

Table 5 presents the results pertaining to the determinants of dropout decisions according to the type of school. While Panel A indicates the results for the pooled sample of students attending private and public universities, Panel B and Panel C consider the type of school. Only the results for the variables of interest, the number of loans received and scholarships received during the previous year, are shown in Table 5.

Column 1 begins with a simple logit regression without controls or fixed effects. First, as the number of loans received increases, the probability of a dropout decision increases by 20% in all three panels. Meanwhile, students who received a scholarship during the previous year drop out of school less than those who did not receive one. In column 2, factors that influence a dropout decision, such as a student's major, the location of the school, monthly income, the existence of a job and debt are included as controls. In addition, as a dropout decision may be linked to the specific year, year effects are considered in column 3. The results in columns 2 and 3 with controls and year effects are similar to those in column 1 despite the magnitude differences in the three panels.

TABLE 5—RESULTS FOR THE DETERMINANTS OF DROPOUT DECISION

Variables	(1)	(2)	(3)	(4)
Panel A. Private and public school				
No. of loans received	0.200***	0.123***	0.119***	0.031**
	(0.009)	(0.010)	(0.010)	(0.014)
Scholarship received during the previous year	-0.064***	-0.096***	-0.103***	-0.049**
	(0.016)	(0.015)	(0.015)	(0.021)
Observations	6895	6205	6205	6205
Panel B. private school				
No. of loans received	0.223***	0.149***	0.144***	0.069**
	(0.025)	(0.027)	(0.027)	(0.033)
Scholarship received during the previous year	-0.055***	-0.078***	-0.089***	-0.054
	(0.026)	(0.027)	(0.027)	(0.033)
Observations	1506	1403	1403	1403
Panel C. public school				
No. of loans received	0.195***	0.108***	0.104***	0.023
	(0.010)	(0.0110)	(0.010)	(0.016)
Scholarship received at a previous year	-0.074***	-0.115***	-0.120***	-0.046*
	(0.020)	(0.019)	(0.019)	(0.028)
Observations	5337	4756	4756	4756
Controls	No	Yes	Yes	Yes
Year fixed effects	No	No	Yes	Yes
Individual fixed effects	No	No	No	Yes

Note: 1) Major, school location, monthly income, the existence of a job, and debt are included as controls. 2) Robust standard errors are in parentheses. 3) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

Finally, column 4 considers individual fixed effects with other controls. Panel A shows that the probability of dropout decision increases by 3% as the number of loans received increases. Akin to the results in the previous columns, students who received a scholarship during the previous year drop out of school less than those who did not receive one. However, because the tuitions between private and public universities differ significantly, it is important to determine if the dropout decision may also differ according to the type of university.

Panel B and Panel C consider dropout decisions according to the type of school. Interestingly, as the number of loans received increases for students attending a private university, the probability of a dropout decision increases by 6.9%. The result for students at private universities is two times higher than that for Panel C on average. Meanwhile, for students attending a public university, the number of loans received does not have a statistically significant effect on a dropout decision. As discussed above, the higher tuition of private universities may have led to these results. Thus, one would expect that students attending a private university are more likely to have trouble paying their tuition. If we link these results to the delinquency rate, clearer policy suggestions can be provided.

C. *Analysis of Defaulters' Characteristics*

The ICL program, which allows students to pay back their loans when they are employed, began in 2010. Defaults cannot occur in the ICL framework conceptually, though a practical repayment plan has been devised. On the other hand, the GSL program has been implemented for nearly five years, and the total amount overdue has substantially increased since then. We have reached a pivotal moment with regard to managing those who default. It is necessary to determine which group has a higher probability of defaulting for the efficient management of delinquent students. Therefore, this analysis focuses on students who received a GSL. It is natural that variables strongly related to delinquency are household income, loan amounts and loan balances. Table 6 presents the characteristics of those who default after received a GSL.

These results show that students who have high loan balances are more likely to be in default. Students' academic performance levels have little impact on delinquency. Interestingly, as household income increases, the probability of being in default increases. It is possible to interpret this result in two different ways.

First, the GSL interest rate is 2.9% per year, lower than any loan in the private sector. If a student (or household) borrows money both on the GSL program and in the private sector, GSL repayment may be pushed back on the priority list. The expectation that the government will protect those who default also plays a major role in delinquency decisions. However, this interpretation is not appropriate because students are restricted by financial transaction laws if their loans go unpaid for six months.

The second interpretation is that the high university tuition places a burden on household economies even if students are not from low-income families. In 2012, tuition amounts at public and private universities are on average 4 million won and 7.4 million won per semester, respectively. Average yearly income from the fourth

TABLE 6—CHARACTERISTICS OF THOSE WHO DEFAULT AFTER RECEIVING A GSL

Variables	(1)
Loan balance	0.388***
	(0.016)
Grade	0.021
	(0.030)
Age	0.028***
	(0.044)
Income decile	0.031***
	(0.001)
Controls	yes
Year effect	yes
N	25,010

Note: 1) Sex, age, loan balance, type of school (public university or private university), school region and total loan amount are included as controls. 2) Robust standard errors are in parentheses. 3) *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

TABLE 7—DELINQUENCY RATE BY INCOME DECILE

Income Decile	No. of recipients	No. of delinquency	Delinquency rate (%)
1st	59,921	3,797	5.96
2nd	96,785	4,849	4.77
3rd	63,417	3,435	5.14
4th	61,463	5,331	7.79
5th	52,581	4,443	8.31
6th	44,903	4,073	8.32
7th	48,844	4,265	8.03
8th	105,877	9,169	7.97
9th	134,448	11,336	7.78
10th	84,130	6,424	7.09

to the seventh income deciles per household is 33 million won and 50 million won, respectively, while for the eighth income decile per household it is 58 million won. Once two students in a household attend a private university, 74% and 56% of the yearly income goes to pay tuition for households in the fifth and seventh income deciles, respectively. Thus, the high tuition may be a major cause of defaults in these cases.

Table 7 presents the delinquency rate for GSL recipients according to their income decile. The delinquency rate from low-income families is lower than that for other income groups. This is related to the fact that the government continuously attempts to support students from low-income families.[7] The problem is how efficiently to manage those who default from middle-income families.

The Korea Student Aid Foundation introduced a system in 2014 which allows the transfer of relatively high-interest debt from government-guaranteed loans (second semester of 2005 to the first semester of 2009) and the GSL program (second semester of 2009) to the Foundation's low-interest student loan. However, to apply, debtors with government-guaranteed loans and loans from the GSL program must meet low-interest transfer qualifications. Among the criteria are no overdue balances, an account in good standing, and no ongoing legal processes. An applicant who is delinquent must clear the overdue payment to receive a transfer loan, making this program practically meaningless to those who are delinquent. A means of unconditionally relieving those who are delinquent can lead to moral hazard. However, it is necessary to give them a second chance. It is suggested to classify these debtors according to their repayment rate instead of treating all of them in the same way and to help them in efforts to gain a loan transfer. It appears that people with small amounts overdue are included in some cases along with those who are delinquent with high overdue amounts. The plan to provide the federation of banks with overdue information can be delayed or altered for students in financial need. Currently, students behind by more than six months on GSL

[7]Type I of the national scholarship program provides students with various amounts of financial aid according to their income decile. Students in the first income decile up to the eighth can receive 4.5 mil won, 2.7 mil won, 1.8 mil won, 1.35 mil won, 1.125 mil won, 0.9 mil won, and 67.5 mil won, respectively. This program places more emphasis on helping students from the low-income classes.

payments are registered as delinquents by the federation of banks. A graded information system should be considered, classifying those who are delinquent into several classes and give exemptions to those with small overdue amounts.

Furthermore, it is necessary to consider a method which allows families with two children to use the ICL program, as the current program only allows families with three children or more to apply for an ICL when the family is in the upper 20% income class. The government's financial capability should be carefully examined in advance before pursing such a change.

VI. Discussion and Policy Implications

This study mainly focuses on the effects of the government college loan program on academic performance, dropout decisions and loan defaults. A simple theoretical model shows that the human capital investment level can vary depending on the type of student loan. The GSL program, which makes students start to pay their debt immediately after receiving the loan, can present a greater economical and psychological burden on students as compared to the ICL program, which has a grace period. This implies that the GSL program induces low human capital investment levels because students who receive a GSL due to financial constraints are forced to work for pay these loans off, thus having less time to study.

An empirical analysis shows that the academic performance of GSL recipients is lower than that of ICL recipients. Moreover, having more loans increases the probability of a dropout decision, especially for students attending a private university. Finally, an analysis of the characteristics of delinquent borrowers reveals that students from the middle class have a greater probability of being overdue on their payments than students from low-income households.

The government introduced college loan programs to provide equal opportunities to receive a higher education regardless of the income level of students and their families. These programs have clearly helped students in financial need to gain the opportunity to receive a higher education. However, it is necessary to provide an environment for students to continue their education comfortably as well as an opportunity to initiate study. Several suggestions are given below for politicians to improve the government loan programs based on the results found in this study.

First, it is necessary to expand the ICL program within the allowance of the government's finance condition. Currently, students use two types of loans depending on their income class. Discrimination based on income level should be gradually removed due to the high tuition rates of Korean universities. Some may debate the appropriateness of supporting high-income families. However, considering that government scholarships are provided at a level of 650 thousand won to students from households up to the 80% income level, further discussion is warranted.

Secondly, various jobs should be created to allow students to work in an area related to their major. These can include on-campus jobs as well as positions at co-op systems, providing links to future employment. The government and companies

currently have these types of programs and jobs, but they are too few in number. It is essential to build an infrastructure which can provide job information for student loan recipients.

Lastly, it is necessary to devise a means of relieving those who are delinquent depending on their effort to pay the loan off as a means of managing delinquent payments. Creating a delinquent class can be an option. Those who are delinquent and who are also making an effort to pay off their loans can be given an option to delay the registration of a credit alert or to transfer their loan to the ICL program. This should be positively considered to reduce the delinquent rate and to provide a second opportunity to study. In conclusion, this study suggests that the government should try to pursue an education policy not for education providers but for education consumers.

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Admissions Quotas in Metropolitan Areas and Competition between Universities in Korea

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The excessive demand for universities in metropolitan areas as a result of location premiums and regulated admissions quotas diminishes the competition between universities and the incentive to enhance educational performance to attract more students. Cases in point are the lower graduate employment rates (a measure of educational performance) of universities in metropolitan areas compared to those in non-metropolitan areas despite higher quality students. Additionally, the graduate employment rates of non-metropolitan universities are influenced by educational input factors such as an increase in the percentage of courses taught by full-time faculty, while those of metropolitan universities are contingent merely on enrollees' entrance scores. Ergo, a structure that revitalizes the competition between universities and encourages them to improve their educational services must be established in order to enhance the quality of higher education.

Key Word: Admission Quotas, Disincentives to Compete, University Restructuring
JEL Code: I23, I28

I. Introduction

In 1996, the Korean government adopted a normative system of institutional establishment with the goals of authorizing the establishment of a university upon the satisfaction of predetermined requirements and of recognizing its legal personality status simply through registration without additional administrative procedures such as government approval or permission — termed a 'normative system' in this paper. Since the adoption of the system, universities in Korea have expanded rapidly in size. However, this has been under fire in that quality improvements in education have not been guaranteed. The quantitative expansion of higher education clearly has positive outcomes, such as mass accessibility and

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equal opportunities in higher education, but these are by far outnumbered by the negative consequences, mainly more underperforming universities that fail to recruit enough faculty members and students to fulfill their capacities, according to critics. Social costs incurred by these underperformers lingering in the market are considered to be significant. Furthermore, looming changes in Korea's demographic structure are expected to accelerate the decline in the school-age population, likely leaving many universities with difficulties in recruiting enough students to stay afloat by around 2030.

In its master plan for the development of higher education released in August of 2013, the Ministry of Education announced the abolition of the normative system, entering into effect in 2014, meaning that the establishment of universities will become more difficult. This plan, however, would not help at all to solve the ongoing problems of underperforming universities. As the school-age population decreases, the number of prospective undergraduates is as well on the decline as well, allowing a projection of the excess supply of higher education. For example, given that private universities accounting for 80 percent of all higher education institutions rely mainly on student tuition payments to operate, if current conditions persist, there will be more underperforming universities as a result of the decline in the number of students.

The Korean government now faces two challenges: to enhance the competitiveness of universities and to cope with the decline in the school-age population. It would be reasonable to view these two issues as not mutually exclusive and to consider that they could be explored simultaneously. As an example, consider three universities, A, B and C, each able to admit one hundred students, in a society with a school-age population of three hundred. Assuming no increase in their admissions capacities, a rise in the school-age population would result in fierce competition among students, but none among these universities because regardless of their academic achievements, it is simply impossible to attract more students. On the other hand, assuming that the school-age population decreases by Δ per year from three hundred, this would cause the universities to compete for students. In this regard, unlike an increase in the school-age population, a decrease would introduce the natural pressure of competition among universities, implying that efforts to resolve the decrease in the school-age population, as long as they do not hinder competition among universities, would be compatible with the policy goal of strengthening their competitiveness. More fundamental methods to enhance competitiveness are needed, as the competition pressure brought by the decline in the school-age population may be short-lived.

Government policies affecting higher education have thus far focused on control through fiscal support using multi-faceted regulations. This has partly contributed to complacency by universities, leaning towards satisfaction with the given conditions instead of taking a leap forward. Therefore, this study seeks measures to enhance the competitiveness of Korean universities and to respond to the decline in the school-age population. To this end, this paper initially outlines academic achievements by Korean universities and then reviews two fundamental regulations pertaining to Korean universities: university establishment regulations in the capital area, and the normative system currently in place. The findings on Korean universities are then analyzed in an effort to examine their implications and to

consider the possibility of the adoption of quasi-market competition. In particular, this paper makes assumptions about the academic achievements by universities in the capital and in non-capital areas and tests them, based on which it intends to analyze problems of current university restructuring policies and then suggest solutions.

II. Current Status of Korean Universities

A. *Higher Education Achievements*

What it takes for Korea to be at the center of the Asian economy and culture overall is talented human capital with creative and innovative minds and with the capabilities to realize value-added results in knowledge-intensive sectors. Over the past fifty years, universities in Korea have grown substantially in terms of size, but not in terms of their global competitiveness. According to the IMD's World Competitiveness Yearbook for 2013, Korea ranks twenty-fifth in educational competitiveness out of sixty nations, following Sweden (1st), Denmark (2nd), Israel (11th) and Taiwan (21st), as shown in Table 1.

Meanwhile, approximately 2.6 persons per 1,000 Koreans are now studying abroad for higher education, placing Korea at eleventh on this list. On the other hand, Korea ranks among the lowest (41st) in terms of university education; its highest ranking in this category was thirty-ninth out of 59 nations in 2011, changing only slightly since 2009. Despite its high rate of university enrollment, Korean universities show low employment rates for graduates and only modest educational achievements. Hence, it is necessary to determine the fundamental reasons for the current conditions and to develop measures which will lead to institutional improvements.

Table 1 shows Korea that ranks approximately fiftieth in terms of the number of students per teacher at primary and secondary schools, at 20 and 18 students, respectively, whereas it is typically eighth to tenth in terms of the secondary school enrollment rate, which stands at 96 percent. Korean students typically rank fourth or fifth in math and science on the PISA test. These outstanding achievements can be understood as the outcome of parents' much larger investments in private education compared to the levels of public investment in primary and secondary education. Also, Korea ranks second in terms of the higher education completion rate for the population aged 25~34, at 65 percent. On the other hand, as of 2013, Korea ranks twenty-seventh, forty-first and forty-first again in terms of educational system, university education, and management education, thus showing backwardness. The simultaneous presence of a large number of Korean students studying abroad and the low level of university education together imply that it is the low quality of domestic university education that motivates many students to choose to study abroad.

Korea's gross tertiary enrollment rate[1] is among the highest, as shown in Table 2,

[1]Gross enrollment ratio is the ratio of total enrollment, regardless of age, to the population of the age group that officially corresponds to the level of education shown, tertiary education, according to the UNESCO Institute

TABLE 1— CHANGES IN KOREA'S EDUCATION COMPETITIVENESS BY SUB-INDEX (2009~13): RANKINGS AND SCORES

	Detailed indicators of education competitiveness		2009	2010	2011	2012	2013
	Korea's ranking/Number of participating nations		36/57	35/58	29/59	31/59	25/60
Quantity	1. Education-related public spending as a percentage of GDP (%)		36 (4.2)	36 (4.2)	33 (4.6)	31 (4.6)	32 (4.63)
	2. Education-related public expenditure per person US$)[1]		27 (831)	29 (916)	32 (793)	31 (785)	33 (785)
	3. Number of students per teacher in elementary schools (umber)		51 (26.7)	51 (25.6)	51 (24.1)	50 (22.4)	51 (20.9)
	4. Number of students per teacher in secondary schools (umber)		50 (18.0)	51 (18.1)	53 (18.2)	53 (18.0)	52 (17.6)
	5. Secondary school enrollment rate (%)		6 (96.1)	8 (96.5)	6 (98.0)	8 (95.7)	10 (96.0)
	6. Higher education completion rate for the population aged 25~34 (%)		4 (53.0)	2 (56.0)	2 (58.0)	2 (63.0)	2 (65.0)
	7. Number of foreign students studying in higher education in Korea per 1,000 population (number)		37 (0.46)	34 (0.66)	33 (0.83)	34 (1.02)	32 (1.20)
	8. Number of Korean students studying abroad for higher education per 1,000 population1) (number)		10 (2.11)	11 (2.17)	11 (2.32)	11 (2.54)	11 (2.56)
	9. Scholastic achievement [2, 3]	Total	4	4	5	5	5
		Math (PISA score)	4 (547)	4 (547)	4 (546)	4 (546)	4 (546)
		Science (PISA score)	10 (522)	10 (522)	6 (538)	6 (538)	6 (538)
	10. English proficiency (TOEFL score)[2, 4]		48 (77)	48 (78)	46 (81)	46 (81)	46 (82)
	11. Illiteracy rate of population aged 15 and older (%)		32 (2.0)	32 (1.7)	33 (1.7)	34 (1.7)	34 (1.7)
Quality	12. Educational system		32 (4.38)	31 (5.03)	20 (6.00)	27 (5.58)	27 (5.71)
	13. Science education[5]		-	32 (4.96)	20 (5.37)	37 (4.57)	23 (5.32)
	14. University education		51 (3.95)	46 (4.28)	39 (5.00)	42 (4.57)	41 (4.93)
	15. Management education		42 (4.52)	43 (4.70)	35 (5.41)	43 (4.95)	41 (5.19)
	16. Linguistic ability		34 (4.88)	39 (4.98)	31 (5.60)	32 (5.59)	28 (5.88)

Note: 1) Not used for the ranking calculation; this is only reference information used to check the backgrounds of the subject nations. 2) Used as background information until 2008. Incorporated into the quantitative index from 2009 to 2012 and then categorized as background information from 2013. The rankings and scores are based on the IMD World Competitiveness Yearbook and are therefore partly inconsistent with those published in PISA 2009. 3) Scores from 2009 to 2010 come from PISA 2006, and those from 2011 to 2013 come from PISA 2009. 4) The TOEFL test changed from CBT (scores of 0~300) to iBT (scores of 0~120); hence, the rankings from 2009 are calculated based on the iBT. A score of 218 on the CBT scale is equivalent to a score of 81~82 on the iBT scale. 5) One of the sub-indices of the science infrastructure before 2010, when it was incorporated into the sub-indices for education competitiveness 6) * −: Scores and rankings are not released. Figures in * ( ) are indicator values.

Source: *IMD World Competitiveness Yearbook* (Various years). Recitation of the KEDI (2013).

for Statistics.

TABLE 2—WEF'S EDUCATION RANKINGS

(UNIT: RANK)

Category		2009	2010	2011	2012	2013
Higher education and vocational training	Total higher education enrollment rate	1	1	1	1	1
	Quality of the educational system	47	57	55	44	64
	Quality of universities /graduate schools of business	44	47	50	42	56
Corporate innovation	University-industry research collaboration	24	23	25	25	26

Note: 1) The number of surveyed nations varies, with 133 in 2009, 139 in 2010, 142 in 2011, 144 in 2012 and 148 in 2013. 2) According to the WEF's 2013 report on the secondary enrollment rate, Korea ranked 27th among 148 nations as of 2010.

Source: World Economic Forum (Various years).

TABLE 3—PROPORTION OF ENROLLED STUDENTS BY UNIVERSITY TYPE (2011)

(UNIT: %)

Category	Public	Government-dependent private	Independent/Private
Australia	96		4
Austria	84	13	3
Finland	74	26	
France	86	5	9
Germany	96	4	
Italy	90		10
Japan	25		75
South Korea	23		77
Mexico	67		33
Norway	85	5	10
Poland	90		10
Spain	88		12
Switzerland	93	7	
Turkey	94		6
UK		100	
US	70		30

Source: OECD (2013.

whereas the quality levels of its educational system and its management courses at universities and graduate schools are among the lowest (44th~64th and 42nd~56th, respectively). In the category of university-industry research collaboration, Korea ranks twenty-third to twenty-sixth and therefore shows a low level in this regard considering its economic power.

Contrary to the popular belief that the private sector-led supply of higher education would result an undersupply due to external effects, private universities outnumber national and public universities by almost fourfold in Korea, as shown in Table 3. In most nations, public universities account for 70~90 percent of all universities, with the exception of Korea and Japan, where only 23 percent and 25 percent, respectively, are publicly operated.

TABLE 4—EMPLOYMENT RATES BY AREA, STUDY FIELD, UNIVERSITY TYPE AND GENDER (2012)

(UNIT: %)

Category		Total			National/Public			Private		
		Total	Male	Female	Total	Male	Female	Total	Male	Female
	Total	56.2	60.1	52.1	53.4	59.1	45.5	56.9	60.4	53.5
Capital area	Subtotal	56.7	62.8	50.9	59.7	64.5	51.9	56.5	62.6	50.8
	Humanities	50.0	55.2	47.9	51.0	52.9	49.6	50.0	56.3	47.8
	Social Sciences	56.4	59.0	53.8	62.7	66.6	56.0	56.0	58.4	53.7
	Education	45.9	44.1	46.7	47.3	47.3	47.3	45.8	43.7	46.7
	Engineering	71.0	73.4	62.8	70.2	72.6	61.0	71.0	73.5	62.9
	Natural Sciences	51.1	55.7	48.2	51.7	54.5	48.4	51.0	56.8	48.2
	Medical Sciences & Pharmacy	75.8	81.3	73.1	84.2	88.7	79.8	75.4	80.7	72.9
	Arts & Physical Education	39.1	43.2	37.2	42.3	49.2	35.4	38.9	42.5	37.3
Non-capital area	Subtotal	55.8	58.5	52.9	52.7	58.4	44.8	57.2	58.5	55.9
	Humanities	47.1	48.0	46.6	39.8	43.9	37.8	49.7	49.5	49.8
	Social Sciences	53.2	52.8	53.5	48.3	50.4	45.8	54.5	53.6	55.6
	Education	50.2	47.4	51.5	32.7	37.3	29.6	60.4	56.8	62.4
	Engineering	65.4	66.2	61.3	66.9	67.2	59.2	64.9	66.3	63.0
	Natural Sciences	52.8	54.9	51.1	50.2	53.8	46.9	55.4	56.1	54.9
	Medical Sciences & Pharmacy	73.9	79.2	71.1	66.7	77.8	64.4	74.7	79.5	72.2
	Arts & Physical Education	47.7	53.0	44.3	38.3	48.8	33.2	49.3	53.6	46.4

Note: 1) Employment rate (as of 2012) = {employees with workplace-based health insurance + graduates employed on campus + overseas employees + employed persons in farming business/persons eligible for employment} x 100 2) The employed (as of 2012) include those with workplace-based health insurance, graduates employed on campus, overseas employees and persons employed in farming businesses. 3) Graduates employed on campus (as of 2012) refer to those with workplace-based health insurance, as of the date of the survey, who signed a contract exceeding one year with a university foundation or a relevant institution (industry-academic cooperation foundation, university or corporate) and who are paid more than the minimum wage; the annual salary of a person employed at the per-hour minimum wage of 4,580 won (as of 2012) is 957,220 won. 4) Overseas employees refer to those who work for more than 15 hours per week and who have an employment contract which exceeds 91 days. 5) Persons employed in farming businesses refer to those without workplace-based health insurance working in farming businesses as of the date of the survey. 6) Persons eligible for employment (according to the 2012 guideline): Graduates — persons (who are advancing into higher education, undertaking their mandatory military service, unable to work, officially excluded and foreign students) 7) Persons who are unable to work refer to those who are inmates, dead, those who emigrate overseas and those hospitalized for more than six months. 8) Persons who are deemed officially excluded refer to those who are medical aid recipients, graduates with a degree from a religious leader training course, female military officers attending a training course before being officially commissioned, and persons eligible for education courses provided by professional education institutes for aviation workers.

Source: KEDI(Korean Educational Development Institute), Employment Statistics DB.

As shown in Table 4, the employment rate of university graduates is 56.2 percent for the year 2012. It should be noted that these figures may be overestimated, as they include the number of graduates employed on campus. Universities occasionally do this in order to raise the employment rates of their graduates. The employment rate of university graduates in the capital area is 56.7 percent, not very

different from the rate of 55.8 percent in non-capital area. However, the gap between the two widens sharply with regard to the employment rate according to field of study. This implies that universities have made sufficient efforts, such as adjusting the admission capacity of each study field or creating market demand for a particular field of study, even considering the fact that the market demand for different fields of study can vary. For instance, universities may have attempted to raise the total employment rate by expanding the capacity for medical sciences and pharmacy while decreasing capacity for less popular fields of study.

B. *Current Regulations*

1. Regulations Affecting Capital-Area Universities

Pursuant to the policy intending to control the increasing population in the capital area, the Korean government enacted the Seoul Metropolitan Area Readjustment Planning Act in 1984 and strengthened regulatory policies regarding the establishment and expansion of large-scale enterprises, universities (four-year, in particular) and public institutions. The central government's policy to curb the concentration in the capital area is largely an attempt to discourage behavior itself through the Act and to restructure zones and spaces through readjustment plans. Laws which sought total quantity control over the admissions capacities of universities were adopted in 1994 in order to control the total number of prospective students at universities in the capital area. Given that the Seoul Metropolitan Area Readjustment Planning Act entered into effect in 1984, regulations pertaining to the establishment of universities in the capital area have been guided by the principle of no establishment or expansion of universities, particularly in Seoul, with some exceptions, as shown in Table 5.

The consequences of these regulations are illustrated in Figures 1~4 using data concerning changes in the number of universities and registered students in the capital and non-capital areas.

The number of universities remains constant until 1979 and then shows a sustained increase in non-capital areas starting in 1980. After the adoption of the normative system in 1997, the numbers of universities in Seoul and in the capital area remain relatively stable, whereas for non-capital areas, it continues to rise.

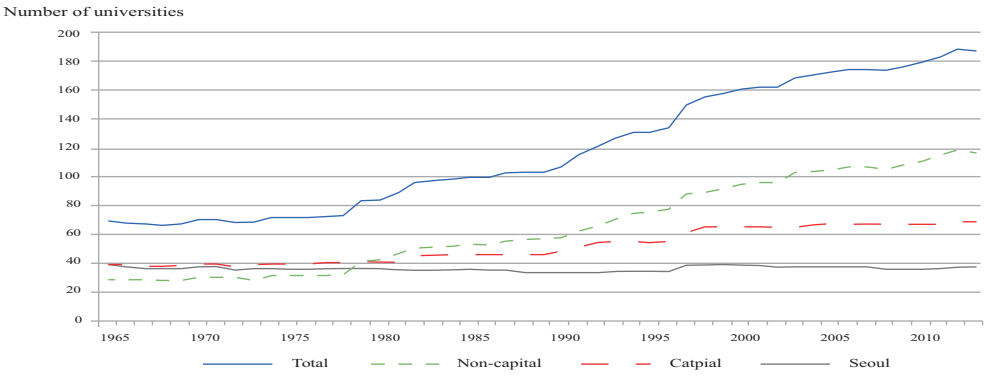
A similar pattern is observed with regard to the number of registered students. The number of undergraduates shows little change until 1979, with a sharp rise in both capital and non-capital areas starting in 1982 with the adoption of the graduation capacity system. After the system was abolished in 1987, the number remains steady until 1996. After the adoption of the normative system in 1997, the numbers of undergraduates in both Seoul and the capital area climb slightly, whereas the numbers of students in non-capital areas increase rapidly.

The ratio of universities in the capital to those in non-capital areas remains close to 6:4 until 1979, but it reversed to 4:6 by 2003 as the proportion of universities in the capital region decreased continuously after 1979.

TABLE 5—CHANGES IN SCHOOL REGULATIONS IN THE CAPITAL AREA

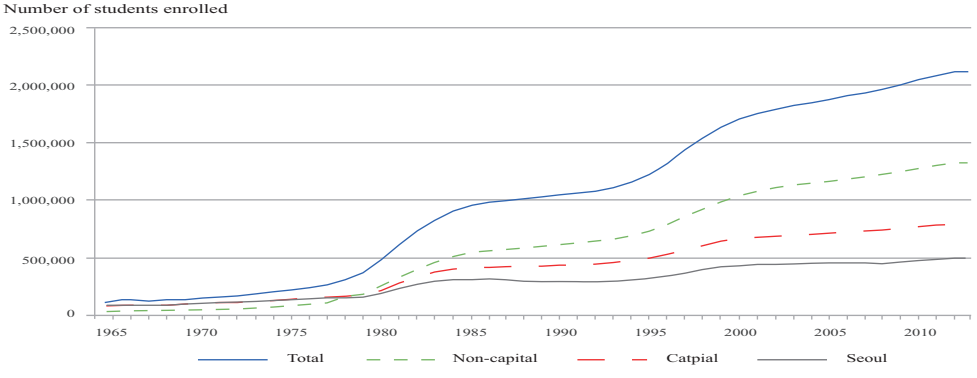
Date of revision	Scope of schools	Description of regulations affecting the relocation promotion zone (Seoul)
Oct. 20, 1983	High school and higher education	- Ban on establishing or expanding school and academic courses and raising admissions capacities · Allow the construction of new facilities requested by junior colleges or higher educational institutions within the minimum scope stipulated in the Decree on Standards for School Facilities.
Oct. 10, 1985	Universities, teachers' colleges, colleges of education at universities, air and correspondence colleges, open universities and junior colleges (or various types of schools)	- Ban on establishing or expanding schools and/or raising admissions capacities (except for night courses) · Allow the construction of new facilities requested by junior colleges or higher educational institutions within the minimum scope stipulated in the Decree on Standards for School Facilities. . Allow the construction of new facilities at the Korea Aerospace University.
Dec. 24, 1988	Same as above	- Ban on establishing or expanding schools and raising admissions capacities (except for night courses) · Allow the construction of new facilities requested by junior colleges or higher educational institutions within the minimum scope stipulated in the Decree on Standards for School Facilities.
Dec. 23, 1989	Same as above (except for air and correspondence colleges)	- Ban on establishing or expanding schools and raising admissions capacities (except for night courses) · Allow the construction of new facilities requested by junior colleges or higher educational institutions within the minimum scope stipulated in the Decree on Standards for School Facilities. . Allow the establishment of new religious schools when the head of the Ministry of Education, in consultation with the head of the Ministry of Construction, deem it necessary to foster educators. . Allow the establishment of a junior college in a non-Seoul area.
Dec. 31, 1992	Same as above	(Same as above) - Allow the expansion of admissions capacities in the fields of advanced science and engineering by 1995 (under review). ※ Allow the establishment of small-scale colleges (in zones designated for reserved development and environmental preservation).
Feb. 20, 1993	Same as above	- Allow the establishment of the Korea National University of Arts.
Apr. 30, 1994	Same as above	- Ban on establishing or expanding schools - Allow the establishment of junior and open colleges in non-Seoul areas (under review). - Adopt a total quantity control scheme pertaining to admissions capacities ※ Allow the establishment of small-scale colleges (in zones designated for growth management and environmental preservation)

Source: GRI(Gyeanggi Research Institute) (2008).



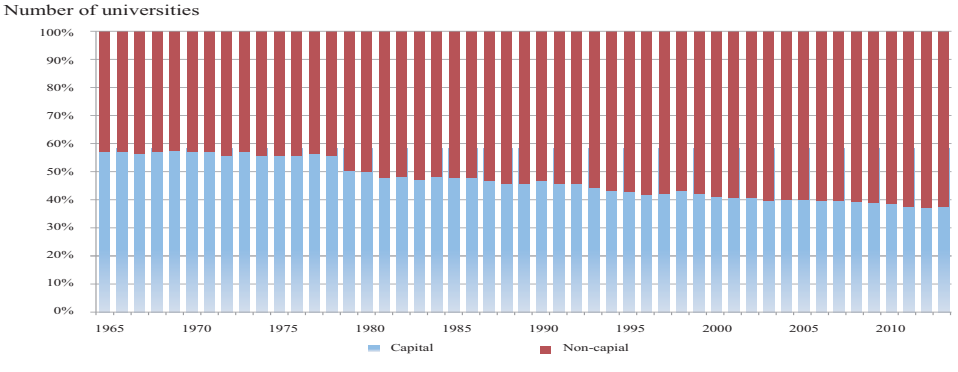
Source: Ministry of Education (1965~2013).

FIGURE 1. NUMBER OF UNIVERSITIES



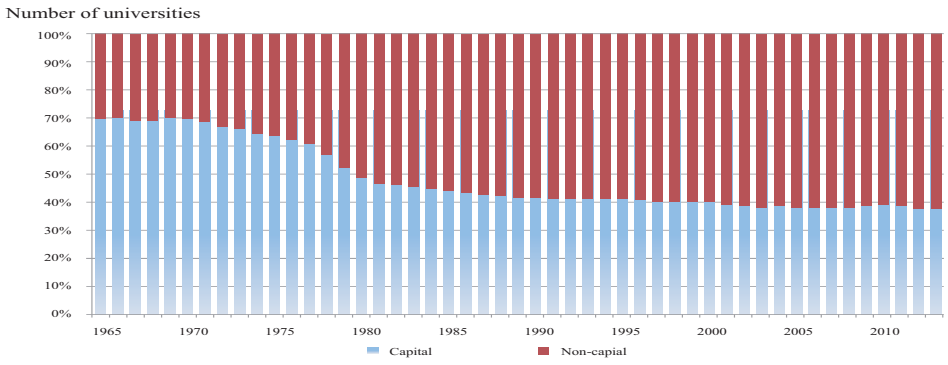
Source: Ministry of Education (1965~2013).

FIGURE 2. NUMBER OF STUDENTS ENROLLED AT UNIVERSITIES



Source: Ministry of Education (1965~2013).

FIGURE 3. NUMBER OF UNIVERSITIES IN THE CAPITAL AND NON-CAPITAL AREAS



Source: Ministry of Education (1965~2013).

FIGURE 4. NUMBER OF ENROLLED STUDENTS IN THE CAPITAL AND NON-CAPITAL AREAS

The ratio of enrolled students in the capital and non-capital areas remains close to 7:3 until 1972, but the gradual decrease in the proportion of those in the capital area reverses the ratio to 4:6, where it has remained since approximately 1990.

2. Normative System of University Establishment

By initiating the May 31st agenda for educational reform in 1995, the government sought to shift the paradigm of Korea's higher education policy. The main goals of this reform encompass the creation of a normative system and university autonomy when setting admissions capacities. Some have been critical, stating that since the reform, Korea's higher education system has grown overly large.

The following summarizes the reform policy for universities (Presidential Committee on Education Innovation, 2006a):

① More diversity and specialty: to develop a variety of university models and to adopt a (independent) specialized graduate school system
② Autonomy of the university establishment process, admissions capacity and academic operations: normative system and university autonomy for admissions capacity
③ Upgrade Korea's academic research to the world's best standards: to upgrade the research at universities to world-class levels, with financial assistance tied to evaluation results
④ Globalized education at universities: to foster professionals in international relations and to attract more foreign students and to promote the establishment of overseas campuses

Relaxation of regulation regarding the establishment of universities was embodied into the 'normative system' and the '(independent) specialized graduate

school system' — which runs no bachelor's degree programs — while regulations affecting admissions capacities were phased into a policy of 'autonomy of admissions capacity.'

III. Main Issues

A. *Regulations on University Establishment in the Capital Area and Admissions Capacities*

Regulations on private universities in the capital area, mainly their admissions capacities and the establishment of these institutions, have made universities more dependent on non-tuition resources, such as financial assistance from the government. In fact, there is little room for universities to make investments in quality educational services. Meanwhile, those in the capital area make no extra efforts to recruit students, as there are no new universities to challenge them.

TABLE 6—STUDENT ENROLLMENT RATE

Category		Observed value	Average	Standard deviation
2011	Non-capital	90	94.33	18.04
	Capital	62	111.25	17.93
2012	Non-capital	91	91.38	25.69
	Capital	62	110.95	23.16
2013	Non-capital	91	95.36	20.80
	Capital	62	112.83	18.74
Three-year total	Non-capital	272	93.69	21.74
	Capital	186	111.67	21.74

Source: Data from the Higher Education in Korea (http://www.academyinfo.go.kr), reprocessed.

TABLE 7—GOVERNMENT SUPPORT
(CENTRAL GOVERNMENT + LOCAL AUTHORITY)

Category		Observed value	Average (1m won)	Standard deviation (1m won)
2011	Non-capital	75	7,617	11,671
	Capital	47	16,954	27,963
2012	Non-capital	82	10,834	23,771
	Capital	56	18,381	31,564
2013	Non-capital	80	9,240	13,627
	Capital	52	24,120	51,161
Three-year total	Non-capital	237	9,278	17,336
	Capital	155	19,873	38,284

Source: Data from the Higher Education in Korea (http://www.academyinfo.go.kr), reprocessed.

TABLE 8—GOVERNMENT SUPPORT
(CENTRAL GOVERNMENT + LOCAL AUTHORITY,
PER ENROLLED STUDENT (BELOW AND ABOVE CAPACITY))

Category		Observed value	Average (1k won)	Standard deviation (1k won)
2011	Non-capital	75	1,348	3,901
	Capital	47	1,455	1,791
2012	Non-capital	82	2,863	15,352
	Capital	56	1,626	1,982
2013	Non-capital	80	1,794	6,361
	Capital	52	2,113	3,348
Three-year total	Non-capital	237	2,023	9,981
	Capital	155	1,737	2,480

Source: Data from the Higher Education in Korea (http://www.academyinfo.go.kr), reprocessed.

TABLE 9—PROPORTION OF GOVERNMENT GRANT FUNDS OUT OF TOTAL SCHOOL REVENUES (%)
(PROPORTION OF GOVERNMENT GRANT FUNDS OUT OF EDUCATIONAL REVENUES)

(UNIT: %)

Classification		Observed value	Average (%)	Standard deviation
2011	Non-capital	91	5.06	3.53
	Capital	62	2.59	1.80
2012	Non-capital	91	5.22	3.86
	Capital	62	2.74	1.80
2013	Non-capital	90	9.95	4.40
	Capital	62	6.99	2.91
Three-year total	Non-capital	272	6.73	4.54
	Capital	186	4.11	3.02

Source: Data from the Higher Education in Korea (http://www.academyinfo.go.kr), reprocessed.

Capital-area universities receiving admission applications which exceed their capacities and making no new investment results in little change in university rankings; universities have little incentive to make new efforts or to increase their investments.

Moreover, universities in the capital area are given government support in amounts which are two to three times greater than the support given to universities in non-capital areas. Such a difference in government support, however, is not as large as it first appears given the fact that in terms of per-student support, universities in the capital region are given only 1.2 times more support than those in non-capital areas. This can be interpreted to mean that government support is nearly balanced between universities in the capital and those in non-capital areas.

With regard to private universities in non-capital areas, they cannot compete with their counterparts in the capital area without active investment from a major corporation or foundation. Of course, this does not mean that private universities in non-capital areas have not competed with each other for students. Compared to their counterparts in the capital area, they are not less dependent on non-tuition revenues, leaving them more dependent on financial support from the government.

In addition, because they do not have access to the advantages available in the capital area, they are in a lower position with regard to their university rankings and therefore have difficulty recruiting students and hence excellent faculty members as well. Inevitably, the quality of their educational services cannot reach high levels.

Universities in the capital area are subject to the admission capacity regulation, unlike their counterparts in non-capital areas. When asking whether this regulation resolves the market distortion brought by the location premium by which inefficient universities are sustained without extra effort simply because they are located in the capital area, the answer may in fact be negative, as discussed below.

First, the number of registered students in the capital and non-capital areas has changed little since 1984, when the establishment regulation was adopted Figure 4. The fact that the proportion of registered students in the capital area against those in non-capital areas was decreasing before the adoption of the regulation implies that university autonomy with regard to admission capacity serves to reduce inefficiency. Moreover, few universities in the capital area have been dissolved thus far despite the efforts of the government, implying that the establishment regulation fails to eliminate the underlying market distortion. Second, the establishment regulation has made universities more dependent on governmental fiscal support so as to make up for the decrease in their tuition revenues and engage in inefficient activities such as launching campuses in non-capital areas. Even after setting aside the dependence on government support, several top-ranking private universities in the capital area appear to have obtained a cross-subsidy from their local campuses.

More importantly, the establishment regulation itself seems to have an adverse effect of mitigating competition pressure on capital-area universities, as will be discussed in Chapter 4. Taken all together, it can be said that the underlying inefficiency caused by the location premium cannot be resolved by the government's establishment regulation. Because it causes other inefficiencies, such as reduced competitiveness and cross-subsidies through local campuses, putting an end to this regulation should be considered.

B. *University Restructuring Policy*

The 2013 master plan for the development of higher education (Oct. 1, 2013) contains the basic directions for university structural reforms and evaluation systems and suggests policy agendas for building the basis to sharpen competitiveness, strengthen industry-academy collaboration and lifelong education, reinforce research capacities, and create innovative university education programs. The Ministry of Education then released the "Action Plan for University Structural Reform" (hereinafter, the action plan) on Jan. 29, 2014, which sought to upgrade the quality of university education and to prepare for a rapid decline in the school-age population. The action plan is mainly designed to carry out performance evaluations of all universities and to determine the reductions in the admissions capacities according to the evaluation results.

The main objective of this plan is to develop a proactive and aggressive reform measure for restructuring so as to enhance the competitiveness of universities by

TABLE 10—CAPACITY REDUCTION TARGETS PER CYCLE (PROVISIONAL)

Evaluation cycle	First cycle (2014~2016)	Second cycle (2017~2019)	Third cycle (2020~2022)
Reduction target	40,000	50,000	70,000
Period (Academic year basis)	2015~2017	2018~2020	2021~2023

Source: Ministry of Education (January 28th, 2014).

significantly reducing the numbers of universities and by upgrading their educational quality levels. All universities, except for those rated as excellent, will be subject to capacity reductions, and new systems for specialized universities and evaluations are to be adopted with legal and institutional foundations for consistent and systemic structural reforms established. Given these basic directions, the action plan includes the following detailed tasks.

First, based on the results of the performance evaluations, capacity reduction plans will be implemented with a target of 40,000 by 2017 and 160,000 in total by 2023, reflecting the number of prospective students after 2014 and the expected increase in the school-age population after 2025. The (provisional) targets pertaining to the amount of the reduction per cycle are shown in Table 10. All universities will be evaluated during every cycle. Based on the evaluation results, all universities except for those rated as excellent will be subject to differentiated capacity reductions, and those rated as excellent will also be encouraged voluntarily to reduce their capacities through government-funded projects, with the ends results (performance outcomes) of the structural reforms reflected in the evaluations of all government-funded projects and detailed methods to enact the structural reforms suggested in the respective project action plans.

Second, a new university evaluation system will be adopted to improve the quality of education. This is primarily intended to expand the qualitative evaluation part in the existing quantitative evaluation in order to develop an evaluation system for university structural reforms. Therefore, absolute evaluations of all universities will be conducted, and they will all be given five grades according to the results. The evaluations, using both qualitative and quantitative methods, cover all areas ranging from the overall management and operation to the curriculum, and they consist of common and specialized indicators. Four-year universities and two-year colleges are subject to different sets of evaluation indicators, while national, public and private universities are subject to the same indicators. The measures for structural reform according to the grade are shown in Table 11.

Third, to build legal and institutional foundations for sustainable structural reform, the action plan aims to formulate an enforcement system and relevant laws. The process of realizing an enforcement system includes the establishment of a committee for university structural reforms and the establishment of a non-standing evaluation task force and a university council attended by approximately 400~500 personnel, including incumbent and former professors and industry leaders. Relevant laws mainly concern the legislation of the (provisional) “Act on University Structural Reform and Evaluation,” as a means of implementing structural reforms such as capacity reductions and as a means of developing

TABLE 11—STRUCTURAL REFORM MEASURES: FIVE-LEVEL GRADES

Grade	Structural reform measures
Excellent	• Voluntary capacity reduction, participation in government-funded projects
Good	• Partial capacity reduction, participation in government-funded projects
Average	• Average capacity reduction, participation in government-funded projects
Poor	• A higher-than-average capacity reduction, unqualified for participation in government-funded projects, unqualified for the National Scholarship II, partial restrictions on student loans
Very poor	• A sharp capacity reduction, unqualified for participation in government-funded projects, unqualified for the National Scholarships I and II, full restrictions on student loans, induction of voluntary closure

Note: 1) A university rated "very poor" two times consecutively will be forced to close. 2) National Scholarship I: Differentiated support in connection with income. National Scholarship II: Support in connection with the university's independent efforts (reducing tuitions, expanding scholarships)

Source: Ministry of Education (January 28th, 2014).

a channel for the voluntary dissolution of private universities according to the results of their evaluations.

To recap, the government's university restructuring policy intends to implement differentiated reductions of admissions capacities at all universities according to their respective evaluation results. With regard to the goal of strengthening university competitiveness, it would be reasonable to allow universities deemed more efficient to continue to provide educational services while closing those which are deemed inefficient. The government currently pursues policy measures that aim at differentiated reductions in admissions capacities based on the results of university evaluations. It is doubtful, however, that these evaluations can in fact lead to the intended outcome. Regardless of the strictness of the evaluations, it will be challenging to force out a university unless its illegality is clear and certain. The Ministry of Education, not immune from political pressure, is most likely to conclude almost all universities are average in terms of quality. If this is the case, the restructuring policy will mean an average cut in the admissions capacities at all universities, implying that even inefficient institutions will continue to provide educational services. This may be a problem. In other words, any evaluation lacking a market assessment based on students' choices — assuming all students are provided with accurate information — would only show 'average in quality.' This may cause eventual delays in the restructuring process, a possibility that should not be taken lightly.

C. *University Reform Experiences of Advanced Economies and Lessons for Korea*

The university reform experiences of the US and of European countries have many implications for Korea, which is now under the pressure of restructuring and of realizing higher competitiveness at its universities due to the decline in the school-age population. By the mid-1980s, universities in Europe were managed by academic self-governance and strict government regulations and control efforts; i.e., they were subject to several government regulations. Afterwards, new public management initiatives were introduced with an emphasis on less government

control and more quasi-market elements, based on the expectation that universities with more autonomy over their internal resource allocation and management systems would be more likely to realize management efficiency levels through competition.

Schimank (2007) describes a new type of university governance structure with the following characteristics: high competition, low academic self-governance, high stakeholder guidance, low state regulation levels, and high managerial self-governance.

Meanwhile, Aghion *et al.* (2009) analyzed the impacts of the university governance structure on the research outputs as measured according to the number of patents and the global university research ranking. Their analysis shows a positive correlation between institutional autonomy and competition at public universities in the US and Europe and their research outputs. When given additional financial support, public universities produce more patents in fierce competition with private research universities, which enjoy greater autonomy levels. The quasi-market competition for research funding and for students serves as a foundation for the success of US university departments (Aghion *et al.* 2009).

Schneider and Sadowski (2010) analyzed data pertaining to the employment of doctoral graduates in economics for 2001 and 2002 from 14 universities at Germany and other European countries. According to their analysis, the major characteristics of successful departments are transparency of their academic achievements, no governmental or university regulations, and research funding that is allocated through performance competition. On the other hand, unsuccessful departments are found to lack transparency of their academic achievements, to be under the control of university regulations, and to be given research funding that disregards performance competition.

To summarize, university reforms in advanced economies are moving towards granting more autonomy to universities. This is particularly impressive considering that Germany and many other European countries — where universities were mostly state-run in the past — have made efforts to step away from excessive control (using government support as a means) and to respect the autonomy of universities. Behind these changes is a shift in consciousness: autonomy shall act to encourage inter-university competition and hence have maximum effectiveness. Aghion *et al.* (2009) show that in the US, with several of the world's leading universities, the maximum effectiveness stemming from competition between private universities with greater autonomy is the driving force behind competitiveness by public universities. This offers significant implications to Korean policies regarding universities.

In Korea, due to the area-based regulations, particularly admissions capacity control regulations, universities have provided overall low-quality educational services and have shown weak responsiveness towards social needs; the relevant theoretical assumptions and tests are described in Chapter 4 and 5, respectively. Therefore, the government's planned restructuring policy, with differentiated fiscal support for admissions capacity reductions, could only lead to more inefficiency and even a paradoxical situation of a delay in university restructuring. This policy is, in other words, to impose admissions capacity control on universities in non-capital areas, where admissions capacities have not been regulated thus far,

meaning that the adoption of the policy itself could generate inefficiency.

Universities with low student recruitment rates and hence room for admissions capacity reductions will experience little impact and even be given an incentive to seek fiscal support through a capacity reduction. On the other hand, reducing the admissions capacities at universities with high student recruitment rates would result in decreased opportunities for students. As universities that should be closed come to rely more on fiscal support, the market for university education would experience higher inefficiency at more universities. This is the consequence that the current restructuring policy is most likely to generate. This policy therefore needs to be reconsidered.

The crucial point of a restructuring policy lies in the choice between imposing overall admissions capacity control — as in the current policy — and forcing out those universities ranked at the bottom under a goal of university autonomy over admissions capacity. Simply put, this is a matter of admissions capacity control by the government or by universities themselves. Theoretical and empirical analyses concerning this are described in the following chapter.

IV. Hypotheses and Tests

At present, universities in the capital area are subject to government regulations on their admissions capacities, whereas those in non-capital areas have autonomy in setting their own policies. This chapter discusses the consequences of equilibrium behavior at universities under the current regulations, after which hypotheses that could be tested using data are introduced.

A. *Analysis of Equilibrium Behavior According to Admissions Capacity Regulation*

For analytic convenience, we assume the followings: 1) there are three universities in a society: A, B and C; 2) each provide educational services, the quality levels of which are identical in the early stage — providing better educational services requires increased effort and costs by each university; 3) there is no information asymmetry between students and universities with regard to the educational service; 4) other physical conditions, such as dormitory and lecture rooms, are all identical; and 5) they are all subject to the same government regulations affecting tuition fees, and they earn nothing other than tuition revenues — meaning that the educational service is a single subject focused on by the universities. This section investigates the equilibrium behaviors of universities under these assumptions when their admissions capacities are controlled and when they are not controlled. Each scenario is again examined by applying the two cases of a sufficient number of students and an insufficient number.

For explanatory convenience, each university has an admissions capacity of 100 students, which here is below the optimal level in terms of the cost structure of the university. The supply of students is assumed to be $300+\Delta$ ($\Delta > 0$), and all three universities provide educational services of the same quality; i.e., which university a student attends is irrelevant (a random choice scenario). In addition, for each

university, there are no incentives to upgrade their educational quality, as there is no way for them to recruit more students and to increase their capacity. This leaves students competing to be included in the total admissions capacity of 300 students.

Under this condition, what would happen to the quality of the educational services provided by these universities? The optimal choice for the universities would be to provide educational services in which there is no discrimination between university graduates and high school graduates, taking into account the time and money invested by each high school graduate in order to complete their university courses, which would be the baseline for comparison in the following discussions in this paper. This level of service with regard to university education is hereinafter referred to as the baseline educational service.

If the supply of students is $300-\Delta$ ($\Delta \in (0,100)$) and if the universities provide the baseline educational service, they would have $100-\Delta/3$ students, as the students' choices are random. Here, if one of them incurs extra costs and provides services of a higher quality, it may be able to fulfill its capacity of 100 students. Therefore, the provision of educational services of the same quality would not yield a state of equilibrium.

Equilibrium would result when A and B meet their capacity by providing educational services of a higher quality. For C, with $100-\Delta$ students, it would occur when they provide the baseline educational service. In this scenario, the quality the educational services offered by A and B is equivalent to the level resulting from the costs paid by A and B pay — which equal precisely the loss in C's revenue resulting from its failure to fill its capacity. Consequently, C's balance of operations is equal to those of A and B, leaving no incentives for C to alter the state of equilibrium. Even if C provides educational services equal to the quality of that by A and B, the number students C could recruit would be $100-\Delta/3$, and C's operating balance would then be lower than that when recruiting $100-\Delta$ when providing the baseline educational service. Moreover, when A and B reduce the quality of their services such that they are no longer above the baseline, this would then provide C an incentive to provide services equal to those offered by A and B. Over concerns about a decrease in their operating balances, A and B would not be induced to alter the equilibrium state. Hence, this is how equilibrium holds.[2]

This leads to the question of what would happen to student competition under this condition. Because the educational services of A and B are better than that by C, students are going to compete more strongly. Therefore, when the overall student supply is reduced, it remains possible for A and B to meet their student capacities by offering better quality education—a feasible scenario of educational service improvement through competition under student capacity regulations. This, however, applies only when C can afford the loss of operating revenue resulting from the decreased number of registered students. If C cannot handle the loss and is closed, the student supply would eventually be identical to the situation which arises when the student supply exceeds the total capacity. In other words, A and B will be capable of meeting their student capacities only by providing the baseline

[2]Equilibrium does not hold when two universities provide the baseline educational service. If this scenario is true and hence each university has $100-\Delta/2$ students, a slight upgrade in the educational services would enable the universities to meet their admissions capacities of 100 students, though this is not a state of equilibrium.

educational service, i.e., returning to the starting point with no educational quality improvement in either.

The quality educational services under the student capacity regulation can be summarized as follows. When the student supply exceeds the total capacity, the education quality level would be at the baseline. When the student supply drops below the total capacity, the university may provide better quality education only when there is a university incapable of meeting its capacity. Moreover, upon the closure of this university, the overall quality level would revert to the baseline. Shortly, as long as the capacity regulation is in effect, the baseline educational service remains predominant. Even in the exceptional case of a short supply of students, at which point which some universities may opt to upgrade their education quality, the overall quality would be at the baseline level in the end after the forcing out of the university that fails to meet its capacity.

At this stage, we move on to the case without regulations on student capacity levels. For convenience of the comparison, all three universities are assumed to have an admissions capacity of 100 students at the beginning. The supply of students is set to $300+\Delta$ ($\Delta > 0$). Each university then establishes a student capacity level with which its marginal revenue (the gain in revenue when one additional student is admitted) is equal to the marginal cost (the cost to provide the additional student with the targeted services). The structure of the marginal revenue is identical at all three universities, as assumed above, but that of the marginal cost can vary slightly depending on the level of efficiency in the administrative, governance and incentive structures. Therefore, the different student capacities of the universities are set autonomously.

For convenience of the analysis, A's cost structure is the most efficient, followed by those of B and C. The student capacities which lead to the highest levels of efficiency are 130, 120 and 100. Here, $\Delta > 60$. The capacities vary depending on the efficiency level of the cost structure, and additional revenue is set to be used only for an upgrade in the educational services; educational improvements are the sole target of each university's spending, as each is a non-profit legal person and is not allowed to own operating revenues itself. Therefore, with regard to the quality of educational services, A is first, B second and C third. Here, C's quality of education is higher than the baseline educational service under the capacity regulation. Students at these universities are given more opportunities to enjoy a better education compared to those at universities affected by the capacity control regulation. Furthermore, B and C have an incentive to benchmark A so as to make their cost structure work more efficiently. Therefore A, motivated by competitive catch-up activities by B and C, will have an incentive to be more efficient than the other two.

Meanwhile, when $\Delta < 60$, C, with the lowest education quality and efficiency, will not be able to meet its capacity. Its survival depends on whether or not it can achieve efficiency. This in other words means that more efficient educational services would be available. During this process, it is students that will eventually benefit from the better efficiency and educational quality brought by the autonomous capacity setting. It is this autonomy that provides more students with better quality education, while capacity control efforts provide the baseline

educational service.

B. *Hypotheses on the Effects of Regulated Admissions Quotas*

Generally, universities encourage enrollments and in order to be selected by prospective students, entering into sharp competition with each other. However, government regulated admissions quotas may change these common practices.

From a purely theoretical perspective, regulated admissions quotas eliminate the pressure of competition among universities to attract more students. This would in turn limit their incentive to offer a higher level of educational services (from the students' perspective when considering the cost of attending university) than the baseline level, as it would not result in increased enrollment. In such a case, the competition between universities would not entail enhancing the level of education to attract more students but based on the standard of the prospective students. As such, the educational performance capabilities of universities would be contingent on the competency level of the enrollees for the respective year.

In contrast, if universities were to have autonomy with regards to their admissions quotas, this would encourage them to become more competitive and to make additional efforts to upgrade their educational services in order to increase their enrollment. This would consequently motivate neighboring universities to boost their own efforts for fear of becoming obsolete. In such a case, universities' educational performance levels would become dependent on the amount of effort made.

Under the premise above, Table 12 shows the trends in educational services and educational performance levels with both regulated admissions quotas and autonomous admissions quotas.

The above discussion of the differing effects of regulated and autonomous admissions quotas can be applied to Korea's case, where universities in metropolitan areas have regulated admissions quotas while those in non-metropolitan areas do not. Generally, Korean students prefer universities in metropolitan areas (which have a location premium). Ergo, the competition to enter metropolitan universities is markedly higher than the competition to enter universities in non-metropolitan areas. Furthermore, the university rankings, based

TABLE 12—EFFECTS OF REGULATED AND AUTONOMOUS ADMISSIONS QUOTAS

	Regulated admissions quota	Autonomous admissions quota
Efforts to improve educational service	Low	High
Educational service	Baseline educational service (A)[3]	Higher than (A)
Education performance	Dependent on the competency level of students	Dependent on the university's efforts

Note: The baseline level of educational service refers to the level of university educational service that, after taking into account the time and cost of completing university, nullifies the merit of going on to university from high school.

[3]Samples from teacher's colleges, the Korea National University of Education, remote colleges, broadcasting universities, technical colleges, cyber universities, and various school and graduate schools amongst others were excluded. Universities that were established solely for the purpose of training religious leaders and to teach the arts and physical education, and are hence not subject to government support, were also excluded.

on entrance exam scores, for the former are also higher. In this respect, universities in metropolitan areas are able to select a higher level of students.

Regulating admissions quotas in metropolitan areas was originally a part of the effort to suppress the excessive population inflow into metropolitan areas. However, despite the increasing population in metropolitan areas, fixed quotas have exacerbated the excessive demand for placement at universities in metropolitan areas and have ramped up the competition for private education (tutoring and supplementary education). At the same time, the excessive demand is weakening the competition between universities.

Based on a theoretical analysis of regulated and autonomous admissions quotas, there is a high probability that the excessive demand resulting from regulated admissions quotas in metropolitan areas is lowering the efforts of these universities to enhance their educational services. Specifically, if universities had to compete with each other to attract more students, this would serve as an incentive for them to enhance the quality of the education they offer. In turn, these efforts would have an impact on their educational performance capabilities.

As such, the following theoretical hypotheses can be established pertaining to the behavior of universities with regard to educational input and performance in both metropolitan and non-metropolitan areas. Of course, this assumes that the universities in metropolitan areas have a location premium.

> **Hypothesis 1**: [Efforts to improve educational services] Compared to universities in metropolitan areas which have a location premium and for which excessive demand exists due to the regulation on admissions quotas, universities in non-metropolitan areas, which have to compete in order to attract more students, would be more committed to enhancing their educational services.

> **Hypothesis 2**: [Education performance] Universities in non-metropolitan areas would have higher levels of educational performance compared to the quality of their enrollees. Additionally, their educational performance levels would be affected by input variables that reflect their efforts to improve their educational services. However, universities in metropolitan areas, which have less of an incentive, would show lower educational performance levels compared to the standard of their enrollees, and their educational performance levels would depend on input variables that are relevant to the efforts made.

Although it would be difficult to examine the validity of the above hypotheses closely, this paper will attempt to find circumstantial evidence through a series of analyses that are based on variables for which data were available.

First, the educational performance levels and the graduate employment rates are measured. Although the quality of employment cannot be reflected, with government focusing on the gradate employment rate in university evaluations and

in funding decisions, it is a vital performance indicator. There are many input factors that affect education performance. However, the main factors can be broadly divided into two categories, i.e., preliminary input factors such as the quality of enrollees, and process input factors which are related to the quality of the universities' educational services.

For the preliminary input factor, this paper uses enrollees' CSAT results, and for the process input factor, the percentage of courses taught by full-time faculty was used as the key variable along with the educational environment, i.e., the number of full-time faculty members per student, the amount of government funding per student, and the amount of university investment per student, as the control variable.

C. *Hypotheses Tests*

The subjects for the empirical analysis presented in this paper are limited to private four-year universities that are eligible for government funding. Data on the variables necessary for the analysis were extracted from the government's Higher Education in Korea report (http://www.academyinfo.go.kr).[4] A total of 391 observations of 132 universities from 2011 to 2013 were used.

The most appropriate criterion for educational performance is the disparity between students' competence levels at the points of enrollment and graduation. Variables that reflect this may vary, but this paper uses the graduate employment rate[5] as the dependent variable. The employment rate denotes the market's evaluation of the graduates' abilities, and when entrance scores, which show students' competence levels at enrollment, are considered here, educational performance can be confirmed.

For the explanatory variables, the percentage of courses taught by full-time faculty and the number of full-faculty members per student, government funding, and grant transfer amounts from industry-academic cooperation departments were used.[6] Entrance scores have the largest impact on the graduate employment rate

[4]Given that the analysis data in this study are based on three-year panel data (2011-2013), a fixed-effect model may be most suitable. However, there are limitations when applying this model, as the variables used cannot change radically over the short term; hence, a pooled ordinary least-square model was used.

[5]The employment rate (as of 2012) = {(those with workplace-based health insurance + graduates employed on campus + overseas employment + employed persons in farming businesses)/employable persons} X 100. The employed (as of 2012) include those with workplace-based health insurance, graduates employed on campus, overseas employment and persons employed in farming businesses. Graduates employed on campus (as of 2012) refer to those with workplace-based health insurance, as of the date of the survey, who signed a contract which is longer than one year with a university foundation or relevant institution (industry-education foundation, university or enterprise) and are paid more than the minimum wage; the salary of a person employed at the per-hour minimum wage of 4,580 won (as of 2012) is 957,220 won. Overseas employment refers to those who work for more than 15 hours per week and maintain an employment contract which is longer than 91 days. Persons employed in farming businesses refer to those without workplace-based health insurance working in farming businesses as of the date of the survey. Employable persons (according to the 2012 guideline): Graduates - (those who are advancing into higher education, undertaking their mandatory military service, those unable to work, the officially excluded and foreign students). Persons who are unable to work refer to those who are inmates, dead, those who have immigrated overseas and patients hospitalized for more than six months. Persons who are deemed officially excluded refer to those who are medical aid recipients, graduates with a degree from religious leader training courses, female military officers attending a training course before being officially commissioned and persons eligible for education courses provided by professional education institutes for aviation workers.

[6]There are diverse ways to enhance educational performance. Examples include adjusting the percentage of

and as such are the most suitable variable; however, due to difficulties in obtaining data, placement scores from private university entrance exam organizations were used (CSAT score percentile: CSAT score out of 400 points (sum of points for the four sections) converted into a percentile). Also, variables that reflect whether the respective universities were established after the implementation of the normative system for university establishment (implemented in 1997: policy to ensure that universities can be established when the requirements are met)[7] and the admissions quotas were added as control variables. Finally, in order to control the disparity in the employment possibilities of different majors, this paper used the percentage of students majoring in humanities and social sciences as well as arts and physical education.

1. Percentage of Courses Taught by Full-time Faculty

Under the assumption that the percentage of classes taught by full-time faculty correlates to a university's efforts to enhance their educational service, this paper deduces (as shown in Hypothesis 1) that universities in non-metropolitan areas have a higher percentage of courses taught by full-time faculty than those in metropolitan areas. In order to confirm this, Table 13 uses the combined data pertaining to the observed values from universities in metropolitan and non-metropolitan areas to verify the differences in the percentages of courses taught by full-time members of the faculty.

Even if the average CSAT score for each university was controlled to take into account the discrepancy in the average competency level of students at metropolitan and non-metropolitan universities (a comparison between universities with similar scores), it was again revealed that the percentage of courses taught by full-time faculty members at non-metropolitan universities was higher than that at metropolitan universities by nearly 11%.

As shown by the coefficients of the interaction terms in Table 15, the percentage of courses taught by full-time faculty members was not influenced by the enrollees' entrance scores. This implies that non-metropolitan universities are more committed to enhancing their educational services than those in metropolitan areas regardless of the competency level of the students. Meanwhile, although full-time faculty members conduct research in addition to teaching, the percentage of courses taught by full-time faculty cannot be used to measure their levels of

courses taught by full-time faculty, increasing the number of full-time faculty workers, and making efforts to secure government funding and/or efforts to promote industry-education cooperation. Which ones are used depend on the marginal costs. Specifically, government funding will depend on official measures, and industry-education cooperation and university enterprises entail considerable costs. In particular, increasing full-time faculty from the universities' perspective will be a considerable burden in both the short and long term. As such, the easiest method for universities is to adjust the percentage of courses taught by full-time faculty.

[7]Before the adoption of the normative system, the necessary procedures to obtain permission to establish a university were highly complicated and difficult to complete. The system simplified the process, allowing universities to be established if the requirements are met. The government sought a change in Korea's higher education policy paradigm in 1995, often called the May 31 Education Reform, and its core policy was the creation of a normative system. Now that the system has become fully initiated, Korea's higher education system has become corpulent, according to certain critics.

TABLE 13—DIFFERENCE IN THE PERCENTAGE OF COURSES TAUGHT BY FULL-TIME FACULTY

Variable	Total
Average CSAT score (A) (0 ~ 400)	-0.003 (0.011)
Non-metropolitan university (B)	10.843*** (3.769)
(A) * (B) Interaction	-0.022 (0.016)
Year dummy and relevant variables controlled	○
Constant	75.299*** (5.517)
Obs.	384
Adjusted coefficient of determination	0.2968

Note: Figures in ( ) are standard errors * p < 0.1; ** p < 0.05; *** p < 0.01. Relevant control variables include whether the university was established after the adoption of the normative system, the log value of the admissions quota, and the proportion of humanities and social sciences and arts and physical education majors.

Source: Reproduction of data provided by Higher Education in Korea (http://www.academyinfo.go.kr).

research accomplishment.[8] However, even when these differences are considered, the results show that the greater level of commitment by universities in non-metropolitan areas to increase the percentage of courses taught by full-time faculty remains unchanged.

2. Graduate Employment Rate

Location premiums enable universities in metropolitan areas to attract more competent students. In turn, the students' high competence levels serve to increase the respective universities' educational performance levels (graduate employment rates). Under the assumption that the efforts by universities in all areas are at the same level, the graduate employment rates of metropolitan universities should be higher or at least similar to those of non-metropolitan universities. However, this paper reveals that the graduate employment rates of metropolitan universities are on average 56.2%, 3.1%p lower than that of non-metropolitan universities (59.3%), indicating that the former has inefficiencies which hinder their efforts to enhance their educational performance and make improvements.

Furthermore, despite the reservation wage, i.e., the subjective minimum wage level that determines employment, being higher on average for students from metropolitan universities, the number of instances of delayed employment is also higher. Accordingly, the graduate employment rates of metropolitan universities

[8]From a quantitative perspective, there are no statistical differences in the number research papers per full-time faculty member published in research journals listed in the NRFK. However, with regard to internationally published papers or SCI papers per faculty member, there is a difference of 0.1 between metropolitan (0.2) and non-metropolitan (0.1) universities, meaning that for every two papers published by ten faculty members of metropolitan universities, one will be published by a researcher at a non-metropolitan university.

may be lower in the short term. It should be noted, that the quality of employment was not reflected. Ergo, the analysis of the graduate employment rate should be supplemented with an analysis using variables that reflect the quality of employment, e.g., the average wage and/or the numbers of permanent positions. However, as the relevant data was unavailable, this research is left for the future.

The following section will analyze the different effects of input factors on the graduate employment rate. The focus will be placed on comparing the relative effects by the preliminary input factors (enrollee scores) and the process input factors (efforts to improve educational service) on educational performance (employment). Even under the assumption that there is a systematic difference in the quality of lectures and entrance scores, as the analysis in this paper divides metropolitan and non-metropolitan universities and examines the factors influencing the graduate employment rate in each league, it represents an opportunity to investigate the differences between the behaviors of universities based on whether they have regulated admissions quotas or not.

Table 14 shows that the educational performance (graduate employment rate) of metropolitan universities is contingent on individual students' competence levels and not on the efforts of the respective universities. A rise of 100 points in the average CSAT score accounts for a 2.2~5%p increase in the graduate employment rate, but the percentage of courses taught by a full-time faculty member is found to have contributed little to the employment rate.

TABLE 14—ANALYSIS OF FACTORS THAT INFLUENCE METROPOLITAN UNIVERSITIES' GRADUATE EMPLOYMENT RATES

Variable	(1)	(2)	(3)	(4)
Percentage of courses taught by full-time faculty (%)	-0.051 (0.054)	-0.049 (0.054)	-0.036 (0.056)	-0.054 (0.054)
Average CSAT score (0 ~ 400)	0.050*** (0.010)	0.048*** (0.011)	0.044*** (0.012)	0.022* (0.013)
Log value of the admissions capacity	-4.719*** (0.968)	-4.567*** (1.042)	-4.632*** (1.046)	-4.141*** (1.002)
University established after the adoption of the normative system	2.335 (1.980)	2.036 (2.121)	2.279 (2.141)	1.720 (2.042)
Proportion of humanities & social sciences and arts & physical education majors	-0.187*** (0.035)	-0.184*** (0.036)	-0.169*** (0.040)	-0.172*** (0.038)
Number of full-time faculty per student		4.921 (12.280)	2.451 (12.615)	1.828 (12.001)
Log value for the amount of government funding per student			0.350 (0.403)	0.260 (0.384)
Log value for per-student grants transferred from industry-academic cooperation departments and school-based enterprises				0.008*** (0.002)
Year dummy controlled	○	○	○	○
Constant value	89.486*** (7.848)	88.368*** (8.351)	86.551*** (8.615)	89.438*** (8.227)
Obs.	155	155	155	155
Adjusted coefficient of determination	0.3331	0.3293	0.3281	0.3920

Note: Figures in ( ) are standard errors * p < 0.1; ** p < 0.05; *** p < 0.01.

Source: Reproduction of data provided by Higher Education in Korea (http://www.academyinfo.go.kr).

The above findings prove that universities in metropolitan areas have little incentive to improve their educational services. Indeed, the reason behind the insignificant contribution of the percentage of courses taught by full-time faculty to the improvement of educational performance may be that there is an ample supply of competent part-time lecturers in the region whose quality levels are similar to those of full-time lecturers. However, even if the quality of part-time lecturers is superior, the bond that full-time faculty members have with the students and their education must be taken into account. Furthermore, as expected, Table 14 confirms that graduate employment rates decrease with an increase in the number of enrollments and students majoring in the humanities and social sciences, and arts and physical education majors.[9] The same phenomenon can be seen in Table 4 for universities in non-metropolitan areas.

Table 15 shows for universities in non-metropolitan areas, educational performance (the graduate employment rate) is contingent on their efforts and not on the competence level of the students. Moreover, although CSAT scores are unrelated to the graduate employment rate, a 10%p rise in the percentage of courses taught by full-time faculty is equivalent to a 1.07~1.19%p increase in the graduate employment rate. This also implies that unlike metropolitan universities, there is a wide quality gap between part-time lecturers and full-time faculty at non-metropolitan universities. Nevertheless, the results are still significant because increasing the percentage of courses taught by full-time faculty members is a major part of universities' efforts to enhance the quality of their education. What is confirmed here is that the educational performance levels of non-metropolitan universities that do not have a location premium and that have regulated admissions quotas can be changed through the efforts of the respective universities. Furthermore, contrary to general beliefs, the graduate employment rates of non-metropolitan universities established after the adoption of the normative system are higher than those of universities established before this system.[10]

As shown above, despite metropolitan universities having higher quality students, the graduate employment rates are lower. Furthermore, the graduate employment rates of metropolitan universities are determined by preliminary input factors such as the students' entrance scores, while those of non-metropolitan universities are affected by process input factors such as the efforts made to improve educational services. However, due to the limited amount of available data, it would be an exaggeration to claim that the efforts made by universities in metropolitan areas to enhance their educational performance levels are weak purely based on the results of this analysis.

Nonetheless, based on the theoretical argument that excessive demand reduces the incentive for universities that have regulated admissions quotas to improve the quality of their educational services, this paper has deduced implications

[9]If investments do not correlate with the increase in students, this could negatively impact students' educational performance levels and may lead to difficulties in the management of students, lectures and employment and start-ups. As such, small universities are preferable to large universities with regard to student and degree management, which is the basis for the argument that even with autonomy, admissions quotas cannot be limitless.

[10]Because the lecturers at universities that were established after the adoption of university establishment regulations are younger, fixed costs such as wages are low. Therefore, such universities are able to invest to enhance their educational performance.

TABLE 15—ANALYSIS OF FACTORS THAT INFLUENCE NON-METROPOLITAN UNIVERSITIES' GRADUATE EMPLOYMENT RATES

Variable	(1)	(2)	(3)	(4)
Percentage of courses taught by full-time faculty (%)	0.107** (0.048)	0.115** (0.049)	0.118** (0.049)	0.119** (0.049)
Average CSAT score expressed as a percentile of the respective university (0 ~ 400)	-0.011 (0.009)	-0.009 (0.009)	-0.012 (0.010)	-0.013 (0.010)
Log value of the admissions quota	-1.176** (0.511)	-1.292** (0.535)	-1.323** (0.536)	-1.333** (0.540)
Universities established after the adoption of the normative system	3.515*** (1.264)	3.532*** (1.266)	3.619*** (1.269)	3.624*** (1.272)
Proportion of humanities & social sciences and arts & physical education majors	-0.234*** (0.028)	-0.238*** (0.029)	-0.232*** (0.030)	-0.232*** (0.030)
Number of full-time faculty per student		-10.622 (14.503)	-11.287 (14.517)	-11.327 (14.552)
Log value for the amount of government funding per student			0.335 (0.332)	0.330 (0.333)
Log value for per-student grant amounts transferred from industry-education foundations and school-based enterprises				0.001 (0.006)
Year dummy controlled	○	○	○	○
Constant	74.679*** (6.222)	75.415*** (6.309)	73.715*** (6.530)	73.843*** (6.583)
Obs.	222	222	222	222
Adjusted coefficient of determination	0.4248	0.4236	0.4236	0.4210

Note: Figures in ( ) are standard errors * p < 0.1; ** p < 0.05; *** p < 0.01.

Source: Reproduction of data provided by Higher Education in Korea (http://www.academyinfo.go.kr).

regarding the behavior of universities in metropolitan areas. Specifically, although the regulated admissions quota was implemented to alleviate the excessive concentration of admissions in metropolitan areas, the current structure (quotas can be filled without effort and the number of enrollments cannot be increased even with more effort) will fail to encourage universities to boost efforts to strengthen their educational performance levels.

V. Conclusion and Policy Recommendations

In order to enhance the competitiveness and educational performance capabilities of higher education overall in Korea, universities must be given autonomy and an incentive system must be established to generate competition so as to provide better quality education. In particular, to achieve this based on the pursuit of 'consumer-oriented' education and university restructuring through 'voting with one's feet', universities must be selected by more prospective students through the improvement of the educational services offered by them. However, under the current policies, which strictly control the admissions quotas of metropolitan universities, excessive demand will continue, with the result being weakened incentives to enhance the quality of educational services.

From this perspective, it is at least theoretically valid to provide universities with autonomy over their admissions quotas rather than controlling them with government policies. Moreover, although the original aim of regulated admissions quotas was to control the overflow in metropolitan universities, the question of how long a policy that serves to overheat the competition for private education while weakening the competition between universities to improve educational services can continue needs to be addressed.

The government's current university restructuring policies include ranking universities based on evaluation indices and adjusting or maintaining admissions quotas accordingly. Additionally, government funding is increased based on universities' voluntary efforts to reduce their quotas. However, despite the fact that the aim of providing the incentives is to correlate the provision of higher education with the declining student population, these policies can introduce the following problems.

Korean private universities are highly dependent on tuition-based revenue because, as private universities in metropolitan areas with regulated admissions quotas as well as regulated tuition, they have little financial leeway. On the other hand, universities that are in less demand and are able to reduce their admissions quotas remain unaffected by the reductions or by revenue from funding provided by the government to meet the reduced quota. However, this situation results in the failure to weed out uncompetitive universities (based on weak demand). The effect of quota reductions on universities in high demand can take two forms, both of which also result in inefficiency. First, the reductions serve to reduce the opportunities for students to enroll in universities of their choice. Secondly, the reduction in admissions will deteriorate the universities' finances, which will in turn cut education investments and eventually diminish the quality of education.

The most appropriate method to restructure universities is one that is founded on the market function, which is centered on consumer choice. However, considering the constraints of the location premiums of metropolitan areas, this will be an impossible feat. In this respect, rather than focusing on the quality of educational services, a level playing ground which minimizes the rent of the location premium should be established.

An example of this would be to maintain or reduce the current level of the total admissions quota for metropolitan areas or to consider giving those universities autonomy to decide on their level within the total admissions quota. More pointedly, universities would be allowed to compete with other universities in their respective regions. There will be little opposition from universities in non-metropolitan areas, as this does not entail any significant changes. As such, the political implications will be minimal. Of course, in this case there would be the burden of regularly adjusting the admissions quotas of metropolitan universities to maintain fairness to those in non-metropolitan areas.

Additionally, there are numerous other measures, including integrating and fostering non-metropolitan universities or relocating metropolitan universities to non-metropolitan areas. In any case, a societal consensus must be reached. Whichever measure is selected, consideration must be given to whether the measures revitalize competition to enhance the quality of educational services at universities. Furthermore, prospective students must be allowed to make their own

choices based on detailed and transparent information about the universities' educational environments and performance levels, and universities which are not competitive must be weeded out.

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