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Impact of the Expansion of Private Brands on Korean Retail and Manufacturing†

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The private brands (PB) of corporate retailers are booming in Korea. This paper examines the effect of the rise of PB on Korean retail and manufacturing. By utilizing both store-level data and firm-level data, I find that the expansion of PB elevates the profits of corporate retailers but does not significantly affect, and in some cases even reduces, those of subcontracting manufacturers. This occurs not only because sales of national brands (NB) decline due to the launch of similar PBs but also because the imbalance in the bargaining positions of the two parties has caused retail margins to be set high while manufacturers' operating profits are set low. The paper provides policy recommendations for fair contracts and cooperative development between retail and manufacturing companies.

Key Word: Private brands, Store brands, Retailers, Buyer power
JEL Code: L11, L13, L16, L22, L81

I. Introduction

Beginning with food and daily necessities and now spanning across all consumer goods, private brands (PB) of corporate retailers are booming in Korea. An increasing number of PBs are rising as top sellers, and product quality now rivals that of national brands (NB).[1] The overall market size of PBs accounts for one fourth of all sales in the corporate retail industry. Indeed, we have entered the golden age of PBs, with large discount stores, super supermarkets (SSM) and convenience stores at the helm.

This impressive growth of the market necessitates a concrete understanding of

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[1]A private brand (PB) product is a type of good produced by one company (manufacturer) for exclusive sale under another company's (retailer) brand and available only at its stores. A national brand (NB) product refers to manufactured goods for sale under the manufacturer's brand and available at any store around the country.

and objective views on the PB business in Korea. However, official statistics are very insufficient, and thus data from several sources and numerous calculations are required even to begin to understand the size of the PB market.

Moreover, key issues that are critical when attempting to understand the PB business—the industrial background of market growth, its impact on the growth of retail and manufacturing industries, PB development methods, and types of unfair trade practices—have yet to be analyzed.[2]

Focusing on these issues, the study empirically examines the domestic PB industry. To the best of my knowledge, this is the first paper which utilizes micro-level data to analyze the effects of PB expansion on both Korean retail and manufacturing sectors. Thereupon, suggestions will be presented with regard to policy directions for sustainable growth and a fair market order.

II. Related Literature

Previous studies of PB have mainly dealt with the issues of price and quality levels, rivalry between PBs and NBs, and the influence on related firms and sectors. These studies mostly focused on the European and U.S. markets, where PBs have been actively launched and thus have a strong market presence.

With reference to the price level, Griffith *et al*. (2009) analyzed the UK food market. Using household scanner data in 2006, they found that economy store brands are 39% less expensive than NBs and that standard store brands are 25% less expensive than NBs.[3]

Bontemps *et al*. (2008) showed that there existed a positive correlation between PB entry and NB prices and that this relationship was particularly evident in NBs with high market shares. Olbrich and Grewe (2009) also found that consumer prices rose after the launch of a PB, whereas the overall product diversity decreased. Considering that PBs are usually less expensive than NBs of similar quality levels, one may think that the introduction of PBs contributes to lowering the overall price level. However, as both of the aforementioned studies show, retailers who set final consumer prices are tempted to raise NB prices to increase the market share of their PBs, making the overall price level increase or decrease depending on their market shares.

Another group of studies discusses the effect of PB expansion on retailer earnings. Ailawadi and Harlam (2004) found that PBs had higher percentage margins than NBs and that retailers with higher PB shares tended to have higher percentage margins on NBs as well.[4] With a more microscopic approach, Richards *et al*. (2010) investigated the US California ice cream market. By estimating a structural model, he found that retailers' percentage margins tended to be higher, especially in cases when PBs imitated NBs.

[2]Although some of these issues have been addressed in the European and US markets, there has been scant analysis of the Korean PB market.

[3]In the United Kingdom and Europe, the term ‘store brand’ is commonly used to refer to PBs. Griffith *et al*. (2009) divided PBs into standard own brands (cheaper than NBs), economy own brands (cheaper than NBs but with poor packaging) and premium own brands (comparable to NBs).

[4]‘Percentage margin’ in these studies refers to the retail margin relative to the final consumer price.

Further, Raju *et al*. (1995) shows that retailers' profits from PB launches increase when price competition between NB goods is low and price competition between PBs and NBs is severe. This implies that certain conditions need to be met in order for higher PB sales to lead to higher profitability of retailers.

With regard to the effect on the manufacturer, Cho *et al*. (2012) analyzed the effects of PB delivery on the performance of Korean manufacturers. They conducted surveys of 55 manufacturers and reported that 51% of manufacturers were worried about decreased operating profits due to the low delivery price of PBs. The paper also showed that manufacturers with sales exceeding 10 billion won experienced more of a decline in their operating profits than those with lower sales volumes.

Other papers studied the factors influencing PB market development. For example, Dhar and Hoch (1997) analyzed the food sales data of 50 U.S. retailers and found that the variety of PB items, the availability of premium PBs, the number of PB stores, and consumers' incomes and ages in a region to be the main causes of differential PB outcomes. On the development gap of PB markets across countries, Cuneo *et al*. (2015) discussed the distribution structure, logistics structure, and retailer typology as the main contributing factors.

As Korea's PB market has grown, public surveys have been steadily continuing. The Korea Consumer Agency (2008; 2011; 2014) investigated differences in prices, quality levels, and raw materials between PBs and NBs. It also surveyed PB sales trends, consumers' purchase behaviors and satisfaction levels, and so on. While the survey has only focused on large discount stores thus far, it is becoming more necessary to broaden the scope of the investigation so as to include SSMs and convenience stores, which are leading the growth in the Korean PB market at present.

III. Current Status of the Korean PB Market

In PB sales took off in earnest starting in the late 2000s. The market grew 2.5 fold in five years, from 3.6 trillion won in 2008 to 9.3 trillion won in 2013 (left panel of Figure 1).[5] Although the economic slowdown weakened consumer sentiment overall during this period, the PB market maintained its upward momentum owing to the increasing demand for economical products and the supply at all types of retail channels.

Large discount stores, the originators of the PB market, remain the largest sellers of PBs. However, heated competition and market restrictions have dampened their sales growth since 2011.

Rather, convenience stores are now spurring new growth. The three largest chains (GS25, 7-Eleven and CU) increased their PB sales by a staggering 16 fold such that the share of PB sales rose to 28.8% in 2013 (right panel of Figure 1). This

[5]The market size of PBs refers to the sum of PB sales at all samples (=3 major large discount store chains + 3 major SSM chains + 3 convenience store chains). PB sales at other retailers in addition to these are reported, though irregularly, in the Korea Chain Store Association's Yearbook of Retailers, but their share is less than 1% of the total PB sales for each business type.

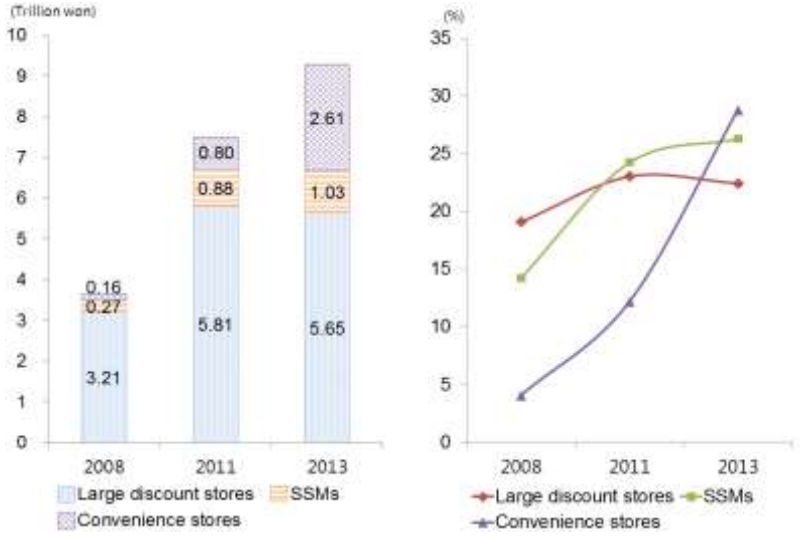

FIGURE 1. PB SALES (LEFT) AND SHARE OF PB TO TOTAL SALES (RIGHT): COMPARISON BETWEEN LARGE DISCOUNT STORES, SSMS AND CONVENIENCE STORES.

Note: Each category represents the top three chains with the highest sales volumes.

Source: Calculated using the Yearbook of Retailers (2009~2015) and companies' annual reports (same period).

was possible because, unlike large discount stores and SSMs, convenience stores are not bound by restrictions in terms of opening new stores. Moreover, 24-hour operations and PBs based on convenience foods met the needs of both the local community and single-person households.

Indeed, the axis of the PB market is shifting towards convenience stores at an accelerated pace. Accordingly, large discount stores such as Emart and HomePlus are now entering the convenience store business.[6]

When compared to foreign retailers (left panel in Figure 2), Korean retail chains' overall share of PB sales is not much lower than that of other global retail chains; it is below those of Aldi & Lidl, Sainsbury and Tesco but similar to those of Kroger, Costco and Walmart.

On the other hand, PB sales when compared to all retail trade in Korea (general retail + specialized retail) account for a mere 3.1% of total sales (right panel in Figure 2).[7] This is slightly higher than the average for Asia but far below that of Europe, Oceania and America, where retail industries are more advanced. Nonetheless, considering that Korea's PB market is in its infancy, there is potential for further growth. This may be true particularly as Korea's PB market is exhibiting a development pattern similar to those of its counterparts in Europe—wherein an oligopoly of a few companies has stimulated the PB business.

[6]Since starting their respective convenience store businesses, Emart and HomePlus have actively expanded their numbers of stores (With Me and 365PLUS, respectively). As of July of 2016, there were 1,422 With Me stores and 402 365PLUS stores nationwide (The Korea Economic Daily, Aug. 22 2016). Recently, With Me was rebranded to Emart 24.

[7]Nielsen (2014) determined a country's PB sales share by calculating the share of PB sales in total sales in the retail business. This study applies the same calculation to gauge Korea's PB sales to make international comparisons easier.

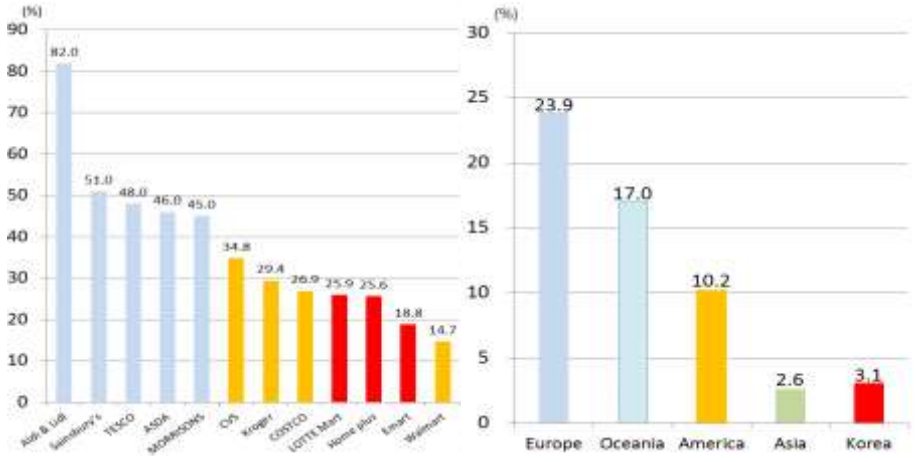

FIGURE 2. SHARE OF PB SALES BY RETAIL CHAIN (LEFT) AND CONTINENT (RIGHT):

Note: 1) Share of PB sales by company (%, as of 2014) = PB sales / Company sales. 2) Share of PB sales by country (%, as of 2013) = Total PB sales / Total retailer sales. 3) Share of PB sales by continent is the mean of the share of PB sales by country within the continent.

Source: Calculated using PLMA (2014); Nielsen (2014); Korea Chain Store Association (2014); Statistics Korea, "Wholesale and Retail Trade Survey Microdata," 2013.

IV. Structural Changes Underlying the PB Expansion in the Korean Retail Industry

A. *Market Concentration in General Retail*

The following section examines the structural changes within the retail sector that spurred on and nurtured the PB industry. Above all, it is important to note that the recent growth of the general retail business was heavily dependent on the growth of corporate retailers. Figure 3 shows that the market for general retail expanded by 53.7 trillion won in the period of 2003~2014, of which 78% (41.9 trillion won) stemmed from increased sales by corporate retailers.

Accordingly, the share held by corporate retailers in general retail advanced from 67.8% to 73.1% over the same period. This implies that corporate retail businesses have taken a larger stake in the distribution of manufactured goods, thus strengthening the influence of this sector over consumers.

However, these changes may aggravate the imbalance in the bargaining position between corporate retailers and manufacturers. As sellers, manufacturers have a greater economic incentive to supply their products to large retailers who dominate the retail market. Conversely, this means that the business loss to the manufacturing company can be significant when the transaction is halted for any reason.

On the other hand, as buyers, retailers have little difficulty in finding alternative suppliers who can offer similar or more favorable contract terms. Additionally, even when a contract is terminated, there is little impact on the total sales of corporate

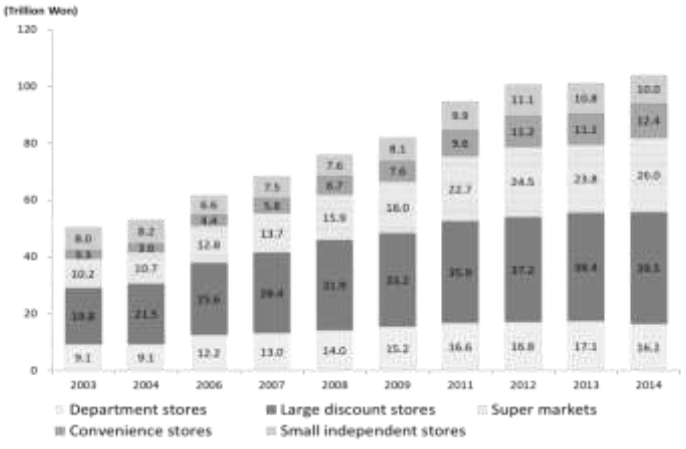

FIGURE 3. CHANGES IN SALES BY RETAIL BUSINESS TYPE

Note: Corporate retail encompasses department stores, large discount stores, SSMs within supermarkets, and convenience stores.

Source: Based on Statistics Korea, "Wholesale and Retail Trade Survey Microdata," 2003~2014.

retailers, as they have tens of thousands of products on their shelves.

PBs are created when corporate retailers participate in the planning, production, and labeling of products, all of which were traditionally conducted by manufacturing companies. This intervention is only possible when such retailers possess strong buyers' power. In other words, market concentration in general retail is a prerequisite to the creation of PBs; accordingly, small independent stores do not have PBs.

B. *Intensifying Competition between Large Retailers*

As much as the level of buyers' power determines the creation of PBs, the competition between corporate retailers affects the economic incentive to release them. In fact, the Herfindahl-Hirschman Index (HHI) of corporate retailers (diamond line in Figure 4)[8] has been in decline since 2006, pointing to more heated competition between rivals.

In the midst of the intensifying competition, if shelves were stocked with NB products, corporate retailers would have no other choice but to engage in a discount war as a means to gain a competitive edge. This strategy, however, cannot serve as a long-term solution, as the ensuing price competition would eventually diminish the delivery price and retail margin.

In contrast, PBs offer product differentiation because corporate retailers are able to decide on the product features and sell the products exclusively at their stores. Thus, retailers are free from consumers' direct comparisons of price and quality and can set a stable retail margin. Additionally, differentiated products contribute to

[8]This study calculates HHI using the market share of each retail store, taking into account the level of observation in the Wholesale and Retail Trade Survey MDIS: $HHI = 10,000 \times \Sigma_i S_i^2$.

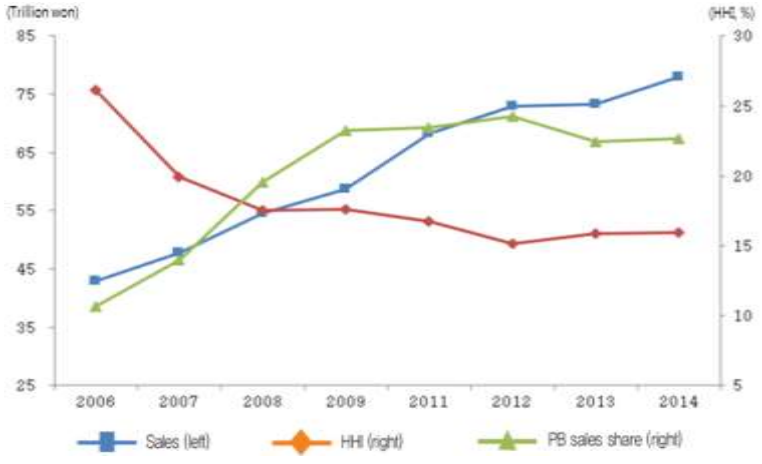

FIGURE 4. HHI, SALES AND PB SALES SHARE IN CORPORATE RETAIL BUSINIESS

Note: Corporate retailers include large discount stores, SSMs within supermarkets, and convenience stores. The share of PB sales is the share of the three largest chains of large discount stores and SSMs.[9]

Source: Based on the Korea Chain Store Association, Yearbook of Retailers (2009~2015) and companies' annual reports (2009~2015).

differentiation among stores, which, in turn, strengthens customer loyalty.

In all, it is evident that PBs are a profit-maximizing solution created by retailers in response to such structural changes as greater market concentration levels and intensifying competition within the market.

V. Impact of Increased PB Sales on the Growth of Corporate Retailers

A. *Data and Empirical Specifications*

While retailers have been thrilled with the launch of PBs, there is very little evidence pertaining to whether the strategy has actually helped their growth. To identify this, this paper secured two groups of data. The first group refers to the Wholesale and Retail Trade Survey MDIS (2006~2014, Statistics Korea), including information on sales, expenses, and profits for individual stores.[10]

The second dataset should be PB sales information. Because the observations in MDIS are at the store level, obtaining PB sales information at the store level would be ideal for merging data and identifying this effect. However, in that such data do not exist at present, I construct an average PB sales ratio by distribution type and year, where the distribution type includes large discount stores, SSMs, convenience

[9]Three major convenience store chains are excluded from the calculation of the PB sales share due to limited data. If sufficient annual data could be applied, it is expected that the share of PB sales (square line in Figure 4) would rise steeply to the right.

[10]This data also include business information such as the store location, number of employees, number of annual business months, average daily business hours, store floor area and other information, making it easy to create various control variables.

stores, and small independent stores.[11]

Finally, I merge the PB sales ratio with the MDIS data based on the subcategories (at the five-digit level) in the standard industry classification code. Table 1 shows summary statistics of the retail data.

TABLE 1—SUMMARY STATISTICS OF RETAIL DATA

Variables		No. of Obs	Mean	Std. Dev	Min	Max
Sales (100 million won)		39,391	90.09	272.28	0.01	4,898.51
PB Sales Ratio (0~1)		38,296	0.15	0.06	0.04	0.33
Large Discount Store (0/1)		39,391	0.10	0.30	0.00	1.00
Supermarket (0/1)		39,391	0.35	0.48	0.00	1.00
Convenience Store (0/1)		39,391	0.55	0.50	0.00	1.00
Headquarters (0/1)		39,391	0.23	0.42	0.00	1.00
Branch (0/1)		39,391	0.09	0.28	0.00	1.00
Independent Store (0/1)		39,391	0.68	0.47	0.00	1.00
Shop Area (m^2)		39,391	1,358.02	4,125.40	10.00	98,461
Business Period (months)		37,604	106.29	77.79	1.00	706.00
Business Months per Year		39,391	11.01	2.57	1.00	12.00
Average Business Hours per Day		39,391	4.67	0.76	1.00	5.00
Days Closed per Month		39,391	4.35	2.21	1.00	6.00
Sales Composition Ratio	Between Headquarters and Branch	39,388	0.08	1.75	0.00	100.00
	Wholesaler	39,389	0.05	1.23	0.00	98.00
	Retailer	39,384	0.69	6.61	0.00	100.00
	Industrial Activity	39,389	0.56	6.15	0.00	100.00
	Consumer	39,390	98.56	9.48	0.00	100.00
	Overseas Exports	39,388	0.01	0.69	0.00	100.00
	Etc.	39,386	0.06	1.21	0.00	100.00
Purchase Composition Ratio	Between Headquarters and Branch	39,379	19.27	38.13	0.00	100.00
	Producer	39,386	13.92	31.35	0.00	100.00
	Wholesaler	39,391	65.28	45.19	0.00	100.00
	Overseas Exports	39,386	0.27	4.12	0.00	100.00
	Etc.	39,388	1.26	9.90	0.00	100.00

Source: Statistics Korea, "Wholesale and Retail Trade Survey MDIS," 2006~2014; Statistics Korea, "Economic Census MDIS," 2010; Korea Chain Store Association, the Yearbook of Retailers (2009~2015); Companies' Annual Reports (2006~2015).

[11]Specifically, because PB sales data could not be established at the store level, I constructed it at the enterprise level instead using the Yearbook of Retailers and a range of other sources. However, the enterprise level of PB sales data could not be merged and utilized due to missing business registration numbers and corporation registration numbers in MDIS. Finally, I derive the average PB sales ratio by year and distribution type (five-digit code in KSIC).

The estimation model has the following form:

$$y_{ijst} = \alpha PB_{jt} + X_{ijst}\beta + \sum_{s} \gamma_s D_s + \sum_{t} \delta_t T_t + u_{ijst} \quad (1)$$

The dependent variable y_{ijst} denotes the sales (or profits) of store i of distribution type j located in region s in year t. For example, y_{ijst} can represent the sales of a certain large discount store located in Seoul in 2013.

PB_{jt} is the PB sales ratio, which is the proportion of PB sales to total sales by distribution type and year. When constructing the PB sales ratio at the distribution type level, we need a relatively strong assumption that stores in the same category have the same PB sales ratio. This assumption is generally realistic in that stores operated by a corporate retailer are standardized in terms of their supply characteristics, product composition, sales method, and shopping environment.[12],[13]

X_{ijst} is a vector of various store characteristics, including the distribution type, annual business months, average daily business hours, number of holidays, and store floor area. D_s is a vector of region dummies at the metropolitan city level. T_t is a vector of year dummies controlling for the effects of the overall economic downturn on domestic demand since the mid-2000s. u_{ijst} is an i.i.d. error term.[14]

B. *Estimation Results*

Model (1) in Table 2 reports OLS estimates, which show that a 1%p rise in the PB sales ratio tends to increase a store's sales by 165 million won. This estimate is statistically significant, but its magnitude appears to be relatively large, as 165 million won is equivalent to around 2% of sales.[15]

Meanwhile, the error terms may not satisfy the IID condition. Because stores in the same category (i.e., discount store, SSM, or convenience store) can be influenced by common factors, the distribution of the error terms can vary with the category. Considering this heteroscedasticity, model 2 estimates the equation with iterative reweighted least square (IRLS) method, a robust type of regression. According

[12]Nevertheless, given that the demand characteristics of each store may differ, it is necessary to utilize PB sales shares by each store or company. In the future, more abundant PB sales information must be generated and constructed in order to promote further studies.

[13]If the PB sales ratio can be merged at more micro-levels (enterprise or store level), there is an advantage in that the potential endogeneity problem can be mitigated in a regression analysis. Because PBs tend to be released in profitable categories, adverse causality may exist. To address this, Ailawadi and Harlam (2004) estimated a simultaneous equation system, using one equation with the distribution profit as a dependent variable and the other equation with PB sales as the dependent variable.

[14]As the PB ratio is generated at the aggregated level according to the distribution type and year, it is likely that the correlation between the PB ratio and various fixed effects will increase. Accordingly, various fixed effects (time, location, distribution type) were controlled. Therefore, 'α' measures how much sales increase when the PB ratio of the average or representative store rises. Because the coefficient measures the average effect, a large discount store will have a greater impact and convenience stores will have relatively smaller impacts compared to the average effect.

[15]The average sales amount for retail stores in the sample is 9 billion won.

TABLE 2—EFFECTS OF AN INCREASE IN THE PB SALES RATIO ON THE SALES OF RETAIL STORES

Dep. Var.: Sales (100 million won)	(1) OLS	(2) IRLS	(3) WLS_Firm	(4) WLS_Emp
PB Sales Ratio (0~1)	164.71***	22.33***	25.18***	28.52***
	(28.18)	(0.69)	(3.81)	(3.92)
Large Discount Store (0/1)	482.42***	382.04***	513.18***	512.90***
	(5.25)	(0.13)	(2.07)	(2.09)
Supermarket (0/1)	25.65***	0.55***	10.63***	10.77***
	(2.63)	(0.06)	(0.44)	(0.45)
Headquarters (0/1)	30.18***	3.88***	21.14***	21.33***
	(2.56)	(0.06)	(0.53)	(0.55)
Branch (0/1)	56.63***	6.91***	34.49***	34.88***
	(4.61)	(0.11)	(1.10)	(1.12)
Shop Area (m^2)	0.01***	0.02***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Business Period (months)	0.16***	0.00***	0.03***	0.03***
	(0.01)	(0.00)	(0.00)	(0.00)
Number of Stores in Region	-0.02***	0.00***	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Business Months per Year	1.48***	0.31***	0.86***	0.88***
	(0.33)	(0.01)	(0.07)	(0.07)
Average Business Hours per Day	13.43***	-0.37***	3.38***	3.44***
	(1.40)	(0.03)	(0.30)	(0.31)
Closed Days per Month	7.41***	0.29***	1.20***	1.17***
	(0.96)	(0.02)	(0.21)	(0.21)
Number of Households	0.00***	0.00***	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Sales Composition Ratio (between Headquarters and Branch)	2.75***	1.38***	-0.33	-0.32
	(0.84)	(0.02)	(0.28)	(0.28)
Sales Composition Ratio (Wholesaler)	6.13***	7.01***	3.49***	3.50***
	(0.97)	(0.02)	(0.36)	(0.36)
Sales Composition Ratio (Retailer)	0.04	-0.01	-0.99***	-0.99***
	(0.68)	(0.02)	(0.26)	(0.26)
Sales Composition Ratio (Industrial Activity)	-0.87	-0.02	-1.03***	-1.03***
	(0.68)	(0.02)	(0.26)	(0.27)
Sales Composition Ratio (Consumer)	-1.07	-0.01	-1.21***	-1.22***
	(0.67)	(0.02)	(0.26)	(0.26)
Sales Composition Ratio (Overseas Exports)	2.03	18.12***	0.11	0.17
	(1.59)	(0.09)	(0.63)	(0.64)
Constant	263.54***	-1.27	84.55***	89.27***
	(71.79)	(1.77)	(26.00)	(26.47)
Year_dummy	Y	Y	Y	Y
Region_dummy	Y	Y	Y	Y
Observations	37,604	37,603	204,191	199,598
Adj R^2	0.61	-	0.62	0.62

Note: Standard errors are in parentheses. *, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Source: Statistics Korea, "Wholesale and Retail Trade Survey MDIS," 2006~2014; Statistics Korea, "Economic Census MDIS," 2010; Korea Chain Store Association, the Yearbook of Retailers (2009~2015); Companies' Annual Reports (2006~2015).

to model 2, a 1%p rise in the PB sales ratio is likely to increase store sales by 22 million won on average. It is still found that a higher PB sales ratio contributes to sales growth, but now the magnitude of the coefficient is decreased to 1/7 of the OLS estimate.

The IRLS assigns low weight values to observations with large absolute values of residuals, while giving large values to those with small absolute values of residuals. Therefore, the IRLS helps to induce homoscedasticity such that more efficient and accurate estimates can be derived.

Additionally, models 3 and 4 adopt the weighted least square (WLS) approach with a business multiplier and an employee multiplier as the weights, respectively. While both estimates are statistically significant at the 1% level, they are relatively close to the IRLS estimate as compared to that by OLS.

Moving on to the impact of PB sales on retail profit (see Table 3),[16] the IRLS model shows that a 1%p increase in the PB sales ratio tends to raise the retail profit by 2.65 million won. This tendency was consistently estimated in the following two WLS models, where retail profits are likely to rise by 8.31 and 9.04 million won, respectively. The coefficient fluctuates somewhat depending on the model, but all estimates confirm that higher PB sales contribute to increasing the sales and profits of retail stores.

These findings are consistent with those by Ailawadi and Harlam (2004), who demonstrated a positive impact of PB expansion on retailer earnings. Indeed, the strategy of expanding PBs in response to a sluggish economy and heated competition appears to have been successful.

TABLE 3—EFFECTS OF AN INCREASE IN THE PB SALES RATIO ON THE PROFITS OF RETAIL STORES

Dep. Var.: Sales (100 million won)	(1) OLS	(2) IRLS	(3) WLS_Firm	(4) WLS_Emp
PB Sales Ratio (0~1)	51.94***	2.65***	8.31***	9.04***
	(8.56)	(0.19)	(1.15)	(1.18)
Large Discount Store (0/1)	150.43***	146.66***	160.55***	160.49***
	(1.60)	(0.03)	(0.62)	(0.63)
Supermarket (0/1)	5.24***	-0.12***	1.36***	1.39***
	(0.80)	(0.02)	(0.14)	(0.14)
Headquarters (0/1)	8.67***	1.09***	5.56***	5.58***
	(0.90)	(0.02)	(0.17)	(0.17)
Branch (0/1)	0.44	1.84***	2.71***	2.73***
	(1.42)	(0.03)	(0.33)	(0.34)
Shop Area (m^2)	0.00***	0.00***	0.00***	0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
Business Period (months)	0.05***	0.00***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
Number of Stores in Region	-0.01***	0.00***	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Business Months per Year	0.37***	0.10***	0.21***	0.21***
	(0.10)	(0.00)	(0.02)	(0.02)

[16]Retail profit corresponds to value-added created by the retailer, which is calculated as the amount of total annual sales minus the total amount of goods purchased.

TABLE 3—EFFECTS OF AN INCREASE IN THE PB SALES RATIO ON THE PROFITS OF RETAIL STORES *(CONT'D)*

Dep. Var.: Sales (100 million won)	(1) OLS	(2) IRLS	(3) WLS_Firm	(4) WLS_Emp
Average Business Hours per Day	1.24***	-0.03***	0.32***	0.33***
	(0.43)	(0.01)	(0.09)	(0.09)
Closed Days per Month	1.97***	0.04***	0.39***	0.40***
	(0.29)	(0.01)	(0.06)	(0.06)
Number of Households	0.00***	0.00***	0.00**	0.00**
	(0.00)	(0.00)	(0.00)	(0.00)
Sales Composition Ratio (between Headquarters and Branch)	0.37	0.16***	-0.03	-0.02
	(0.25)	(0.01)	(0.08)	(0.08)
Sales Composition Ratio (Wholesaler)	0.35	0.02***	0.25**	0.25**
	(0.30)	(0.01)	(0.11)	(0.11)
Sales Composition Ratio (Retailer)	0.07	0.00	-0.13*	-0.13*
	(0.21)	(0.00)	(0.08)	(0.08)
Sales Composition Ratio (Industrial Activity)	-0.11	0.00	-0.19**	-0.19**
	(0.21)	(0.00)	(0.08)	(0.08)
Sales Composition Ratio (Consumer)	-0.08	0.00	-0.17**	-0.17**
	(0.2)	(0.00)	(0.08)	(0.08)
Sales Composition Ratio (Overseas Exports)	-1.94***	-0.20***	-1.46***	-1.46***
	(0.49)	(0.01)	(0.19)	(0.19)
Purchase Composition Ratio (between Headquarters and Branch)	-0.02	0.00	0.00	0.00
	(0.03)	(0.00)	(0.01)	(0.01)
Purchase Composition Ratio (Producer)	-0.01	0.00	0.00	0.00
	(0.03)	(0.00)	(0.01)	(0.01)
Purchase Composition Ratio (Wholesaler)	-0.02	0.00	-0.01	-0.01
	(0.02)	(0.00)	(0.01)	(0.01)
Purchase Composition Ratio (Overseas Exports)	1.33***	-0.01***	1.28***	1.28***
	(0.07)	(0.00)	(0.03)	(0.03)
Constant	80.42***	-0.21	10.93	12.42
	(21.83)	(0.47)	(7.84)	(7.98)
Year_dummy	Y	Y	Y	Y
Region_dummy	Y	Y	Y	Y
Observations	37,604	37,604	204,191	199,598
Adj R^2	0.62	-	0.63	0.63

Note: Standard errors are in parentheses. *, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

Source: Statistics Korea, "Wholesale and Retail Trade Survey MDIS," 2006~2014; Statistics Korea, "Economic Census MDIS," 2010; Korea Chain Store Association, the Yearbook of Retailers (2009~2015); Companies' Annual Reports (2006~2015).

VI. Impact of Increased PB Production on the Growth of Manufacturing Firms

Will the expansion of PB products then help manufacturers' growth? To test this, I surveyed 1,000 manufacturers that were supplying their products to domestic corporate retail companies. The questionnaire mainly asked about sales, production

costs, delivery prices, final consumer prices, and the market share for both NBs and PBs. It also asked about quality differences between PBs and NBs, the method of PB development, types of unfair trade practices experienced, and other factors.[17]

A. *Impact on the Quantitative Growth (Sales) of Manufacturing Firms*

As in the analysis on the retail side, the key independent variable is the PB sales ratio. A firm's PB sales ratio is defined as the proportion of 'major' PB sales to annual total sales. Because a firm may produce several and different types of PBs, I focused on the major PBs with the highest sales proportions.[18]

The model is estimated using ordinary least squares while controlling for various firm characteristics. Table 4 shows the basic statistics of the main variables used in the regression analysis.

According to the estimates (see model 1 in Table 5), a higher PB sales ratio tends to decrease sales of the top SMEs (PB sales ratio(t) = -2.76).[19] Compared to this negative impact, large enterprises are affected more negatively (PB sales ratio(t) ∗ Large enterprises = -8.10), while the middle and bottom SMEs are affected less negatively (PB sales ratio(t) ∗ SMEs_middle = 2.06, PB sales ratio(t) ∗ SMEs_ bottom = 2.38). The only positively affected group is the small business group (PB sales ratio(t) ∗ Micro_businesses = 2.94). In short, all types of establishments with the

TABLE 4—DESCRIPTIVE STATISTICS OF THE SURVEY DATA

Variables	No. of Obs.	Mean	Std.. Dev.	Min	Max
Sales (100 million won)	926	246.44	517.59	0.64	4,360.00
Business Period (months)	926	16.58	11.20	1.00	64.00
Large Enterprises (0/1)	926	0.06	0.23	0.00	1.00
SMEs_top (0/1)	926	0.25	0.43	0.00	1.00
SMEs_middle (0/1)	926	0.33	0.47	0.00	1.00
SMEs_bottom (0/1)	926	0.24	0.43	0.00	1.00
Micro-Businesses (0/1)	926	0.12	0.33	0.00	1.00
PB Sales Ratio (%)	926	8.37	19.78	0.00	100.00
Having Overseas Factory (0/1)	926	0.11	0.32	0.00	1.00
Ranking of NB_1st (0/1)	926	0.10	0.29	0.00	1.00
Ranking of NB_2nd-3rd (0/1)	926	0.18	0.38	0.00	1.00
Ranking of NB_4th-5th (0/1)	926	0.19	0.39	0.00	1.00

Note: SMEs are categorized into 'SMEs_top' (the upper 30%), 'SMEs_middle' (the middle 40%) and 'SMEs_bottom' (the bottom 30%) according to the employment size.

[17]There were a total of 4,063 companies in the supplier list provided by retailers, but the final sample size was set to 1,000 firms in consideration of time and cost. The survey questionnaire is presented in Appendix of Lee (2017).

[18]Suppose that one company produces NB milk and similar quality of PB milk as its main products and PB cheese as an auxiliary product. In this case, the yield of NB milk can be mostly influenced by PB milk rather than PB cheese. Considering this substitution pattern, PB sales ratio was set to reflect proportion of main PB product.

[19]In Table 5, PB sales ratio represents the effect on top SMEs since it is not controlled as interaction terms and thus become base group.

TABLE 5—EFFECTS OF AN INCREASE IN THE PB SALES RATIO ON THE SALES OF MANUFACTURERS

Dep. Var.: Sales_yr2015 (100 million won)	Model 1	Model 2	Model 3
Business Period (months)	3.57***	3.58***	4.10***
	(0.85)	(0.85)	(0.88)
Large Enterprises (0/1)	1,665.90***	1,668.44***	1,650.59***
	(44.16)	(44.13)	(44.41)
SMEs_middle (0/1)	-214.73***	-213.98***	-211.12***
	(26.29)	(26.21)	(26.59)
SMEs_bottom (0/1)	-257.50***	-255.09***	-240.35***
	(28.30)	(28.26)	(29.91)
Micro-Businesses (0/1)	-300.22***	-297.72***	-282.84***
	(34.01)	(33.92)	(34.41)
PB Sales Ratio (t)	-2.76***		
	(1.01)		
PB Sales Ratio(t) * Large Enterprises	-8.10*		
	(4.31)		
PB Sales Ratio(t) * SMEs_middle	2.06*		
	(1.24)		
PB Sales Ratio(t) * SMEs_bottom	2.38*		
	(1.30)		
PB Sales Ratio(t) * Micro-Businesses	2.94*		
	(1.63)		
PB Sales Ratio(t-1)		-2.65**	-2.88***
		(1.07)	(1.09)
PB Sales Ratio(t-1) * Large Enterprises		-8.39*	-7.91*
		(4.31)	(4.32)
PB Sales Ratio(t-1) * SMEs_middle		2.11	2.59**
		(1.30)	(1.31)
PB Sales Ratio(t-1) * SMEs_bottom		2.29*	2.07
		(1.34)	(1.35)
PB Sales Ratio(t-1) * Micro-Businesses		2.85*	3.55**
		(1.71)	(1.74)
Having Overseas Factory (0/1)			76.53**
			(30.41)
Industry Dummy	N	N	Y
Product Category Dummy	N	N	Y
Region Dummy	N	N	Y
Constant	275.25***	272.62***	89.38
	(26.72)	(26.65)	(289.09)
Observations	926	926	926
R^2	0.74	0.74	0.75

exception of micro-businesses exhibit reduced sales when the PB sales ratio rises. Moreover the size of the decrease in sales was proportional to the size of the company. That is, a higher PB sales ratio negatively affects the quantitative growth of manufacturing firms on average.

Model 2 considers the possibility of endogeneity of the PB sales ratio(t). The dependent variable, annual total sales (sales_yr2015), is located in the denominator when calculating PB sales ratio(t). Thus, when sales_yr2015 changes, both the dependent variable and the independent variable change even if PB sales remains constant. Considering this simultaneity problem, model 2 calculates the PB sales ratio using sales information as of the previous year(t-1). Further, model 3 controls for additional fixed effects with firm, industry, and region dummies. According to

the estimations, both models exhibit results similar to those of model 1 in terms of the direction and size of the coefficients.

This leads to the question of why large companies and small businesses are affected differently. We can expect that as PB sales increase, the annual total sales will also increase. Micro-businesses appear to experience a quantitative growth effect from this path. In actuality, when micro-businesses sign PB delivery agreements with corporate retailers, they can increase their plant utilization rate and production volume.

However, this explanation does not apply to larger corporations, whose overall sales decrease. Thus, for them, we can consider that sales of NBs are reduced due to the competition with PBs and that the characteristics of their NBs are different from those of micro-businesses. Indeed, Figure 5 shows that the larger the firm, the more it relies on the sales of NBs and the more top-selling NBs it has in the market.

Considering this point, I apply the market share ranking of NBs to a regression analysis (See Table 6), finding that a 1%p rise in the PB sales ratio generates higher sales losses (approximately 1.06 billion won) in firms with top-selling NBs than in those with NBs ranked sixth or lower in sales. This implies that the cannibalization effect—PBs crowding out NBs—is stronger in firms with NBs which sell better in the market.

This may be due to the practices of corporate retailers, who often place their PBs right next to best-selling NBs on shelves or replace NBs with PBs. In addition, NB consumers may switch to PBs if influenced by the recognition of PBs as being less expensive but of similar quality to NBs.[20]

Meanwhile, the NBs of micro-businesses usually account for a small share of sales; thus, the effect of cannibalization can be relatively weak. The supply of PBs to corporate retailers helped them to secure more sales channels and higher capacity utilization rates, leading to higher sales.

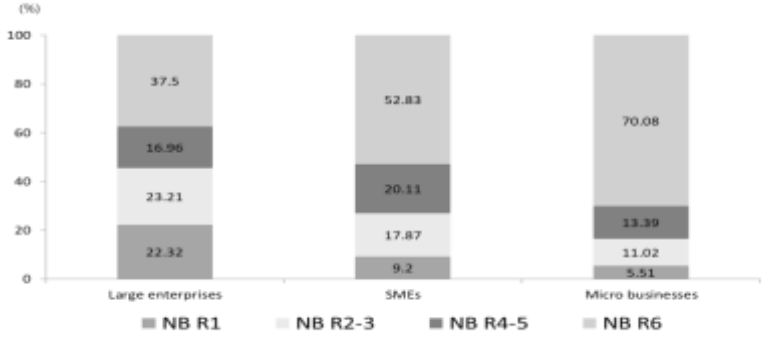

FIGURE 5. MARKET SHARE RANKING OF NBS BY FIRM SIZE

Note: SMEs is the average for SMEs_top, SMEs_middle and SMEs_bottom.

Source: Data from the Survey on Manufacturing Establishments (Korea Development Institute, 2016).

[20]Along with the cannibalization effect, the low prices of PBs may lead to an overall increase in demand. While these two opposing effects coexist, the estimation results show that the former effect may be stronger than the latter.

TABLE 6—EFFECT OF AN INCREASE IN THE PB SALES RATIO ON THE SALES OF MANUFACTURERS

Dep. Var: Sales_yr2015 (100 million won)			
PB Sales Ratio(t-1)	-2.88*** (1.00)	PB sales ratio(t-1) * NB Ranking_1	-10.63** (5.19)
NB Ranking_1	269.00*** (60.49)	PB sales ratio(t-1) * NB Ranking_2-3	-9.14*** (2.63)
NB Ranking_2-3	285.38*** (49.84)	PB sales ratio(t-1) * NB Ranking_4-5	-3.80 (2.35)
NB Ranking_4-5	119.54** (46.81)	Major PB sales(t)	2.43*** (0.35)
Observations	904	R^2	0.24

Note: 1) As in the models in Table 4, several characteristics (business period, industry dummy, product category dummy, region dummy) are controlled. Their coefficients are available upon request. 2) Standard errors are in parentheses. *, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

B. *Impact on the Qualitative Growth (Operating Profit) of Manufacturing Firms*

As a follow-up question, it can be asked whether quantitative growth for micro-businesses leads to qualitative growth. Specifically, this pertains to whether their higher sales from increased PB sales generate higher profits.

According to the estimation results, there were no significant increases in the operating profits of most SMEs and even of micro-businesses (See Table 7). This implies that the production increase caused by the PB supply does not guarantee actual profit gains.

To investigate the fundamental root of this finding, I measured how the value-added (created by PB sales) was distributed between retailers and manufacturers. Figure 6 describes the manufacturers' production costs, their operating profits, and retailers' margins as a proportion of the final consumer price (= 100%).[21]

In general, PB production is less costly because advertising, marketing and distribution costs borne by manufacturers are lower relative to the amounts they have to pay to supply NBs. This enables higher retail margins and operating profits for PBs, as shown in the case of large enterprises.

On the other hand, SMEs and micro-businesses exhibit decreased operating profits and increased retail margins from PBs, and the increment of the retail margin appears to be larger compared to that of large companies. The fact that the retail margins for smaller firms are larger may not be a critical issue. If retailers expended more effort and funding to develop PBs with smaller companies, the resulting higher retail margins would be reasonable compensation for them.

However, as shown in Table 8, most PBs have been developed from slight modifications from NBs (51.8%) or through package replacements of NBs (51.8%)

[21]Figure 6 is generated using survey data (of operating profit per sale, production cost per sale, supply price and final consumer price) with an assumption pertaining to the retail margin. I set the retail margin of NB to 30%, which is the mean value of margins according to all types of retailers represented in the Wholesale and Retail Trade Survey (MDIS). A different level of retail margin caused no change in the implications.

TABLE 7—IMPACT OF INCREASED PB SALES ON THE OPERATING PROFIT OF MANUFACTURERS

Dep. Var: Sales_yr2015 (100 million won)	Operating Profit		Operating Profit from PBs	
	(1)	(2)	(3)	(4)
PB Sales Ratio(t)	-0.34 (0.32)		0.18* (0.09)	
PB Sales Ratio(t) * Large Enterprises	-3.079** (1.36)		6.77*** (0.42)	
PB Sales Ratio(t) * SMEs_middle	0.23 (0.39)		-0.07 (0.12)	
PB Sales Ratio(t) * SMEs_bottom	0.32 (0.41)		-0.14 (0.13)	
PB Sales Ratio(t) * Micro-Businesses	0.34 (0.52)		-0.08 (0.17)	
PB Sales Ratio(t-1)		-0.33 (0.34)		0.18* (0.10)
PB Sales Ratio(t-1) * Large Enterprises		-2.73** (1.36)		6.39*** (0.43)
PB Sales Ratio(t-1) * SMEs_middle		0.32 (0.41)		-0.06 (0.13)
PB Sales Ratio(t-1) * SMEs_bottom		0.31 (0.43)		-0.14 (0.14)
PB Sales Ratio(t-1) * Micro-Businesses		0.33 (0.54)		-0.08 (0.18)
Observations	893	893	263	263
R^2	0.22	0.22	0.67	0.64

Note: 1) All models in Table 6 are controlled for the business period, industry dummy, product category dummy, region dummy. 2) Standard errors are in parentheses. *, **, *** denote statistical significance at the 10%, 5%, and 1% level, respectively.

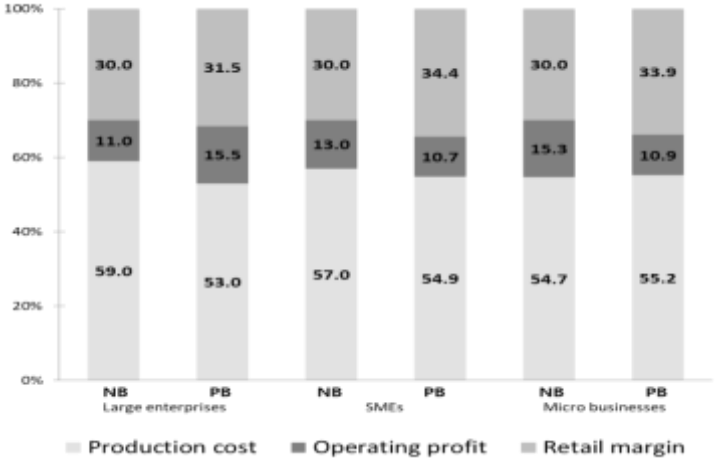

FIGURE 6. NB AND PB: COMPOSITION OF RETAIL MARGINS, OPERATING PROFITS AND PRODUCTION COSTS

Source: Based on data on operating profit per sales, production cost, unit price for supply and list price from the Survey on Manufacturing Establishments (Korea Development Institute, 2016).

TABLE 8—TYPES OF PBS IN COMPARISON WITH NBS

	Response	Percentage
Slight Modification of NB	160	51.8
Package Replacement of NB	81	26.2
Entirely New Product	41	13.3
Others	27	8.7
Total	309	100.0

Note: Based on companies with available data on PB sales.

Source: Data from the Survey on Manufacturing Establishments (Korea Development Institute, 2016).

or through package replacements of NBs (26.2%). Further, 88% of these cases occurred when SMEs and micro-businesses developed PBs. That is, it appears to be less convincing that efforts and costs by retailers are greater for PB development, especially in the case of smaller firms.

Overall, the findings imply that the above profit sharing structure derives from an imbalance in the bargaining position, possibly providing a rational explanation of why micro-businesses exhibited no significant gains in their operating profits, even after their sales volumes increased.

VII. Survey of the Types of PB Development and Unfair Trade Practices

Such aspects of the profit distribution can be linked to the PB development methods. According to Table 9, approximately 31% of manufacturers claim to have converted their NBs to PBs upon the recommendation of retailers (11.7%) or to have supplied products (developed through their own skills and efforts) as PBs (19.7%). These methods of supplying PBs can hinder the self-reliance and competitiveness of manufacturers. Unfortunately, these methods are more frequently adopted by SMEs (32%) and micro-businesses (41%) than by large enterprises (19%).

Even with the development of partnerships with retailers, accounting for the highest proportion, 77% of cases correspond to slight modifications of NB characteristics or a simple change in the packaging form, leading to higher substitutability between PBs and NBs. Overall, these PB development methods can help retailers to gain more profits, but they can also generate a strong cannibalization effect which affects manufacturers.

With respect to unfair trade practices by retailers, 30 (9.7%) out of 309 manufacturing suppliers reported that they had experienced such practices. With multiple answer choices allowed, the most common unfair request was to cut the supply price (20 firms, 34%), followed by the coerced development of PBs (8 firms, 14%), transfers of promotional expenses (7 firms, 12%) and unreasonable returns (7 firms, 12%).

TABLE 9—METHODS OF PB DEVELOPMENT

	Total	Large Enterprise	SME	Micro-businesses
Converting NBs to PBs at the Recommendation of Retailers	36 (11.7)	3 (9.4)	28 (11.2)	5 (18.5)
In-house Development of PBs	61 (19.7)	3 (9.4)	52 (20.8)	6 (22.2)
Development of Partnerships with Retailers	212 (68.6)	26 (81.3)	170 (68.0)	16 (59.3)
Total	309 (100)	32 (100)	250 (100)	27 (100)

Note: Based on companies with available data on PB sales.

Source: Data from the Survey on Manufacturing Establishments (Korea Development Institute, 2016).

VIII. Conclusion and Policy Suggestions

This study finds that the expansion of PBs raises the profits of corporate retailers but insignificantly affects, or in some cases reduces, those of subcontracting manufacturers. This occurs not only because the sales of national brands (NBs) decline due to the launch of similar PBs but also because the imbalance in the bargaining positions of the two parties and potential unfair trade practices have caused retail margins to be set high while manufacturers' operating profits are set low. In this regard, this study suggests the following policy recommendations.

Above all, the PB business should be subject to stricter inspections and monitoring to secure fair market orders. When investigating subcontractor transactions, the Fair Trade Commission should closely examine any violations of the ban on requesting management information of PB manufacturers (Article 11 of the Enforcement Decree of the Act on Fair Transactions in Large Franchise and Retail Business). By remaining involved in the PB development process, retailers may have access to suppliers' management information. Moreover, requests for reduced supply prices, the most frequently chosen item among unfair trade practices, could originate from retailers demanding or gaining access to suppliers' information.

Further, of the surveyed PB manufacturers who reported that they had been coerced into complying with unfair trade practices, 83% admitted to accepting all or some of the requests. Their somewhat tepid stance may be rooted in concerns over profit losses in response to any rejections of retailers' requests. To tackle this, (other than institutional efforts to encourage reporting with improved confidentiality) the Fair Trade Commissions needs to intensify ex-officio investigations and increase the penalty levels for unfair trade practices so as to lower the possibility of the recurrence of such practices.

Meanwhile, SME manufacturers need to step beyond the narrow domestic market into larger PB markets abroad by actively utilizing government support programs. The Private Label Manufacturers Association (PLMA) holds trade shows and exhibitions every year in Amsterdam (May), Chicago (November) and Shanghai (December), where retailers, buyers and PB manufacturers convene to

establish new channels and share product information. However, relatively few Korean manufacturers are aware of these events. Thus, there has been little participation. PB manufacturers must actively utilize government programs such as support for Overseas Distribution Network · Export Marketing (Ministry of SMEs and Startup) and Consumer Goods Specialization · Participation in Overseas Exhibitions (Ministry of Trade, Industry and Energy). At the same time, the government should focus on resolving the difficulties that these firms encounter while taking advantage of such policies and exploring trade partners. If manufacturing firms can successfully advance into new overseas markets and secure sales channels, they will become less dependent on domestic enterprise retailers. In doing so, they will eventually earn a better bargaining position for future negotiations.

Lastly, the research environment needs to be improved so that analyses of the domestic PB industry becomes more active. Prime examples are creating additional subcategories, such as 'PB,' 'NB' and 'Original Equipment Manufacturer (OEM),' under the establishment's sales in Statistics Korea's annual Mining and Manufacturing Survey, or adding separate survey items that can help discern PB sales to the Wholesale and Retail Trade Survey. Further, the Korea Consumer Agency could add convenience stores and SSMs to their current targets—mostly large discount stores—for its survey on PB prices and marks. A shorter survey interval than the current three-year term would also help to improve the practicality and use of research information.[22]

PBs have the potential to serve as a win-win scenario with regard to growth in the retail and manufacturing sectors. However, this can be achieved only when the value-added created during the production and sales processes is distributed via fair negotiations and contracts by market participants. To prevent PBs from being merely another type of subcontract, voluntary efforts by the industry and legal and institutional efforts by the government should be strengthened.

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[22]In the future, PBs will no longer be me-too products, but they are likely to be differentiated from NBs in terms of the product characteristics. What are known as premium PBs will increase. In such a situation, economic analyses of how the characteristics of PBs are affected by the degree of the market power of the manufacturer and the type of distributor, or on how the changes in the characteristics influence consumer utility, will gain more attention. In order to carry out such research, it is necessary to secure micro-data at individual product level.

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Applying a New Approach to Estimate the Net Capital Stock of Transport Infrastructure by Region in South Korea†

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Given the limited availability of data in South Korea, this study proposes a method by which to estimate regional capital stock by modifying the benchmark year method (BYM) and applies it to estimate regional net capital stock by sector in transport infrastructure. First, it estimates time-varying sectoral depreciation rates using the sectoral net capital stock and the investment amount for each period. Second, it estimates the net capital stock of each period using the net capital stock in the base year and the investment in each period. Third, in order to ensure that the sum of net capital stocks by region is equal to the nationwide estimate, the national estimates are allocated to each region according to the proportion of the values derived from the previous stage. The proposed method can alleviate well-known problems associated with conventional BYMs, specifically the upward bias and arbitrary choice of the depreciation rate.

Key Word: Regional Capital Stock, Transport Infrastructure, Modified Benchmark Year Method
JEL Code: H54, R53, R42, R58

I. Introduction

Estimating the size of capital stock by region is an important task that serves as the foundation of related research such as that on the growth of the national economy and the allocation of budgetary funding and resources in social overhead capital (SOC) investments for balanced regional growth. Due to the lack of basic data in South Korea, however, no official time-series statistics of regional capital

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stock is secured and estimation methods are very limited.

Methods of estimating the capital stock can be divided into direct survey methods for estimating stocks through investigations by telephone and/or field surveys and indirect estimation methods using available statistical data. Representative indirect estimation methods include the perpetual inventory method (PIM), the benchmark year method (BYM), and the polynomial BYM (for a detailed description of each, see Kim and Kwon, 2002, pp.16-22).

Types of capital stock are divided into gross capital stock and net capital stock. Gross capital stock refers to an estimate of the cost of repurchasing all fixed assets still in use at current prices, irrespective of the age of the assets. Net capital stock, on the other hand, is the market value of the fixed assets of the economy at some point in time. It represents the gross capital stock minus the consumption of fixed capital accumulated up to some point in time (Pyo, Jung and Cho, 2007, p. 143).

Gross capital stock using the PIM is the total investment in assets within the useful life period, and net capital stock can be estimated as gross capital stock excluding depreciation. Therefore, in order to apply the PIM, it is necessary to provide not only a long-term investment time-series but also information about the economic useful life of the asset and the disposal distribution. However, without credible data available in South Korea, it is impossible to use the PIM as used by most OECD member countries. For this reason, international comparisons are not possible.

As an alternative, the BYM uses the initial capital stock at the base year obtained through a direct survey method and the time-series of the investment over the estimation period. This method has the advantage of reducing the estimation error because the estimated results can be verified with survey data from the base year. Unfortunately, it also has the disadvantage of upward bias as it moves away from the base year because it cannot reflect the sudden disappearance of the capital or discoloration of the value (Kim, 2011, p. 195).

Finally, the polynomial BYM estimates capital stock between baselines using capital stock data for two base years and the investment time-series during that period. Therefore, it cannot be used in the absence of capital stock data for multiple base years (for more detailed comparisons of estimation methods in the context of South Korea, see Seo, 2000).

In South Korea, the National Wealth Survey (NWS) using the direct survey method was conducted once every ten years in 1968, 1977, 1987 and 1997. Since 1998, the indirect estimation method based on the 1997 survey results has been adopted because the direct investigation approach was deemed to be too expensive. Subsequently, the National Asset Statistics (NAS) as a replacement of the NWS has been released.

In order to replace the NAS, the Bank of Korea (BOK) and Statistics Korea provisionally announced in 2014 the results of the joint development of the National Balance Sheet (NBS) for the nation's net assets up to 2012 and announced the preliminary results of the national balance sheet up to 2013 in May of 2015. The NBS was intended to comply with the United Nations' new national accounts system (System of National Accounts 2008), which included non-financial assets, financial assets and financial liabilities, as opposed to how the existing NAS compiled non-financial assets only (Statistics Korea and Bank of Korea, 2015,

p.22). However, it is also impossible to estimate the capital stock of each region using the SOC data with both the NAS and the NBS.

Given such a limitation, this study proposes a means of estimating regional capital stock by modifying the BYM and applies it to estimate the regional net capital stock by sector in transport infrastructure, specifically roads, railroads and ports. Estimations by this method are done in three stages. First, the method estimates the time-varying sectoral depreciation rates using the sectoral net capital stock and the investment amount for each period. Second, it estimates the net capital stock of each period using the net capital stock in the base year and the investment amount in each period. Third, in order to ensure that the sum of net capital stocks by region is equal to the nationwide estimate, the national estimates are allocated to each region according to the proportion of the values derived from the previous stage.

The proposed method can alleviate some well-known problems of conventional BYMs. First, it is possible to realize the improvement of eliminating the upward bias of conventional BYMs, by which the sum of regional estimated values exceeds the national estimated value as the distance from the base year is increased. Second, it is possible to enhance the reliability of the estimation results by allowing time-varying depreciation rates for each sector instead of fixing these rates arbitrarily as some conventional BYMs do.

The rest of this paper is structured as follows. Section II examines previous studies attempting to estimate capital stock in South Korea. Section III explains the estimation method proposed by this study and Section IV discusses the results of estimating the regional net capital stock of the transport infrastructure in South Korea using this estimation method. Section V compares the results of this study with those of similar previous studies and discusses ways to use them in future policy-making efforts. Finally, Section VI presents the concluding remarks.

II. Related Literature

As shown in Table 1, previous studies which estimate the capital stock of South Korea given the limitations of the above-mentioned data cannot use the PIM completely, instead using the BYM, the polynomial BYM or the PIM in part. Only Kim and Cho (2006) have estimated the SOC using the modified PIM, but they targeted only ports in their study. Moreover, one can confirm that related studies commonly used estimation methods involving annual investment amounts in conjunction with the NWS. For a more detailed explanation of these previous studies, the reader can refer to Moon (2014) and Gong (2015).

Previous studies also used a variety of data to estimate capital stock investment by year. Early studies, such as those by Kim (1996) and Pyo (1998), used the gross fixed capital formation values from the National Accounts and from National Income Accounts. However, this is limited in that with these approaches, SOC stock cannot be divided according to different sectors. Later, Ha and Cho (2000) and Hyun and Kwon (2002) used internal data of the Ministry of Construction and Transportation and the BOK as annual investment levels. In these cases, the credibility of investment data is weak due to inconsistencies over time and large

TABLE 1—PREVIOUS STUDIES OF ESTIMATIONS OF CAPITAL STOCK IN SOUTH KOREA

Author	Published Year	Target[1]	Period	Stock Data[2]	Investment Data[3]	Methodology[4]	Classification
Estimation at the National Level							
Kim	1996	GCS, NCS	1968-1993	Y68, Y77, Y87	NA, NIA	PBY	Private/Public
Pyo	1998	GCS, NCS	1954-1996	Y68, Y77,Y87	NA, NIA	PBY, PI	By industry and capital
Ha and Cho	2000	GCS	1968-1997	Y68, Y77, Y87, Y97	iMOCT	PBY	By type of transport infrastructure
Hyun and Kwon	2002	GCS, NCS	1987-1999	Y68, Y77, Y87, Y97	iBOK	PBY	By capital
Kim	2002	GCS, NCS	1988-1999	Y87, Y97	CIS	PBY, BY	By sector of infrastructure
Kim and Cho	2006	GCS	1977-1997	Y97	Y97	MPI	Port
Pyo, Jung and Cho	2007	NCS	1970-2005	Y68, Y77, Y87, Y97	GFCF	BY, PI	By industry and capital
Estimation by Region							
Park, Jun and Park	1996	GCS	1972-1991	Y77, Y87	NCTP	PBY, PI, RA	By sector of infrastructure
Byeon	2000	GCS	1971-1996	Y77, Y87, Y97	VS	PBY, PI, RA	By sector of infrastructure
Ha and Cho	2001	GCS	1968-1997	Y68, Y77, Y87, Y97	iMOCT	PBY, RA	By type of transport infrastructure
Kim	2010	GCS	1997-2007	Y97	CIS	PBY	By type of transport infrastructure
Kim	2011	NCS	1977-2007	Y77, Y87,Y97	CIS	PBY	By type of transport infrastructure
Moon	2014	NCS	1977-2010	Y97	CIS	PBY, BY	By sector of infrastructure
Gong	2015	NCS	1997-2012	Y97	CIS	BY	By sector of infrastructure

Note: 1) GCS=Gross Capital Stock and NCS=Net Capital Stock. 2) Y##=National wealth statistics at year ##. 3) NA=National Account, NIA=National Income Account, iMOCT=internal data of the Ministry of Construction and Transport, iBOK=internal data of the Bank of Korea, CIS=Construction Industry Survey, GFCF=gross fixed capital formation table (supplementary table of the Bank of Korea's input-output table), NCTP=national comprehensive territorial plan (actual value) and VS=various sources. 4) BY=benchmark year method, PBY=polynomial benchmark year method, PI=perpetual inventory method, MPI=modified perpetual inventory method and RA=regional allocation.

variations across datasets (for a more detailed explanation, see Kim, 2010, pp.74-76). In order to overcome these limitations, Kim (2002) proposed a method which used investment data from the Construction Industry Survey (CIS) of Statistics Korea (formerly the Construction Industry Statistics Survey (before 2007)). This method became a typical way in the context of South Korea to which it is difficult to apply the PIM.

In addition, when estimating capital stock by region, it can be seen that certain data limits restrict the subject to SOC. At the nascent stage of the related research, the capital stock of the nation was allocated according to the capacity of the infrastructure, such as extensions of roads and railways, and the sizes of the facilities of ports and airports (Park, Jun and Park, 1996; Byeon, 2000; Ha and Cho, 2001). This method, however, incurs a major disadvantage in that accurate local allocations of stocks estimated according to monetary units cannot be performed. To overcome this challenge, Kim (2010) adopts a method which allocates regions using the progress payments of investments in CIS via the method of Kim (2002). In so doing, the procedure searches for the "progress payment of public construction in SOC by region" such that each yearly progress payment amount for domestic construction in SOC divided by region is multiplied by the proportion of the public construction amount from among the total progress payments in SOC for each year. This method has been established as a typical method with regard to the distribution of capital stock by region.

On the other hand, several studies have attempted to examine the effects of local capital stocks on local economies after estimating them. Park, Jun and Park (1996) showed that the influence of SOC is approximately 60% of that of private capital according to regional production function estimations. In particular, it has been shown that the transport sector contributes significantly to the increase in production compared to non-transport sectors. Byeon (2000) also estimated regional production and employment functions. As a result of estimating the regional production function, the effect of SOC and private capital on the gross domestic product (GDP) was found to be similar, and traffic and communication facilities have a greater impact on regional development than do other facilities. As the economy grows, the effects of SOC on regional development decline. Moreover, the regional employment function estimation shows that SOC affects local employment in the order of regional utilization facilities, transport and communication facilities, total SOC, and other facilities.

Ahn and Kim (2006) examined the relationship between the regional allocation policy for transport infrastructure and the growth of the regional economy. First, they concluded through a cointegration analysis that road investments are not the cause of the gaps in regional economic growth. Second, as a result of a causality test, it was found that investments in growing regions expanded regional gaps before 1998, whereas the gaps between regions were reduced after 1999, as investments in the transport infrastructure affected regional economic growth in a limited manner and the growing regions did not drive investment demand. Third, they concluded that the interregional allocation of investments in infrastructure gradually shifted with concerns over efficiency. The rigor of their analysis, however, is limited given the fact that their conclusion stemmed from the finding that the marginal productivity of the transport infrastructure is similar to that of

private capital.

Gong and Kim (2016) estimated the spatial lag model (SAM) using the SOC net capital stock estimated by Gong (2015). They show that the building of transport infrastructure can lead to growth in the affected region and in neighboring areas but that the effect of non-transport infrastructure is reversed. They judged that investments in non-infrastructure areas reflect equity concerns and the public interest.

III. A New Approach to Estimate Capital Stock by Region

As discussed above, because capital stocks in the transport sector are not broken down into regional and sectoral data in South Korea, it is necessary to use estimations. In this paper, we propose a modified BYM to obtain more reasonable estimates. Unlike previous research, we use the method of the regional allocation of quarterly net stock data by sector provided by the BOK. In other words, we regard the time-series data of secured sectoral capital stock as the national amount for each sector. This is done to compensate for the shortcomings of the conventional BYM, which does not reflect the sudden disappearance of capital or the discontinuance of value, as mentioned above, and which tends to show upward bias as the outcomes move away from the base year.

Moreover, with the proposed method, the depreciation rates for each segment are allowed to have different values over time. With this flexibility, the depreciation rate in this study can be accurately calculated for each sector and period using survey data. This generality stands in contrast to a recent study by Gong (2015), which is most similar to this study. That study applies the depreciation rate according to SOC assets as of 2011 from the NBS, which are assumed to be identical to the depreciation rate according to the SOC throughout the period.

However, a "negative" depreciation rate is still likely to be obtained due to the difference between the stock deflator and the flow deflator and the differences in the valuation methods of the assets according to the dataset used (Kim, 2011, p.197). The negative depreciation rate problem has been consistently raised in stock-estimating studies, but there remains no clear solution without a significant improvement in the data. Moreover, if the estimate is revised, it will negate the numerical value of the NWS (Kim, 2004, p.91). At present, therefore, we accept the limitations of the data and proceed with the estimation.

A. *Background and Assumption*

In this study, we assume that the most recent available data on the regional and sectoral capital stock provided in NWS 1997 is the stock of the base year. Similar to Kim (2010; 2011) and Gong (2015), we use publicly funded progress payment amounts of regional investment in SOC from the CIS as the investment amount. Table 2 shows the type of construction involved. In order to obtain quarterly data, the investment amount is assumed to be identical quarterly, and the actual investment amount in each case is based on the quarterly value of the GDP deflator in the construction sector.

TABLE 2—TYPES OF CONSTRUCTION BY TYPE OF INFRASTRUCTURE IN THE CONSTRUCTION INDUSTRY SURVEY

Type of Infrastructure	Type of Construction
Roads and Airports	General roads (210), Highways (211), Urban highways (212), Road bridges (220), Road tunnels (260), Airports (251)
Railroads	General railways (270), High-speed railways (271), Subways (272), Railway bridges (221), Railway tunnels (261)
Ports	Ports (250)

Note: The numbers in parentheses are the work type classification codes in the CIS.

Source: Adopted from Statistics Korea (2015), pp.72-73, and arranged.

The targeted transport infrastructure is limited to roads, railways and ports. This is done fundamentally because the BOK's quarterly net capital stock data show that the transport infrastructure is divided into roads, airports, railways and ports. Airports included in the road category here pertain to runways. In Gong (2015), the type of construction at airport facilities is also considered to be runways when calculating the investment amount. In that there are no available time-series of quarterly net capital stock data and considering that the stock of airports is estimated to reach at most one to two percent of that of roads in previous studies (Kim, 2011; Gong, 2015), airports (runways) were included in the road category.

In addition, the BOK's quarterly net capital stock data is divided into the government and private sectors according to the current NAS sector classification. The capital stock of the transport infrastructure in this study adopts these sums for the following reasons. First, the function of the facility is a more important consideration than the identity of the client of the transport infrastructure capital stock. In other words, unlike other sectors, transport infrastructure is used not only for private investment but also for providing public services such as government investments.

TABLE 3—CLASSIFICATIONS IN THE SOUTH KOREAN NATIONAL ACCOUNTS SYSTEM

Government	Private			
	Non-financial corporation	Financial corporation	Household and non-profit organization	Overseas
• Central government • Local government • Social security fund • Public non-profit organization	• Private enterprise • Public enterprise • Quasi-corporate enterprise	• Financial corporation	• Household • Small private enterprise • Non-profit organization serving households (NPISHs)	• Non-resident

Note: A quasi-corporate enterprise means a private company that is large enough to report a balance sheet or income statement to the National Tax Service, and private companies not falling into this category are included as households and non-profit organizations.

Source: Rearranged from Table II-2 in Bank of Korea (2014), p.25.

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Third, investments in transport infrastructure are made not only by public corporations but by private investments, typically in significant amounts. Figure 1 shows the trend of private investment compared to fiscal investment in the SOC sector. In particular, since the mid-2000s, private investment has accounted for seven to seventeen percent of the total investment for each year. Table 5 compares the self-investment amounts by public corporations and private capital investments with a governmental budget for SOC. It can be confirmed once again that the shares of public corporations and the private sector are significant.

TABLE 4—ALLOCATION OF FUNDING BY TYPE OF TRANSPORT INFRASTRUCTURE

Type	Classification	Support criteria and Contents	Funding (%)		
			National expense	Local expense	Public corporation
Road	Highways	Construction	40	-	60
		Compensation	100	-	-
	National roads	Construction + Compensation	100	-	-
	Wide area roads	Roads over two or more Metropolitan Cities and Provinces (Cap amount 100 billion Korean Won)	50	50	-
	Detours roads / National subsidy roads	Construction	100	-	-
		Compensation expenses can be supported by national treasury if the total construction cost exceeds 30%	-	30% of compensation	-
	National industrial complex access roads	Construction + Compensation	100	-	-
Railroad	High-speed railways	Construction + Compensation	50	-	50
	General railways	Construction + Compensation	100	-	-
	Wide area railways	Running over two or more Metropolitan Cities and Provinces Construction + Compensation	70	30	-
		Local government business	60	40	-
		Seoul Metropolitan City	50	50	-
	City railways	Construction and operation in urban traffic zone	60	40	-
		Seoul Metropolitan City	40	60	-
Port	Port facilities	Only the items and support regulations of the supportable facilities are presented.	Support regulations		
Airport	Airports	Airport facilities	100	-	-

Source: Rearranged from Table 3 in Cho and Park (2013), p.4 and internal data of the Ministry of Strategy and Finance.

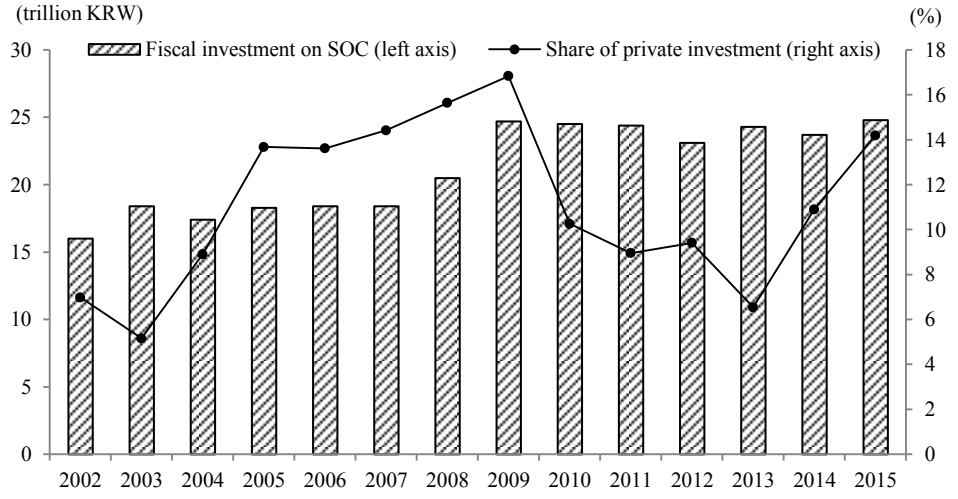


FIGURE 1. SHARE OF PRIVATE INVESTMENT COMPARED WITH FISCAL INVESTMENT

Source: Internal data of the Ministry of Strategy and Finance.

TABLE 5—TRENDS IN SOC INVESTMENTS

Classification	2004	2006	2008	2010	2012	2014	2015
Government budget	17.4	18.4	20.5	25.1	23.1	23.7	24.8
Public corporations' investments	4.5 (19.1%)	4.2 (16.5%)	4.4 (15.3%)	9.9 (26.3%)	6.3 (19.6%)	5.7 (17.8%)	6.9 (19.1%)
Private investments	1.7 (7.2%)	2.9 (11.4%)	3.8 (13.2%)	2.7 (7.2%)	2.7 (8.4%)	2.7 (8.4%)	4.4* (12.2%)
Total	23.6	25.5	28.7	37.7	32.1	32.1	36.1

Note: 1) Figures in parentheses represent the proportion of the total investment. 2) * Private investment accounts for nationally managed businesses, with the amount in 2015 preliminary.

Source: Rearranged from Table 1-3 in the Working Group of the SOC Field in the National Finance Operation Plan (2015), p.6.

Finally, the regional unit was set to seven metropolitan cities and nine provinces in South Korea. Although it is not possible to classify by city or county in more detail due to data limitations, it is possible to classify all metropolitan cities and provinces, excluding the Sejong Special Self-Governing City, with the NWS 1997 data as the base year. Sejong Special Self-Governing City, which was launched in 2012, was included in Chungcheongnam-do (do = province), to which it previously belonged to.

B. *Estimation Strategy*

To estimate the transport infrastructure stock by region, this study uses the modified BYM divided into three stages. In the first stage, the time-variable depreciation rates are calculated by sector. Let δ_{jt} be the depreciation rate of

sector j at time t (quarterly spaced from 1998 to 2014 in the data); hence, we can use the formula

$$C_{jt}^{BOK} = \left(1 - \delta_{jt}\right) C_{jt-1}^{BOK} + I_{jt-1}^{CIS}$$

to obtain each period's depreciation rate δ_{jt} sequentially. Here, C_{jt}^{BOK} and I_{jt}^{CIS} represent the sectoral net capital stock and investment (progress payment by construction type), respectively, and their time-series $\{C_{jt}^{BOK}\}$ and $\{I_{jt}^{CIS}\}$ are obtained from data from the BOK and the CIS, respectively.

Meanwhile, it can be assumed that the depreciation rate of capital stock by sector may change depending on the region more flexibly, but it is considered that there are no large differences between regions of specific sectors in South Korea in a given epoch and that it is impossible to acquire suitable data. Therefore, depreciation is assumed to be different for each sector but not for different regions. In the second stage, the ratio of the interregional distribution of capital stock by region and sector is obtained. Substituting the depreciation rates of capital stocks by sector as obtained above, δ_{jt} into the equation

$$C_{ijt}^{0} = \left(1 - \delta_{jt}\right) C_{ijt-1}^{0} + I_{ijt-1}^{CIS}$$

the "preliminary" time-series of regional and sectoral capital stock, $\{C_{ijt}^{0}\}$, can be obtained for each region i and sector j at time t. In so doing, using the capital stock value of each region and sector of NWS 1997 (fourth quarter) corresponding to the base year, C_{ij1997}^{0}, and the time-series of investment by region and sector of the CIS, $\{I_{ijt}^{CIS}\}$, the values in the time-series $\{C_{ijt}^{0}\}$ can be obtained sequentially for all time points.

The above-mentioned time-series of capital stock by region and sector, $\{C_{ijt}^{0}\}$, is called the "preliminary" value because the estimated regional capital stock using the conventional BYM may show a large difference from the actual value after a long period of time from the base year (In fact, the total of these regional estimates, $\sum_{i} C_{ijt}^{0}$, revealed a significant overestimation compared to the national level data of the BOK, C_{jt}^{BOK}).

In the third stage, the capital stock by sector at the national level is allocated by region. Rather than taking the level of the time-series obtained in the previous step as the capital stock for each region and sector, it would be more appropriate to take the ratio between them only and allocate more accurate capital stock estimates to the corresponding ratio. Finally, it is possible to establish the regional and sectoral capital stock time-series, $\{C_{ijt}\}$, the entire procedure of the estimation strategy is illustrated in Figure 2.

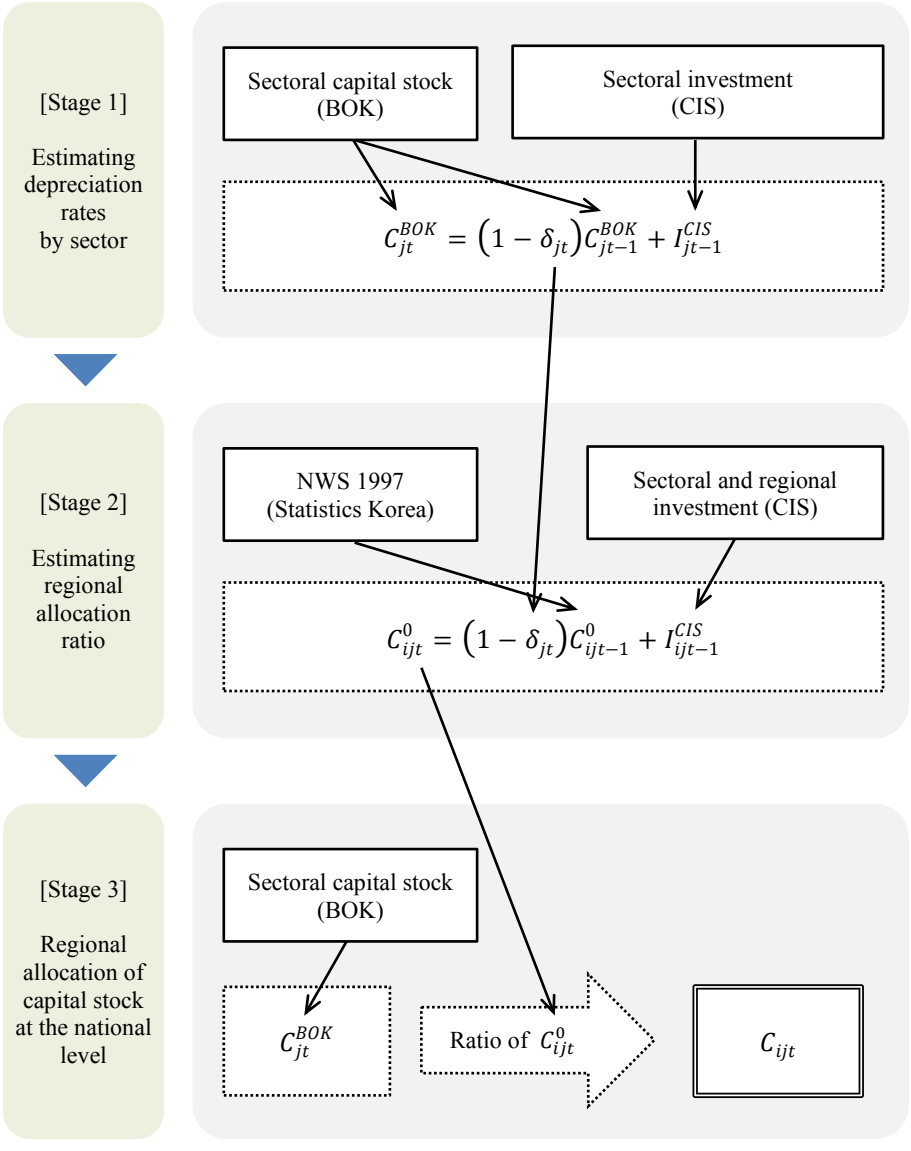


FIGURE 2. THREE-STAGE MODIFIED BENCHMARK YEAR METHOD TO ESTIMATE SECTORAL CAPITAL STOCK BY REGION

IV. Estimation Results

Figures 3, 4 and 5 show the regional transport infrastructure capital stock estimated through the above-mentioned method for roads, railroads and ports, respectively. All cases are the real net capital stocks of transport infrastructure chained at 2010, and the unit is billion Korean won (KRW).

First, for roads, as shown in Figure 3, the stock increase is more prominent in provinces than the metropolitan cities. This suggests that more roads for inter-regional traffic are replenished than for intra-regional traffic. From the data in CIS,

in fact, during the period from 2000 to 2014, the actual investment amount by the central and local governments in metropolitan cities and provinces was 23.2 trillion KRW and 175.9 trillion KRW, respectively, showing a considerable discrepancy.

Among metropolitan cities, stocks in Seoul were significantly higher than those in Incheon and Busan. However, after the rapid increase of stocks in Incheon in the early 2000s, this data tended toward a constant gap. Subsequently, Daegu followed with a weak increase. On the other hand, the stock of Gwangju was estimated to be the lowest, but it did not show much of a difference from Ulsan and Daejeon, which showed lower levels among the comparison group.

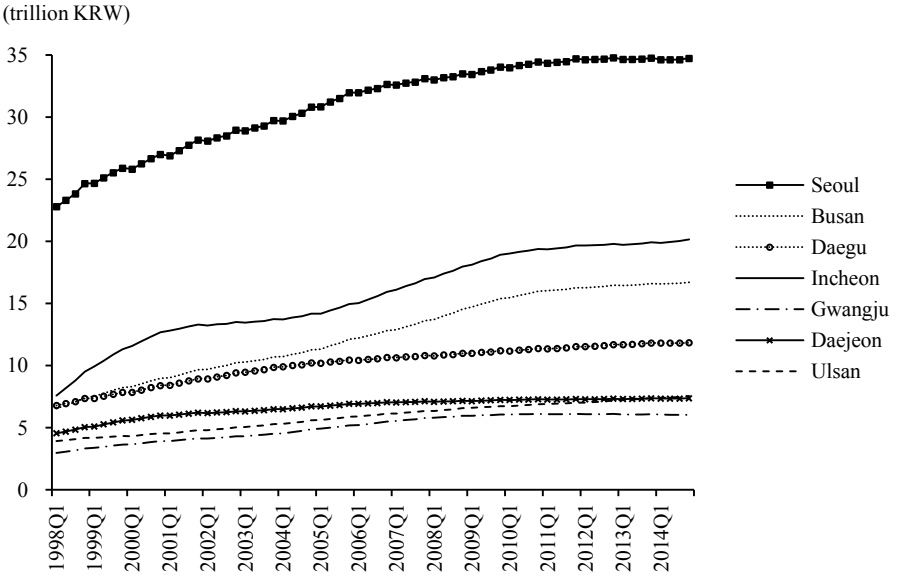
For provinces, the stock of Gyeonggi-do is highest, as expected from its unrivaled high level of urbanization. Next, Gyeongsangbuk-do and Gyeongsangnam-do are close to each other, and the stocks of Gangwon-do and Jeollanam-do are shown to converge at a similar level more recently. It can be seen that the amounts for Gangwon-do and Jeollanam-do grew relatively high in the early 2000s and in the late 2000s, respectively. Also, Chungcheongnam-do, Jeollabuk-do and Chungcheongbuk-do show similar trends, most likely due to some similarities caused by the proximity of their locations.

In the case of the railroads, shown in Figure 4, Seoul, Busan and Daegu metropolitan cities consistently occupied the top slots. They have a common point of being base regions for a wide area railways and relatively developed cities in a railway area. Subways began operating in 1974 in Seoul, 1985 in Busan and 1997 in Daegu. The remaining metropolitan cities showed low levels at the beginning of the estimation period, but the increase in the stocks of Daejeon, whose city railway opened in 2006, in the early 2000s and Incheon in late 2000s showed a marked increase.

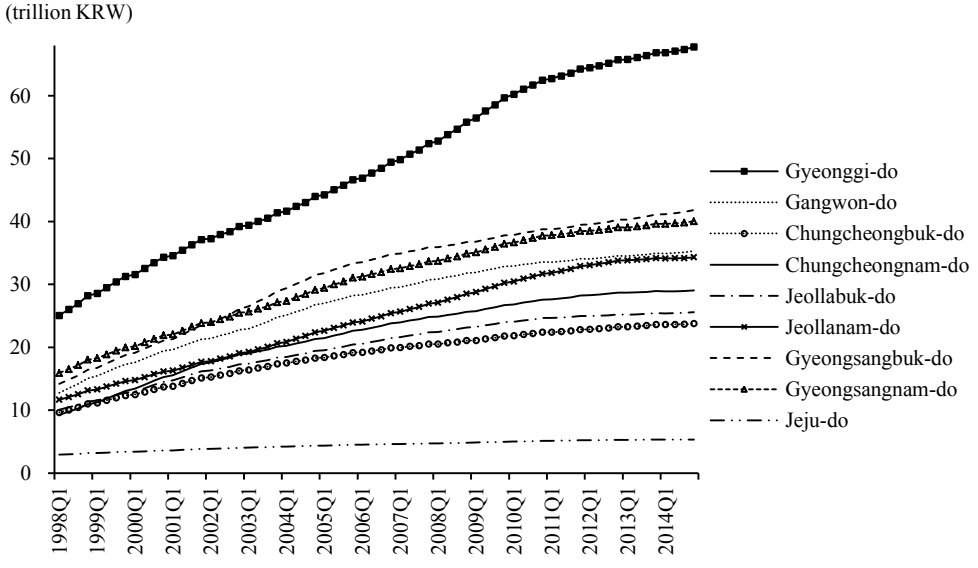
Unlike the metropolitan cities, however, the stocks of railroads in provinces at the end of the 1990s were not very large. This is due to the fact that the proportion of road investment out of South Korea's total transport infrastructure is high, though the relative share of railways was reduced in the 1980s to 1990s (Ahn and Kim, 2006, pp.37-38). Nevertheless, during the era of the expansion of infrastructure investment in the 1990s, the stock of Gyeonggi-do grew steadily, followed by Gyeongsangbuk-do with a large gap. In addition, Gyeongsangnam-do during the late 2000s and Jeollabuk-do in the early 2010s showed relatively large increases in stocks. The construction of high-speed railways in each region can be regarded as the main driver of the stock growth. Other provinces showed no significant differences, only showing moderate growth.

Finally, the ports shown in Figure 5 were excluded from Seoul, Gwangju and Daejeon metropolitan cities, and Chungcheongbuk-do, which have very low stocks due to their inland geographical characteristics. With regard to metropolitan cities, stock levels were in the order of Busan, Incheon, and Ulsan over most of the estimation period. However, the increase in the stock in Incheon Metropolitan City is noticeable in the early part of the estimation period, as are the recent reversals of Incheon and Busan.

Among the provinces, the stock of Jeollanam-do grew steadily, followed by Gyeongsangnam-do with recent rapid growth in the middle and late 2000s. Other provinces showed gradual growth, and the recent growth of Chungcheongnam-do is remarkable.

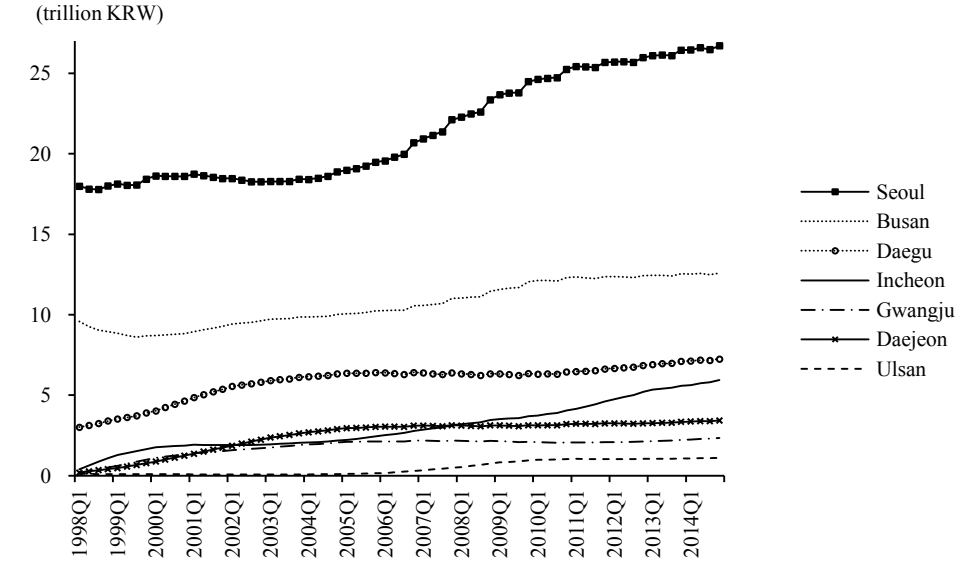


(a) Metropolitan Cities

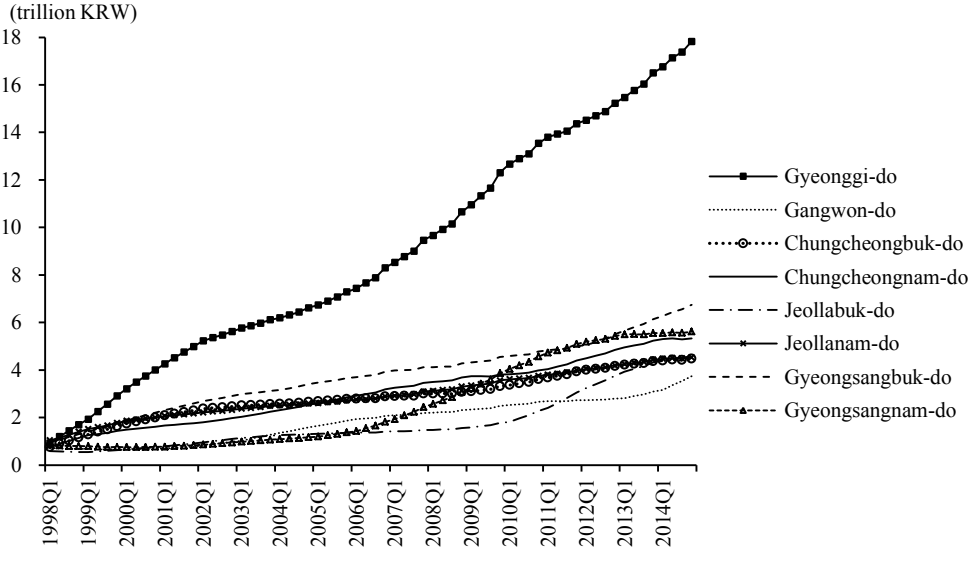


(b) Provinces

FIGURE 3. ESTIMATED NET STOCK OF TRANSPORT INFRASTRUCTURE BY REGION I: ROADS

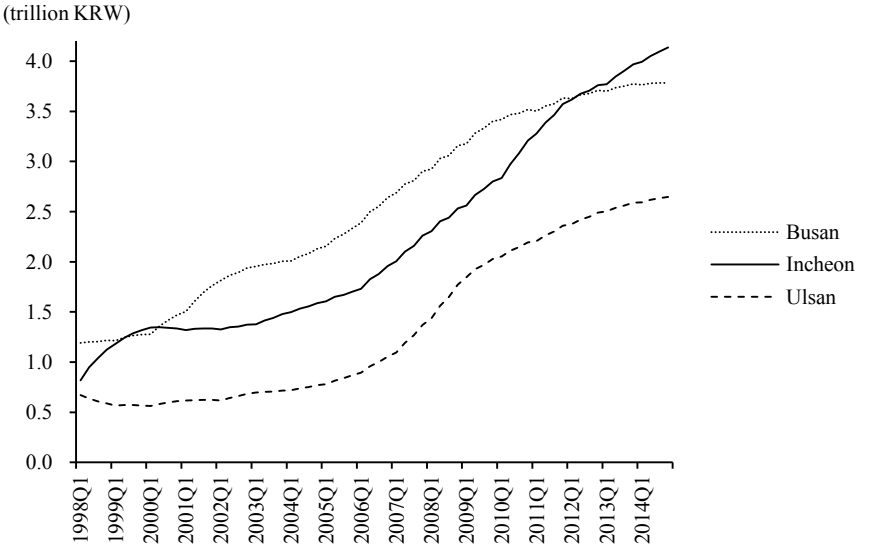


(a) Metropolitan Cities

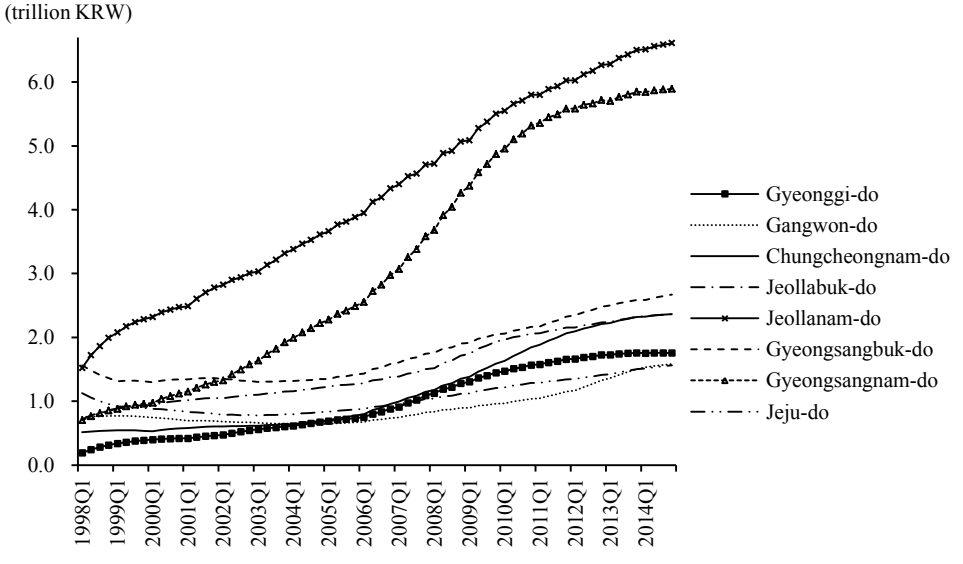


(b) Provinces

FIGURE 4. ESTIMATED NET STOCK OF TRANSPORT INFRASTRUCTURE BY REGION II: RAILROADS



(a) Metropolitan Cities



(b) Provinces

FIGURE 5. ESTIMATED NET STOCK OF TRANSPORT INFRASTRUCTURE BY REGION III: PORTS

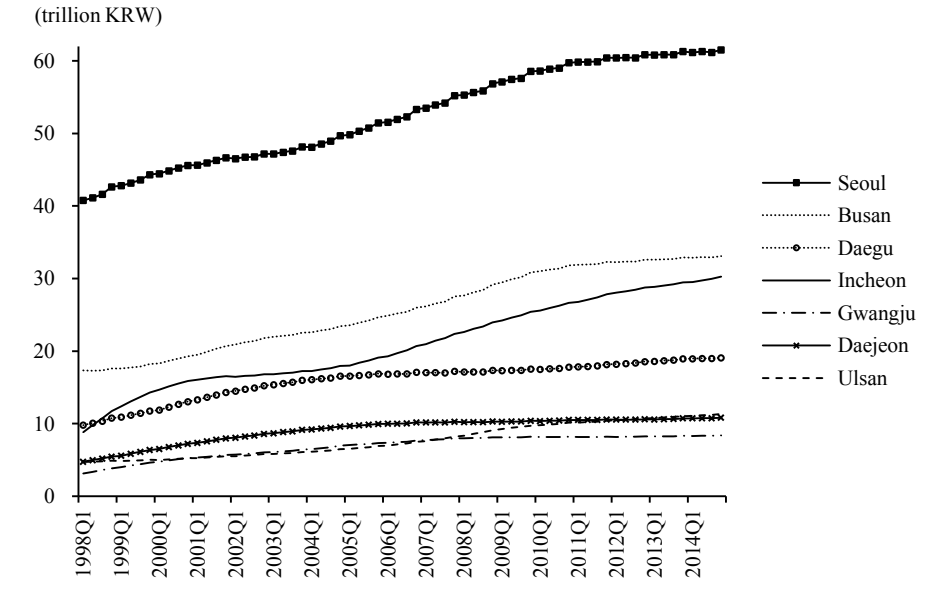
The following are some of the distinguishing features of each sector of transport infrastructure. First, in the case of roads, the concentration on specific regions tended to be relatively small compared to other sectors, although Seoul is more concentrated among metropolitan cities. This can be deduced from the fact that transport infrastructure investment in South Korea concentrates on roads. In other words, as a result of steadily expanding roads based on traffic demand, for instance, various types of roads, specifically highways, national roads, national subsidy roads and local roads, were relatively uniformly constructed in each area.

Second, railroads are concentrated heavily in Gyeonggi-do when compared to other provinces, and the concentration in Seoul among metropolitan cities is relatively low compared to roads. In addition, for railroads, regional reversal phenomena, by which relatively low (high) regions tend to become relatively higher (lower) over time, occur more frequently than in other sectors. These results are inferred from the analogy of the characteristics of roads above and from the fact that the proportion of relative investments in railroads is low, which may result in the concentration on a specific region being prominent. For example, the construction of city railways in various metropolitan cities has the effect of reducing the gaps between them. In contrast, the gap between Gyeonggi-do, where city railways were constructed, and other provinces is widening. Furthermore, given that investments in railways are relatively low compared to those for roads, the number of individual projects is small. Accordingly, the scope of the region in which the project is conducted also becomes smaller, resulting in the investment being concentrated in a specific region. Regional reversal can also occur between areas where railway projects are promoted and areas where they are not.

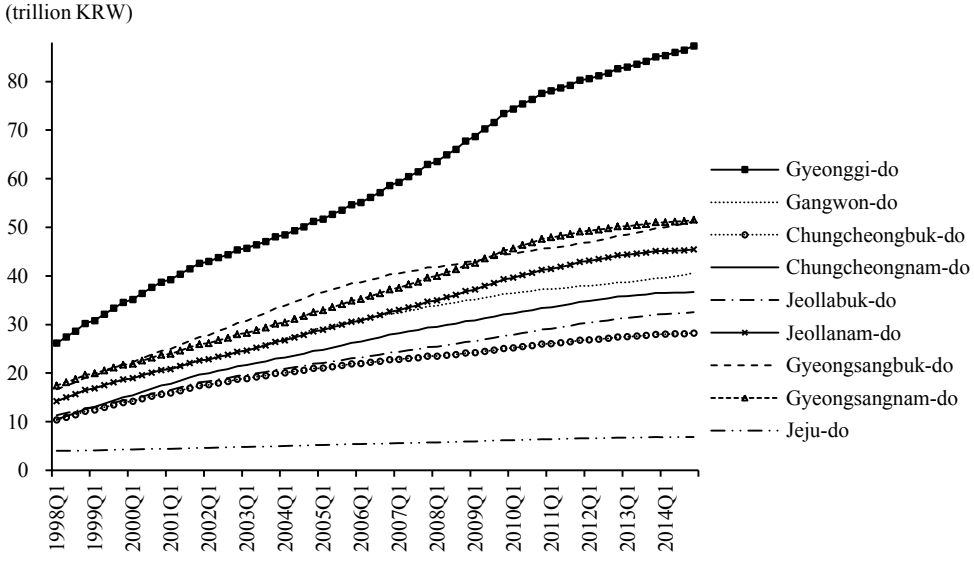
Third, ports have recently grown more than the other two sectors. This stems from the fact that investments in ports in the late 2000s increased greatly.

The estimates of the transport infrastructure stocks that comprise all three sectors are shown in Figure 6.

In addition, as discussed above, the depreciation rates may vary over time when using the modified BYM proposed in this study. The average quarterly depreciation rates for the road, railway and port divisions were 0.231%, 0.342% and 1.88%, respectively. It should be noted again that negative depreciation rates may occur due to data limitations. As a result of the estimation, negative depreciation rates account for 33.8%, 21.1% and 9.86% for roads, railroads and ports, respectively.



(a) Metropolitan Cities



(b) Provinces

FIGURE 6. ESTIMATED NET STOCK OF TRANSPORT INFRASTRUCTURE BY REGION IV: ROADS, RAILROADS, AND PORTS

V. Discussions and Policy Implications

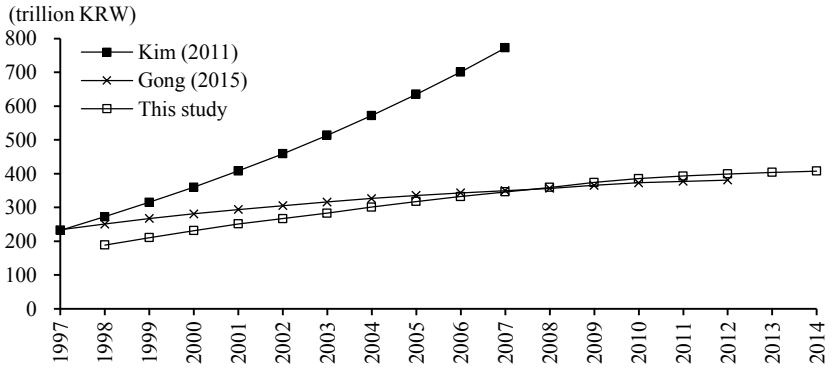
A. *Comparison with Previous Studies*

We can now compare the transport infrastructure stocks estimated in this study with those in previous studies. In so doing, it becomes possible to compare the results obtained from the studies by Kim (2011) and Gong (2015), of which the targets and estimation periods are similar to those in this study. Both studies estimated the net capital stock of transport infrastructure, as was done here, and the results are compared in Figure 7. For the sake of an equal comparison with this study, roads and airports in the previous studies were combined into the road category. Note that the result of this study shown in Figure 7 is identical to the sectoral capital stock estimated by the BOK, which can be considered most reliable for its dominance in accessibility to basic data among all three given the limitations of the data.

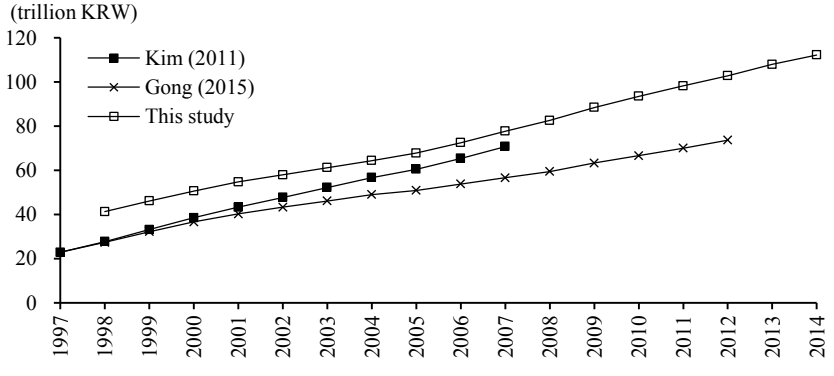
The differences between Kim (2011) and Gong (2015) are based on differences between the estimation methods, the method of avoiding negative depreciation rates, and whether private capital is included, as discussed in Gong (2015, pp.64-67). As shown in Table 1, Kim (2011) adopted the polynomial BYM using the net capital stock in 2007 as the basis; this was arbitrarily estimated based on the NWSs of 1977, 1987 and 1997, while for Gong (2015), the estimation was done using the BYM with NWS 1997. Moreover, the fact that Kim (2011) considers both the public and private sectors while Gong (2015) estimates only for public capital when estimating the SOC capital stock will also factor into the difference in the results (Gong, 2015, p.66).

The results of these studies by sector are compared as follows. First, for roads (including airport runways), the result in Kim (2011) showed a tendency to increase significantly over time, while that in Gong (2015) indicated a trend similar to that here. Compared to this study, Kim (2011) and Gong (2015) tend to overestimate by 79.0% and 8.6% on average, respectively.

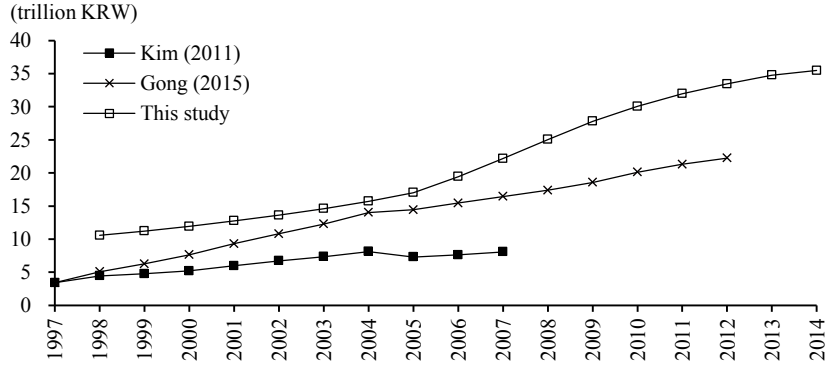
Second, railroads and ports in their studies were estimated to be smaller than the sectoral capital stocks adopted in this study. Kim (2011) and Gong (2015) showed a tendency toward underestimation by approximately 18.0% and 27.5% for railroads and 55.5% and 28.8%, respectively, for ports. Recalling that both Kim (2011) and this study included both the public and private sectors while Gong (2015) took into account only the public sector, and given that the share of private sector is higher for railroads and ports than it is for roads, it can be seen that the estimation results of Gong (2015) are closer to the sectoral capital stock data of the BOK than those of Kim (2011), especially in the railroad and port sectors.



(a) Roads and Airports



(b) Railroads



(c) Ports

FIGURE 7. COMPARISONS OF ESTIMATED NET STOCK OF TRANSPORT INFRASTRUCTURE BY REGION

Let us now compare the interregional allocation results of the transport infrastructure capital stock estimated in this study with those from the earlier studies. In this case, it is more appropriate to compare the share of each region because the amount of national capital stock in this study differs from that in the previous studies, as shown in Figure 7. In addition, we excluded regions with very low stocks in the sector, such as railroads in Jeju-do and ports in Chungcheongbuk-do. For a comparison with Kim (2011), the regions in this study are reorganized; i.e., some metropolitan cities and provinces are amalgamated, as structured in Kim (2011, p.205, Table 1).

Table 6 summarizes the results of such a comparison. First, the results of Kim (2011) differed from the results of this study by less than one percent on average in all sectors. However, the range of the difference was lowest in the case of roads, while those for railroads and ports were relatively large. This appears to be due to the fact that the stock of roads is much larger than those of other sectors. On the other hand, when the results of Gong (2015) are compared with those of this study, a similar tendency is shown, but the difference is considerable.

To determine if the difference between the pair of estimates follows a symmetric distribution around zero, we conducted Wilcoxon signed-rank tests for the percentages of the differences. As a result, the above null hypothesis was rejected only for roads and railroads in Gong (2015). Consequently, the interregional allocation of the transport infrastructure capital stocks in this study can be interpreted as similar to that in Kim (2011) rather than Gong (2015).

TABLE 6—COMPARISON OF ESTIMATED CAPITAL STOCKS WITH PREVIOUS STUDIES

Previous Study	Classification		Roads	Railroads	Ports
Kim (2011)	Period			1998-2007	
	Number of regions		11	10	9
	Difference (%)	Mean	-0.3163	0.8349	0.2213
		Std. dev.	1.898	7.770	10.01
		Range	[-5.135, 3.791]	[-16.48, 16.75]	[-15.70, 26.48]
	Wilcoxon signed-rank test		z = 1.421	z = 1.214	z = 0.336
Gong (2015)	Period			1998-2012	
	Number of regions		16	15	11
	Difference (%)	Mean	-0.7499	2.673	-1.017
		Std. dev.	3.265	7.388	7.921
		Range	[-8.165, 5.513]	[-19.70, 21.25]	[-15.13, 32.20]
	Wilcoxon signed-rank test		z = 2.087***	z = 5.355***	z = 1.620

Note: *** indicates that the p-value is less than 0.001.

B. *Applicability to Policy Making*

Although the scope of this study is limited to estimating the capital stock of transport infrastructure by region using available data, the results of this study can be used for future research and policy formulation purposes. Some possible uses are discussed below.

First, it is possible to look at the immediate trends in the estimates, as listed in the Appendix. For example, it is clear how the regional disparity has been changing with changes in the capital stock amount itself and its rate of growth in formulating policies to attain balanced regional growth. It is also possible to make cross-regional comparisons using other indices, such as regional net capital stock versus gross regional domestic product (GRDP) or regional net capital stock per employed person.

Second, the results of this study can be used for an in-depth analysis to derive policy implications, similar to some of the previous studies introduced in Section II. For example, how much transportation infrastructure influenced economic growth, whether allocations were made according to regional demand, or whether there was any political influence on the distribution of transport infrastructure by region can be studied, to name a few.

Third, the results here can be used when discussing the optimal level of transport infrastructure stock. As an example, Ryu (2006) presents an immediate application using regional SOC stock among others in estimations using an endogenous growth model.

Fourth, the results can be used for a closer examination of the appropriateness of the inter-sectoral allocation of transport infrastructure. We noted above that transport infrastructure investments in South Korea are centered on roads. Considering that roads play a pivotal role as the basis of all forms of transport infrastructure, road-based investments may be inevitable. Nonetheless, it would be worthwhile to examine whether the relative share of investment in South Korea is excessive based on the inter-sectoral distribution of regional capital stocks. To the best of the author's knowledge, however, no such study exists. Alternatively, Figure 8 compares the proportion of road investments relative to railroads among OECD member countries. South Korea is located close to the OECD average, except for a few years when the country marked relatively low levels. The shaded domain in Figure 8 represents the range between the minimum and the maximum values of the proportion of road investment relative to that for railroads by country for each year; particularly, the dark shaded region represents the interquartile range (IQR). South Korea is located within the IQR of all available years (2001~2013), suggesting that the proportion of road investment relative to that for railroads by the country does not deviate significantly from the average for OECD member countries. However, such a comparison is intended to skim the extent to which South Korea has invested heavily in roads, and it should be avoided when interpreting this result as over- or under-investment in transport infrastructure. Such a conclusion should be made after carrying out a more rigorous analysis taking into account regional stock amounts by sector in transport infrastructure.

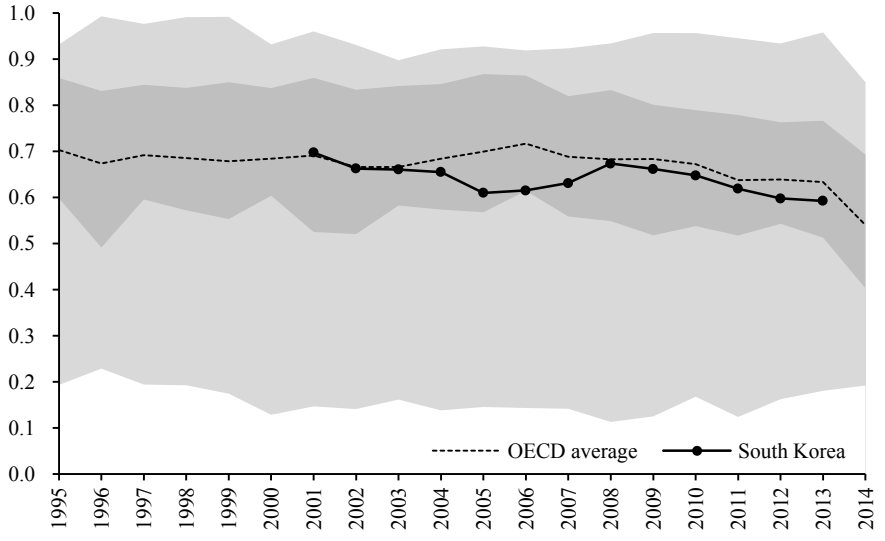


FIGURE 8. COMPARISONS OF OECD MEMBER JURISDICTIONS' SHARES OF INVESTMENT IN ROADS COMPARED TO THAT IN RAILROADS

Note: 1) Only data from the year after joining the OECD were included, and in some years, data from some countries are missing. (14% of the total) 2) The light shading indicates the range of the minimum and maximum values, and the dark shading indicates the IQR of each year.

Source: OECD Infrastructure investment indicator. (doi: 10.1787/b06ce3ad-en, accessed on March 15, 2018)

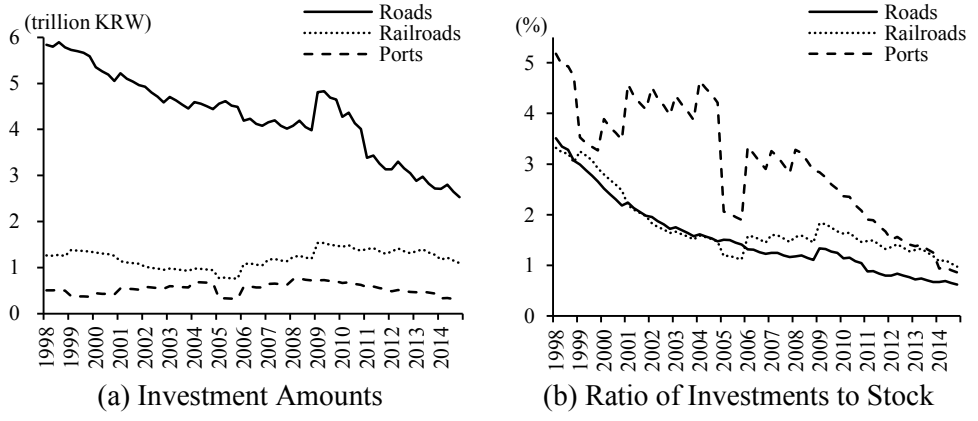
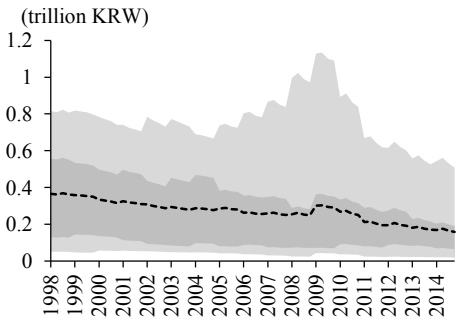


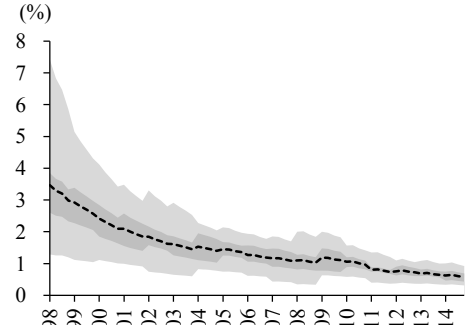
FIGURE 9. INVESTMENT IN TRANSPORT INFRASTRUCTURE BY SECTOR

Source: Construction Industry Survey, Statistics Korea.

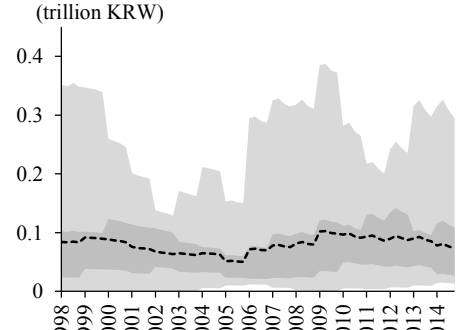
Although examining the above domains with rigorous analyses of sectoral and regional investment allocations and accumulated capital stocks is beyond the scope of this study, we can highlight several stylized facts as a basis for future research and policy making from the times-series of investment in transport infrastructure published in CIS and the capital stock amounts estimated in this study.



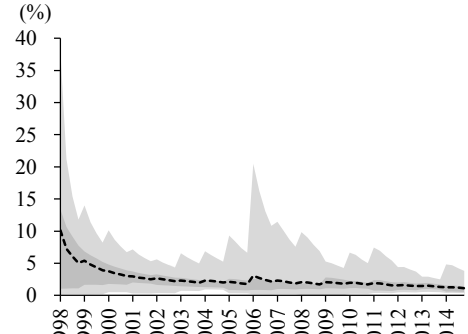
(a) Investment Amounts I: Roads



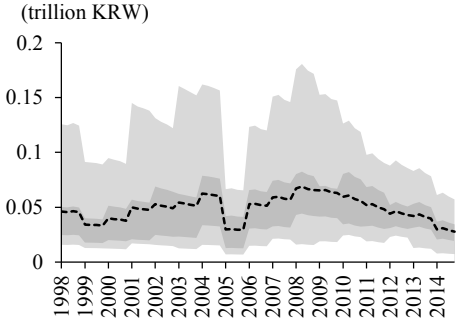
(b) Ratio of Investments to Stock I: Roads



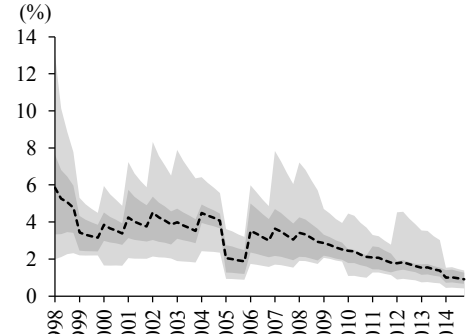
(a) Investment Amounts II: Railroads



(b) Ratio of Investments to Stock II: Railroads



(a) Investment Amounts III: Ports



(b) Ratio of Investments to Stock III: Ports

FIGURE 10. SECTORAL INVESTMENT IN TRANSPORT INFRASTRUCTURE BY REGION

Note: The dotted line represents the average, the light shading indicates the range of the minimum and maximum values, and the dark shading is the IQR for all metropolitan cities and provinces.

Source: Construction Industry Survey, Statistics Korea.

Figure 9 illustrates the trends of nationwide sectoral investment in transport infrastructure, where Figure 9 (a) shows the investment amount by sector and Figure 9 (b) represents the ratio of investment to capital stock. Both are in real values. In both figures, the decline in investment is noticeable, except for gentle increases in investments in railroads and ports in the late 2000s. In terms of investments, roads, railroads, and ports remain in that order during the entire analysis period. On the other hand, the ratio of investment to stocks indicates that ports have high amounts during most of the period. Recently, the values for railroads and ports are higher than those for roads.

Moreover, similar exercises can be performed by region to obtain the results shown in Figure 10. In this case, the investment amount and the ratio of investment to stocks are calculated for each metropolitan city and province, except for regions where the amounts are miniscule for railroads and ports. Looking at the amount of investment, it can be seen from the lightly shaded areas that the regional disparities in all three sectors were large in the late 2000s. Excluding abnormalities, IQR shows that the regional disparities in investments in roads and ports have declined since the mid-2000s, while that for railroads was maintained for the same period. On the other hand, if we look at the ratio of investment to stocks, the gap between regions tends to decrease, at least recently. In particular, this tendency appears throughout the analysis period for roads, which is larger in scale than the other sectors.

The results presented in both Figure 9 and Figure 10 reflect the fact that the budget for SOC has been reduced in recent years. As a result of examining the amount of investment relative to stocks, a trend of declining disparity between regions along with a nationwide declining trend can be observed. Consequently, it will be an interesting future research topic to explore how efficiency and equity are considered when allocating transportation infrastructure investments in South Korea using the results of this study.

VI. Concluding Remarks

Although estimations using the PIM are logical and accurate for the time-series of capital stocks, using this method is impossible in South Korea because basic data such as the disposal function and the economic useful lifetimes of facilities are not provided in the country. Given these limitations, this paper proposed a new method by which to estimate the net capital stock, which is the market value of fixed total assets at a certain point in time by region, through improvements in the BYM. The proposed method is applied to three sectors of transport infrastructure: roads, railroads and ports. The method consists of the following three steps.

First, it substitutes the sectoral capital stocks in two consecutive periods and the sectoral investment amount into the capital accumulation equation to obtain the sectoral depreciation rate for each period. Second, the ratio of the capital stock for each region and the sector for each period is calculated sequentially using the capital stock and investment amount of each region and sector provided by the NWS for the base year (1997) and CIS data for each period, respectively. Third,

capital stock by sector is allocated to each region using the above ratio.

There are two advantages of this method over the conventional BYM. First, by making the sum of regional estimates coincide with national estimates, it is possible to eliminate upwards bias (a phenomenon by which the sum of regional estimates is larger than that in national estimates), which is common in existing BYMs. Second, it is possible to increase the reliability of the estimation results by allowing the depreciation rates for each sector to vary over time for each period instead of fixing them arbitrarily.

Nevertheless, the method proposed in this study also has limitations. The most serious is that negative depreciation rates cannot be prevented during the estimation process. This is a common drawback of a methodology based on BYM. In addition, the method is restricted to cases when time-series data of capital stock by sector can be secured. Therefore, at least credible estimates of sectoral capital stock should be kept and made public so that one can estimate the persistent sectoral capital stock by region. This will be a very important reference when establishing a national agenda, such as balanced regional growth.

APPENDIX

TABLE A1—REGIONAL NET CAPITAL STOCK OF TRANSPORT INFRASTRUCTURE I: ROADS

(Unit: billion KRW)

Year	Metropolitan City						
	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Ulsan
1998	24,668	7,416	7,356	9,515	3,326	5,044	4,180
1999	25,909	8,227	7,836	11,321	3,635	5,573	4,335
2000	27,008	8,970	8,395	12,680	3,909	5,970	4,544
2001	28,178	9,662	8,931	13,309	4,126	6,207	4,797
2002	28,954	10,221	9,417	13,514	4,302	6,325	5,026
2003	29,732	10,689	9,868	13,742	4,508	6,490	5,280
2004	30,816	11,270	10,209	14,178	4,867	6,702	5,586
2005	31,977	12,105	10,463	14,948	5,177	6,916	5,882
2006	32,651	12,808	10,660	15,942	5,496	7,048	6,125
2007	33,123	13,599	10,817	16,970	5,773	7,116	6,337
2008	33,500	14,549	10,993	17,956	5,943	7,153	6,567
2009	34,053	15,380	11,188	18,910	6,060	7,239	6,730
2010	34,455	15,987	11,368	19,383	6,108	7,287	6,890
2011	34,703	16,277	11,524	19,666	6,109	7,306	7,015
2012	34,804	16,466	11,692	19,790	6,098	7,324	7,191
2013	34,775	16,594	11,828	19,919	6,077	7,359	7,378
2014	34,747	16,711	11,841	20,164	6,043	7,358	7,542

Year	Province								
	Gyeonggi-do	Gangwon-do	Chung cheong buk-do	Chung cheong nam-do	Jeolla buk-do	Jeolla nam-do	Gyeong sang buk-do	Gyeong sang nam-do	Jeju-do
1998	28,209	15,051	10,975	10,931	11,384	13,120	16,395	18,001	3,167
1999	31,261	17,304	12,333	13,064	12,780	14,611	18,778	19,973	3,379
2000	34,309	19,400	13,682	15,250	14,498	16,129	21,065	21,875	3,598
2001	37,122	21,273	15,109	17,335	16,144	17,649	23,486	23,825	3,833
2002	39,217	22,764	16,264	18,846	17,261	19,041	26,083	25,461	4,018
2003	41,377	24,763	17,352	20,080	18,332	20,604	28,903	27,140	4,184
2004	43,960	26,764	18,299	21,321	19,413	22,367	31,461	29,139	4,363
2005	46,642	28,240	19,152	22,627	20,459	23,936	33,393	31,030	4,512
2006	49,423	29,426	19,893	23,818	21,473	25,422	34,802	32,418	4,626
2007	52,393	30,715	20,509	24,804	22,377	26,917	35,898	33,646	4,717
2008	55,811	31,789	21,055	25,643	23,159	28,482	36,727	34,889	4,833
2009	59,651	32,846	21,776	26,707	23,998	30,215	37,806	36,452	4,986
2010	62,455	33,568	22,374	27,558	24,643	31,661	38,738	37,731	5,126
2011	64,247	34,055	22,820	28,229	24,978	32,869	39,465	38,474	5,221
2012	65,701	34,540	23,248	28,705	25,227	33,772	40,285	39,058	5,292
2013	66,836	34,948	23,614	28,941	25,430	34,171	41,109	39,621	5,318
2014	67,764	35,297	23,763	29,034	25,572	34,302	41,803	40,031	5,309

Note: Prices are chained at 2010.

TABLE A2—REGIONAL NET CAPITAL STOCK OF TRANSPORT INFRASTRUCTURE II: RAILROADS

(Unit: billion KRW)

Year	Metropolitan City						
	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Ulsan
1998	18,000	8,956	3,401	1,088	517	407	103
1999	18,435	8,695	3,897	1,658	999	779	93
2000	18,599	8,837	4,640	1,877	1,324	1,243	87
2001	18,472	9,278	5,376	1,897	1,539	1,741	84
2002	18,258	9,616	5,810	1,933	1,709	2,244	81
2003	18,428	9,857	6,114	2,038	1,900	2,627	81
2004	18,882	10,028	6,329	2,182	2,071	2,896	102
2005	19,482	10,240	6,410	2,450	2,134	3,035	150
2006	20,692	10,556	6,416	2,790	2,178	3,110	299
2007	22,119	11,007	6,397	3,149	2,189	3,134	499
2008	23,364	11,459	6,337	3,449	2,156	3,121	758
2009	24,489	12,044	6,347	3,706	2,113	3,135	951
2010	25,255	12,303	6,442	4,054	2,072	3,206	1,031
2011	25,680	12,375	6,639	4,621	2,080	3,251	1,037
2012	25,983	12,420	6,855	5,205	2,135	3,256	1,042
2013	26,450	12,542	7,102	5,580	2,230	3,346	1,071
2014	26,721	12,588	7,252	5,951	2,344	3,431	1,120

Year	Province								
	Gyeonggi-do	Gangwon-do	Chung cheong buk-do	Chung cheong nam-do	Jeolla buk-do	Jeolla nam-do	Gyeong sang buk-do	Gyeong sang nam-do	Jeju-do
1998	1,702	682	1,164	1,144	553	1,400	1,300	797	1
1999	2,906	668	1,634	1,431	631	1,770	1,757	756	0
2000	3,999	683	1,996	1,612	751	1,998	2,197	763	0
2001	4,986	781	2,297	1,759	914	2,170	2,590	835	0
2002	5,617	971	2,465	1,969	1,097	2,324	2,901	950	0
2003	6,112	1,278	2,565	2,248	1,236	2,487	3,123	1,067	0
2004	6,620	1,581	2,662	2,534	1,307	2,589	3,404	1,173	0
2005	7,287	1,871	2,774	2,846	1,358	2,717	3,657	1,372	0
2006	8,304	2,063	2,884	3,189	1,410	2,885	3,933	1,817	0
2007	9,462	2,196	3,001	3,460	1,476	3,091	4,113	2,434	0
2008	10,656	2,305	3,078	3,688	1,561	3,295	4,276	3,079	0
2009	12,303	2,490	3,316	3,814	1,770	3,559	4,545	3,863	2
2010	13,540	2,655	3,607	3,989	2,264	3,753	4,776	4,567	6
2011	14,365	2,727	3,932	4,395	3,051	3,985	5,005	5,088	6
2012	15,228	2,794	4,161	4,841	3,760	4,196	5,508	5,424	6
2013	16,500	3,092	4,366	5,237	4,324	4,431	6,144	5,556	6
2014	17,827	3,738	4,470	5,331	4,593	4,530	6,742	5,618	6

Note: Prices are chained at 2010.

TABLE A3—REGIONAL NET CAPITAL STOCK OF TRANSPORT INFRASTRUCTURE III: PORTS

(Unit: billion KRW)

Year	Metropolitan City						
	Seoul	Busan	Daegu	Incheon	Gwangju	Daejeon	Ulsan
1998	1	1,216	0	1,125	0	0	588
1999	2	1,273	0	1,319	0	5	566
2000	4	1,469	0	1,334	0	6	609
2001	4	1,764	0	1,336	0	5	622
2002	4	1,937	0	1,375	0	4	683
2003	4	2,006	0	1,479	0	4	717
2004	4	2,129	0	1,587	0	4	768
2005	5	2,334	0	1,702	0	4	868
2006	7	2,641	0	1,956	0	4	1,056
2007	8	2,904	0	2,261	0	4	1,371
2008	10	3,158	0	2,533	0	4	1,771
2009	22	3,401	1	2,801	0	4	2,027
2010	50	3,519	2	3,207	1	8	2,194
2011	72	3,632	2	3,571	1	9	2,359
2012	76	3,710	2	3,761	1	9	2,491
2013	75	3,774	2	3,967	1	9	2,589
2014	73	3,785	2	4,139	1	9	2,648

Year	Province								
	Gyeonggi-do	Gangwon-do	Chung cheong buk-do	Chung cheong nam-do	Jeolla buk-do	Jeolla nam-do	Gyeong sang buk-do	Gyeong sang nam-do	Jeju-do
1998	313	770	0	541	861	1,992	1,364	853	958
1999	388	755	2	536	937	2,284	1,309	960	896
2000	417	710	2	575	1,007	2,471	1,344	1,120	848
2001	463	688	1	604	1,050	2,778	1,360	1,300	805
2002	544	668	1	617	1,098	3,005	1,319	1,577	784
2003	604	652	1	639	1,150	3,317	1,318	1,920	796
2004	673	646	1	690	1,213	3,610	1,345	2,220	829
2005	734	669	1	775	1,269	3,883	1,415	2,488	869
2006	878	735	1	955	1,376	4,331	1,582	2,973	944
2007	1,086	825	1	1,146	1,504	4,703	1,744	3,579	1,034
2008	1,277	895	1	1,350	1,712	5,068	1,902	4,263	1,117
2009	1,445	963	1	1,590	1,933	5,504	2,050	4,872	1,208
2010	1,567	1,038	10	1,843	2,061	5,799	2,166	5,317	1,285
2011	1,657	1,149	13	2,063	2,153	6,025	2,324	5,581	1,344
2012	1,725	1,326	15	2,210	2,236	6,265	2,481	5,715	1,414
2013	1,757	1,504	15	2,318	2,323	6,500	2,585	5,847	1,502
2014	1,755	1,584	15	2,365	2,360	6,609	2,671	5,892	1,562

Note: Prices are chained at 2010.

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The Intergenerational Effects of Tax Policy in an Overlapping Generations Model with Housing Assets†

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Using an overlapping generations model, this paper examines tax policy effects across generations. The model incorporates housing assets separately from capital assets and includes taxes on labor income, capital income, consumption and housing assets. Tax reforms for each tax rate have different effects on tax burdens across generations and the overall efficiency of the economy, leading to different welfare costs for generations. Specifically, raising housing property taxes results in the smallest welfare loss by future generations, as in the model it does not hurt economic efficiency and the tax burden increases mainly for the elderly, who have accumulated housing assets in preparation for retirement.

Key Word: Tax Policy, Life Cycle, Generation, Housing
JEL Code: E62, H22, R21

I. Introduction

Concerns about fiscal sustainability are rising as government expenditures on welfare continue to increase. Specifically, rapid population aging is expected to increase expenditures on pensions, health insurance, and long-term care insurance for the elderly. On the other hand, population aging can slow economic growth and weaken the tax revenue base. As a result, total expenditures are expected to increase more rapidly than total revenue, and government debt is expected to expand.[1]

Government debt is increased by deferring the tax burden of the current generation, which may ultimately lead to an increase in the tax burden of future generations. However, if the expansion of government expenditures is mainly due to welfare expenditures for the current generation, there could be an intergenerational

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[1]The debt ratio is expected to increase from 40% of GDP to 62.4~151.8% in 2060 (Ministry of Strategy and Finance, 2015; National Assembly Budget Office, 2016).

imbalance between the benefit and the burden. In particular, as welfare expenditures due to population aging are expected to increase sharply, the intergenerational problem of who will bear the burden could become serious. In fact, several studies point out that intergenerational equity has worsened in Korea. Chun (2012) argues that as aging-related expenditures grow, the burden on the current young and future generations will also increase. Moreover, under the current pension and welfare systems, the current generation has less of a burden than the benefit received, while future generations may experience more burden than benefit to secure fiscal sustainability (Choi, 2013; Lee, 2015a).

In the early stages of the development of a welfare system, some difference in burden and benefit between generations may be inevitable. However, fiscal efforts should not seek to maintain or expand this imbalance and should instead seek to ensure financial sustainability. Recently, a tax increase is being discussed to cover increasing government expenditures. In discussing tax policies, it is also necessary to consider how to alleviate the current imbalance structure of the burden and benefit between generations.

This paper examines tax policy effects across generations using an overlapping generations general equilibrium model. I consider housing-related taxes as well as taxes on consumption and income by including housing assets separately from capital assets. In the case of Korea, households have a large portion of their assets as housing assets and hold substantial housing assets in old age. Thus, tax policies on housing assets may have significant and different effects across generations. Additionally, housing assets have a distinct characteristic in that housing assets, unlike capital assets, directly affect the utility of households by providing housing services rather than being used as production inputs. Accordingly, a change in housing property taxes can affect the choice of economic agents differently compared to changes in capital income taxes.

The overlapping generations model here is an extension of that in Yang (2009) and Fernandez-Villaverde and Krueger (2011), and it as well separates housing and capital assets. These studies note that housing plays a role not only as an asset to accumulate for savings but also as collateral under imperfect capital markets. In addition, unlike other assets, housing assets directly affect the utility of households through the provision of housing services. These studies mainly focus on different consumption and accumulation patterns pertaining to housing assets compared to other consumer goods and assets (Gervais, 2002; Yang, 2009; Fernandez-Villaverde and Krueger, 2011; Díaz and Luengo-Prado, 2010). In this paper, I extend this model by introducing taxes on housing assets, consumption, and labor and capital income types.

I compare the effects of tax policy changes on the overall economy and on welfare. According to my model, the welfare losses are lower when raising housing property taxes and consumption taxes compared to tax increases on capital and labor income. An increase in housing property taxes encourages investments in capital assets instead of housing assets and promotes economic growth, which reduces the welfare loss of future generations. Similarly, increased consumption taxes induce capital accumulation and production instead of consumption. On the other hand, increasing the capital income tax reduces aggregate capital and production, resulting in the largest welfare loss.

I also analyze the intergenerational impacts of tax increases along the transition path. An increase in labor income taxes reduces the welfare of the current working age group and future generations who will work and earn labor income, but it scarcely affects the welfare of older people in retirement. On the other hand, taxes on assets have negative effects on the welfare of older people, who have accumulated assets for retirement. In particular, increasing housing property taxes lowers the welfare of the elderly the most because they hold substantial housing assets to consume housing services and finance non-housing consumption in retirement. However, the welfare losses of young and future generations is less than in other tax reform cases because an increase in housing property taxes does not decrease economic efficiency.

Many studies have examined the effects of tax policy on overall economy efficiency and welfare gains or losses across generations using the overlapping generations model. Auerbach and Kotlikoff (1987) examine the intergenerational effects of tax policies on wages, consumption and capital income. Altig *et al*. (2001) study the welfare effects of tax policy changes between and within generations. In the case of Korea, Kim (2013) examines the tax policy effects to preserve tax revenues which were reduced due to the corporate tax cut of 2008. Overall, the literature on tax policy focuses on taxes on labor income, consumption and capital income, but I introduce housing related taxes, which have not been addressed in the literature.

The remainder of this paper is organized as follows. Section 2 presents empirical findings with regard to distributions of incomes, assets, and related taxes across ages. Section 3 presents the model. Section 4 calibrates the model and shows quantitative results based on the model. Section 6 presents empirical results on heterogeneous preferences for tax policies across generations using survey data, and Section 7 concludes the paper.

II. Empirical Findings

In this section, I analyze the current tax burden across ages using the 2012 (wave 5) National Survey of Tax and Benefit. The survey data provides information about households' tax burden, including individual income taxes, property taxes, and comprehensive real estate taxes. Using this information, I compare the distributions of the tax burden with those of household incomes and assets.

The distributions of the tax burden across age are closely related to the distributions of income and assets, which are the tax sources. The figure on the left in Figure 1 shows the distributions of total household income and earned income. Earned income includes salary and business incomes. Total income encompasses earned income as well as rental income, interest and dividend income. Both total income and earned income rise when people are in their 20s and 30s, peak when they are in their 40s and 50s and sharply decrease when they reach their 60s. The gap between total income and earned income increases with age, meaning that income other than labor income accounts for a larger share as people age. The figure on the right shows the individual income tax burden, including working income taxes and comprehensive income taxes. The distribution shows that the

average income tax burden is concentrated on working age groups under 60 years of age. Similarly to the income distribution, income taxes increase when people are in their 20s and 30s, peak when they are in their 50s, and then decline. After retirement the income tax burden becomes very low.

Figure 2 shows the distributions of assets and asset holding taxes. Asset holding taxes includes property taxes and comprehensive real estate taxes. Total assets increase gradually with age, peaking when people are in their late 50s. Past that point, total assets decrease steadily, unlike the income distribution, which decreases steeply after it peaks. Even after the age of 70, the average asset size is substantial and close to 200 million won. Net assets, equal to total assets minus total liability, is distributed similarly to total asset and decreases gradually when people are past their 50s. Housing assets account for a large portion of total assets. Similarly to asset distributions, elderly people have substantial housing assets, and those in their 70s have more housing assets than those in their 30s. Accordingly, the tax burden on asset holdings is the largest when people are in their late 50s and remains considerable when they reach their 70s and 80s. These asset-related distributions are distinctly different from the income-related distributions discussed above.

Figure 3 presents the distribution of consumption expenditure across age. Because consumption tax is not surveyed, the distribution of consumption tax is not compared. However, consumption tax distribution is assumed to be quite similar to the consumption distribution, as much of the consumption tax is value added tax (VAT), which can be roughly calculated by multiplying the consumption expenditure by the VAT ratio. Consumption expenditures increase with age, peaking when people reach their 50s. Then, consumption declines, but the level of consumption remains constant in retirement. I also quantify consumption per adult-equivalent, which is adjusted for changes in household size across ages. The distribution of consumption per adult-equivalent shows the consumption pattern while controlling for the household size effect on consumption.[2] The pattern of consumption per adult-equivalence is smoother than that of household consumption because household size changes across ages account for much of the change in household consumption, especially for young people, who increase household sizes by marriage and childbirth.

These results show that income sources and asset compositions vary across ages; hence, the main source of the tax burden also differs by age. For the working age group, the tax burden is mainly from labor income taxes, while older people have substantial tax burdens on their accumulated assets.

Individuals experience changes in their incomes and asset holdings. Accordingly the tax burden on income, assets, and consumption also changes over the life cycle. The difference in the age-related tax burden is less problematic with regard to intergenerational equity from the perspective of the life cycle than in the cross-sectional analysis, as the differences in income sources and asset compositions over the life cycle are experienced during one's lifetime. Even if the tax burden imposed on some age group is excessive due to unequal tax burdens across tax sources, all individuals experience a life cycle. Therefore, when the entire life cycle is considered,

[2]Consumption per adult-equivalent is calculated by dividing household consumption by equivalence scales. I use equivalence scales, defined as the square-root of the household size following the recent OECD method.

the problem of equity between generations disappears.

However, if the tax structure is changed at some time, the tax policy effect will differ across generations. Because each generation is at a different point in their life cycles, the dynamic effect on their welfare varies from generation to generation depending on the direction of tax policy changes. Which tax rate is adjusted directly affects the tax burden on each generation depending on their incomes and assets at the time of the tax policy change. Moreover, tax structure changes affect the choice of economic agents and the overall economy, possibly leading to different welfare changes across generations.

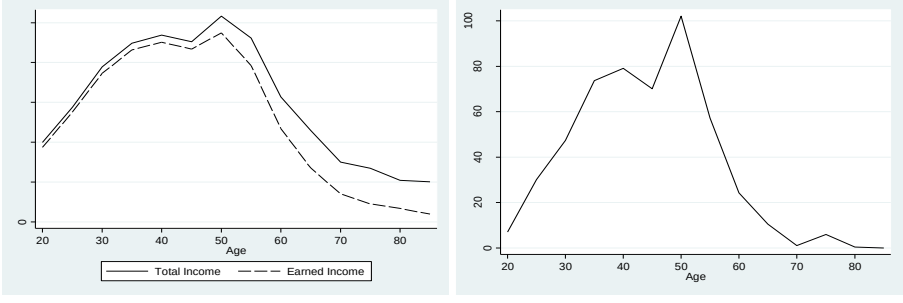

FIGURE 1. DISTRIBUTIONS OF HOUSEHOLDS' INCOMES AND INCOME TAXES (UNIT: KRW 10,000)

Source: National Survey of Tax and Benefit.

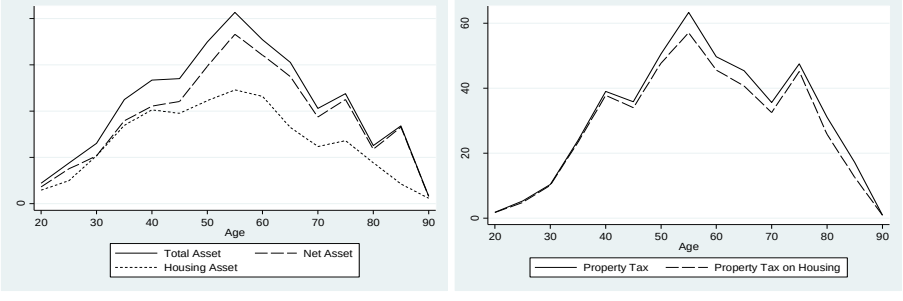

FIGURE 2. DISTRIBUTIONS OF HOUSEHOLDS' ASSETS AND ASSET HOLDING TAXES (UNIT: KRW 10,000)

Source: National Survey of Tax and Benefit.

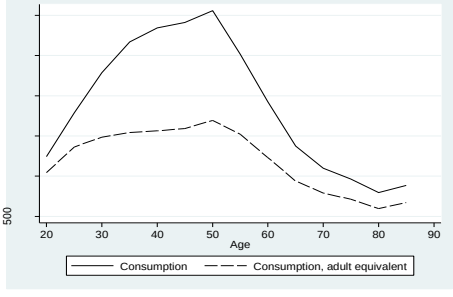

FIGURE 3. DISTRIBUTIONS OF HOUSEHOLDS' CONSUMPTION PATTERNS (UNIT: KRW 10,000)

Source: National Survey of Tax and Benefit.

III. Model

In this section, I build the overlapping generations model to examine tax policy effects across generations. The model includes various types of taxes, such as labor income taxes, capital income taxes, consumption taxes, and housing-related taxes (i.e., housing property taxes and transaction taxes). To study housing-related taxes separately, this paper considers two types of assets: housing and non-housing assets. Non-housing assets are used as input for production, while housing assets are used for consumption of housing services. The model is extended based on work by Fernandez-Villaverde and Krueger (2011) and Yang (2009). For modeling simplicity, I assume that a housing rental market does not exist.[3]

A. *Preferences*

Each period, a new generation enters into the model and begins working. Then, the generation retires at T_R and can live up to T. The conditional probability of individuals aged t surviving to become age $t+1$ is s_t. Here, s_T is defined as 0.

Individuals maximize their expected lifetime utility, which is derived from general consumption on non-housing goods (c_t), consumption of housing service (h_{t+1}), and leisure ($1 - l_t$),

$$(1) \qquad \mathrm{Max}\ E_0 \sum_{t=1}^{T} \beta^{t-1} \left(\frac{\left(c_t^{\gamma} h_{t+1}^{1-\gamma} \right)^{1-\eta} - 1}{1-\eta} - B \frac{l_t^{1+\frac{1}{\upsilon}}}{1+\frac{1}{\upsilon}} \right)$$

where β is a discount factor, η is a risk aversion parameter, and υ is a labor supply elasticity parameter. γ is a parameter measuring the weight of consumption of non-housing goods over consumption of housing services.

Individuals have one unit of time in each period. Before they reach retirement age, each individual makes a labor supply decision at the beginning of each period. If they choose to work, they spend time working as much as l_t and earn labor income. Instead, they have a disutility from working. After they retire, they do not choose to work.

The heterogeneity of the labor productivity of individuals comes from age and idiosyncratic shocks. Total labor productivity at age t is $\theta_t e_t$, where θ_t is the average labor productivity at age t and e_t is an idiosyncratic shock of labor

[3]While Fernandez-Villaverde and Krueger (2011) do not include a housing rental market in their model, Yang (2009) accounts for the housing rental market with a renting shock that makes individuals rent. According to Yang's results, as the cost of buying a house decreases, households acquire more housing assets instead of renting. This implies that housing-related tax policy effects are greater in a model which assumes a housing rental market than in a model without a rental market.

productivity. e_t is assumed to follow a Markov process, and its transition probability matrix is $\pi(e' \mid e)$.

The consumer problem can be represented as

$$(2) \qquad V(t,a,h,e) = \max_{c,a',h'l} \left\{ U(c,h',l) + \beta s_t E\left[V(t+1,a',h',e') \right] \right\}$$

subject to

$$\begin{aligned} &(1+\tau_c)c + a' + h' + \tau(h,h') \\ &= (1-\tau_l) w\theta e l + \left(1 + (1-\tau_a) r\right) a + (1-\delta_h)(1-\tau_h) h + \xi + b \\ &a' \geq -\kappa h', \quad h' > 0, \end{aligned}$$

where V is a value function, r is the real interest rate, w is the wage rate for one efficiency unit of labor, and δ_h is the depreciation rate for housing assets. Individuals receive government transfer b and the new generation who enters into the model receives accidental bequests of ξ. They make decisions about consumption and the allocation of capital and housing assets. Individuals are assumed to derive utility from the consumption of housing services equal to the value of the housing assets held. They can borrow capital but face a borrowing constraint. Borrowing capital is limited to κ of the value of the housing asset held. Here, housing assets are used as collateral. If individuals borrow capital, $a' < 0$, I assume that capital income taxes are not paid.

τ_c, τ_l, τ_a and τ_h denote the consumption tax rate, the labor income tax rate, the capital income tax rate, and the housing property tax rate, respectively. When capital income is positive, a capital income tax is imposed. $\tau(h,h')$ is the housing transaction tax that is paid when people buy housing assets and ψ_b is the the housing transaction tax rate. The transaction tax is paid when the value of the housing asset increases or decreases more than the depreciated value.

$$\tau(h,h') = \begin{cases} 0 & \text{if } (1-\delta_h)h \leq h' \leq h \\ \psi_b h' & \text{otherwise.} \end{cases}$$

Using first-order conditions of the consumer's maximization problem, I derive the following equations.

$$(3) \qquad U_{h'} = \frac{U_c}{1+\tau_c} \left(\psi_b + \frac{\delta_h + (1-\delta_h)\tau_h}{1+(1-\tau_a)r} + \frac{(1-\tau_a)r}{1+(1-\tau_a)r} \right)$$

$$\text{if } h' > h \text{ or } h' < (1-\delta_h)h; \text{ and } a' > -\kappa h'$$

$$U_{h'} = \frac{U_c}{1+\tau_c}(1+\psi_b-\kappa) + \frac{\beta s E(U_{c'})}{1+\tau_c}(\delta_h + (1-\delta_h)\tau_h + r\kappa - \quad) \tag{4}$$

$$\text{if } h' > h \text{ or } h' < (1-\delta_h)h; \text{ and } a' = -\kappa h'$$

Equation (3) shows which costs are linked to housing assets or housing services when the borrowing constraint is not binding ($a' > -\kappa h'$). An increase in housing assets leads to a utility gain from housing services but incurs utility costs from direct costs related housing assets and the implicit opportunity cost of buying housing assets instead of capital assets. When increasing housing assets, individuals pay housing transaction taxes. They will also pay depreciation on housing assets and housing property taxes in the next period. With these explicit costs, they also lose the opportunity to invest in capital assets with a return of $(1-\tau_a)r$. If the borrowing constraint is binding ($a' = -\kappa h'$), the value of housing as a collateral is added. As housing assets are increased, they can borrow more capital at a rate of κ using the housing assets as collateral. Instead, the interest cost on more borrowed capital is borne in the next period.

B. *Firm*

The representative firm produces goods using a Cobb-Douglas production function,

$$F(K, L) = L^{\alpha} K^{1-\alpha}$$

where K is the aggregate capital stock and L is the aggregate labor input. The produced goods are used for consumption by consumers, government consumption, and investments with which to produce capital assets and housing assets. Therefore,

$$F(K, L) = Y = C + G + I_k + I_h,$$

where C is the aggregate consumption of non-housing goods, G is the aggregate government consumption, I_k is the investment in capital assets, and I_h is the investment in housing assets.

C. *Government*

Governments raise revenue by collecting taxes and run a balanced budget every period. The tax revenues consist of taxes on consumption, labor income, capital asset income, housing property, and housing transactions. The tax revenue is used for government consumption (G) and transfers for households (b).

D. *Equilibrium*

A competitive equilibrium consists of the value function $V(t,a,h,e)$, policy functions of consumption, capital and housing asset holdings, the labor supply, $c(a,h,e)$, $a'(a,h,e)$, $h'(a,h,e)$, $l(a,h,e)$, aggregate capital and labor inputs, (K,L), input prices, (r,w), and the invariant distributions of consumers, $\Phi(a,h,e)$ such that the following hold:

a. Given r and w, policy functions solve the consumer's problem (2).

b. The firm maximizes its profit and input prices satisfy

$$w = F_L(K,L)$$

$$r = F_K(K,L) - \delta_K$$

c. The goods market clears

$$\int \{c(a,h,e) + a'(a,h,e) + h'(a,h,e)\} d\Phi + G$$

$$= F(K,L) + \int \{(1-\delta_k)a + (1-\delta_h)h\} d\Phi$$

d. Capital and labor input markets clear

$$\int a'(a,h,e) d\Phi = K$$

$$\int \theta e l(a,h,e) d\Phi = L$$

e. The government runs a balanced budget.

$$\int \{\tau_c c + \tau_l w \theta e l + \tau_a r a + \tau_h (1-\delta_h) h + \tau(h,h')\} d\Phi = G + b$$

IV. Quantitative Analysis

A. *Calibration*

The time period for the model is five years. The model has 12 generations, denoted by $t = 1, \cdots, 12$. Each generation enters into the model at the age of 25 ($t = 1$), and can live up to 85 years old ($t = 12$). The retirement age (T_R) is assumed to be 65 ($t = 9$). The conditional survival probability $\{s_t\}_{t=1}^{T}$ is from the life table of 2010.

The stochastic part of labor productivity is assumed to follow the AR (1) process, i.e.,

$$\ln\left(e_{i,t+1}\right) = \rho \ln\left(e_{i,t}\right) + \varepsilon^{e}_{i,t},$$

where $\varepsilon^{e}_{i,t} \sim N\left(0, \sigma_e^2\right)$. To estimate this part, I use the labor income of waves 1 to 15 of the Korea Labor Income Panel Study (KLIPS). To be consistent with the period of the model, labor income is summed for each five years. The estimates are $\rho = 0.81$ and $\sigma_e = 0.35$.

The age-specific labor productivity is calculated by estimating the age-labor income profile using KLIPS data. The average labor productivity at age t follows the equation

$$\ln\left(\theta_t\right) = 3.2469 + 0.3672 \cdot t - 0.0065 \cdot t^2 + 0.000034 \cdot t^3.$$

The new generation which enters into the model receives accidental bequests from individuals who die. The bequests are distributed to the new generation following the distribution of net assets of 25-year-old individuals, as estimated from the 2012 Korea Finance and Welfare Survey. The remaining bequests are then given equally to the new generation aged 25.

If individuals decide to work, they work for a fixed number of working hours $\bar{l}$, assumed to be one third of their total time. The value of the risk aversion parameter η is set to 1.2, within the range of values used in the literature. α is set to 0.39, the value of the capital income share in 2012. The labor supply elasticity ν is set to 1. Given that the number of working hours is a fixed constant, the value of this parameter does not affect the result. The annual depreciation rate for capital δ_k is set to 10% and the annual depreciation rate for housing assets δ_h is 4%. The selected upper limit of the loan-to-value ratio (κ) is 50%.

The annual discount factor $\beta = 0.975$ is chosen so that the capital-output ratio in the model matches that of the data. To be consistent with the model economy, output is calculated as GDP minus the value of housing services from the National Account (Fernandez-Villaverde and Krueger, 2011; Yang, 2009). The weight parameter between the amounts of consumption of housing services and non-housing goods, $\gamma = 0.545$, is set such that the share of housing assets among total assets is equal to 63%, which is calculated from the 2012 Korea Finance and Welfare Survey. The parameter of disutility from working, B, is selected to meet the average employment rate from KLIPS, which is 69%.

The consumption tax rate τ_c is set to 10%, which is the value-added tax rate. The labor income tax rate τ_l, which includes labor income taxes and social security contributions, is set to 20%, as calculated from the OECD tax database. The housing property tax rate τ_h is set to 0.106% per annum, which is the actual effective tax rate.[4] The housing transaction tax rate for buying housing assets, ψ_b,

[4]The housing property tax rate is calculated by multiplying the effective tax rate of local housing property

is set to 1.3% of the house price, which includes the acquisition tax and related special taxes (Kim, 2015). The model does not explicitly include corporate taxes the firm' profits, as firms are assumed to be in perfect competition and do not generate excess profits in the model. Corporate taxes are assumed to be imposed on the capital income of individuals that provide capital assets for production. The capital income tax rate τ_a is set to 36% so that the model can meet the ratio of capital income taxes, including taxes on individuals' capital incomes and corporate incomes, to output from the data. Government consumption is set to 15% of output.

B. *Steady State*

Figure 4-6 compares the life-cycle patterns of labor income, consumption, housing assets (h'), non-housing assets (a'), and the employment rate from the model with those from the data. The data patterns of average labor income, consumption, and employment rate are estimated from the KLIPS data used to estimate the age-labor income profile in the model. The patterns of housing and non-housing assets are estimated from the 2012 Korea Finance and Welfare Survey, as used to calculate asset-related moments for the calibration.

The distributions of housing and non-housing assets in the model are similar to those from the data. The distribution of housing assets is smoother than that of non-housing assets. Young agents initially borrow capital to buy housing assets needed to consume housing services in the model. They then accumulate financial assets while working and later dissave them for consumption in retirement. On the other hand, agents tend to hold housing assets when retired because they still need to consume housing services and can finance non-housing consumption using the housing asset as collateral for borrowing.

The labor income distribution for workers in the model is also close to that from the data. The pattern of labor income is hump-shaped and peaks when people are in their 40s. Working age agents earn substantial labor income, after which labor income decreases after it peaks up to retirement. Because agents are assumed not to work in retirement in the model, retirees do not have any labor income. In the data, however, some older agents continue to work even after retirement age and have positive average labor incomes. Employment rates also have hump-shaped patterns in the data and the model. In the model, the employment rate peaks when people are in their 30s, whereas it is highest when people are in their 40s in the data.

Consumption in the model is flat across ages, similar to consumption per adult-equivalent from the data (Yang, 2009; Fernandez-Villaverde and Krueger, 2011). Given that the model does not take into account household sizes, it does not reflect changes in household consumption due to changes in household sizes across ages. Due to this limitation, I do not compare the intergenerational effects of consumption taxes in the analysis that examines tax policy effects across generations taking into account transition paths.

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taxes and the comprehensive real estate tax, which is 0.265% (Lee, 2015b), by the ratio of the tax base to the market value, 0.399 (Park, 2014).

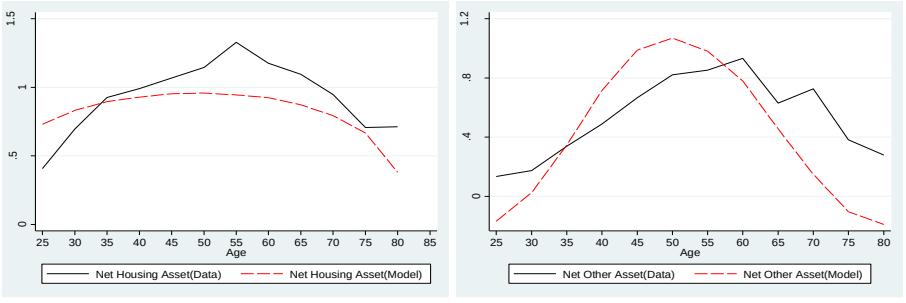

FIGURE 4. LIFE-CYCLE PATTERNS OF HOUSING AND NON-HOUSING ASSETS

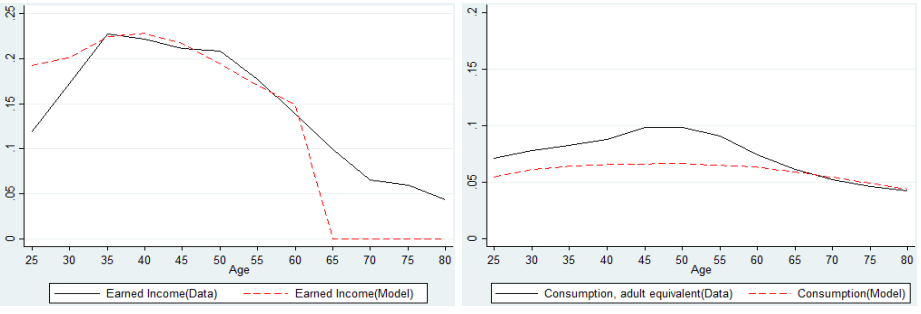

FIGURE 5. LIFE-CYCLE PATTERNS OF LABOR INCOME AND CONSUMPTION

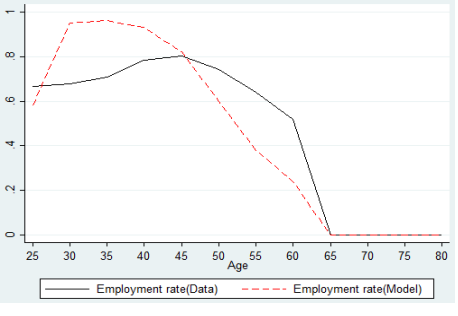

FIGURE 6. LIFE-CYCLE PATTERNS OF THE EMPLOYMENT RATE[5]

Figure 7 shows the life-cycle patterns of the tax burdens. The labor income tax, capital income tax and consumption tax distributions are similar to the labor income, non-housing asset and consumption distributions, respectively. Labor income taxes are levied on working age agents. On the other hand, the capital income tax burden peaks when people are in their 50s and 60s and have accumulated assets in preparation for retirement. Consumption taxes are constant across ages, similar to the consumption pattern from the model. The distribution of housing property taxes is close to the pattern of housing assets, which increases with age and gradually decreases after retirement. Accordingly, the elderly bear a substantial housing property tax burden. The burden of the housing transaction tax

[5]The employment rate of workers 65 and over is set to 0 in the data, as in the model.

FIGURE 7. LIFE-CYCLE PATTERNS OF TAX BURDENS

is mainly seen in early and later life. The housing transaction tax burden is highest for young agents because they buy housing assets actively to consume housing services. Thereafter, the transaction tax is gradually lowered and surges again in the last period of life because those at this stage sell the housing assets that they have held. Although the pattern of housing transaction taxes across ages could not be directly compared to that from the data, actual transaction taxes may be levied primarily on young agents, who must buy larger homes for marriage and childbirth. In addition, the transaction tax burden may increase in old age as the elderly downsize their housing.

Table 1 compares the shares of tax revenue from each tax source in the model to those from the data. The capital income tax rate in the model is set to meet the share of capital income tax revenue from the data, but for other tax rates, the shares of tax revenue are not targeted in the calibration. The shares of tax revenue from each tax source in the model are similar to those in the data. Tax revenue on labor income is 12.2% of output in the model, which is slightly greater than that in the data,

TABLE 1—STEADY STATE

The Ratio of Tax to Output	Model	Data
Labor Income Tax	0.122	0.010
Consumption Tax (Value Added Tax)	0.035	0.045
Capital Income Tax	0.039	0.039
Housing Property Tax	0.004	0.003
Housing Transaction Tax	0.004	0.004

10.4%. Housing property tax revenue and housing transaction tax revenue in the data (0.3% and 0.4%, respectively) are similar to those in the model (0.4% of output in both cases). The value-added tax revenue on consumption is 3.5% of output in the model, which is lower than the value of 4.5% in the data.

C. *Tax Reforms*

In this section, I examine the effects of tax reforms on the economy and the welfare of generations. I consider tax reforms that lead to a 10% increase in total tax revenue by adjusting each tax rate.

Table 2 compares the initial steady states and the new steady states of tax reforms increasing the tax rates on consumption, capital income, and housing property and labor income. I assume that the increased tax revenue is used for government consumption when analyzing the effects of tax policy changes.

With regard to increasing the consumption tax, the aggregate capital (K) and output (Y)[6] are increased by 0.04% and 0.17% in such a case compared to the benchmark economy. The increased consumption tax encourages investments in capital instead of consumption, leading to more production. Moreover, when housing property taxes are increased, the positive effects of the tax reform on capital accumulation and production are much greater. Increasing housing property tax rates reduces the demand for housing assets, which may decrease investments in housing assets and output. Instead, the increased tax burden on housing assets could encourage the investments in capital assets and increase production. In my model, increasing the tax burden on housing assets leads to increases in capital accumulation and production by 3.81% and 2.18%, respectively.

On the other hand, if capital income taxes increase, both aggregate capital and production output are lowered. The increase in the tax burden with regard to capital income hinders investments in capital, which leads to reductions in capital accumulation by 7.91% and production by 2.55%. Instead, agents increase their labor supply to compensate for the income reduction, causing the employment rate to increase by 1.11%. If the labor income tax is increased, capital is reduced by 2.03% and production output by 0.99%. Furthermore, the employment rate is lowered slightly.

I compare welfare losses from tax reforms using the concept of equivalent consumption variation (ECV) with regard to how much non-housing consumption (%) should be changed under the benchmark economy in order to gain welfare as much as in the post-reform period. The tax reform of increasing housing property

[6]As mentioned in the calibration section, output (Y) is calculated as GDP minus the value of housing services. Because this model does not include housing rental markets, I do not explicitly calculate the value of housing services, which can be calculated based on rents actually paid. Instead, I compare tax policy effects on output not including the value of housing services. However, even when the value of housing services is considered, this paper's main outcomes with regard to the tax policy effects on output would not be affected. If I assume that the rental housing market exists in the model, the rental price on housing services could be derived from the cost of housing services, as determined by equation (3). With rental prices and housing assets, the value of imputed rent could be calculated across tax reform scenarios. According to the calculation results, the changes in the total GDP including output and the imputed rent are -1.15, -2.80, 0.18, and 2.11% when increasing taxes on labor income, capital income, consumption, and housing property, respectively. These tax policy effects on GDP are quite similar to those on output in Table 2, and the results of this paper therefore remain valid.

TABLE 2—TAX REFORMS

	Bench mark	A 10% Increase in Total Tax Revenue (%)			
		Labor Income Tax	Capital Income Tax	Consumption Tax	Housing Property Tax
Tax Revenue		10%			
Output (Y)	0.171	-0.99	-2.55	0.17	2.18
Capital (K)	0.497	-2.03	-7.91	0.04	3.81
Employment Rate	68.9	-0.54	1.11	0.38	1.59
Welfare (ECV)		-5.23	-5.52	-3.78	-2.67

taxes shows the smallest welfare loss, a 2.67% decrease in consumption. Increasing housing property taxes raises investments in capital assets instead of housing assets, thereby increasing production. This positive effect of housing property taxes on the overall efficiency of the economy reduces the welfare loss from the tax increase and leads to the lowest welfare loss among the tax reforms.

Similarly, increasing consumption taxes leads to a relatively small welfare loss, a 3.78% decrease in consumption, because the increases in capital accumulation and production compensate to some extent for the welfare loss due to the tax increase. However, the tax reform choice of increasing capital income taxes results in the largest welfare loss, a 5.52% decrease in consumption. Because the increased capital income taxes reduce capital accumulation and the overall size of the economy, the welfare loss becomes greater.

Overall, in the model economy, the tax reform choices of increasing tax revenues lead to a welfare loss, but tax policy changes that raise housing property taxes and consumption taxes are better than other tax increases in terms of economic efficiency and welfare. The result pertaining to consumption taxes is consistent with those in previous studies. For housing property taxes, newly introduced here, increasing the tax burden on housing assets could allocate resources more efficiently from housing assets not used for production to capital assets, which are production inputs.

Figure 8 shows the welfare changes across generations by each tax reform choice along the transition path from the initial steady state to the new steady state. The X-axis represents age at the time of the tax policy change and the negative numbers denote future generations who enter into the model economy after the tax reform. For future generations, the figure shows the change in lifetime consumption under the benchmark economy in order to gain welfare as much as in the post-reform period, and for the current generation it shows the change in consumption over the period remaining after this time point.

Each tax reform has different impacts on different generations. While the increase in labor income tax sharply reduces the welfare of the working age group, the welfare of older people not participating in the labor force while in retirement is hardly affected. Specifically, younger and future generations experience larger welfare losses because they are expected to earn substantial amounts of labor income by working over their lifetimes. Furthermore, the increased labor income taxes reduce output and slow economic growth, which deepens the welfare reduction of future generations.

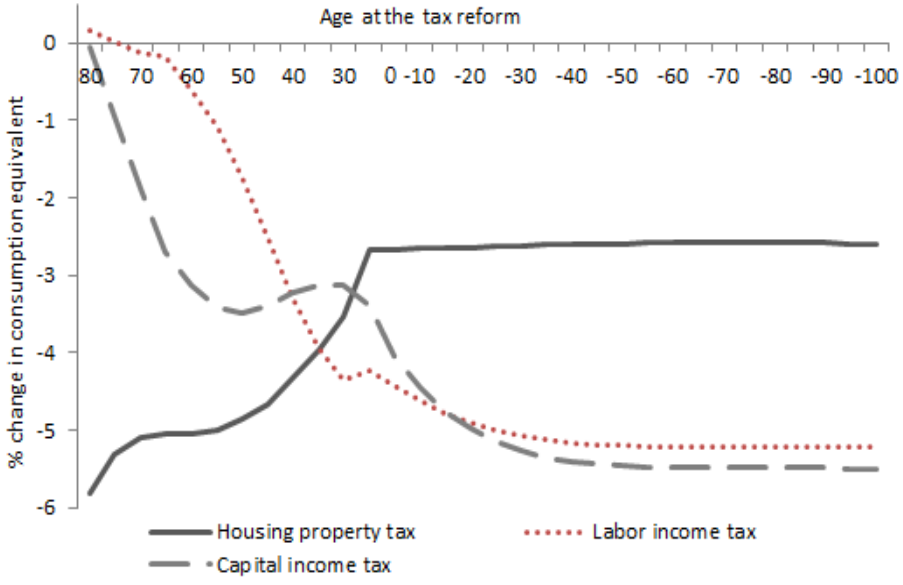

FIGURE 8. WELFARE CHANGE BY TAX REFORM (UNIT: %)

Note: The X-axis represents the age at the time of the tax policy change. The negative numbers on the X-axis denote future generations entering the model economy after the tax policy change.

In contrast, when raising housing property taxes, the reduction in welfare is greater for older age groups. Because the elderly hold considerable housing assets to consume housing services and finance non-housing consumption, the increased housing property tax rate hurts their welfare. On the other hand, increased housing property taxes induce investments in capital assets, which are used for production instead of housing assets, thus expanding the size of the economy. This has a positive effect on the welfare of future generations, and the welfare loss of future generations is accordingly smallest among all tax reform choices.

An increase in capital income taxes decreases the welfare of future generations the most. Contrary to the case of increasing housing property taxes, increasing capital income taxes reduces capital accumulation and production, which lowers the welfare of future generations. For the current generation, an increase in the capital income tax reduces the welfare of those in their 50s and 60s the most because they have accumulated substantial capital assets to finance consumption when in retirement. On the other hand, the effects of increasing the capital income tax on young people, who hold few capital assets, and the elderly, who dissave capital assets for consumption, are relatively minor.

V. Heterogeneous Preference on Tax Policy across Generations

The above results using the overlapping generations model show that the tax policy effects can differ across generations. In this section, I examine actual preferences with reference to tax policy across age groups using survey results

from the KDI Generation Study of 2015. Tax policy changes are based on a consensus among members of society at present; hence, it is important to consider the opinions of the current generation concerning policy implementation. The opinions of the current generation on tax policy can be compared to the model results for the current generation.

The survey conducted in order to study intergenerational issues covers 3,500 individuals aged 15 to 79, and each age group, from teenagers to those in their seventies, contains 500 individuals. The survey includes the question "Which tax do you prefer if you need to pay more taxes?" Using the answers to this question, I examine preferred tax policies across age groups.

Figure 9 shows the most preferred tax among consumption taxes, corporate and individual income taxes, and property taxes when respondents are forced to pay more in taxes. In this case, 48% of the respondents choose corporate income taxes. Corporate income taxes seem to be most often preferred, as they are directly applied to the corporate sector rather than to the household sector. Individual income taxes and property taxes were next. Consumption taxes are least favored.

Table 3 presents the factors that affect opinions about preferred taxes. The preference for favored taxes in the case of a tax increase is examined from the first rank to the fourth rank. The preferred tax ranking is the dependent variable and ordered logistic regression is used for the estimation. Main explanatory variables are dummy variables for each age group from their twenties to their seventies. I also include the control variables of household income, household assets and debt, the number of household members, a progressive political view, gender, education, marital status, and dummies for area.

Regarding corporate income taxes, there were no significant differences in preferences across ages. Every age group selects corporate income taxes as their favored tax if taxes have to be raised. Households with more financial assets do not prefer corporate income taxes, as capital income taxes are levied on capital incomes from financial assets. Households with higher incomes prefer to increase corporate income taxes to other taxes. Moreover, households with a progressive political view are more likely to prefer an increase in corporate income taxes.

For individual income taxes, working age groups do not prefer an increase in this type of tax. Those in their 30s and 40s, whose incomes rise sharply and reach their peak, especially do not favor an increase in individual income taxes. With other control variables, households with greater incomes are less likely to prefer an increase in individual income taxes.

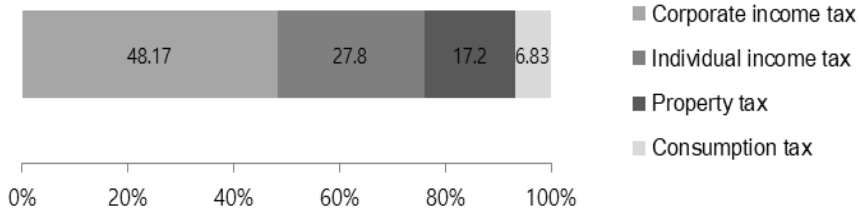

FIGURE 9. FAVORED TAX RANKING (UNIT: %)

Source: KDI Generation Study 2015.

TABLE 3—PREFERRED TAX IN THE CASE OF A TAX INCREASE

Dependent Variables	Corporate Income Tax		Individual Income Tax		Property Tax		Consumption Tax	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Age Dummy (Reference Group: 70s)								
(1) 20s	0.136	-0.186	-0.162	0.139	0.193*	0.268	-0.196*	-0.266
	(0.120)	(0.186)	(0.113)	(0.181)	(0.112)	(0.176)	(0.117)	(0.180)
(2) 30s	0.082	-0.156	-0.368***	-0.166	0.487***	0.573***	-0.294**	-0.350**
	(0.116)	(0.170)	(0.113)	(0.163)	(0.117)	(0.162)	(0.116)	(0.165)
(3) 40s	0.136	-0.011	-0.262**	-0.117	0.209*	0.339**	-0.081	-0.159
	(0.118)	(0.173)	(0.116)	(0.164)	(0.115)	(0.165)	(0.112)	(0.161)
(4) 50s	0.159	0.041	-0.213*	-0.101	0.146	0.287*	-0.114	-0.219
	(0.115)	(0.160)	(0.118)	(0.158)	(0.115)	(0.157)	(0.113)	(0.153)
(5) 60s	-0.109	-0.205	-0.057	-0.007	0.148	0.240*	-0.002	-0.045
	(0.117)	(0.133)	(0.115)	(0.127)	(0.122)	(0.127)	(0.109)	(0.119)
Household Income (log)		0.222***		-0.135**		-0.112*		0.050
		(0.060)		(0.065)		(0.060)		(0.071)
Household Real Estate Assets (log)		0.001		0.039		-0.075**		0.041
		(0.032)		(0.033)		(0.030)		(0.035)
Household Financial Assets (log)		-0.034*		0.015		0.021		-0.009
		(0.020)		(0.019)		(0.019)		(0.017)
Household Debt (log)		-0.003		-0.008		-0.012		0.032***
		(0.009)		(0.009)		(0.009)		(0.009)
Number of Household Members		-0.066		0.026		0.062		-0.041
		(0.044)		(0.045)		(0.044)		(0.045)
Progressive Political View		0.202**		-0.156*		0.116		-0.190**
		(0.093)		(0.082)		(0.084)		(0.092)
Observations	3,000	2,997	3,000	2,997	3,000	2,997	3,000	2,997

Note: This table reports the coefficient estimates from ordered logistic regressions. In columns (2), (4), (6), and (8), gender, education, marital status, regions are controlled. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively. Robust standard errors are in parentheses.

On the other hand, with regard to property taxes, younger age groups prefer to increase this type of tax. In column (6), compared to those in their 70s, other age groups are more likely to prefer to raise property taxes, while younger people, especially those in their 30s, favor an increase in property taxes. Households with more real estate assets do not prefer to raise property taxes because they are expected to bear a higher tax burden.

Consumption taxes are less preferred by the younger age groups. In particular, the preference for increased consumption taxes is lowest for those in their 20s and 30s, whose consumption is expected to increase as their household sizes increase with marriage and childbirth.

Although the model could not reflect all of the factors that influence actual tax policy preferences, the empirical results in several respects are quite consistent with the model results for the current generation along the transition path. The preferences for increased labor income taxes and property taxes are distinctly different across generations depending on their incomes and assets. Increased property taxes are not preferred by the elderly according to the empirical analysis. This outcome is similar to the result from the model, which showed that increased housing property taxes lead to a greater reduction in the welfare of older age groups, who have substantial housing assets. On the other hand, younger age groups do not favor individual income tax increases because people in this age group have significant earned income by working, consistent with the model result, which held that increases in labor income taxes reduce the welfare of working age groups the most. However, unlike the theoretical prediction for capital income taxes, preferential differences for corporate income taxes across age groups are not found in the empirical analysis. All age groups prefer to raise corporate income taxes.

VI. Conclusion

This paper examines tax policy effects across generations. I develop an overlapping generations model that includes taxes on labor income, capital income, consumption, and housing assets. With the model, I compare the effects of tax reforms that increase tax revenues through each tax rate increase. When increasing the housing property tax, capital accumulation and production increase because investments in capital assets are accelerated as opposed to those in housing assets. Similarly, increased consumption taxes also lead to capital accumulation instead of consumption. Accordingly, economy growth is promoted in these two cases and the welfare loss to be borne by future generations is relatively small. Moreover, the tax rate adjusted to increase tax revenues has different effects on the welfare of generations because incomes and assets differ across generations at the time of the tax changes. An increase in labor income taxes reduces the welfare of the working age group but scarcely affects retirees. On the other hand, taxes on assets increase the tax burden on the elderly, who have accumulated assets for consumption. Specifically, raising housing property taxes leads to a greater reduction in the welfare of older age groups, whereas the welfare loss of future generations is the smallest among the tax reform options.

These results show that the tax burden imposed on each generation varies depending on the direction of tax policy changes. Currently, as welfare spending has expanded, there is a growing consensus with regard to the need to increase taxes. The change in tax policy is related to the intergenerational question of who should bear the burden of increasing benefits. Thus, when discussing tax increases, the intergenerational effects of tax policy as addressed here must be considered as a group. However, the model economy in this paper has limitations, and the results should be cautiously interpreted. This paper has assumed that individuals can decide whether to work, but the working hours are fixed at the full-time level. Recent optimal tax policy studies show that the optimal capital income tax is significantly positive with an endogenous labor supply when the income distribution effect is considered (Conesa *et al*., 2009). This implies that the results here pertaining to capital income taxes may be overestimated. This paper also focuses on the distinctive characteristics of housing assets, which differ from capital assets, but the model here without endogenous housing prices does not take into account changes in housing prices according to tax policies and investments in housing assets for capital gains. In this sense, the tax incidence by housing price changes and tax policy effects on the level of speculative housing demand cannot be explained by this model. Furthermore, this paper does not consider housing market friction from the rigidity of the housing supply in the short run. It would be interesting to incorporate these housing-specific factors more fully into the overlapping generations model and to investigate tax policy effects across generations in future studies.

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Does Early Incubating Improve the Performance of Start-ups?: Evidence from TIPS in Korea

By JAHYUN KOO*

Recently, the government has been pursuing various policies to create new industries and jobs through the invigoration of start-ups. For the sustained growth of start-ups, it is necessary to look not only at the supply of risk capital but also at policies for venture capital firms that nurture and foster start-ups. The purpose of this study is to estimate the effects of the nurturing and fostering role of risk capital, such as mentorship on the performance of start-ups, and to do this we analyzed the effects, as a newly introduced form of venture capital, of mentoring by an accelerator and investor ties on the performance outcomes of start-ups. We find that mentoring and investor ties for start-up enterprises positively influence follow-up investment in start-ups. In addition, this study finds that with a younger CEO of a start-up, it is more likely that the performance of the start-up will improve. Meanwhile, when examining increases in employment as a measure of the business performance of start-ups, mentoring and investor ties are found to have a positive effect on the increase of employment at start-ups. These results suggest that there is a need to promote policies that strengthen the mentoring role of venture capital in Korea's equity finance policies and in the government's SME support policies.

Key Word: Accelerator, Venture Capital, Business Incubator, Start-up, TIPS (Tech Incubator Program for Start-ups)
JEL Code: G24, G32

I. Introduction

Recently, the Korean economy has been suffering from decreasing economic dynamism, resulting in several years of prolonged low economic growth, a narrowing of the growth gap with regard to Korea and advanced countries, and a deterioration of potential growth (Lee and Cho, 2017). These economic problems are more urgent than ever, as the economic growth model as a fast-follower has shown limitations (Kim, 2016). Thus, it is now time for Korea to transform her old

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economic growth model into a first-mover model through innovation. To become an innovation-driven economy, start-ups by entrepreneurs must be brisk. Entrepreneurs are considered to have the potential to lead economic growth, promote competition, create jobs, improve productivity, and restructure industries (Block *et al*., 2017).

Therefore, the Korean government in recent years has pursued various policies to transform the economic model from imitation-led growth to innovation-driven growth through the invigoration of start-ups (See Table 1). In particular, policies affecting the active role of venture capital in promoting start-ups have been vigorously pursued to establish a virtuous circle of a venture ecosystem. As noted by Perez (2002), "whether the innovator works in the laboratory of a big firm or in his/her garage, someone will be willing to put up the required investment money to test the process, launch the product or expand production". Venture capital – be it a venture capitalist or an angel investor – plays a crucial role in the survival and scale-up activities of start-ups by providing equity capital and bearing the risk of failure.

Due to these policy efforts, the supply of venture capital in Korea has increased drastically in recent years. As shown in Figure 1, the amount of new investment by venture capitalists increased by almost one trillion KRW over four years, from 1.23 trillion won by the end of 2012 to 2.15 trillion won by the end of 2016. Furthermore, the number of newly invested firms jumped from 688 by the end of 2012 to 1,191 by the end of 2016.

TABLE 1—POLICIES FOR ENHANCING THE VENTURE ECOSYSTEM

Date	Measures	Ministry in charge
2013.5	Measures to develop a virtuous cycle in the venture start-up capital ecosystem	Ministry of Strategy and Finance Small and Medium Business Administration
2013.7	Opening of the Korea New Exchange (KONEX)	Financial Services Commission
2013.8	Raising growth-ladder fund	Financial Services Commission
2014.3	Measures to foster M&As	Small and Medium Business Administration
2014.3	Measures to promote global accelerators	Small and Medium Business Administration
2014.3	Measures to invigorate technology-led start-ups	Small and Medium Business Administration
2015.7	Measures to step up equity financing in the SMEs and venture start-ups	Financial Services Commission Small and Medium Business Administration
2016.1	Implementation of equity-type crowdfunding by which start-ups and SMEs are allowed to issue securities through crowdfunding platforms.	Financial Services Commission
2017.11	Measures to create ecosystem for innovation-led start-ups • Creating friendly environments at innovation-led start-ups • Increasing venture capital fund • Creating a virtuous circle of start-up and equity investment	Ministry of Strategy and Finance Ministry of SMEs and Start-ups

Source: Press releases by SME-related Government Ministries.

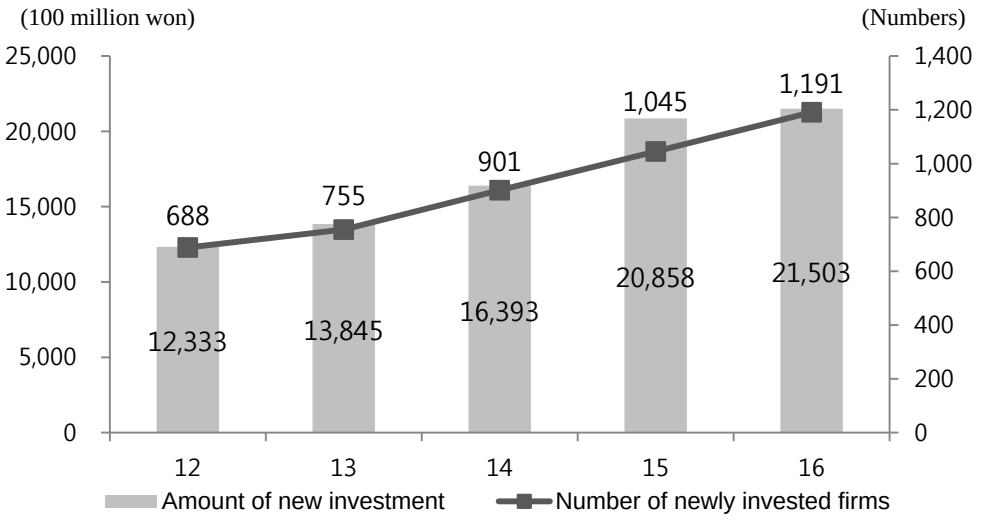

FIGURE 1. VENTURE CAPITAL INVESTMENT TRENDS

Source: Korean Venture Capital Association, Venture Capital News Letter, 2017 December vol.114.

Although venture capital plays an important role in promoting innovation by supplying a source of funds for commercializing innovations by start-ups, financing radical innovations requires more than merely capital. Not only monetary support but also nurturing and fostering roles by venture capital for start-ups are also important for their growth (Cohen and Hochberg, 2014). In addition to money, early-stage start-ups need mentoring, marketing support, workspaces, investment meetings, as well as legal advice (see Figure 2).

In particular, Korean venture companies have stated that Korean venture capital is rarely helpful aside from the provision of money (see Figure 3).

This study examines methods which may improve the nurturing and fostering of start-ups by venture capitalists, aside from providing monetary support, while focusing on business accelerators, which are recently attracting attraction from academics and practitioners (e.g., Mejia and Gopal, 2015; Gonzalez-Uribe and Leatherbee, 2017; Dempwolf *et al*., 2014). Particularly, by utilizing data from Start-up Chile,[1] Mejia and Gopal (2015) empirically determined that start-ups actively participating in mentoring activities are more likely to realize accomplishments such as developing a business model and increasing sales, and they are highly likely to attract investors. Gonzalez-Uribe and Leatherbee, also making use of data from Start-up Chile, analytically demonstrated that participation by an accelerator has an impact on the subsequent performance of the start-up.

[1]The Start-up Chile program is Chilean government-supported accelerator located in Santiago, Chile. The program was created by the Chilean Ministry of the Economy with the goal of transforming Chile into an innovation and entrepreneurial hub for Latin America. The project started as a pilot in 2010 with 22 startups from 14 countries providing $40,000 USD of equity-free seed capital to develop a startup for six months. After the success of the pilot, Start-up Chile expanded to two rounds per year in 2011, each round lasting six months (Mejia and Gopal, 2015).

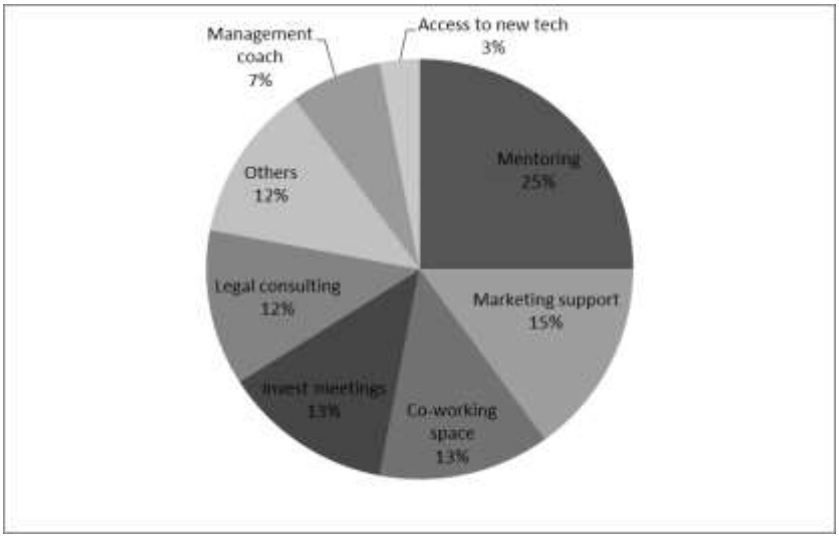

FIGURE 2. START-UP NEEDS ASIDE FROM MONEY

Note: E-survey by Telefónica Global Affairs and New Ventures on "Aside from money, what is the single most important necessity for a startup?"

Source: Salido *et al*. (2013).

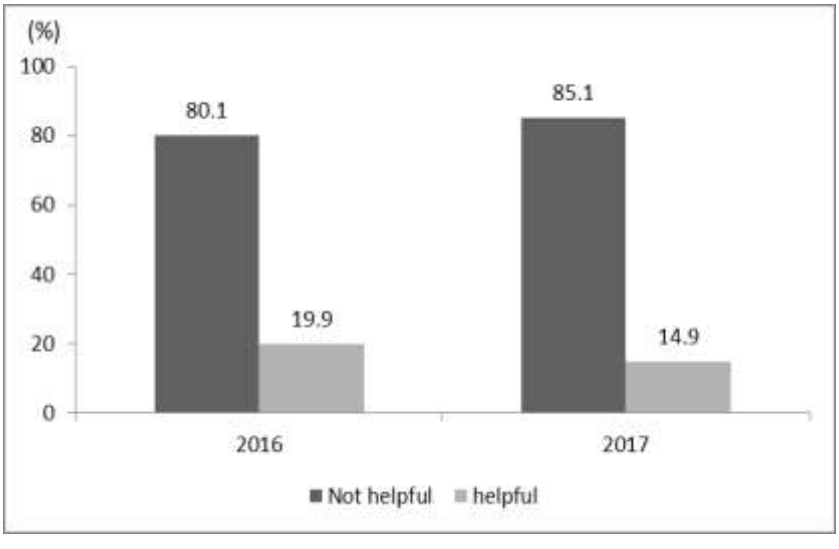

FIGURE 3. DEGREE OF NON-MONETARY HELP TO START-UPS BY VENTURE CAPITALISTS

Source: Ministry of SMEs and Start-ups, "Survey on Venture Firms," 2017.

Following Mejia and Gopal (2015) and Gonzalez-Uribe and Leatherbee (2017), this paper examines whether additional roles such as mentoring and arranging meetings with investors by a Korean accelerator has had a positive effect on improving the performance outcomes of start-ups. In addition, the results of this study have policy implications which enhance nurturing and fostering as roles by venture capitalists for start-ups aside from their providing monetary support. In

particular, this study employs data from TIPS (the Tech Incubator Program for Start-ups),[2] which is gaining attention as a notable governmental financial sponsor program for start-ups, with which to analyze the effects of an accelerator on the performance of start-ups. To the best of my knowledge, this paper is the first to carry out an empirical examination of the relationship between the roles of an accelerator and the start-up performance while particularly making use of TIPS data.

The estimation results have shown that mentoring and investor ties for start-up enterprises by an accelerator, such as a TIPS operator, positively influence follow-up investments in the start-ups. In addition, this study finds that a younger CEO of a start-up is associated with a higher likelihood that the performance of the start-ups will show an improvement. In the meantime, when examining the increase in employment increase as a business performance metric of start-ups, mentoring and investor ties are shown to have a positive effect on this outcome as well at start-up enterprises. These results suggest that there is a need to promote policies to strengthen the mentoring role of venture capitalists in Korea's equity finance policies and governmental SME support policies.

The composition of this study is as follows. Section II examines the relevant literature. Section III explores the roles and characteristics of an accelerator as a source of risk capital, including an overview of accelerators in Korea. In Section IV, we discuss the data and empirically analyze the impact of accelerators on the performance of start-ups. Section V summarizes the paper and presents policy implications.

II. Literature Review

It is important for entrepreneurs to survive by securing financing, and especially by securing equity financing, which encourages innovation activities because the debt burden is relatively low even if they fail. In particular, venture capital has been championed that it has promoted innovations by providing a source of funds for commercializing radical innovations (e.g., Kortum and Lerner, 2000; Lerner *et al.*, 2011).

Meanwhile, in order to shape an entrepreneur’s ideas and execute them, the roles of nurturing and cultivating risk capital are also very important (Dee *et al*., 2011).

In particular, mentoring (e.g., know-how related to business model development, technology development, management) and links to various human networks are important with regard to incubating and nurturing entrepreneurs because they provide both human capital and social capital (Berger and Udell, 1998). In that context, an empirical analysis of the effects of the mentoring and network linking activities provided by the accelerator on the performance of entrepreneurs in a recent venture capital model suggests certain implications for policies regarding the incubation of venture capital.

With respect to the nurturing and fostering of start-ups, studies have been mainly concerned with the impact of business incubators on entrepreneurs. It has been

[2]See in detail in Section III and data in Section IV.

found that business incubators have a positive effect on start-ups by, for instance, increasing the survival rate of start-ups by supporting various needs in the early stage for weaker start-up companies (Scillitoe and Chakrabarti, 2010; Bruneel *et al*., 2012; Ratinho *et al*., 2010). In Korea, Jo and Kim (2011) noted that non-physical factors such as management, administrative support, and technical support have a significant effect on the performance of companies backed by incubators. On the other hand, regarding the incubation functions of venture capital, the main focus of recent studies is mentorship by angel investors and venture capitalists, and the majority of studies focus on qualitative discussions rather than on an empirical analysis.

In addition, recent interest in the entrepreneurial nurture and incubation roles of accelerators, which combine the characteristics of venture capital and entrepreneurial incubators, has been increasing significantly (Cohen and Hochberg, 2014). Accelerators are proposed to increase the likelihood of the success of start-ups mainly through three mechanisms (Miller and Bound, 2011; Dempwolf *et al*., 2014). Firstly, the accelerator makes various resources available to entrepreneurs. Local and stand-alone entrepreneurs can only use limited resources within the capabilities of the start-up team in the region, but the accelerator can bring the start-up into a specific area (i.e., a boot camp) of expertise of the accelerator, thus providing a wide range of resource utilization opportunities. Secondly, the accelerator improves the performance of the entrepreneur by mentoring the entrepreneurs. Accelerators will provide advice about business model development, technology development, business management, and investment promotion activities through a mentor team composed of experts in various fields. Mentoring plays an important role in fostering leaders and career development in organizations (Srivastava, 2013). Lastly, the accelerator provides a variety of human networks, such as angel investors, venture capitalists, and other entrepreneurial accelerators (Cohen and Hochberg, 2014). As investors and entrepreneurs are in the accelerator ecosystem, the information asymmetry problem is mitigated, which opens up opportunities for start-ups to attract further investment.

Despite the active discussions of the positive effects of accelerators on the performance of start-ups, empirical research is limited given that accelerators are a form of risk capital that has emerged relatively recently and because the availability of statistical data is limited. However, in recent years, empirical studies are increasingly being carried out. Mejia and Gopal (2015) conducted an empirical analysis of the effects of accelerator mentoring and investor engagement on the performance of start-ups participating in the Start-up Chile program. Companies that actively participate in mentoring activities are more likely to realize accomplishments in areas such as business development and sales, and such companies are highly likely to attract investors. By making use of data on the participants in Start-up Chile, Gonzalez-Uribe and Leatherbee (2017) also uncovered empirical evidence that entrepreneurial schooling (e.g., management skills or know-how in relation to pitching an idea) bundled with basic services (e.g., cash or co-working spaces) can significantly increase the performance of a start-up, whilst basic services alone barely affect performance outcomes.

However, as far as the author knows, no empirical analysis of the effects of

accelerators on entrepreneurial performance outcomes has been made in Korea. In this study, by making use of data from companies participating in the government's TIPS, we empirically analyzed the effects of mentoring and investor ties on start-up outcomes such as follow-up investment amounts or increased employment, following Mejia and Gopal (2015).

This study was verified by establishing the following hypotheses.

Hypothesis 1: Mentoring by an accelerator (TIPS operator) increases the possibility of attracting follow-up investment for start-ups (entrepreneurs).

Hypothesis 2: An accelerator's (TIPS operator) investor linkage activities increase the possibility of attracting follow-up investment for start-ups (entrepreneurs).

III. Overview of Accelerators

A. *Characteristics of an Accelerator*

It has been argued that venture capital (or venture capitalists) plays an important role in promoting innovation by supplying equity capital as well as providing other types of business support aside from funding to start-ups. However, empirical evidence has often shown that the activities of VCs actually play relatively weak causal role in stimulating the creation of innovative and successful start-up companies (Bernstein *et al*., 2016).

At present, accelerators, which are short-term incubation programs for entrepreneurs that offer mentoring, networking, and equity investment, are attracting attention as a new form of risk capital that can increase the chances of success at start-ups.

The accelerator selects entrepreneurs as a cohort and fosters them intensively for a certain period of time (e.g., six months). It generally provides early-stage seed investment funding in exchange for equity, accelerates the commercialization of entrepreneurial ideas through mentoring, and/or provides direct future funding or links to other investors (Miller and Bound, 2011). Accelerators have played a major role in entrepreneurial ecosystems (e.g., 51 in 2009 and 200 in 2014) since the first introduction of Y-Combinator in the US in 2005 (Lennon, 2013).

The similarities and differences between an accelerator and a business incubator are as follows. Both accelerators and business incubators offer advice, corporate services, money, and office space to nascent firms, forms of help which are more likely to increase their chances of success as compared to firms which have not received such benefits (Isabelle, 2013). The National Business Incubation Association (NBIA) has found that US business incubators provide support for start-ups that cover a variety of industries, ages, and experience levels, whereas accelerators mainly focus on companies that are based on web technologies and that are operated by a young CEO. In addition, the accelerator aims to move quickly from the start-up stage to the next stage. However, the business incubator

aims to achieve a mature stage for the entrepreneur with a self-sustaining system. While business incubators invest almost nothing, accelerators make equity investments in entrepreneurs in order to enjoy future profits. Meanwhile, angel investors mentor investors individually when necessary, as do accelerators but without a boot camp.

TABLE 2—CHARACTERISTICS OF INCUBATORS AND ACCELERATORS

Characteristics	Incubators	Accelerators
Clients	• All types, including science-based businesses (e.g., biotech, medical devices, nanotechnology, and clean energy) and those not related to technology; all ages and genders; includes those with previous experience in an industry or sector.	• Web-based, mobile apps, social networking, gaming, cloud-based, software, etc.; firms that do not require significant immediate investment or proof of concept; primarily youthful, often male technology enthusiasts, gamers, and hackers.
Selection Process	• Competitive selection, mostly from the local community.	• Competitive selection of firms from a wider region or even nationally (or globally).
Terms of Assistance	• One to five or more years (33 months on average)	• Generally one- to three-month boot camps
Services	• Offers access to management and other consulting entities, specialized in intellectual property and networks of experienced entrepreneurs; helps businesses mature to become self-sustaining or reach a high-growth stage; helps entrepreneurs round out skills, develop a management team and, often, obtain external financing.	• "Fast-test" validation of ideas; opportunities to create a functioning beta versions and to find initial customers; linkage of entrepreneurs to business consulting and experienced entrepreneurs on the web or in the mobile apps space; assistance in preparing pitches to try to obtain follow-up investment.
Investment	• Usually does not have funds to invest directly in the company; more frequently than not, does not take equity.	• Invests $18,000 to $25,000 in teams of co-founders; takes equity in every investee (usually 4 to 8 percent).

Source: Adkins (2011).

TABLE 3—DIFFERENCES BETWEEN INCUBATORS, ACCELERATORS AND ANGEL INVESTORS

	Accelerators	Incubators	Angel Investors
Duration	Three months	One to five years	Ongoing
Cohorts	Yes	No	No
Business model	Investment; non-profit	Rent; non-profit	Investment
Selection frequency	Competitive, cyclical	Non competitive	Competitive, ongoing
Venture stage	Early	Early, or late	Early
Education offered	Seminars	Ad hoc	None
Venture location	Usually on-site	On-site	Off-site
Mentorship	Intense, by self and others	Minimal, tactical	As needed, by investor

Source: Cohen and Hochberg (2014).

B. *Estimation Strategy*

In Korea, the establishment and operation of accelerators have been increasing, starting with 'Primer', which was introduced in 2010 as the first start-up accelerator in Korea. The government has institutionalized accelerators through an amendment of the Small and Medium Enterprise Support Act following market demands for the development of high-quality accelerators.

The revised bill clarified the criteria for accelerators and systematically supported and fostered entrepreneurs. The main points of the amendment related to accelerators are as follows. First, it is now possible to create an accelerator investment fund, and the legal basis of such funding has been clarified, processes which had not been drawn up than other for investment funds such as venture capitalists and angel investors. Through these measures, investment support for a start-up company by an accelerator, which acts as a catalyst for the entrepreneurial ecosystem, can be made more actively. The government plans to offer various incentives, including tax deductions and the permission to raise funds through private placement by individuals to accelerators when they have been registered with the legal requirements (see Table 4). Meanwhile, the Korean Accelerator Association was launched on December 22 of 2017 with 55 initial members.

Secondly, excluding what is known as the FinTech industry from being placed on the banned list for SME start-up support has boosted start-ups in the FinTech industry and promoted the development of this industry.

In addition, the Small and Medium Business Administration (SMBA, the newly established Ministry of SMEs and Start-ups) has enacted qualification requirements for TIPS operators, who head these private investment-led technology start-up support programs, which state that they must be registered accelerators according to the Small and Medium Enterprise Support Act, thereby regulating the management, supervision and support of private accelerators related to TIPS. Whilst an accelerator in general is a stand-alone start-up incubating program which selects start-ups as a cohort and intensively fosters them for a certain period of time (e.g., six months) in a boot camp, such as Start-up Chile, Y-Combinator in the US, and a number of accelerators in Korea, TIPS is a government-private joint accelerator program intended to boost technology-based start-ups by sponsoring government funding proportional to the TIPS operator’s investment to make use of a private investor’s incentive for the start-up’s success. The TIPS program was initially benchmarked on the YOZMA Scheme in Israel (details given in the following section).

TABLE 4—OUTLINE OF ACCELERATOR REGISTRATION IN KOREA

Condition		Incentives		Obligation	
① Capital: Over 100 million * Non-profit: 50 million, Creative Center: 10 million ② Experts: Over two qualified specialists * over the three years of investing or incubating experience ③ Incubating Space	→	Raising individual funds for early-stage start-ups (Corporations allowed to invest up to 49%)	+	Investment	Invest over 10 million in early stage start-ups and invest over 50% of total funds in early stage start-ups Support for more than three months to early-stage start-ups, including incubating activities
				Report	Submit reports semi-annually
		Capital gains, Dividends Corporate Tax Exemption		disclosure	Disclose organization, personnel, financial conditions, profit and loss statements and other information

Source: Ministry of SMEs and Start-ups, Press release, 2017. 12. 22.

IV. Empirical Results

A. *Data*

In Korea, accelerators were recently introduced, and it is difficult to define the characteristics of entrepreneurs participating in an accelerator program operated by the private sector. In this study, we analyzed the effects of mentoring and investor linkages provided by TIPS operators on the performance of start-ups using 52 companies participating in the government's TIPS program from 2013 to 2015. The TIPS program is a government-sponsored technology start-up support program, as noted above. If an operator, such as an accelerator (e.g., an angel investor) and a

professional VC firm, led for instance by a successful venture businessman, finds a promising entrepreneurial team and invests more than 100 million won and recommends it to the government, the government then supports the team with up to 900 million won, including R&D funds of 500 million won. Operators, through a consortium of universities and research institutes, among others, put the team in the business incubator center where the accelerator fosters the start-up for up to three years by fulfilling the needs of the start-up, such as mentoring and links to other investors. The accelerators can reap a large profit if the start-up succeeds after the government-matching R&D support, and accelerators have an incentive to engage entrepreneurs actively via mentoring and through investor relationships in order to increase the likelihood of the success of the start-up.

The TIPS program sets the success criteria for participating companies, who must engage in M&A or IPO activities (including Konex) or attract more than KRW 2 billion of follow-up investments from venture capitalists, or must achieve annual sales of more than 600 million won. In principle, the government collects 10% of the subsidy from firms that achieve the target objectives.

In the case of Chile, it is difficult to tell the difference between the support effect of an accelerator and the initiative of participating companies due to the fact that

TABLE 5—VARIABLE DESCRIPTIONS

Variable	Description
Follow-up investment	attract=1, not attract=0
Variables related to mentorship and investor ties	
Mentorship	five-point scale (very helpful=5, not helpful =1)
The number of contacts by mobile messenger	five -point scale (above 7=5, nothing=0)
Investor network ties	five -point scale (strongly positive=5, strongly negative=1)
Access to network ties	five -point scale (above 5=5, nothing=0)
Characteristics of the start-up	
Firm ages (months)	Age of the start-up (months)
Size of employment (No.)	The number of people on the founding team
Age of founder	Average age of the founder
Previous occupation	Dummy variable for previous occupation -business administrative position=1, R&D or others=0
Educational background	Dummy variable for founder's educational background -above master's/doctoral degree=1, or others=0
Major	Dummy variable for founder's major field of study -science and engineering=1, economics, management, humanities and others =0
Business type	Dummy variable for type of business -manufacturing=1, knowledge service business and others=0

TABLE 6—SUMMARY STATISTICS

Variable	Unit	Mean	SD
Follow-up investment	1 or 0	0.212	0.412
Firm age (months)	Month	39.212	18.402
Size of employment (No.)	No. of employees	8.519	4.945
Age of founder	Years	43	7.636
Previous occupation	1 or 0	0.327	0.474
Educational background	1 or 0	0.519	0.505
Major	1 or 0	0.846	0.364
Business type	1 or 0	0.346	0.480

Start-up Chile is the single accelerator program in Mejia and Gopal (2015). However, the TIPS program in Korea is a system in which each operating company, specifically an accelerator, selects entrepreneurs and provides mentoring and networking to them. The use of TIPS program data has the advantage of allowing us more clearly to discern the effects of accelerator support on the performance of start-ups.

Whether a venture capital firm attracted follow-up investment was set as a performance index with reference to the role of risk capital. In order to control for the characteristics of start-up companies, we utilized the firm's employment size, the age of the founder, their previous occupation before running the start-up, and the educational background of the founder as control variables. In addition, mentoring satisfaction levels and a preference for the accelerator's IR (investor relation) program were utilized as the accelerator mentoring and investor linkage index. Considering that subjectivity is very high, to ensure objectivity of the mentoring and investor linkage index, we utilized the number of mobile message communication instances with accelerators and the number of monthly average investor introductions as proxy variables.

The data on the characteristics of entrepreneurial firms were obtained from the Korea Angel Investment Association, which administers TIPS, and the proxy variables for mentoring and investor linkage were constructed through a survey of companies participating in TIPS with the cooperation of the association. The total numbers of selected firms for the TIPS programs are 15 in 2013, 39 in 2014, and 79 in 2015, for 133 companies overall. Of these, 52 companies (4 in 2013, 11 in 2014, and 37 in 2015) responded to a survey asking about company performance indicators and satisfaction with mentoring.

According to the basic statistics pertaining to the characteristics of start-ups, the average firm age was 39 months, the employment size was 8.5, and the average age of the founder was 43 years.

B. *Main Findings*

This study quantitatively analyzed econometric models addressing the impact of mentoring and investor ties on the performance outcomes of start-ups using characteristics, mentoring and variables related to the investors in 52 firms

participating in TIPS. Two models were estimated for hypothesis testing.

The hypotheses in this study and the survey items to assess them are as follows.

Hypothesis1-1: Mentoring by TIPS operators increases the likelihood of start-up companies attracting follow-up investment.

Hypothesis1-2: Entrepreneurs who frequently contact TIPS operators by mobile messages are likely to attract follow-up investment.

Hypothesis2-1: Access to network opportunities for start-ups given by TIPS operators increases the possibility of attracting follow-up investment.

Hypothesis2-2: The number of business meeting between start-ups and investors facilitated by TIPS operators increases the possibility of attracting follow-up investment.

$$Logit\left(Y^{k}\right) = X\beta + Z\gamma + \varepsilon$$

This study estimates whether follow-up investment (1 = attract and 0 = not attract) was attracted using a logit model. In the logit model above, X is a variable which controls for the characteristics of the start-up company. It includes the age of the start-up, the number of employees, the age of the founder, their previous occupation before running the start-up, and the founder's education Z represents the mentoring by the accelerator and the incubation and upbringing function related to the activities of the entrepreneurial network. We undertake the empirical estimation with two types of models. Model 1 estimates whether mentoring has a positive effect on follow-up investment and model 2 investigates whether investor ties have an affirmative effect on follow-up investment. We also conduct run the regression with both subjective and objective proxies for each model.[3]

Specifically, mentoring satisfaction, the number of contacts, satisfaction with investor links, and the number of investor links were used as proxy variables. The detailed questions on the questionnaire pertaining to the four main proxy variables are shown in Table 7. Furthermore, in order to examine the appropriateness as a proxy for subjective satisfaction of the objective proxy variable, the correlation between the objective proxy variable and the subjective variable was analyzed (Table 8). The results of this study are as follows. There is a significant relationship between the number of contacts and the level of satisfaction with mentoring by the TIPS operator. This is also true for the number of investment arrangement opportunities by operators and the subjective satisfaction rating of investor introductions by operators. These findings indicate that the proxy variables for the number of contacts by mobile messages and the number of business meetings provided by TIPS operators are adequate.

Table 9 and Table 10 present the results of the empirical analysis of the effects of mentoring on the performance outcomes of the start-ups. These results are summarized below.

[3]We fully agree with the concern over endogeneity due to selection bias, fixed effects in the operators, omitted variables, and reverse causality, among other areas. However, our data is limited owing to the short TIPS history. More rigorous studies can be done by future researchers with richer data.

TABLE 7—QUESTIONNAIRE ITEMS

Hypothesis	Items	Scale
Model 1-1	Does the accelerator's mentoring help the performance (e.g., sales, employment increase, attracting follow-up investment) of start-ups	five-point scale
Model 1-2	On average, how many times do you and your accelerator exchange text messages every day?	five-point scale
Model 2-1	Does the accelerator actively provide opportunities of investor ties for start-ups?	five-point scale
Model 2-2	On average, how many investors are introduced by the accelerator per month?	five-point scale

TABLE 8—CORRELATION ANALYSIS

	Mentorship (Subjective index)	Mentorship (No. of contacts by mobile phone)	Investor ties (Subjective index)	Investor ties (No. of investor relations)
Mentorship (Subjective index)	1	-	-	-
Mentorship (No. of contacts)	0.2307*	1	-	-
Investor ties (Subjective index)	-	-	1	-
Investor ties (No. of investor relations)	-	-	0.5048***	1

Note: *** Significant at the 1% level; * Significant at the 10% level.

TABLE 9—THE EFFECT OF MENTORING ON THE PERFORMANCES OF START-UPS (LOGIT)

Model 1-1 (Subjective index)	Coefficient	Z-statistics	dF/dx	Z-statistics
Dependent Var.	Follow-up investment (attract=1, not attract=0)			
Mentorship	0.177	0.490	0.021	0.500
Firm age	0.046*	1.750	0.005**	2.100
Size of employment	0.031	0.340	0.004	0.350
Age of founder	-0.162*	-1.760	-0.019**	-2.030
Previous occupation	2.648*	1.780	0.311**	2.380
Educational background	-0.261	-0.290	-0.031	-0.280
Major	0.596	0.410	0.070	0.410
Business type	3.600***	2.680	0.421***	4.140
Constant	-0.278	-0.090		
Observation	52	52	52	52
Year (dummy)	YES	YES	YES	YES
Pseudo R^2	0.296			

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

TABLE 10—THE EFFECT OF MENTORING ON THE PERFORMANCES OF START-UPS (LOGIT)

Model 1-2 (No. of contacts)	Coefficient	Z-statistics	dF/dx	Z-statistics
Dependent Var.	Follow-up investment (attract=1, not attract=0)			
Mentorship	0.503*	1.810	0.056**	2.050
Firm age	0.046	1.540	0.005*	1.890
Size of employment	-0.024	-0.250	-0.003	-0.250
Age of founder	-0.158*	-1.730	-0.018**	-2.240
Previous occupation	2.632	1.590	0.286**	2.290
Educational background	-0.298	-0.310	-0.033	-0.310
Major	1.359	0.890	0.152	0.890
Business type	4.017**	2.350	0.450***	3.940
Constant	-0.686	-0.280		
Observation	52	52	52	52
Year (dummy)	YES	YES	YES	YES
Pseudo R^2	0.330			

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

First, the results of the estimation of subjective satisfaction with mentoring are not significant, as indicated in Table 9. However, it is estimated in Table 10 that the number of mobile message contacts, which provides more objective evidence of mentoring satisfaction, has a meaningful positive effect.

This result suggests that mentoring enhances the success of entrepreneurs through tacit knowledge transfers on the topics of product development, talent recruitment, resource management, branding, investment pitching and business pitching (Stuart and Sorenson, 2005; Klepper and Sleeper, 2005).

Regarding the other variables, when the start-up business has been in business longer, it has a greater possibility of attracting follow-up investment. In addition, a younger founder is more likely to succeed in attracting subsequent investments. With regard to pitching ideas, a younger CEO is linked to a higher likelihood of accepting mentoring. For occupations before running the start-up, it was found that business administrative positions are more advantageous for attracting follow-up investment than a background in R&D. Technology development is important for start-up companies to grow, but it appears that the ability of management to develop technology as a business model and explain it to investors is also an important factor in the success of the start-up company.

The effects of the characteristics of each industry on the performance of the start-ups in each industry indicate that the manufacturing industries are better than the service industries on this measure. There is a tendency for the manufacturing industry to be more developed in Korea than the service industry, with one example being software. Alternatively, this may be a reflection of the uniqueness of TIPS.

Table 11 and Table 12 present the estimation results pertaining to the influence of investor links by the accelerator on the performance outcomes of the start-ups.

The results of model 2-1 in Table 11 suggest that when an operator is more likely

TABLE 11—THE EFFECT OF INVENTOR TIES ON THE PERFORMANCES OF START-UPS (LOGIT)

Model 2-1 (Subjective Index)	Coefficient	Z-statistics	dF/dx	Z-statistics
Dependent Var.	Follow-up investment (attract=1, not attract=0)			
Investor ties	0.653	1.590	0.074*	1.840
Firm age	0.054*	1.790	0.006**	2.310
Size of employment	0.050	0.490	0.006	0.510
Age of founder	-0.183*	-1.770	-0.021**	-2.210
Previous occupation	2.832*	1.770	0.322**	2.580
Educational background	-0.434	-0.460	-0.049	-0.450
Major	0.972	0.630	0.110	0.620
Business type	3.797**	2.530	0.429***	4.090
Constant	-2.874	0.375		
Observation	52	52	52	52
Year (dummy)	YES	YES	YES	YES
Pseudo R^2	0.318			

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

TABLE 12—THE EFFECT OF INVENTOR TIES ON THE PERFORMANCES OF START-UPS (LOGIT)

Model 2-2 (No. of IR)	Coefficient	Z-statistics	dF/dx	Z-statistics
Dependent Var.	Follow-up investment (attract=1, not attract=0)			
Investor ties	0.603**	1.980	0.069*	1.940
Firm age	0.052*	1.900	0.006**	2.290
Size of employment	0.025	0.250	0.003	0.250
Age of founder	-0.184*	-1.770	-0.021**	-2.030
Previous occupation	2.854*	1.800	0.323**	2.480
Educational background	-0.329	-0.350	-0.037	-0.340
Major	0.801	0.590	0.091	0.580
Business type	4.211***	2.830	0.479***	4.210
Constant	-0.518	1.980		
Observation	52	52	52	52
Year (dummy)	YES	YES	YES	YES
Pseudo R^2	0.312			

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

actively to arrange an investor, there is a greater likelihood that a start-up will succeed in attracting subsequent investments. The estimation results for the number of investor meeting arrangements in Model 2-2 strongly support this implication in Table 12.

This result suggests that entrepreneurs can inform investors of the existence of the entrepreneurial team through the network and raise the possibility of investment attraction and success by mitigating the asymmetric information problem to investors through frequent interviews with investors. These results are similar to those in previous studies (Stuart and Sorenson, 2005; Hallen, 2008). The effects of other variables on follow-up investments in start-ups are qualitatively similar to the results for follow-up investment inducement in relation to mentoring.

C. *Robustness Checks*

The mentoring and investor linkage effects by accelerators on the performance outcomes of start-ups, such as employment increases and sales increases as well as subsequent investment attraction were assessed. In order to examine the robustness of the empirical results of accelerator mentoring and investor linkages on subsequent investment, we utilized employment growth as a proxy for firm performance.

First, the results show that the effect of mentoring on increased employment at start-ups is positively estimated in Table 13 and Table 14. Furthermore, in Table 15 and Table 16, the influence of investor linkages by operators on employment is also estimated with a positive sign. We also found that a greater number of investor arrangements is linked to a greater probability that the employment increase will be higher than average.

TABLE 13—THE EFFECT OF MENTORING ON THE PERFORMANCES OF START-UPS (LOGIT)

Model 1-1 (Subjective Index)	Coefficient	Z-statistics	dF/dx	Z-statistics
Dependent Var.	Employment increase (above average=1, below average=0)			
Mentorship	0.182	0.500	0.038	0.690
Firm age	0.008	0.490	0.002	0.490
Size of employment	0.076	0.940	0.016	0.970
Age of founder	-0.009	-0.160	-0.002	-0.160
Previous occupation	0.574	0.570	0.121	0.570
Educational background	-0.071	-0.080	-0.015	-0.080
Major	1.462	1.480	0.302	1.560
Business type	-0.981	-1.300	-0.203	-1.380
Constant	-3.851	-1.400		
Observation	52	52	52	52
Year (dummy)	YES	YES	YES	YES
Pseudo R^2	0.119			

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

TABLE 14—THE EFFECT OF MENTORING ON THE PERFORMANCES OF START-UPS (LOGIT)

Model 1-2 (No. of contacts)	Coefficient	Z-statistics	dF/dx	Z-statistics
Dependent Var.	Employment increase (above average=1, below average=0)			
Mentorship	1.164***	2.610	0.201***	3.140
Firm age	-0.000	0.000	0.000	0.000
Size of employment	0.029	0.350	0.005	0.350
Age of founder	-0.013	-0.240	-0.002	-0.240
Previous occupation	0.406	0.440	0.072	0.430
Educational background	-0.252	-0.290	-0.044	-0.290
Major	2.598**	2.380	0.450**	2.510
Business type	-0.991	-1.200	-0.171	-1.290
Constant	-4.534*	-1.940		
Observation	52	52	52	52
Year (dummy)	YES	YES	YES	YES
Pseudo R^2	0.241			

Note: *** Significant at the 1% level; ** Significant at the 5% level; * Significant at the 10% level.

TABLE 15—THE EFFECT OF INVENTOR TIES ON THE PERFORMANCES OF START-UPS (LOGIT)

Model 2-1 (Subjective Index)	Coefficient	Z-statistics	dF/dx	Z-statistics
Dependent Var.	Employment increase (above average=1, below average=0)			
Investor ties	0.433	0.145	0.086	1.530
Firm age	0.010	0.610	0.002	0.610
Size of employment	0.094	1.220	0.019	1.270
Age of founder	-0.009	-0.170	-0.002	-0.170
Previous occupation	0.638	0.670	0.129	0.660
Educational background	-0.172	-0.190	-0.034	-0.190
Major	1.596*	1.670	0.318*	1.770
Business type	-1.059	-1.440	-0.211	-1.550
Constant	-5.444*	-1.860		
Observation	52	52	52	52
Year (dummy)	YES	YES	YES	YES
Pseudo R^2	0.143			

Note: * Significant at the 10% level.

TABLE 16—THE EFFECT OF INVENTOR TIES ON THE PERFORMANCES OF START-UPS (LOGIT)

Model 2-2 (No. of IR)	Coefficient	Z-statistics	dF/dx	Z-statistics
Dependent Var.	Employment increase (above average=1, below average=0)			
Investor ties	0.681*	1.790	0.132*	1.960
Firm age	0.009	0.510	0.002	0.510
Size of employment	0.072	0.950	0.014	0.980
Age of founder	0.002	0.030	0.000	0.030
Previous occupation	0.520	0.570	0.103	0.560
Educational background	-0.118	-0.140	-0.023	-0.140
Major	1.677	1.440	0.326	1.500
Business type	-0.717	-0.970	-0.139	-1.020
Constant	-4.903*			
Observation	52	52	52	52
Year (dummy)	YES	YES	YES	YES
Pseudo R^2	0.162			

Note: * Significant at the 10% level.

V. Conclusions and Policy Implications

It is important for start-ups to obtain financial resources to enter the stage of growth after the start-up stage, and this is the primary role of venture capitalists. However, the role of nurturing by venture capitalists has been recently championed to increase the possibility of the success of a start-up. In this study, we analyzed the effects of mentoring and investor ties by an accelerator, a newly introduced form of venture capital, on start-up outcomes. In particular, we analyzed the effects of accelerator-based mentoring and investor links on the performance outcomes of 52 start-up companies participating in the government's TIPS program, which is a type of accelerator. As a result, it was found that the mentoring and investor-linking activities of an accelerator have a positive effect on attracting follow-up investment. In addition, it was estimated that a younger CEO of the start-up company is linked to a higher likelihood that the performance of the start-up company will improve.

On the other hand, in the estimation result when using increased employment as a proxy for the business performance of the start-up company, mentoring and investor-linking activities positively affect the employment increase by the start-up. These results have the following implications for Korean venture capital policies and government SME support policies.

First, it is necessary to promote policies that strengthen the mentoring role of venture capitalists when the government supplies risk capital. Considering that most risk capital in Korea, such as angel investments, venture capital, and accelerators, is matched by the government's policy funds, such as a ‘fund of funds’ and ‘growth ladder funds’, it is necessary to assess the mentoring plans of

venture capitalists when designating a matching government fund. With regard to the TIPS program, in which the role of mentoring is relatively active, an evaluation of mentoring is not considered in the selection and evaluation of the accelerator operator. This is also the case for other governmental policy funding programs as well.

Meanwhile, in the mid-to-long term, it is necessary to create policies that strengthen the mentor capacity of accelerators. To this end, a policy for establishing a virtuous circle of professional workers, such as professional investors within the entrepreneurial ecosystem, is also needed.

Second, it is necessary to establish a system that can increase the acceptance of mentoring for start-up firms. In order to maximize the effect of mentoring, it is necessary to ensure a positive and open attitude at start-up companies toward mentors. In Korea's entrepreneurial ecosystem, it is known that start-up firms are often annoyed when considering mentoring by venture capitalists, considering it a form of entrepreneurial intervention, and they passively take part in mentoring by venture capitalists. If risk capital included in policy funds is invested in start-up companies, it is necessary to provide educational programs that stress the importance of mentoring for start-up companies.

Third, it is necessary to improve governmental mentoring support policies through a mentoring voucher system. While the government provides a variety of mentoring programs for start-ups, once a program is selected, entrepreneurs can apply for mentoring within a given period, despite its appropriateness, as opposed to a tailor-made schedule for the start-up. Such a stipulation is being investigated.

Meanwhile, this study also has some limitations (e.g., unable to control for fixed effects of operators; not making use of long-term performance metrics such as sales and net profits) due to data constraints. An in-depth study is planned to determine whether accelerators have effects on start-up performance measures such as sales increases and survival rates as opposed to merely follow-up investments. More rigorous investigations are deferred to future researchers, who may find richer data by mining currently unavailable sources.

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