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Korea's Rapid Export Expansion in the 1960s: How It Began

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Korea's rapid export expansion suddenly began in the early 1960s and boosted the economy. This paper's investigation finds that it began in 1961, as new export items appeared, export of which increased incomparably faster than that of the current export items at the time. How and why of this highly unusual phenomenon can best be explained by a major reform of foreign exchange system in February 1961. This goes against the widely held view that the switch in development policy from import substitution to export promotion in the mid-1960s was the reason for Korea's export success. Rather, the evidence indicates that the rapid export expansion led to the policy switch. The government's export promotion since the policy switch helped the rapid export expansion continue into the 1970s, despite the protectionist import policy.

Key Word: Exchange Rate Policy, Trade Policy, Export Promotion, Comparative Advantage, Import Substitution
JEL Code: O24, O25, O53

I. Introduction

Korea's exports suddenly began to grow very rapidly in the 1960s, and the rapid growth continued into the 1970s. In real terms the annual export growth rate was 35.3 percent on average for 1963~69 and 25.4 percent in the 1970s. It was undoubtedly one of the most important reasons why the Korean economy grew nearly 10 percent per year on average in the two decades. However, when, how, and why the rapid export expansion began has not been clearly accounted for. Early studies of Korea's economic growth tend to attribute the beginning to the switch in development strategy from import substitution to export promotion in the mid-1960s and the trade policy that subsequently moved in the direction of less intervention and more liberalization.[1] On the other hand, later studies that

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[1]One of the earliest studies was Cole and Lyman (1971), especially, Ch. 8, "The Patterns of Economic

appeared since the late 1980s tend to place much greater an emphasis on governmental intervention for the export success. For example, one author claims that the industrial policy that provided credit subsidies, tax incentives, administrative guidance, etc. remedied the coordination failure that had been blocking Korea's economic growth and led to investment boom and rise in import, which in turn led to export expansion.[2] This paper investigates the beginning of the export expansion and finds evidence that a major reform of foreign exchange system in February 1961, which has so far received little attention in the existing literature, started it.

This paper develops no new set of data. Factual information about the policy measures that the Korean government took is mostly drawn from the early studies mentioned above. This paper also draws upon statistics, writings, and other information that have been in the public domain and looks into the details. Section II dates the beginning of the rapid export expansion. Section III reviews the exchange rate and trade policies in the 1950s. Section IV discusses the reform of foreign exchange system in 1961 and explains how it started the rapid export expansion. Section V shows that the beginning of rapid export expansion led to the policy switch from import substitution to export promotion. It also discusses how export promotion since the policy switch helped the rapid export expansion continue into the 1970s, despite the export depressing effect of protectionist import policy that the government was simultaneously pursuing. In light of this paper's findings, Section VI in its concluding remarks disputes the conventional characterization of Korea's export success as "government-made" or "government-led".

II. Beginning of the Rapid Export Expansion

In investigating how and why the rapid export expansion began, the first thing to do is to date its beginning. Then, it will become clear where to look for the cause, which, be it a change in policy or in circumstances, is to be found before the beginning, not after. It may sound nonsensical to date the beginning of a country's export expansion, for trade must have been going on since time immemorial between regions and across borders. What this section intends to do is to date the beginning of "rapid" export expansion, and it makes eminent sense to do so in Korean experience, as will become clear in the following. For the purpose, this section examines Korea's export trends in detail.

The first trend to look at is that of total export for 1957-1970, shown in Table 1. The total is broken into two groups, manufactures and others, and the last column shows the total as a percentage of GNP. The importance of exports to the economy dramatically increased in the 1960s: total export was less than one percent of GNP in the late 1950s but rose to 10.2 percent by 1970.

Policy". Others include Frank, Kim, and Westphal (1975), Kim (1975), Hong and Krueger (1975), Kim and Westphal (1976), and Krueger (1979) among others.

[2] See for example, Rodrik (1995).

TABLE 1—KOREA'S EXPORTS, 1957-1970 (MILLION CURRENT DOLLARS)

	Total Export			Export/GNP (%)
		Manufactures	Non-manufactures	
1957	22.2 (-9.7)	4.1 (66.6)	18.1 (-18.2)	0.6
1958	16.5 (-25.9)	2.6 (-37.3)	13.9 (-23.3)	0.6
1959	19.8 (20.4)	2.4 (-7.1)	17.4 (25.5)	0.7
1960	32.8 (65.7)	4.5 (89.2)	28.3 (62.5)	1.4
1961	40.9 (24.5)	6.2 (37.8)	34.6 (22.4)	1.8
1962	54.8 (34.1)	10.6 (69.6)	44.2 (27.5)	2.0
1963	86.8 (58.4)	39.5 (273.7)	47.3 (6.6)	2.9
1964	119.1 (37.2)	58.3 (47.7)	60.7 (28.9)	3.9
1965	175.1 (47.1)	106.8 (83.1)	68.3 (12.5)	5.8
1966	250.3 (43.0)	153.6 (43.9)	96.7 (41.6)	6.6
1967	320.2 (27.9)	215.2 (40.0)	105.1 (8.7)	7.1
1968	455.4 (42.2)	338.2 (57.2)	117.2 (11.6)	8.1
1969	622.5 (36.7)	479.1 (41.7)	143.4 (22.3)	8.8
1970	835.2 (34.2)	646.3 (34.9)	188.9 (31.8)	10.2

Note: The numbers in the parentheses are annual growth rates in current dollars.

Source: KOSIS, on-line information service, National Statistical Office, the Korean government.

From a quick glance at the table it appears as if 1959 should be considered the beginning year of rapid export expansion, for in that year total export began to grow at double-digit rates. However, the growth in the year was by chance, led by a 25.5 percent increase in non-manufactures exports, which was not to be repeated in the following years. The unmistakable characteristic Korea's export expansion exhibited in the subsequent years was that it was led by export of manufactures. For this reason it is not appropriate to consider 1959 as the beginning year. As the table shows, since 1960 manufactures exports always grew much faster than non-manufactures.

Then, should 1960 be considered the beginning year of the rapid export expansion? Yes, if export of all manufactures should serve as the guide in dating the beginning. However, not all kinds of manufactured goods increased equally rapidly but a particular kind did. This can be seen in Fig. 1, which decomposes manufactures into two subgroups: one comprising SITC (Standard International Trade Classification) 5 "chemicals" and SITC 7 "machinery and transport equipment"; the other comprising SITC 6 "manufactured goods chiefly classified by materials" and SITC 8 "miscellaneous manufactured articles". The subgroup "SITC6+8" consists mostly of labor intensive goods, while "SITC5+7" mostly capital intensive goods, which also tend to be of more sophisticated production technology. Figure 1 shows that the share of SITC6+8 in total exports increased rapidly since 1962, rising from around 10 percent to 70 percent by 1968. It is beyond any doubt that labor-intensive manufactures led the sudden and rapid expansion of Korea's exports in the 1960s. On this ground, 1962 may be called the beginning year of the rapid export expansion.

Yet, there remains still another peculiar feature that deserves attention: new export items suddenly appeared within subgroup SITC6+8 and led the expansion, as can be seen in Appendix Table 1. Striking is the fact that the export products at the two-digit SITC or lower level belonging to the subgroup were almost non-

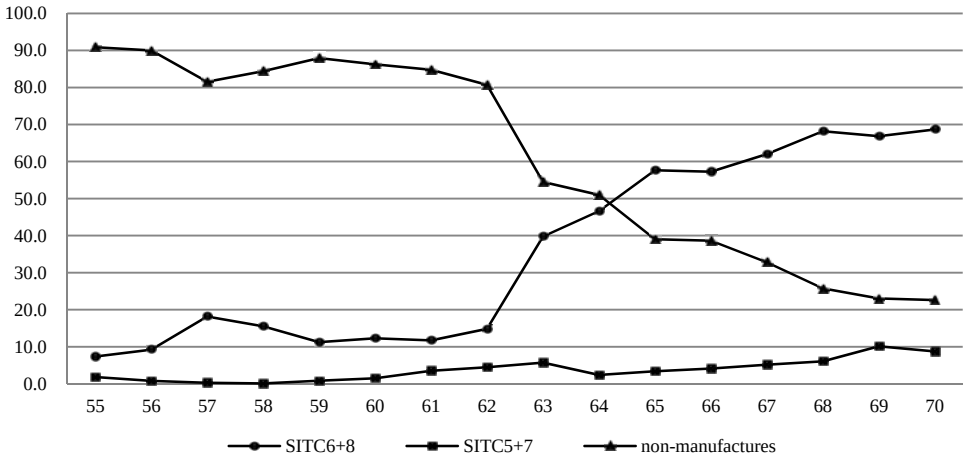

FIGURE 1. EXPORT COMPOSITION, 1957~70

Source: Appendix Table 1.

TABLE 2—EXPORT OF NEW ITEMS, 1960-1970 (THOUSAND CURRENT DOLLARS)

	New Items					All Others
	(in 1961)	(in 1962)	(in 1963)	sum	Share in SITC 6+8 (%)	
1960	-	-	-	-	-	32,827 (65.7)
1961	36	-	-	36 (-)	0.8	40,878 (24.5)
1962	1,358	40	-	1,398 (3783.3)	17.2	53,415 (30.8)
1963	5,384	578	23	5,985 (328.1)	17.3	80,815 (51.3)
1964	7,499	1,431	749	9,679 (61.7)	17.4	109,378 (35.3)
1965	24,914	3,104	4,572	32,590 (236.7)	32.3	142,491 (30.3)
1966	39,269	4,851	14,175	58,295 (78.9)	40.7	191,242 (34.2)
1967	68,556	10,300	26,687	105,543 (81.0)	53.1	214,684 (12.3)
1968	124,103	17,583	39,611	181,297 (71.8)	58.4	274,100 (27.7)
1969	172,474	13,676	63,543	249,693 (37.7)	60.0	372,820 (36.0)
1970	233,313	11,642	104,250	349,205 (39.9)	60.9	485,977 (30.4)

Note: 1) "New items" are footwear, travel goods, and clothing, which began to appear in 1961; synthetic fabrics, umbrellas, and artificial flowers in 1962; woolen fabrics and wigs in 1963. "All others" denotes total export less export of new items. 2) The numbers in the parentheses are percentage growth rates in current prices.

Source: Appendix Table 1.

existent up to 1960, the exceptions being cotton fabrics and veneer sheets. This suddenly changed. Starting in 1961, new items began to appear in the subgroup, including footwear, travel goods, and clothing that year and then, artificial flowers, synthetic fabrics, and umbrellas in 1962, and woolen fabrics and wigs in 1963. Table 2 below shows that, once begun, export expansion of these new items was explosive, incomparably faster than the growth of then-existing export items. Albeit from small bases, in five years the exports of the new items that appeared in 1961 multiplied 1091 times in current dollar terms; those in 1962 multiplied 257 times while those in 1963 multiplied 1722 times. The most incredible example was clothing (SITC84), export of which grew from 2 thousand dollars in 1961 to 213.6 million dollars in 1970, a multiplication of more than 100,000 times in nine years

(Appendix Table 1). In contrast, all other items, that is, total export less the exports of these new items, multiplied 4.7 times in current dollars in five years from 1961 to 1966, very rapid growth but growth at "snail's pace" in comparison. This bifurcation of export goods with very different export behaviors is a highly unusual phenomenon, hardly expected to occur in the same economy. However, it has thus far received no attention in the literature.

The explosive export growth of these new items, of course, could not continue indefinitely. Their growth rate as a whole gradually slowed and approached that of all other items by the end of the decade. It was these new items that led the sudden and rapid export expansion of labor-intensive manufactures of SITC6+8. As shown in Table 2, these new export items accounted for less than 1.0 percent of SITC6+8 in 1961 and more than 60 percent by 1970. Their share in the total export similarly rose from 0.09 percent to 41.8 percent during the same period (not shown in the table). It is little exaggeration to say that Korea' rapid export expansion in the 1960s was the expansion of these new items. For this reason, it seems appropriate to consider 1961 as the year that marks the beginning of the rapid export expansion.

III. Exchange Rate and Trade Policies in the 1950s

Now that the beginning of rapid export expansion is dated, this section briefly reviews the exchange rate and trade policies in the 1950s, which preceded the beginning. In those years immediately following the Liberation in 1945 from under the Japanese rule, commercially financed foreign trade was almost nonexistent. In 1950 the Korean War broke out and ended in 1953, devastating the economy. In the second half of the 1950s the trade account was always in big deficit. Annual export on average was 20 million dollars and annual import 370 million, roughly 80 percent of which were financed by foreign aid. The economy was suffering from a severe foreign exchange shortage.

A. *The Foreign Exchange Rate Policy in the 1950s*[3]

The most important factor that determined the direction of foreign exchange rate policy in the 1950s was the "won advance agreement" between Korea and U.S. The agreement was made in July 1950, shortly after the outbreak of Korean War, to help the UN forces dispatched to Korean peninsula to carry out the mission. Under the agreement, the Korean government would advance won, the Korean currency, to United Nations Command (UNC) for its expenditures in Korea, to be paid back in dollars.[4] Since the agreement, the Korean government kept the official won-dollar exchange rate low throughout the 1950s, apparently to maximize the amount of dollars receivable from won advance, and devaluation was delayed as long as

[3]This subsection heavily draws upon Bank of Korea (1960) for factual information.

[4]The official name of the agreement was "Agreement between the Government of U.S.A. and the Republic of Korea Government Regarding Expenditures by Forces under Command of the Commanding General, Armed Forces of Member States of the United Nations" See Frank, Kim, and Westphal (1975), p.28.

possible despite rampant inflation. The won advance was an important source of foreign exchanges in the decade.[5] This low exchange rate policy inevitably led to an overvaluation of won and the rise of a complex foreign exchange system in the 1950s, which was brought to an end by a major reform of the system in February 1961, as discussed in the next section. This subsection briefly reviews a few episodes of devaluation preceding the reform and the rise of multiple exchange rates.

All devaluations in the 1950s since the won advance agreement were decided upon by negotiation between the two governments, and each time a kind of tug-of-war went on between them. For the low exchange rate policy of the Korean government led to conflicts with U.S., as it must have been in U.S. interest to have the exchange rate high and to delay the dollar payments. One such negotiation resulted in the devaluation in August 1955, which set the official exchange rate to 50 won to the dollar. At this time it was agreed that the exchange rate be determined in the future by referring to the wholesale price index of Seoul with September 1955 as the base period; the official rate was going to rise or fall, as the price index rose or fell by more than 25 percent than the base period.

In late 1959, after a relatively long period of price stability, the wholesale price index reached 130.2. The U.S. government requested a consultation in January 1960, but the Korean government wanted to delay the consultation. Then, on January 29 the U.S. embassy in Seoul unilaterally decided to use the exchange rate of 65 won to the dollar as an internal administrative measure, which was 30 percent higher than the ongoing rate. The Korean government, following a consultation with the IMF, announced in February 1960 a new exchange rate of 65 won to the dollar.

In less than two months, in April 1960 the Student Revolution ousted Syngman Rhee government, and the official relation of aid and economic cooperation between the Korean and U.S. governments, except for the military aid, was temporarily discontinued. In October 1960 on the occasion of resuming the relation, the U.S. government suggested an increase in the exchange rate. Unlike the previous government, the then-newly elected Chang Myon government readily accepted the suggestion and announced a new exchange rate of 100 won to the dollar, effective January 1, 1961. The next month, February 1961, the new government on its own initiative once again devalued won by raising the exchange rate to 130 won to the dollar, as part of a major reform of the foreign exchange system that abolished the multiple exchange rates and adopted a uniform rate.

Thus, three consecutive devaluations in a span of one year from February 1960 to February 1961 raised the exchange rate from 50 won to 130 won to the dollar. Of the three devaluations, the first was the result of a tug-of-war between the Korean and U.S. governments, while the other two were decisions reflecting the exchange rate policy of the newly elected Korean government.

Under the foreign exchange control system in the 1950s a complicated structure of multiple exchange rates arose. The low exchange rate policy made the official exchange rate largely irrelevant to international trade, as far as private traders were

[5]"Foreign exchange from this source amounted to $62 million in 1952 and $122 million in 1953, or about 62 and 70 percent of total foreign exchange receipts in those years." Frank, Kim, and Westphal (1975), p.28.

concerned. For exporters "transfer rates" mattered most. The foreign exchange deposit system, part of the control system, required all privately held foreign exchanges be deposited with the Bank of Korea. Accordingly, exporters had accounts denominated in foreign currencies with Bank of Korea, and sold their foreign exchange earnings by transferring the balances in their accounts to the other traders'. This gave rise to "transfer rates", which were much higher than the official exchange rate (The rates are labelled "market rates" in Appendix Table 2). However, the rates differed, depending on where the foreign exchanges were earned: the transfer rates on "Japan export dollars," the dollars earned from exports to Japan, were higher than the rates on "Other export dollars" earned from exports to other regions. For imports from Japan were more restricted, hence more profitable, and only the dollars earned in Japan were allowed to be used for importing goods from Japan, which was a policy measure to contain the large bilateral trade deficit with Japan. For importers "auction rates" were important, which arose, when the aid dollars and KFX (the dollars held by the Korean government), to be used to finance private imports, were auctioned off to the highest bidder. These rates differed, depending on the ratios of domestic price over foreign price of the items that were going to be imported with the auctioned dollars.

B. *Import Policy*

Throughout the 1950s the government policy on imports was protectionist. It was an integral part of the government's development policy, which aimed at industrialization through import substitution.[6] It also was in part a response to the severe foreign exchange shortage at the time. The import policy is graphically summarized in Fig. 2, which shows from 1955 to the mid-1980s the average legal tariff rate and the percentage of automatic approval (AA) items among all importable items, which could be imported without prior government approval.

Until the mid-1960s the AA items accounted for less than 10 percent of all. Since 1967, when Korea joined GATT, the percentage rose but remained under 60 percent until the end of the 1970s. The average legal tariff rate was consistently around 50 percent for most of the 1960s and 1970s. The policy intention of industrialization through import substitution was apparent in the tariff escalation of the tariff system introduced in 1950. The tariffs were ranging from zero to more than 100 percent: low rates for "essential goods" such as food grains, raw materials and non-competing capital goods; higher rates on imports that were likely to compete with domestically produced goods when imported and also on "finished" goods that would need no further processing in the domestic economy. "Luxury goods" carried tariff rates of 100 percent or higher. Later, tariff exemptions were introduced in 1952 on some imports of capital goods, and individual tariff rates were revised, but the tariff structure remained basically the same in the 1960s until the early 1970s.

[6]Import substitution under protection was the standard policy for industrialization recommended by the economics profession in the 1950s and 1960s. It was only after the East Asian experience that the benefits of open trade regime began to be recognized by the profession. See Krueger (1997).

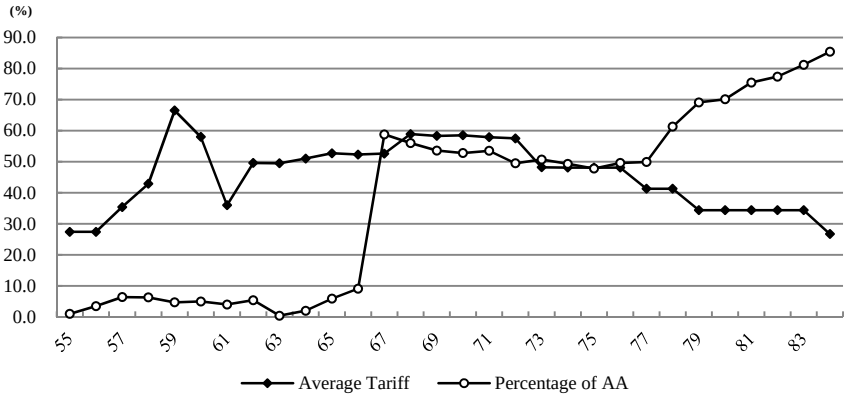

FIGURE 2. GRAPHIC SUMMARY OF IMPORT POLICY

Note: AA stands for "automatic approval". AA items could be imported without prior government approval.

Source: Appendix Table 3: "Overall Index of Trade Liberalization, 1955-1984".

The protectionist import policy in the 1950s could hardly have been the reason for the beginning of the rapid export expansion. As Lerner's Symmetry Theorem demonstrates, imposition of tariff on import goods has an export depressing effect, as it raises the price of import goods relative to export goods, thereby making it more profitable to produce import competing goods for domestic market than to produce export goods for foreign markets.[7] In addition, import restriction has depressing effect on export through another channel, namely, its effect on foreign exchange rate. For import restriction reduces the import demands and, therefore, the demand for foreign exchanges, thus lowering the exchange rate, i.e. the won-dollar rate in Korea.

C. *Export Promotion*

In the 1950s, although import substitution industrialization was the main pillar of development policy, the government adopted some export promotion measures to deal with the severe shortage of foreign exchange. This section briefly reviews those measures in the 1950s and the early 1960s, which to some extent must have had the effect of encouraging export. One of the earliest measures was "trade credit system" ("export credit system" later) that was in place since 1950, under which exporters enjoyed priority in allocation of domestic credits, and the loans to them were not bound by quarterly loan ceilings, an anti-inflationary monetary measure at the time.[8] This policy favor continued in the 1960s and 1970s, and the interest rates on loans to exporters were drastically lowered since the mid-1960s. Also, export goods were not subject to commodity tax. The "preferential export system", also known as "export-import link system", was adopted in 1951, under which the

[7]Lerner, A. P., "The Symmetry between Import and Export Taxes," Economica, Vol. III, No.11 (August, 1936).

[8]Kim and Westphal (1976), p.43.

exporters of so-called nonessential domestic products enjoyed the right to use some parts of foreign exchange earnings for importing popular items, which otherwise could not be imported. This system was discontinued in August 1955 at the time of devaluation.[9] From 1952 to 1954 exporters enjoyed preferential access to foreign exchange loans in a scheme that allocated the government-held foreign exchanges (KFX) to domestic users.[10] In 1955 direct subsidies were provided for exporters. The next year the subsidy was discontinued, as the government failed to provide for it in the budget.[11] "Tariff exemption" was introduced in 1959 on imports of raw materials and intermediate goods for exports (changed to "tariff rebate" in 1974).[12] Lastly in the 1950s, the trader registration system, which required a certain minimum export performance, had a more lenient requirement for exporters than for importers, an implicit encouragement of export.[13]

Thus, the export promotion measures adopted in the 1950s and still in effect in the early 1960s were: export credit system, exemption from commodity tax, tariff exemption on imported inputs for exports, and encouragement of exports implicit in trader registration system. In the following years some additional measures were newly introduced or reinstituted. In 1961 income tax reduction of 30 percent was newly introduced for export earnings, which was raised to 50 percent the next year. A system of direct subsidies was reinstituted in 1961, when the provision was again made in the budget, but it was discontinued in 1964 at the time of large devaluation.[14] Also, Korea Trade Promotion Corporation (KOTRA) was founded in 1962 to assist exporters gather information on and enter new foreign markets.

To see if these export promotion measures were the reason why the rapid export expansion suddenly began, one would naturally turn to exporters' earnings that must have been affected by those measures. Fortunately, the exporters' earnings are estimated for 1958-1970 by Frank, Kim, and Westphal (1975), which is reproduced in Appendix Table 4 "purchasing-power-parity effective exchange rate on exports".[15] The authors first estimated "effective exchange rate on exports", which was the sum of official exchange rate, export dollar premium, and estimated subsidies per dollar exports. "Export dollar premium" was simply the excess of "transfer rate" explained in Subsection III.A ("certificate rate" after the exchange reform in February 1961) over and above the official exchange rate. "Subsidies" refers to the benefits that exporters derived from various export promotion measures. In estimating the "subsidies" the authors took into account the effects on exporters' earnings of such export promotion measures as direct subsidy, internal tax exemptions, custom duties exemptions, and interest rate subsidy on export credit. Thus, some export promotion measures were left unaccounted for: priority in credit allocation that exporters enjoyed under the export credit system,

[9]Frank, Kim, and Westphal (1975), p.38 and 41. The nonessential domestic products refer to some 57 items, including such ones as starfish, dolls, lacquerwares, and nuts.

[10]Frank, Kim, and Westphal (1975), p.39.

[11]Hong (1979), p.49. See also Frank, Kim, and Westphal (1975), p.38 and Kim and Westphal (1976), p.60.

[12]Kim and Westphal (1976), p.64 and p.70.

[13]The registration system required a certain minimum export performance for anyone to be registered as importer as well as exporter, the minimum requirement being greater for importers than for exporters. See Frank, Kim, and Westphal (1975), p.39.

[14]Hong (1979), p.49. See also Frank, Kim, and Westphal (1975), p.38 and Kim and Westphal (1976), p.60.

[15]Frank, Kim, and Westphal (1975), Table 5-8, "Price-Level-Deflated and Purchasing-Power-Parity Effective Exchange Rates on Exports, 1958 to 1970, pp.70-71

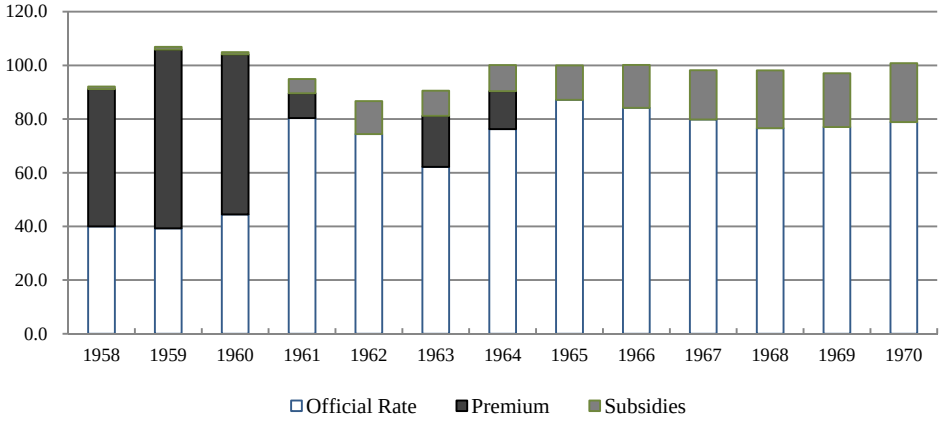

FIGURE 3. EARNINGS PER DOLLAR EXPORTS, INDEX, 1965=100

Source: Appendix Table 4.

implicit encouragement of export in the trader registration system, and the assistance provided by KOTRA. However, these measures did not directly affect exporters' earnings, and their impact on export must have been indirect.

Thus, the "effective exchange rate on exports" represents exporters' earnings in current won for a current dollar's worth of export. Then, the authors turned it into real terms by dividing it by Korea's wholesale price index and multiplying it by major trader partners'. Therefore, the "purchasing-power-parity effective exchange rate on exports" represents exporters' earnings in constant Korean won for a constant dollar's exports. Fig. 3 shows these estimated earnings in indices with 1965 as the base year.

Anyone who expects to find the reason for the beginning of rapid export expansion in the changes in exporters' earnings would be disappointed. As Fig. 3 plainly shows, there was no big jump in exporters' earnings in real terms that might have had triggered the beginning of the export 'explosion'. On the contrary, the earnings were declining in 1961, when the rapid export expansion suddenly began. Moreover, "subsidies", namely, the benefits exporters received from promotion measures, were less than five percent of exporters' earnings before and in 1961. Surely, the changes in exporters' earnings, hence, the government's export promotion measures could not have been the reason why the rapid export expansion started.

IV. Foreign Exchange Reform in February 1961

The reform of foreign exchange system in February 1961 has two main parts to it: one, abolition of multiple exchange rates for uniform rate; the other, devaluation that brought the official exchange rate close to the transfer rate discussed in Subsection III.A. This section considers the effects of the reform. In particular, it takes a close look at the near elimination of won overvaluation and the effect on export behavior of the abolition of complicated exchange rate structure.

A. *Near Elimination of Won-Overvaluation*

As mentioned in Subsection III.A, the exchange rate policy in the 1950s entailed serious overvaluation of won. "Market/Official" ratio in Table 3 shows the extent. For 1955-1961 it is the ratio of transfer rates to official exchange rate; for 1963-64 it is the ratio of "certificate rates" to official rate (see footnote 16 for the certificate rate). In the table the market/official ratios are shown for the second half of the 1950s and for 1961, 1963 and 1964 but not for other years in the 1960s owing to changes in government policy.[16] As a supplement, an alternative indicator of won overvaluation for all years in 1955-1970 is shown in the table, namely, "Curb Market/Official" ratio, which is the ratio of curb market exchange rate of U.S. greenbacks to the official exchange rate. Both ratios, when equal to one, indicate no overvaluation of won; the further greater than one, the more overvalued was won. Interestingly, both ratios show a remarkably similar trend.

The foreign exchange reform in February 1961 nearly eliminated won overvaluation, as Table 3 shows. In the second half of the 1950s the market/official ratios were at times around 2.6 and were always greater than 2.0. Then, the three devaluations between February 1960 and February 1961, the last of which was part of the foreign exchange reform, raised the exchange rate from 50 won to 130 won to the dollar and brought down the market/official ratio close to one. As the result, the market rate was slightly higher than the official rate by around 15 percent, nearly eliminating the won overvaluation, which had been the rule throughout the 1950s. The official exchange rate overvalued won again temporarily in 1963 and 1964, as the import right gave rise to a premium on export dollar, because the government re-instituted a full scale export-import link system. However, the won overvaluation lessened in the subsequent years, as the curb-market/official ratio indicates.[17]

[16]The 'Market Rate' for 1955-61 shown in Table 3 is a weighted average of the transfer rate on 'Japan export dollars' and that on 'Other export dollars', the weights being the proportions of the respective exports to two destinations in total exports. The annual average of the market rate was estimated by taking into account the number of days the market rates were in effect, information obtained from Appendix Table 2. This method of obtaining annual rates means that the rate is an average of two observations in 1954; an average of five observations for 1955, an average of two observations for 1960 and 1961. The 'Curb Market Rate' in Table 3 is similarly estimated.

The reform in February 1961 replaced the "foreign exchange deposit system" mentioned in the Subsection III.A with "foreign exchange buying system", under which exporters had to surrender their dollar earnings at official exchange rate to Bank of Korea and were issued certificates valid for 90 days. The certificates, which entitled the holder to buy back the foreign exchanges, were traded in the curb market. This system was in effect until June 1961, when the military government that came into power in May began to crack down the curb market. For this reason, the market/official ratio is not available for 1962. But the ratio reappears in 1963 and 1964, as the new government re-instituted a full scale export-import link system, under which import rights gave rise to a premium on the export dollars. Reinstitution of the system was a response to worsening trade deficit and sharply declining foreign exchange holdings in those years.

[17]The rise in premium was in part because the government nearly eliminated all items from the list of automatic approval (AA) imports in response to the worsening trade deficit. Frank, Kim and Westphal (1975), p.47. In May 1964 the government carried out another foreign exchange reform, which included a major devaluation of won.

TABLE 3—EXTENT OF WON OVERVALUATION

	Exchange Rates			Ratio	Ratio
	Market	Official	Curb Market	(Market /Official)	(Curb-Market/Official)
	(1)	(2)	(3)	(4)=(1)/(2)	(5)=(3)/(2)
1955	79.0	30.3	77.6	2.61	2.56
1956	102.8	50.0	96.6	2.06	1.93
1957	109.0	50.0	103.3	2.18	2.07
1958	114.6	50.0	118.1	2.29	2.36
1959	134.6	50.0	125.5	2.69	2.51
1960	158.1	62.8	143.7	2.52	2.29
1961	147.0	127.4	148.3	1.15	1.16
1962	NT	130.0	134.0	n.a.	1.03
1963	169.8	130.0	174.5	1.31	1.34
1964	254.0	214.3	285.6	1.19	1.33
1965	NT	265.4	316.0	n.a.	n.a.
1966	NT	271.5	302.7	n.a.	1.11
1967	NT	270.7	301.8	n.a.	1.11
1968	NT	274.6	304.1	n.a.	1.11
1969	NT	285.3	323.6	n.a.	1.13
1970	NT	304.5	342.8	n.a.	1.13

Note: 1) The annual averages of all exchange rates are estimates made by and available in Frank, Kim, and Westphal (1975) except for those for Greenback (curb market rate) for 1955, 1960, 1961, 1964, and 1965. For these years the annual averages of the curb market rate are estimated by taking into account the number of days the rate was in effect, based on the information in Appendix Table 2. 2) The averages of official exchange rate for 1964 and 1965 and the premium on export dollar in 1965 are taken from Table 8-10D, Appendix to Ch. 8, Frank, Kim, and Westphal (1975). 3) 'NT' stands for 'no transaction'; 'n.a.' is 'not available'.

Source: Appendix Table 2.

B. *Abolition of Multiple Exchange Rates*

The other important part of the reform in February 1961 was abolition of the complicated structure of multiple exchange rates, which was briefly explained in Subsection III.A. A consultation report by IMF provides the following snapshot of the complex exchange rate structure in January, 1961, one month before the reform:[18]

> "Prior to the exchange reform in February 1961 Korea operated a complicated multiple-rate system which comprised principally an official rate, auction rates for ICA (International Cooperation Administration) financed commodities and for exchange sold by the government for imports, and various kinds of transfer rates in the free market depending on the original sources of exchange, i.e., bilateral account dollars (from exports to Japan), other areas' export dollars (from exports to other areas), military supply dollars (supply of goods to UN forces), military service dollars (supply of services to UN forces), missionary dollars (remittances received by missionaries). Aid-financed imports were programmed by commodity. Imports eligible to be financed with auctioned government exchange were announced by the government for each auction."

[18]IMF, "Korea-1960 Consultations", June 1961, p.14.

The complexity of the system was greater than this quote indicates: all other rates besides the official rate were fluctuating. The auction rates for the aid dollars averaged 99.74 won per dollar in 1960 and 128.9 won in January 1961, while the other auction rates for the dollars held by the Korean government averaged 105.84 won per dollar in 1960 and 125.5 won in January 1961. The average transfer rate in 1960 was 142.0 won per dollar for "Japan export dollars" and 128.0 won for "Other export dollars".[19]

C. *How the Rapid Export Expansion Began*

The reform of foreign exchange system in February 1961 made the system very simple: now only one exchange rate existed, which involved little overvaluation of won. Then, immediately followed the most unusual beginning of rapid export expansion, discussed in Section II. New export items began to appear and their exports expanded very rapidly, incomparably faster than the exports of then-existing items. This phenomenon would be readily explained, if the reform suddenly and greatly boosted the export profitability for the new items, while leaving it little changed for the then-existing export items. However, the same, new exchange rate applied to all export items, of course. Nevertheless, the reform apparently represented different things to different persons.

To those who had already been in export business, the reform must have meant no change in terms of their export earnings. Before the reform, under the foreign exchange deposit system they kept their export earnings in the foreign-exchange denominated accounts they held with Bank of Korea, as discussed earlier, and all along they had been selling the dollars at the transfer rates, which the new, uniform exchange rate approximated after the reform. Also, they must have been enjoying the benefits derivable from various export promotion measures that were in effect. Thus, their export earnings in won were little affected by the reform, and it is reasonable to assume that the exporters had been maximizing profit as hard before the reform as they were after the reform. Therefore, there was nothing that would have them drastically change their export behaviors. The increase in their exports, which the 1960s saw, must have been the exporters' response to changes in policies and circumstances other than the reform, but not the reform itself.

On the other hand, for others who had not been in export business at the time, the reform could have been an eye-opener to profitable export opportunities. In the late 1950s the total export amounted to less than 1.0 percent of GNP, and export sales accounted for around 2.5 percent of the manufacturing sector's gross output. To most businesspersons in manufacturing industries it may have not even occurred that they could export their products. Even if one were interested in exporting, it would not have been simple to find out if a profitable export opportunity existed because of the complicated and distorted foreign exchange system. It would require expertise to know which one among many exchange rates to use for price comparison between domestic and foreign markets, which obviously is necessary to see the opportunity. Under the circumstances before the reform, it is hardly surprising, if someone, who would soon export his or her own

[19] *Ibid*, Part II, p.30

products in a year or two, had not recognized the export opportunity that he or she had been sitting on.

Then, the reform, by doing away with the multiple exchange rates and adopting a new and realistic exchange rate, made international price comparison simple. It became plain for them, and also for foreign buyers, to see whether or not and how much profit could be made by exporting an item at the existing exchange rate. In addition, a change in banking practice that began the next year must have helped. Bank of Korea, the central bank, used to be the only bank that could legally handle transactions involving foreign exchanges; since April 1962 all commercial banks began handling foreign exchange transactions. This must also have made the exchange rate, now uniform and realistic, a readily available piece of information to anyone who was interested.

In short, it is highly likely that the reform made it possible for those who had not been in the export business to see for the first time the profitable export opportunities, which had been hidden behind the veil of complex and distorted foreign exchange system. Moreover, the export potential of the labor-intensive, new items must have been "unlimited" in the early 1960s. Korea undoubtedly had comparative advantage in labor-intensive manufactures, for labor was the only factor of production it abundantly had. But export of labor-intensive manufactures had been almost absent until 1961, that is, the country's comparative advantage had been virtually unexploited.[20] For these reasons, once begun, the export of the new items expanded explosively.

The foregoing analysis may be regarded as a hypothesis that needs be supported by evidence, statistical or otherwise. The hypothesis explains why the reform of foreign exchange system in 1961 started the highly unusual beginning of the rapid export expansion in 1961. Direct evidence would be the witness of the exporters of new items to the effect that they had not recognized the profitable export opportunities before the reform but did after the reform. Unfortunately, it is hard to obtain direct evidence of this sort today, some fifty six years after the event. At one level, a piece of circumstantial evidence exists: for all eight new export items mentioned in Section II, belonging to SITC6+8, the appearance date was 1961 or later. Other than the foregoing analysis, no alternative hypothesis could be found in the preceding decade's policies regarding exchange rate, import restriction or export promotion, which might explain why the unusual and rapid export expansion suddenly began.

V. Reinterpretation of the reason for Korea's Export Success

The finding in the previous section goes against the widely held view, also shared by the early studies mentioned at the outset, that the policy switch from

[20]According to Frank, Kim, and Westphal (1975), pp.96-98, the norm for exports share in GDP across countries of comparable population and per capita income in 1955 was 9.8 percent of GDP for large countries and 8.1 percent for large manufacturing countries, while the actual share for Korea in 1955 was 1.7 percent. 'Exports' here seems to include services as well as goods. According to Hong (1979), exports were as large as 31 percent of GNP in 1940, although it is debatable whether all of them should be regarded as international trade, as most of them went to Japan.

import substitution to export promotion in the mid-1960s started the rapid export expansion. Nor does it support the claims made by later studies that the heavy intervention by the government eventually led to the export surge. Thus, the finding calls for a re-statement of the relation between Korea's export success and the government policies.

First of all, the relation needs be clarified between the switch in development policy from import substitution to export promotion on the one hand and the beginning of rapid export expansion on the other. The policy switch took place in the mid-1960s and could not have started the rapid export expansion that began in 1961. Rather, evidence suggests that the policy switch was inspired by the beginning of the rapid export expansion. An example of this evidence can be found in the Korean government's First Five-Year Economic Development Plan, original version of which was published in 1961 and revised in 1964. While the original Plan mentions the desirability of and policy measures for export expansion, it explicitly states that the policy priority was on import substitution.[21] Obviously, the Plan considered export promotion as a remedial measure to deal with the severe foreign exchange shortage at the time. Neither did the Plan anticipate the dramatic increase in manufactures exports. Instead, it envisaged exports of 'food products' and 'inedible raw materials', Korea's major export items until 1960, to remain so and account for roughly two thirds of total exports in 1966, the end year of the Plan. Simply, the government did not consider export promotion as a development strategy in 1961.

In the revised Plan announced in February 1964 the export targets of 'food products' and 'inedible raw materials' were adjusted downward. In its place, adjusted upward was the target of combined share of 'manufactured goods chiefly classified by materials' (SITC 6) and 'miscellaneous manufactured articles' (SITC 8) from 16 percent to 38.3 percent in total export for the last year of the Plan. Obviously, this adjustment was made in response to the rapid export expansion of SITC6+8 from 1961 to the first half of 1963, the period which is known to have had been taken into consideration in the revision. More to the point, the revised Plan emphasizes promotion of export industries. The section titled "Export Plan" states that export promotion was necessary not just to provide exporters with incentives but to promote the development of export industries. Indeed, the new policy of the revised Plan was to promote labor-intensive manufacturing and handicrafts as export industries and redirect investments away from import substitution industries to export industries.[22] This revision of the First Five-Year Economic Development Plan is clear evidence that the policy switch to export promotion was inspired by the rapid export expansion that had begun earlier.

With hindsight, once the rapid export expansion had begun, the policy switch was bound to happen. In the early 1960s Korea was in dire need for new sources of foreign exchanges, as the U.S. aid that used to finance as much as 80 percent of imports in 1950s was declining since 1957. The need could be met at least in part by the rapid export expansion, albeit from a small base. Also, because it was led by

[21]Economic Planning Board (1961), p.43, states in the section on trade policy that the priority was on increasing production of the import substitution industries before it mentions various export promotion measures.

[22]Economic Planning Board (1964), pp.44-47.

manufactures, the export expansion was going to enable Korea to realize the aspiration for industrialization and economic development. Moreover, because it was creating new jobs, export expansion could help the new power elites to fulfill the revolutionary pledge they made at the time of the military coup that they would save the people from under the poverty line. In more than one way the export expansion was a tailor-made answer to a number of problems the government had to tackle at the time. It is not surprising at all that the new government grabbed the opportunity and, with such catchphrases as "nation building through export" and "export first", launched all-out efforts for export promotion. For example, among others, it announced in 1964 "Comprehensive Export Promotion Program" and substantially increased the number of types and the volumes of preferential loans for export. The next year "Monthly Expanded Meeting for Export Promotion" began, which was presided by President Park himself.[23]

Then, what role did the government's export promotion play in Korea's experience of rapid export expansion? No doubt, as shown in Fig. 3, the benefits to exporters became much bigger in the second half of the 1960s, thanks to more and stronger export promotion measures. To answer the question properly, it needs be recalled that the import policy was protectionist throughout the 1960s and 1970s, as it was only in the early 1980s that import liberalization began in earnest. Also, it needs be recalled that protectionist policy has export-depressing effect, as was briefly discussed in Subsection III.B. Thus, in the second half of the 1960s and in the 1970s the government in effect was simultaneously pursuing two policies that had opposite effects on export. Export promotion provided incentives for export; protectionist import policy incentives for domestic sales, discouraging exports. To find out what the net effect on export was, it is necessary to quantify the incentives of the two policies, which is beyond the scope of this paper. It suffices to note that Westphal and Kim (1982) estimates the incentives for 1968 and finds that almost equal incentives were provided to production for domestic sales and for export.[24] The estimate is for a single year in the late 1960s. However, it seems certain that, the net effect did not become much more favorable for export in the following years. For export promotion did not strengthen much since 1968, while the import policy became a little more protectionist in the 1970s under the Heavy and Chemical Industry policy. Therefore, if anything, the net effect of the two different policies may have turned somewhat against export in the 1970s. In short, export promotion helped rapid export expansion by neutralizing the negative effects that protectionist import policy had on export. Had there been no protectionist import policy, the export promotion may not have been necessary.

An interesting question from a policy point of view concerns the motivation behind the reform of foreign exchange system in February 1961. Certainly, the reform was a turnabout from a low exchange rate policy to a realistic exchange rate policy. Was it also meant to be a switch in development policy in 1961 from import

[23]Also, "Wastage Allowance" and "System of Local Letter of Credit" were introduced. In addition, public utility and transportation rates were reduced for exporters and accelerated depreciation was introduced as a measure of tax incentive. See Frank, Kim, and Westphal (1975), pp. 49-51.

[24]"In short, although outward looking, the government's strategy has not been purely one of free trade. . . . the government has provided, on the average, almost equal incentives to production for domestic sale and for export." Westphal and Kim (1982), p.270.

substitution to export promotion? Most likely, the answer is "No.". The reform was a campaign pledge of the Democratic Party, of which Chang Myon was the head, in the election that was held in July 1960 to replace the ousted Rhee government. The Democratic Party for years had labeled the unrealistically low official exchange rate a "disguised subsidy" to their cronies by those in power. For instance, if a politician, by exercising some influence on the relevant ministry, had a certain amount of government-held dollars be allocated to his political supporter(s) at the official exchange rate, far below the on-going market rate, it certainly would be an egregious example of corruption. The Democratic Party had promised to eradicate this source of wide-spread corruption, if it seized the power. Apparently, it was not even dreamed that the reform would start the rapid export expansion that eventually led to the great economic transformation called "East Asian Miracle". Daily newspapers of those days carried no report to the effect that Democratic Party anticipated or promised an increase in export, creation of new jobs, progress in industrialization, and so on as the economic effects of the reform.[25] It seems certain that the reform of foreign exchange system was meant to be, more than anything else, an anti-corruption measure. This motivation also seems to explain why the newly elected Chang Myon government readily agreed to the U.S. demand for devaluation in October 1960, which it carried out in January 1, 1961, and once again devalued the currency on its own initiative only one month later as part of the reform in February 1961.

VI. Conclusion

This paper's investigation into the details of the experience finds that Korea's rapid export expansion began in 1961 with the appearance of new items, the export of which increased incomparably faster than that of then-existing export items. When, how and why of the highly unusual beginning can only be explained by the reform of foreign exchange system in February 1961, as discussed in Section IV. Evidence suggests that the sudden beginning of rapid export expansion led to the switch in the Korean government's development policy from import substitution to export promotion in the mid-1960s. The export promotion since then helped the rapid export expansion continue into the 1970s, largely because it neutralized the negative effect on export of the protectionist import policy that the government was simultaneously pursuing. It is misleading to say that the government's export promotion led to the export success in the 1960s and 1970s and to then stop without mentioning the neutralizing effect.

Put differently, the reform of foreign exchange system in 1961 removed the impediment to export, namely, the distorted system of overvalued Korean won and multiple exchange rate structure. Once the impediment was removed, requiring no further governmental assistance, the economy on its own began to realize the export potential it had in labor-intensive manufactures, which had been virtually unexploited until then. In this experience foreign exchange rate was much more

[25]Reports on this and related story can be found in the daily newspapers at the time. See, for example, Dong-a Ilbo, May 31, 1960; Oct. 1, 1960; Kyung-Hyang Shinmun, May 3, 1957.

important as an information-transmitting price variable than as an export incentive. The government's export promotion since the mid-1960s neutralized another impediment to export, i.e. the export-depressing effect of the protectionist import policy. This appears to be the main story of Korea's export success. In this paper's recount of the beginning of the rapid export expansion in 1961 and its continuation into the next decade, there is little evidence that supports the contention that Korea's export success was "government-made" or "government-led".

APPENDIX

APPENDIX TABLE 1—EXPORTS, 1957~70 (THOUSAND DOLLARS)

SITC		1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
0	Food, live animals	3,114	2,456	4,118	9,701	8,948	21,847	16,506	26,350	28,190	40,478	37,928	44,491	50,279	65,537
1	Beverage, tobacco	53	-	106	451	184	14	250	184	897	6,892	7,019	8,621	14,850	14,231
2	Crude materials, inedible	14,591	10,583	11,713	15,816	20,598	19,372	27,742	31,441	37,033	46,679	58,005	61,506	73,042	99,973
3	Mineral fuels, etc.	6	297	657	1,147	2,209	2,760	2,579	2,488	1,899	1,505	1,772	2,298	4,837	8,761
4	Animal, vegetable oils	35	162	177	199	118	69	92	88	71	137	119	113	68	59
5	Chemicals	6	10	115	401	550	990	904	630	380	714	2,359	3,115	9,753	11,413
6	Manufactured goods, classified by materials	3,394	2,408	2,139	3,937	4,004	6,177	28,115	42,309	66,414	84,175	101,382	143,598	173,826	220,886
631211	Veneer sheets	-	-	11	21	1,217	2,060	5,833	11,395	18,030	29,880	36,418	65,590	79,162	91,746
652	Cotton fabrics	276	899	1,425	2,443	857	1,834	4,289	11,119	10,522	10,121	12,591	13,314	18,645	26,355
6532	Woolen fabrics	-	-	-	-	-	-	10	580	2,228	2,153	3,963	4,519	3,344	3,382
6535	Synthetic fabrics	-	-	-	-	-	2	471	1,040	2,507	4,402	9,853	16,653	12,646	9,962
7	Machinery, transport equipment	56	4	48	88	884	446	4,066	2,204	5,501	9,556	14,185	24,464	53,219	61,469
8	Miscellaneous manufactured articles	640	148	86	93	791	1,954	6,400	13,198	34,487	59,197	97,238	167,005	242,344	352,496
83	Travel goods, handbags	-	-	-	-	4	1	2	6	50	417	1,209	827	1,228	2,479
84	Clothing	-	-	-	-	2	1,119	4,644	6,614	20,713	33,385	59,208	112,232	160,770	213,566
85	Footwear	-	-	-	-	30	238	738	879	4,151	5,467	8,139	11,044	10,476	17,268
89941	Umbrellas	-	-	-	-	-	1	-	72	86	26	50	203	431	799
89993	Artificial flowers	-	-	-	-	-	37	107	319	511	423	397	727	599	881
89995	Wigs, false beards	-	-	-	-	-	-	13	169	2,344	12,022	22,724	35,092	60,199	100,868
Total Exports		22,202	16,451	19,812	32,827	40,878	54,813	86,800	119,057	175,081	249,537	320,227	455,397	622,513	835,182

Source: Bank of Korea, *Economics Statistics Yearbook*, 1960, 1964, 1966; Ministry of Commerce, *Trade Statistics Yearbook*, 1964.

APPENDIX TABLE 2—NOMINAL EXCHANGE RATE OF WON TO THE U.S. DOLLAR, 1955-70

	Official Rate	"Market Rates"		
		Japan Export Dollars	Other Export Dollars	U.S. Greenbacks
Jan. 10, 1955	18.0	92.3	83.5	77.2
Apr. 18, 1955	18.0	75.6	46.6	74.8
Jun. 27, 1955	18.0	80.2	56.3	75.3
Aug. 8, 1955	18.0	95.0	82.0	80.2
Aug. 15, 1955	50.0	95.0	82.0	80.2
Avg. 1956	50.0	107.0	100.8	96.6
Avg. 1957	50.0	112.3	105.7	103.3
Avg. 1958	50.0	122.5	101.5	118.1
Avg. 1959	50.0	139.9	124.7	125.5
Jan. 20, 1960	50.0	164.1	132.0	132.0
Feb. 23, 1960	65.0	171.8	138.7	144.9
Jan. 1, 1961	100.0	156.3	141.6	139.8
Feb. 2, 1961	130.0	147.9	145.4	148.3
Avg. 1962	130.0	NT	NT	134.0
Avg. 1963	130.0	169.8		174.5
May. 3, 1964	256.5	314.0		285.6
Mar. 22, 1965	256.5	279.0		316.0
Avg. 1966	271.3	NT		302.7
Avg. 1967	270.7	NT		301.8
Avg. 1968	276.6	NT		304.1
Avg. 1969	288.2	NT		323.6
Avg. 1970	310.7	NT		342.8

Note: 1) This table is adapted from Table 3-1, "Nominal Exchange Rates of Won to U.S. Dollar in South Korea, 1945 to 1970," in Frank, Kim, and Westphal (1975), pp.30-31. 2) "Market rates" refer to the transfer rates that resulted from transfers of foreign exchanges between the deposit accounts traders held with the Bank of Korea until February 1961. For later years, they refer to the rates at which the foreign exchange certificates were traded. 3) "Japan Export Dollars" refers to the transfer rate at which dollar earnings from the exports to Japan were traded, and "Other Export Dollars" the transfer rate at which the earnings from exports to the rest of the world were traded. 4) 'NT' stands for 'no transaction'.

APPENDIX TABLE 3—OVERALL INDEX OF TRADE LIBERALIZATION, 1955-84 (%)

Year	Average Tariffs	Automatic Approval	Year	Average Tariffs	Automatic Approval
1955	27.4	1.0	1970	58.5	52.8
1956	27.4	3.5	1971	57.9	53.5
1957	35.4	6.4	1972	57.5	49.5
1958	42.9	6.3	1973	48.2	50.7
1959	66.5	4.7	1974	48.1	49.3
1960	58.0	5.0	1975	48.1	47.8
1961	36.0	4.0	1976	48.1	49.6
1962	49.6	5.4	1977	41.3	49.9
1963	49.5	0.4	1978	41.3	61.3
1964	51.0	2.0	1979	34.4	69.1
1965	52.7	5.9	1980	34.4	70.1
1966	52.3	9.1	1981	34.4	75.5
1967	52.6	58.8	1982	34.4	77.4
1968	58.9	56.0	1983	34.4	81.2
1969	58.3	53.6	1984	26.7	85.4

Note: Automatic approval (AA) items are shown as a percentage of all importable items.

Source: Kim, Kwang Suk (1991), p.43, Table 3.6.

APPENDIX TABLE 4—PURCHASING POWER PARITY EFFECTIVE EXCHANGE RATES ON EXPORTS, 1958~70

	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
A. Official exchange rate	50.0	50.0	62.5	127.5	130.0	130.0	214.3	265.4	271.3	270.7	276.6	288.2	310.7
B. Average export dollar premium	64.0	84.7	83.9	14.6	-	39.8	39.7	-	-	-	-	-	-
C. Subsidies per dollar exports	1.2	1.3	1.2	8.5	21.5	19.6	27.4	39.2	51.6	62.4	77.7	75.1	86.5
D. Effective exchange rate on exports	115.2	136.0	147.6	150.6	151.5	189.4	281.4	304.6	322.9	333.1	354.3	363.3	397.2
E. WPI, Korea, 1965=100	39.9	40.8	45.2	51.2	56.0	67.5	90.9	100.0	108.8	115.8	125.2	133.7	145.9
F. WPI, major trade partners, 1965=100	97.2	97.7	97.9	98.3	97.6	98.3	98.5	100.0	102.8	104.0	105.6	108.8	112.8
G. Effective exchange rate on exports (D/E)	288.6	333.2	326.5	294.1	270.5	280.6	309.5	304.6	296.8	287.6	283.0	271.7	272.2
H. Purchasing Power Parity Exchange Rate on Exports (FxG)	280.5	325.6	319.6	289.1	264.0	275.8	304.9	304.6	305.1	299.1	298.8	295.7	307.1
I. Index of H, 1965=100	92.1	106.9	104.9	94.9	86.7	90.6	100.1	100.0	100.2	98.2	98.1	97.1	100.8

Note: D (Effective exchange rate on exports) = A + B + C

Source: Frank, Kim, and Westphal (1975), pp.70-71, Table 5-8.

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Korea's Demographic Transition and Long-Term Growth Projection Based on an Overlapping Generations Model

By KYOOHO KWON*

This paper employs an Overlapping Generations Model to quantify the impacts of Korea's demographic transition toward an older population on the total output growth rate. The model incorporates the projected population through 2060 according by Statistics Korea. The effects of the low fertility and increased life expectancy rates are studied. The model is considered suitable for analyzing the effects of demographic changes on the Korean economy. Under the assumption that the TFP growth rate will not slow considerably in the future, remaining at 1.3% per annum, the gross output growth rate of the Korean economy is projected to slow to 1.1% per annum in the 2050s, from 4.0% in the 2000s. The shrinking workforce due to the decline in fertility plays a significant role in the deceleration of the Korean economy. The increased life expectancy rate is expected to mitigate the negative effect, but the magnitude of its effect is found to be limited.

Key Word: Computable General Equilibrium Models, Life Cycle, Aggregate Supply, Population Aging
JEL Code: C680, E210, J110

I. Introduction

Korea's population structure is rapidly changing. According to Statistics Korea, the total population is projected to peak at 52.1 million in 2030 and then to fall to 43.9 million by 2060. In particular, the working-age (15~64) population, which largely determines the size of the labor force, is forecast to shrink at an accelerated rate due to a persistently low fertility rate, dwindling to 21.8 million by 2060; a mere 59% of its peak of 37.0 million in 2016. Roughly speaking, the working-age population will decrease by approximately 0.3 million, or 1~2% per annum, for the next 45 years. On the other hand, as life expectancy continues to improve, the old-age (aged 65 and over) population is projected to surge to 17.6

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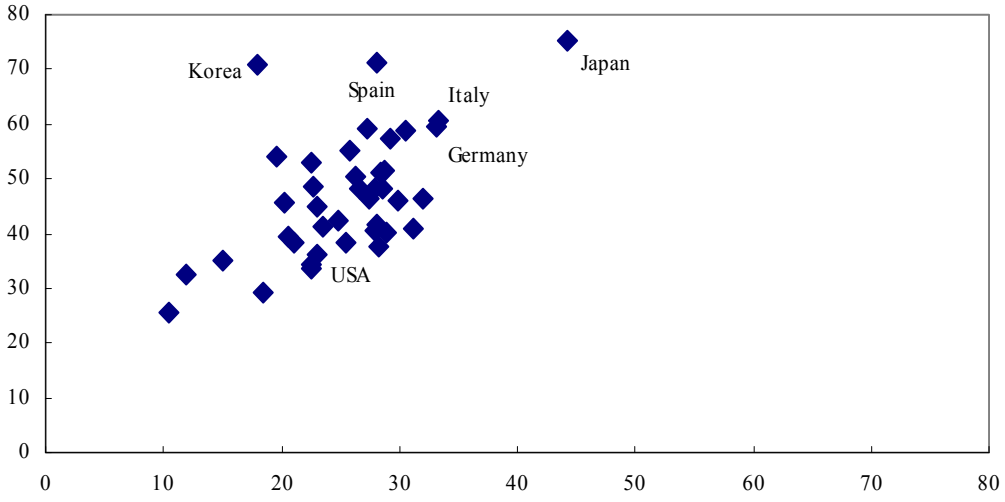

FIGURE 1. A PROJECTION OF THE AGED DEPENDENCY RATIO FOR OECD COUNTRIES

Note: The horizontal axis indicates the old-aged dependency ratio in 2014. The vertical axis indicates the old-aged dependency ratio in 2050.

Source: OECD. Stat.

million in 2060 from 5.4 million in 2010. Consequently, the old-age dependency ratio is also expected to rise to 80.6% from merely 15.2% as of 2010. Indeed, Korea's demographic structure is changing at an alarming rate by international standards. In terms of the old-age dependency ratio, Korea is projected to become one of the most aged countries by 2050 among OECD member countries, as shown in Figure 1.

The rapid demographic transition is expected to affect the economy through various channels. Due to the ongoing low fertility rate, the size of the workforce will decline and lower the growth potential. From a household perspective, the continued increase in longevity, however, will alter economic decisions about consumption-saving and working hours, among others. Specifically, longer life expectancy tends to increase the incentives to work unless the retirement age is prolonged in proportion. Moreover, lower fertility implies that fewer children will be present in households during working years, and this acts to reduce consumption before retirement. These changes in household behavior could positively affect the economy through aggregate labor supply and capital accumulation channels.

In this paper, we build an overlapping generation general equilibrium model to analyze the effects of Korea's demographic changes on GDP growth potential to the year 2060.[1] Focusing on GDP to measure a country's well-being may not be appropriate, especially for countries experiencing rapid population aging. However, it is still an important measure for Korea as a sharp decline in the GDP growth rate exacerbates, for instance, long-term fiscal and generational redistribution issues

[1]In this paper, by output growth rate, we mean not the per capita output growth rate but the total output growth rate.

due to a sharp increase in welfare spending.

The demographic transition of the model economy closely follows the historical data and official projections published in 2011 by Statistics Korea. The model economy is populated with households that face mortality risks and may live to a maximum age of 100. Households have one male and one female adult and a varying number of children. To reflect the possibility that the female workers may play a greater role in the labor market in the future due to the scarcity of labor, an endogenous female labor supply response is considered in the model economy. As a way of modeling the endogenous female labor supply, we assume that adult members jointly choose how much to work and how much to consume (or save) to maximize the household life-time utility. For the demographic transition, two distinct sources of exogenous variation are considered: changes in the fertility rate and changes in the survival probability. In addition to the changes in the volume of the labor force caused by the interaction between fertility rates and survival probabilities, households' endogenous responses, such as work hours and consumption-saving decisions are considered.

Our objective is to assess the effects of demographic changes on the macro economy in the coming decades. The endogenous responses of the model economy to exogenous variations in the demographic variables and the changes in total factor productivity are reasonably successful in reproducing the historical path of labor growth, capital accumulation, and GDP growth. Therefore, the model is considered suitable for analyzing the effects of the aforementioned demographic changes on the Korean economy. Under the assumption that the TFP growth rate will not decelerate much in the future, remaining at 1.3% per year, the growth rate of the Korean economy is projected to decelerate to 1.1% per annum in the 2050s from 4.0% in the 2000s. A shrinking workforce plays a significant role in the slowdown of the Korean economy, although the increased life expectancy is expected to mitigate the negative effects, albeit to a limited degree.

Analyzing the demographic effects on the future Korean economy in the framework of the Overlapping Generations model is not unprecedented. For example, Hong (2007) studies macroeconomic impacts of an aging population in Korea using an Auerbach-Kotlikoff type of model; Lee and Moon (2013) analyze the long-run and transitional impacts of different fiscal rules on the future path of the Korean economy; Shin and Choi (2015) develop a model in which the accumulation of human capital is endogenously determined and project the long-term economic growth.

These studies are, however, silent with regard to how much the model economies can explain the historical paths of macro variables, casting doubt therefore on the validity of the models when used to assess the effects of demographic changes on the macro economy in the coming decades. In addition, to the best of our knowledge, this paper is the first to consider the role of the female labor supply for the Korean economy in the coming decades in the overlapping generations model framework. As Korea's female labor participation rate is one of the lowest among OECD member countries, there appears to be sufficient room for improvement regarding the female labor supply. As the size of the labor force shrinks, the female labor supply is expected to increase as a result of market forces given the scarcity of labor. Therefore, it is important to quantify the contributions

of the female labor supply on the aggregate labor supply to assess the effects of demographic changes on the macro economy for the Korean economy.

For Japan's economy which is also experiencing drastic demographic changes, similar to those in Korea, Chen, Imrohoroglu, and Imrohoroglu (2005, 2007) and Braun, Ikeda, and Joines (2009) analyze the effects of demographic changes on saving rates and show that a demographic transition is a key determinant in the long-run swing in Japan's saving rates.

This paper is organized as follows: Section II specifies the model economy; Section III calibrates the model based on various macro and micro datasets; Section IV evaluates the model's ability to explain the observed macro data and reports our baseline projections for the Korean economy; Section V presents counter factual exercises; Section VI concludes the paper.

II. The Model Economy

Our theoretical model is a standard life- cycle, overlapping generations model. The basic structure of the model economy is adapted from Braun, Ikeda, and Joines (2009), especially for the population and household structure.

A. *Demographic Structure*

Time t is discrete and the model period is one year. Individuals who face mortality risks in each period may live up to J periods such that J birth cohorts are alive in the economy in any period t. Let $N_{j,t}$ denote the population of age j in period t. The population of each cohort in period t is described by $\mathbf{N}_t$, which is a $J \times 1$ vector of which the elements are $N_{j,t}$. The number of the total population in period t is given by $N_t = \sum_{j=1}^{J} N_{j,t}$.

The population of each cohort evolves over time as follows:

$$N_{1,t+1} = \left(1 + n_{1,t+1}\right) N_{1,t}.$$
$$N_{j+1,t+1} = \psi_{j,t} N_{j,t}, \quad 1 \le j \le J-1$$
$$N_{J+1,t+1} = 0.$$

where $n_{1,t+1}$ denotes the growth rate of the population of age 1 in period $t+1$, referred to as the fertility rate hereinafter. $\psi_{j,t}$ denotes the conditional probability that an individual aged j in period t survives to period $t+1$. We assume that J is one hundred and that $\psi_{J,t}$ is zero. We assume further that the same number of males and females are born during each period and that they share identical conditional survival probabilities. That is, the survival probabilities only differ by birth cohorts.

The model economy is populated with households that consist of one male adult, one female adult, and varying number of children under the age of 20. At the age of 21, one male and one female form a household. Hence, the number of households aged j in period t is denoted as $N_{j,t}/2$, for $j \geq 21$. Each household exits from the economy when a mortality shock arrives.

Households have varying numbers of children. Specifically, let $m_{j,t}$ be the number of children born to a household aged j in period t. As time passes, the number of children increases, as does the size of the household $\eta_{j,t}$. When the children become 21, they separate from the household to form their own households and the size of the household decreases. Accordingly, the size of a household evolves over time, as follows:

$$\eta_{j,t} = 2 + \sum_{i=21}^{j} m_{i,t-j+i} - I(j>40) \sum_{i=21}^{j-20} m_{i,t-j+i}, \quad \text{where} \quad I(j>40) = \begin{cases} 1 & if \quad j > 40 \\ 0 & if \quad j \leq 40 \end{cases}$$

B. *Household's Problem*

A household is a unit that makes independent economic decisions concerning consumption-saving and the labor supply, among athers. Each household participates in the labor market at the age of 21 and retires at the age of J^R.[2] We refer to a household aged j in period t as belong to the k_{th} cohort. Note that age, time, and cohort indices are not independent given that $k = t - j + 1$. We notate the model economy with only time and age indices unless it is absolutely necessary to do with the cohort indices.

We assume that there exists a household that represents the average characteristics of the k_{th} cohort. The lifetime utility for this representative household of k_{th} cohort is assumed as follows,

$$U_k = \sum_{j=21}^{J} \beta^{j-1} \pi_{j,t} u\left(c_{j,t}, h_{Mj,t}, h_{Fj,t}; \eta_{j,t}\right),$$

where $c_{j,t}$ denotes the consumption of household aged j in period t, and $h_{Mj,t}$ and $h_{Fj,t}$ denote the hours of work for the male and the female members, respectively. We assume that the lifetime utility is time-separable and that the discount rate is identical for all cohorts. β denotes the preference discount rate. $\pi_{j,t}$ is the unconditional probability of surviving from birth to age j in period t and is calculated as follows: $\pi_{j,t} = \psi_{j-1,t-1}\pi_{j-1,t-1}, \pi_{1,t} = 1$ for all t.

[2]Therefore, the working-age population of the model economy consists of the population aged 21~64, which is different from the conventional definition of the working-age population (15~64).

We assume the following instantaneous utility function:

$$u\left(c,h_M,h_F;\eta\right)=\eta\log\left(\frac{c}{\eta}\right)-B_M\frac{h_M^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}-\eta B_F\frac{h_F^{1+\frac{1}{\gamma}}}{1+\frac{1}{\gamma}}$$

The utility function is separable between consumption and leisure. This utility function was chosen to support a balanced growth path. The parameter γ denotes the intertemporal substitution elasticity of leisure.

We expect that the female labor supply will play a greater role in the coming decades as the working-age population decreases. One channel through which the female labor supply will increase is the decline in the household size. As the average household size over the life cycle decreases, so will the relative value of household production to market work, which results in an increase in the female labor supply. To accommodate this channel, we assume that the disutility from market work by the female household member is an increasing function of the household size.

Each household has two adult workers: one male and one female. Workers have different labor market productivity values according to gender and age. Let ϵ_{Mj} be the time-invariant productivity of an aged-j male worker and $\epsilon_{Fj,t}$ be the productivity of an aged-j female worker in period t. When the household aged j in period t supplies $h_{Mj,t},h_{Fj,t}$ hours to the labor market, it supplies $\epsilon_{Mj}h_{Mj,t}+\epsilon_{Fj,t}h_{Fj,t}$ units of efficiency labor and earns $w_t\epsilon_{Mj}h_{Mj,t}+w_t\epsilon_{Fj,t}h_{Fj,t}$, where w_t denotes the market wage rate for an efficiency unit of labor in period t.

A household enters the economy without assets. Borrowing against the future labor income is not allowed. Let r_t denote the market interest rate, which is rate of return on savings. When a household exits from the economy due to mortality shock, it leaves its unconsumed assets to its children's generations. However, the household does not take into account the children's utility; therefore all of the bequests in this economy are unintended. Likewise, the children inherit assets from their parents' generations. Let $b_{j,t}$ be the amount of transfer income that the representative household aged j in period t receives from their parents' generations.

A household's decision problem is formulated recursively and Bellman's equation for a representative household of age j in period t is given as follows:

$$(1)\quad V\left(a_{j,t};j,\eta_{j,t}\right)=\max_{c_{j,t},h_{Mj,t},h_{Fj,t},a_{j+1,t+1}}\left\{u(c_{j,t},h_{Mj,t},h_{Fj,t};\eta_{j,t})+\beta\psi_{j,t}V\left(a_{j+1,t+1};j+1,\eta_{j+1,t+1}\right)\right\}$$

s.t.

$$c_{j,t}+a_{j+1,t+1}\le\left(1+r_t\right)a_{j,t}+w_t\epsilon_{Mj}h_{Mj,t}+w_t\epsilon_{Fj,t}h_{Fj,t}+b_{j,t},$$

$$c_{j,t}\ge 0,\ 0\le h_{Mj,t}\le 1,\ 0\le h_{Fj,t}\le 1,a_{j+1,t+1}\ge 0,\ \text{and}\ \ V\left(\bullet;J+1,\square\right)=0.$$

The decision rules that solve this problem are denoted as $c_{j,t} = c(j,t)$, $h_{Mj,t} = h_M(j,t)$, $h_{Fj,t} = h_F(j,t)$ and $a_{j+1,t+1} = a'(j,t)$.

The aggregate supply of capital in period $t+1$, K^s_{t+1}, is determined by the households' decisions on savings. In order to calculate the aggregate supply of capital, we need to specify how unintended bequests are distributed to living households. The aggregate supply of aggregate capital in period $t+1$ is determined by the saving behaviors of the representative households in period t. The amount of assets that the representative household aged j in period t saves is $a'(j,t)$. This household survives in period $t+1$ with a probability of $\psi_{j,t}$ or exits from the economy with a probability of $(1-\psi_{j,t})$. If a mortality shock arrives, we assume that the assets, including the return on savings are transferred to their children's generations as an accidental bequest at the end of period $t+1$. In other words, the inheritors receive $(1+r_{t+1})a'(j,t)$ in the period of $t+1$. The total amount of these unintended bequests in the model economy in period $t+1$ is

$$B^s_{t+1} = \sum_{j=21}^{J} (1-\psi_{j,t})(1+r_{t+1})a'(j,t)N_{j,t} / 2.$$

The total amount of the unintended bequest inherited by the living households can be denoted as

$$B^d_t = \sum_{j=21}^{J} b_{j,t+1}N_{j,t+1} / 2.^{3}$$

With this timing of the transfer process, the aggregate supply of capital in period $t+1$, K^s_{t+1}, can be calculated as the total amount saved by the representative households in period t. That is

$$K^s_{t+1} = \sum_{j=21}^{J} a'(j,t)N_{j,t} / 2.^{4}$$

The aggregate supply of labor in period t is

$$L^s_t = \sum_{j=21}^{J^R-1} \epsilon_{Mj} h_M(j,t)N_{j,t} / 2 + \sum_{j=21}^{J^R-1} \epsilon_{Fj,t} h_F(j,t)N_{j,t} / 2.$$

[3]See the appendix for details on the construction of $b_{j,t}$. We assume that unintended bequests from a specific cohort are distributed proportionally to its children generations, unlike the standard equal distribution assumption. However, simulation results show no meaningful differences

[4]In the same manner, the supply of aggregate capital in period t, K^s_t, is equal to the total amount saved by the representative households in period t-1.

$$K^s_t = \sum_{j=21}^{J} a'(j,t\text{-}1)N_{j,t\text{-}1}/2$$

C. *Firm's Problem*

In the model economy, there exists a representative firm which produces output Y_t by combining capital K_t and labor L_t using a constant return to-scale Cobb-Douglas production function in each time period t,

$$Y_t = A_t K_t^{\alpha} L_t^{1-\alpha},$$

where A_t denotes the total factor productivity in period t and α is the output elasticity of capital. The aggregate labor L_t is measured in units of efficiency. We assume that the markets for the factors of production and the market for goods are competitive.

The firm's profit maximizing problem can be stated as follows,

$$\left(K_t^d, L_t^d\right) = \underset{K_t, L_t}{\operatorname{argmax}} \left\{ A_t K_t^{\alpha} L_t^{1-\alpha} - w_t L_t - \left(r_t + \delta_t\right) K_t \right\},$$

where L_t^d and K_t^d denote the demand for labor and the demand for capital, respectively, and δ_t denotes the depreciation rate of capital in period t. Then, L_t^d and K_t^d satisfy the following first-order profit maximizing conditions:

$$\alpha A_t (K_t^d)^{\alpha-1} (L_t^d)^{1-\alpha} = r_t + \delta_t \tag{2}$$

$$\left(1-\alpha\right) A_t (K_t^d)^{\alpha} (L_t^d)^{-\alpha} = w_t \tag{3}$$

D. *Capital Flows*

We assume that the model economy is closed such that the rate of return on capital is determined in the domestic market. We rely on the empirical findings of Feldstein and Horioka (1980), which show that the correlation between the investment rate and the savings rate is close to one in the long run given this assumption. Considering that other economies also have aging populations, the trend in the future capital flows will be determined by the relative speed of Korea's demographic transition. It may be beneficial to model a multi-country large-scale Overlapping Generations Model to account for the effects of the world-wide demographic transition on global rates of return on capital. Examples include Attanasio, Kitao, and Violante (2007) and Krueger and Ludwig(2007). The effects of Korea's demographic transition on the Korean economy can then be analyzed in a single framework under the open economy assumption. However, doing so world be beyond the scope of this paper, and we therefore limit our model to the closed economy assumption.

D. *Definition of Recursive Competitive Equilibrium*

Let $S_t = \{n_{1,t}, \psi_t, \eta_t, A_t, \delta_t\}$ be the aggregate state of the economy in period t, where $\psi_t = \{\psi_{1,t}, \psi_{2,t}, \cdots, \psi_{J,t}\}$ is the vector of conditional survival probability in period t and $\eta_t = \{\eta_{1,t}, \eta_{2,t}, \cdots, \eta_{J,t}\}$ is the size of the representative household in period t. We assume that the economic agents in the economy perfectly foresee the entire path of the state of the aggregate economy, $\{S_t\}$.

Given the path of the aggregate state of the economy, the equilibrium of the economy consists of the household's value function $V(a_{j,t}; j, \eta_{j,t})$; the associated decision rules $c(j,t)$, $h_M(j,t)$, $h_F(j,t)$ and $a'(j,t)$; the sequence of the aggregate factor inputs $\{K_t, L_t\}$; and the sequence of the factor prices; $\{w_t\}$ and $\{r_t\}$ such that

1. Given the path of the factor prices, the household value function and the decision rules solve the household's dynamic problem (1).
2. Given the path of the factor prices, $\{K_t, L_t\}$ denotes the solution to the representative firm's profit maximization problems (2) and (3).
3. The factor markets clear: for all t,

$$K_t = \sum_{j=21}^{J} a'(j,t-1) N_{j,t-1} / 2,$$

$$L_t^S = \sum_{j=21}^{J^R-1} \epsilon_{Mj} h_M(j,t) N_{j,t} / 2 + \sum_{j=21}^{J^R-1} \epsilon_{Fj,t} h_F(j,t) N_{j,t} / 2.$$

4. The goods market clears: for all t, $Y_t \left(= A_t K_t^{\alpha} L_t^{1-\alpha}\right) = C_t + I_t$, where $C_t = \sum_{j=21}^{J} c(j,t) N_{j,t} / 2$ and $I_t = K_{t+1} - (1-\delta_t) K_t$.
5. The amount of transfer income that living households receive is in line with the amount of accidental bequests: for all t, $B_t^s = B_t^d$.

Balanced Growth Path

In order to quantify the model economy, we must specify the characteristics of the balanced growth path to which the model economy converges. We assume, in the end, that the net fertility rate and the conditional survival probabilities converge and become constant:

$$n_{1,t} = n_1^*, \ \psi_{j,t} = \psi_j^* \ \text{ for } \ 1 \le j \le J \ \text{ and all } \ t \ge T^*.$$

After passing J periods after these conditions are satisfied, we have

$$N^*_{t+1} = \left(1 + n^*_1\right) N^*_t \quad \text{and} \quad N^*_{j,t+1} / N^*_{t+1} = N^*_{j,t} / N^*_t .$$

In other words, the growth rate of the total population is equal to the net fertility rate, and the age distribution of the population becomes stationary.

We assume that the growth rate of total factor productivity converges in the end. That is $A_{t+1} / A_t = \gamma^*_A$ for all $t \geq T^*$.

Suppose that a stationary population distribution is achieved and that the growth rate of total factor productivity is constant over time. In such a case, the stationary recursive competitive equilibrium is recursive competitive equilibrium in which the following characteristics are satisfied. For all t, the consumption and savings of the representative household increase proportionally and the supply of labor remains constant:

$$c(j,t+1) = \gamma^*_c c(j,t), \; a'(j,t+1) = \gamma^*_a a'(j,t),$$

$$h_M(j,t+1) = h^*_M, \; h_F(j,t+1) = h^*_F \quad \text{for all} \quad j \quad \text{and} \quad t \geq T^*,$$

Where $\gamma^*_c = \gamma^*_a = \left(\gamma^*_A\right)^{\frac{1}{1-\alpha}}$.

In consequence, the market prices are determined as follows:

$$r_t = r^*, \; w_{t+1} = \gamma^*_w w_t \quad \text{for} \quad t \geq T^*, \quad \text{where} \quad \gamma^*_w = \left(\gamma^*_A\right)^{\frac{1}{1-\alpha}}.$$

III. Calibration

A. *Demographic Transition*

We calibrate the model economy with information for the period between 1991 and 2010. Then, we simulate and analyze the model economy through to the year 2060, for which the official population projection by Statistics Korea is available. The demographic transition of the model economy mimics the projection. Assumptions about fertility and survival probabilities are required to produce the age distribution of the population at each date. The net fertility rates are calculated to match the growth rate of the one-year-old population until the year 2060. To solve the model economy quantitatively, we need information beyond 2060. Between 2060 and 2100, the net fertility rates are drawn from the UN's population projection data. After 2100, they are assumed to be fixed at zero. Through 2060, the conditional survival probabilities are drawn from the life tables projected by Statistics Korea. Because the projected life tables are in five-year periods, the

probabilities for the interim periods are approximated by linear interpolation. After 2060, the survival probabilities remain fixed at the 2060 levels. Under the assumptions specified above, the population distribution reaches a steady state in 2180, wherein the population growth rate is zero percent and the age distribution of the population does not change over time.

The size of the representative household, $\eta_{j,t}$, is constructed in a manner that is consistent with the population projection with simplifying assumptions. The method suggested by Braun, Ikeda, and Joines (2009) is modified to be consistent with our model economy. Regarding the size of a household aged j in period t, as shown in equation (1), we need to construct the number of children born to the household aged j in period t, i.e., $m_{j,t}$. Let $p_{j,t}$ denote the proportion of children that are born to all females aged j in period t to the total number of children born in period t. The number of children born to all females aged j in period t can then be written as $p_{j,t}N_{1,t}$. Finally, we determine the number of children born to household aged j in period t with the equation $m_{j,t} = p_{j,t}N_{1,t} / \left(N_{j,t} / 2\right)$, where $N_{j,t} / 2$ is the number of households aged j in period t in the model economy.

At this stage, we need to find an empirical counterpart for $p_{j,t}$. For the years between 1981 and 2014, we can easily calculate $p_{j,t}$ from Statistics Korea's Birth Statistics data. However, for other years, we need additional simplifying assumptions due to the lack of historical data and projections of $p_{j,t}$. We assume that $m_{j,t} = f_t m_j$, where $m_j = m_{j,1981}$ for the years before 1981 and $m_j = m_{j,2014}$ for the years after 2014. Following Braun, Ikeda, and Joines (2009), we interpret f_t as a time-varying shock to aggregate fertility and m_j as the time-invariant indicator of the relative number of births in each year of the parents' life cycles. We calculate f_t as follows:

$$N_{1,t} = f_t \sum_{i=21}^{J} m_i N_{i,t} / 2 = f_t \left[m_{21}N_{21,t} + m_{22}N_{22,t} + \cdots + m_{50}N_{50,t} \right] / 2$$
$$\Rightarrow f_t = N_{1,t} / \left(m_{21}N_{21,t} + m_{22}N_{22,t} + \cdots + m_{50}N_{50,t} \right).$$

B. *Households*

Micro estimates of the intertemporal substitution elasticity of leisure, γ, range from 0.1 to 0.7. We choose a value of 0.5 for both male and female workers, which is a widely accepted value for the class of the model economy considered in this paper. We choose the weight parameters for disutility from working B_M and B_F such that the average number of hours of work is 1/3, respectively, on the balanced growth path.

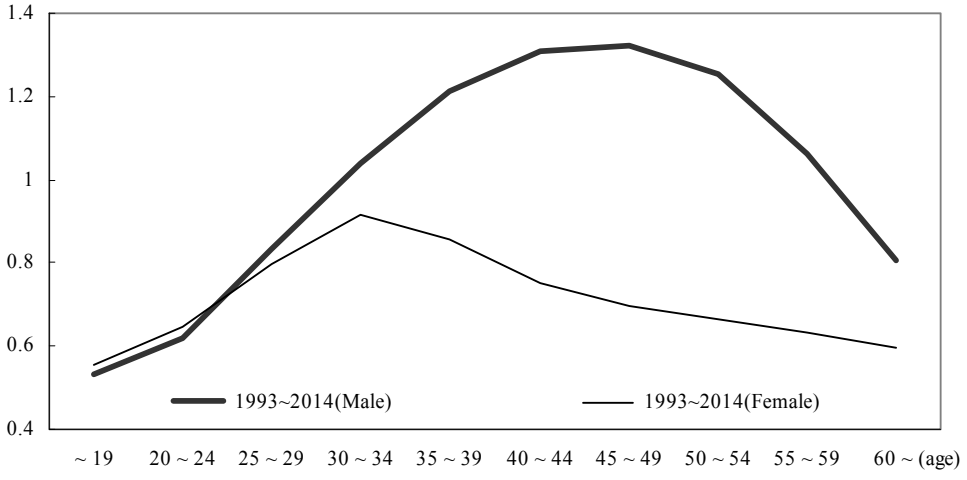

FIGURE 2. AGE-PRODUCTIVITY PROFILE BY GENDER

Note: Employing the method by Hansen (1993), the numbers are calculated by the author.

The preference discount factor β is set such that the average savings rate of the model economy during 1991~2010 matches the average value of the savings rate and investment rate for the same period. Note that we pinned down the average savings rate of the model economy between 1991 and 2010, but the dynamics of these variables are determined endogenously.

Model simulations require initial asset holdings by age in the year 1991. We use Statistics Korea's Household Asset Survey for 2006 to determine the age-asset distribution in 1991; although this survey was conducted for the year 2006, to the best of our knowledge it is the earliest data publically available. Then, the aggregate wealth of the model economy in 1991 is then rescaled to match the capital-output ratio in 1991, which is 2.6.

The age-productivity profiles by gender are constructed from the data on employment, wages, and weekly hours collected by the Ministry of Employment and Labor for 1993~2014.[5] The method suggested by Hansen(1993) is employed to the extract age-productivity profile. Wages are converted to the actual values using the consumer price index. Figure 2 shows the age-productivity profiles by gender. The age-productivity profile for a male worker is normalized to have an average value of one. As reported for most advanced countries, it has an inverted U shape. For male workers, we assume that labor productivity varies with age but that the age-productivity profile itself is invariant over time. Thus, growth in labor productivity for male workers is solely attributed to the total productivity growth in the model economy. The age-productivity profile for a female worker is reported in values relative to those of male workers. For example, the labor productivity rate for female workers aged 40~44 is about 0.8, which is approximately 80% of the average productivity of male worker.

[5]Ministry of Employment and Labor(1993~2014).

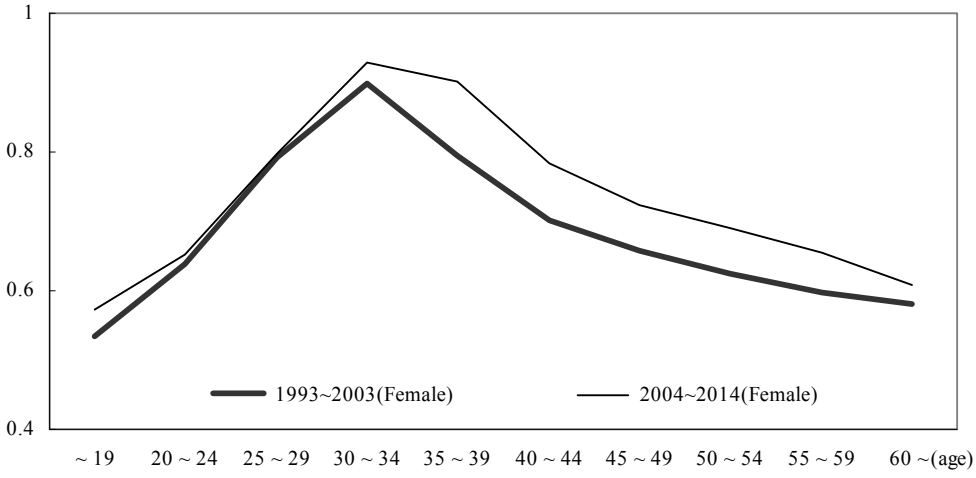

FIGURE 3. DIFFERENCE IN AGE-PRODUCTIVITY PROFILE FOR FEMALES OVER TIME

Note: Employing the method by Hansen (1993), the numbers are calculated by the author.

We assume that the female age-productivity profile converges to that of their male counterparts over time. Figure 3 shows the female age-productivity profiles calculated for the half periods. The age-productivity for a female worker shows an increase in the sample periods. We assume that this improvement continues until it converges to the male age-productivity profile at the historical speed. What the method suggested by Hansen (1993) recovers is simply the average hourly real wage rate by age group and gender. If the labor market is competitive, the hourly wage rate reflects the true worker's productivity. However, we recognize well that the hourly wage rate may not truly reflect worker productivity and that the problem may be more complicated if we compare those values between males and females. The difference may reflect such factors as gender discrimination and different levels of experience or education. As labor is expected to become scarce, we expect that the working environment will improve culturally and legally in such a way that female workers will remain in the labor market and the relative difference between male and female workers will disappear gradually in the future. We interpret the convergence of the female age-productivity profile to its male counterpart as a reflection of these changes.

C. *Other Parameters*

The values for the remaining parameters are chosen in line with Cho (2014). The author reports a GDP projection to 2035 employing what is termed "the production function approach." For the output elasticity of capital, we choose a value of 0.39, which is the capital income share in 2013.[6] We assume that the output elasticity of capital is constant over the simulation period. The time series of the depreciation

[6]The two concepts are interchangeable under the assumption that the firm is under the constant returns to scale Cobb-Douglas production function and that the markets are competitive.

rate is calculated with data pertaining to the aggregate capital stock by the Bank of Korea and the gross real fixed investments of national accounts. The depreciation rate appears to increase from 5.0% to 5.2% during 1990~2014. We project that the value will increase to 5.4% in 2035 and remain constant thereafter.

The historical value of the total factor productivity (TFP) is calculated by the standard growth accounting method. In this paper, the TFP is identified as the Solow residual; thus, different measures of labor and capital input yield different values of the TFP. To maintain consistency with the model economy, we define the labor input as the total number of employees weighted by the age-productivity profiles. For the future values of total factor productivity, we adopted the TFP growth rate from Cho (2014) by 2035 and assume that there is continued growth thereafter at a constant rate of 1.3 percent per annum.[7]

IV. Results

A. *In-Sample Performance of the Model*

Our objectives are to project the future path of macro variables and to analyze the effects of the demographic transition on the growth potential of the Korean economy. Before doing so, we examine the in-sample performance of the model economy in this subsection. We compare the simulated aggregate variables with the relevant historical data, in the case employment, the investment rate, and the real GDP growth rate.

Figure 4 shows the aggregate labor growth rate of the model economy and the employment growth rate from the Economically Active Population Survey.[8] Also shown in the figure is the growth rate of the population aged 21~64 of the model economy. The employment growth rate exhibits a slow downward trend and short-run fluctuations. The trend in the employment growth rate is well- captured by the growth rate of the population aged 21~64 of the model economy. The employment growth rate was 1.6% per annum in the 1990s and 1.2% per annum in 2000s. For the respective periods, the aggregate labor for the model economy grew by 1.5% and 0.8% per annum. The aggregate labor growth rate of the model also displays a pattern similar to that of the employment growth.

Figure 5 presents the investment rate of the model economy together with the gross savings rate and the gross investment rate. The gross saving rate and the gross investment rate have continued to decline from above the 40% range in the early 1990s to slightly above the 30% range in the early 2010s. This secular decline is well replicated by the model economy, which reflects that the slowdown in the TFP growth and the decline in the growth rate of the working-age population have lowered the demand for investment. As the model investment rate shows a pattern

[7]In the growth accounting by Cho (2014), labor input is measured as employment. However, it turns out that the trend in the TFP growth rates is very similar to that of Cho (2014). Therefore, we adopted their assumptions regarding the future TFP growth rate.

[8]A close empirical counterpart of our aggregate labor can be constructed by total working hours weighted by the age-productivity profile. However, the time series of the average working hours can be obtained for the years after 2004, which is much shorter that the in-sample time horizon.

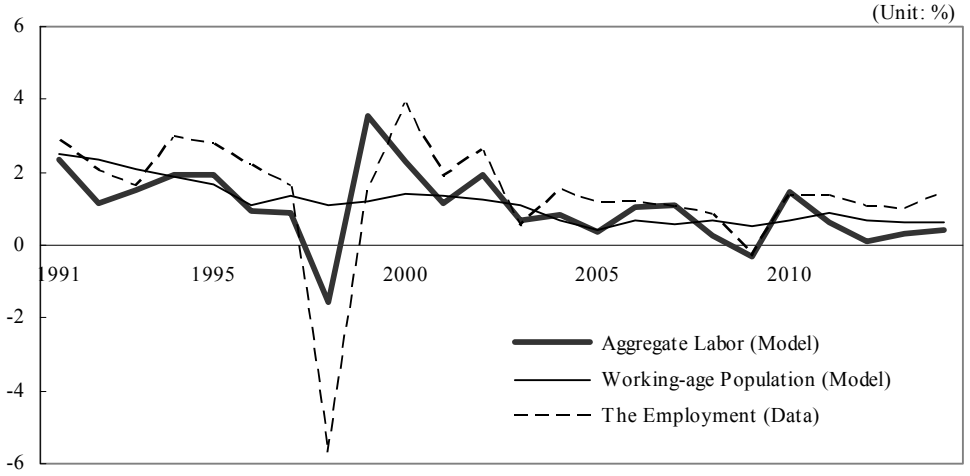

FIGURE 4. GROWTH RATE OF AGGREGATE LABOR

Note: The working-age is between 21 and 64.

Source: Statistics Korea(1993~2014).

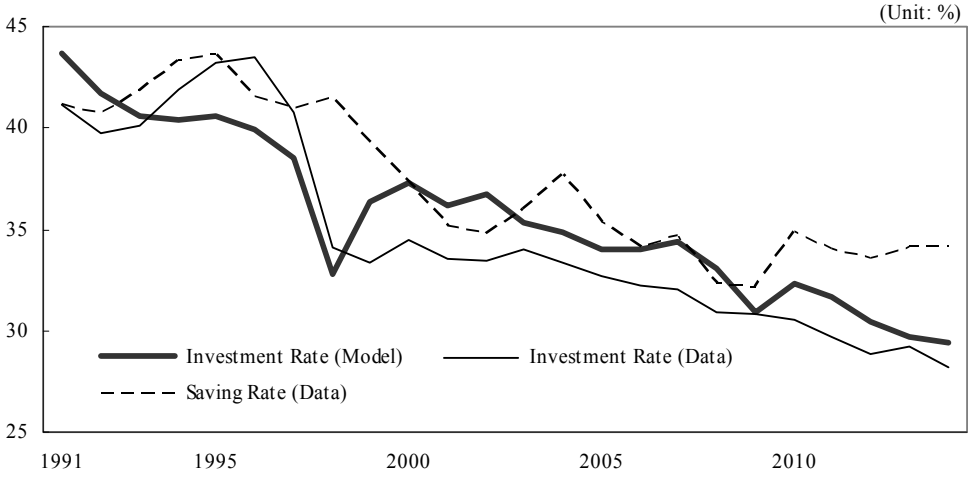

FIGURE 5. INVESTMENT RATE

Note: The investment rate and saving rate are measured as proportions to the real GDP by the author's calculation.

Source: Bank of Korea(1993~2014).

similar to the data, so does the growth rate of capital stock, as presented in Figure 6. However, it was found that the investment boom in the 1990s is not well captured in the model economy. This stems partly from the information assumption that economic agents perfectly foresee the future state of the economy. That is, the investment boom may have been based on optimistic expectations for the Korean economy. However, the economic agents in the model who perfectly forecast the

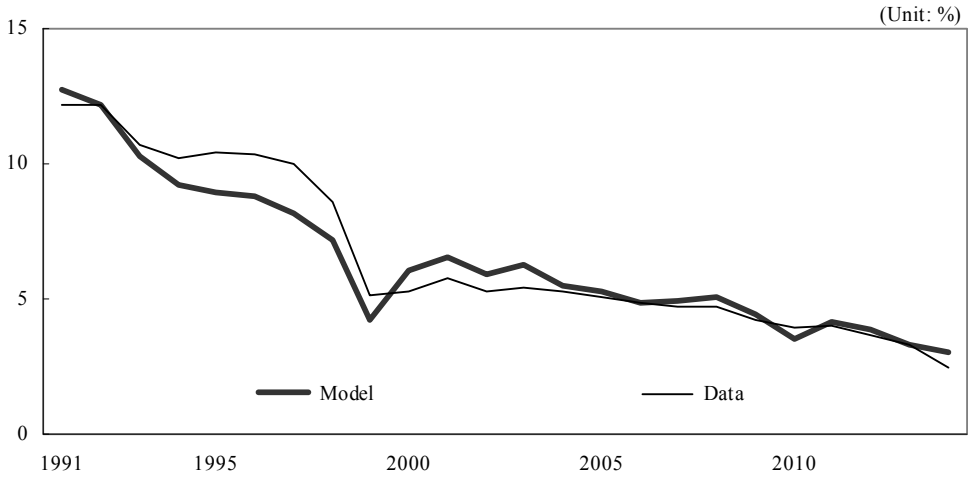

FIGURE 6. GROWTH RATE OF CAPITAL STOCK

Source: Bank of Korea(1993~2014).

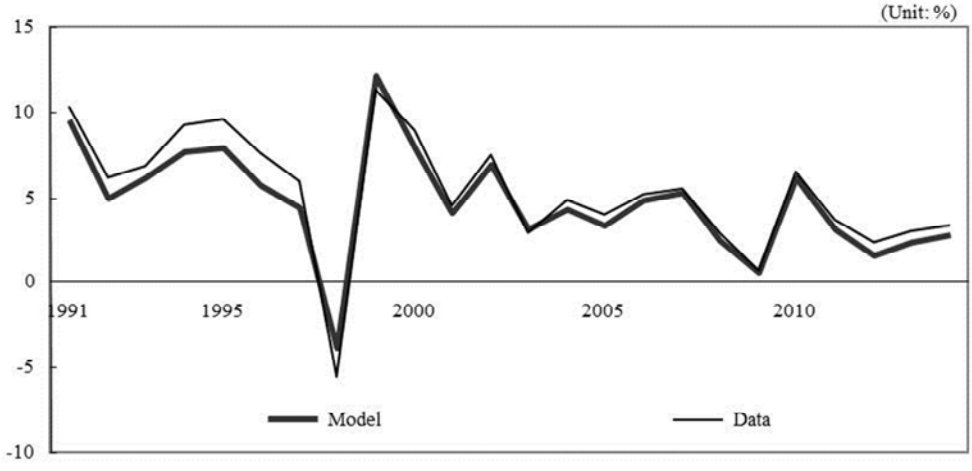

FIGURE 7. GROWTH RATE OF OUTPUT

Source: Bank of Korea(1993~2014).

slowdown of the economy do not invest as much as we see in the data for that period.

Figure 7 shows the output growth rate of the model and the real GDP growth rate. The model economy exhibits not only a declining trend in the GDP growth rate but also similar short-term fluctuations. This occurs because, over the short term, the responses of the endogenous variables of the model to the variation in the TFP are generally in line with the data. Table 1 presents the growth accounting calculations for the model in ten-year periods. The numbers in the parentheses are growth accounting calculations for the Korean economy drawn from Cho (2014).

TABLE 1—GROWTH ACCOUNTING FOR THE MODEL ECONOMY

(UNIT: %, %P)

Period	Output Growth Rate (1+2+3)	Contribution of Labor (1)	Contribution of Capital (2)	Contribution of TFP (3)
1991~2000	6.0(6.7)	0.9(1.0)	3.2(3.9)	1.8(1.9)
2001~2010	4.0(4.3)	0.5(0.7)	2.0(2.0)	1.5(1.6)

Note: The numbers in the parentheses are growth accounting for the Korean economy drawn from Cho (2014).

From approximately 6.7% per annum in the 1990s, the real GDP growth rate has declined to about 4.3% in the 2000s. As is well- known, the contribution of capital accumulation decreased sharply during this period as the TFP growth rate declined and the economically active population growth slowed. Our model economy does not capture the investment boom in the 1990s well. Overall, however, our model economy is considered reasonably successful in replicating the trends in the GDP growth of the Korean economy. Therefore, given the assumptions of a demographic transition and the future path of the TFP, our model economy is expected to yield reasonable responses for macro variables.

B. *Baseline Projection*

We now use the baseline model to project the future path of the Korean economy. Table 2 presents the long-term growth rate projection up to 2060. Also shown in parentheses is the long-term GDP growth projection for the Korean economy drawn from Cho (2014). As expected, the long-term output growth rate is projected to decline steadily. From about 2.6% per annum in the 2010s, it is projected to be about 1.8% per annum in the 2020s and to decline further to 1.1% by the 2050s.

To analyze the factors contributing to this secular decline, we report the results in the form of a growth accounting exercise. The contribution of labor input is projected to turn negative in the 2020s and continue to suppress the output growth rate thereafter. This declining contribution of labor can be mainly attributed to the decrease in the number of those in the economically active population. According to the projection by Statistics Korea, the number of those aged between 21 and 64 will reach peak in the year 2020 and decline thereafter. Moreover, the increase in

TABLE 2—GROWTH ACCOUNTING FOR THE BASELINE PROJECTION

(UNIT: %, %P)

Period	Output Growth Rate (1+2+3)	Contribution of Labor (1)	Contribution of Capital (2)	Contribution of TFP (3)
1991~2000	6.0(6.7)	0.9(1.0)	3.2(3.9)	1.8(1.9)
2001~2010	4.0(4.3)	0.5(0.7)	2.0(2.0)	1.5(1.6)
2011~2020	2.6(3.0)	0.2(0.7)	1.2(1.1)	1.2(1.2)
2021~2030	1.8(2.2)	-0.4(-0.1)	0.8(0.9)	1.4(1.4)
2031~2040	1.2	-0.6	0.5	1.3
2041~2050	1.2	-0.6	0.4	1.3
2051~2060	1.1	-0.7	0.5	1.3

Note: The numbers in parentheses are the GDP growth projection in the form of growth accounting for the Korean economy drawn from Cho (2014).

the proportion of the population over 50, whose labor productivity is declining over the life –cycle, also contributes to the decline in the contribution of labor input. The aging population and the low TFP growth also negatively affect the GDP growth through the capital accumulation channel. The contribution of capital accumulation is projected to decline steadily to 0.5% per annum in the 2050s from 1.2% in the 2010s.

Because our baseline projection indicates that the decrease in aggregate labor puts significant pressure on the output growth, we must further investigate factors affecting the aggregate labor supply. The aggregate labor supply of the model economy consists of the population structure, the age-productivity profile over the life cycle, and the work hours chosen by households:

$$L_t = \sum_{i\in\{M,F\}} \sum_{j=21}^{J^R-1} \epsilon_{ij,t} h_i(j,t) N_{j,t} / 2$$

Thus, the change in aggregate labor can be approximately decomposed into changes in the economically active population (C), changes in the age-productivity profile (A), and changes in work hours (B):

$$\text{(A)} \qquad \frac{L_{t+1}-L_t}{L_t} \approx \left\{ \sum_{i\in\{M,F\}} \sum_{j=21}^{J^R-1} \left(\epsilon_{ij,t+1}-\epsilon_{ij,t}\right) h_i(j,t) N_{j,t} / 2 \right\} / L_t$$

$$\text{(B)} \qquad + \left\{ \sum_{i\in\{M,F\}} \sum_{j=21}^{J^R-1} \epsilon_{ij,t} \left(h_i(j,t+1)-h_i(j,t)\right) N_{j,t} / 2 \right\} / L_t$$

$$\text{(C)} \qquad + \left\{ \sum_{i\in\{M,F\}} \sum_{j=21}^{J^R-1} \epsilon_{ij,t} h_i(j,t) (N_{j,t+1}/2 - N_{j,t}/2) \right\} / L_t$$

Table 3 presents the contribution of these components to the growth in the aggregate labor supply. The decrease in the aggregate labor supply is mainly attributable to changes in the population structure, of which the contribution is reported in column (C) of Table 3. The changes in the population structure will contribute negatively to the aggregate labor supply growth by –1.1~ –1.5% per annum for the coming decades. We are expecting an absolute decrease in the number of those in the economically active population. According to the projections by Statistics Korea, the population aged 15~64 will decrease to about 21 million in 2060 from 37 million in 2016. That is, it will shrink on average 1.2% per annum for the next 45 years. Also accounted for in column (C) of Table 3 is the effect of the increase in the proportion of the population over 50, whose labor productivity declines over the life -cycle.

Changes in the age-productivity profiles represent the second component that influences the changes in the aggregate labor supply. Given that the profile for male workers is time-invariant, the change comes solely from the changes in the profile of female workers. We assumed that the age-productivity profile for female

TABLE 3—GROWTH RATE OF THE AGGREGATE LABOR SUPPLY

(UNIT: %, %P)

Period	Growth Rate of Aggregate Labor (1+2+3)	Contribution of Female Productivity (1)	Contribution of Working Hours (2)	Contribution of Working-age Population (3)
1991~2000	1.5	0.0	-0.2	1.7
2001~2010	0.8	0.2	-0.1	0.8
2011~2020	0.3	0.3	-0.2	0.3
2021~2030	-0.7	0.3	0.1	-1.1
2031~2040	-1.0	0.3	0.1	-1.5
2041~2050	-0.9	0.3	0.1	-1.3
2051~2060	-1.1	0.3	0.1	-1.5

workers is to converge to that of male workers. Thus, this increase in the labor market productivity of female workers contributes to the increase in the aggregate labor supply by 0.3% per annum.

The third component is represented by changes in work hours chosen by households (B). On the one hand, the increase in female labor productivity and the decrease in household size encourage the female labor supply. On the other hand, the increase in the female labor supply reduces the male labor supply due to the income effect. The overall effects are found to be positive, increasing the aggregate labor supply by 0.1% per annum for the next decades.

In addition to the direct effect on the aggregate labor supply, the demographic transition indirectly affects the GDP growth through the capital accumulation channel, as the decrease in the aggregate labor supply lowers the marginal productivity of capital. Because the decline in the TFP growth rate also lowers the marginal productivity of capital, we decompose the demand for capital using the firm's first order condition to determine the relative importance.

The firm's demand for capital is given by the condition

$$\alpha A_t (K_t^d)^{\alpha-1} (L_t^d)^{1-\alpha} = r_t + \delta_t .$$

Rearranging this equation for the demand for capital, we obtain

$$K_t = \left[\frac{r_t + \delta_t}{\alpha A_t} \right]^{\frac{1}{\alpha-1}} L_t = \alpha^{\frac{1}{1-\alpha}} A_t^{\frac{1}{1-\alpha}} \left(r_t + \delta_t \right)^{\frac{1}{\alpha-1}} L_t .$$

Therefore, the growth rate of the capital stock can be expressed approximately follows:

$$\frac{K_t - K_{t-1}}{K_t} \approx \Delta \ln K_t$$

$$= \left(\frac{1}{1-\alpha} \right) \Delta \ln A_t + \left(\frac{1}{\alpha - 1} \right) \Delta \ln (r_t + \delta_t) + \Delta \ln L_t$$

TABLE 4—GROWTH RATE OF CAPITAL STOCK

(UNIT: %, %P)

Period	Growth Rate of Capital Stock (1+2+3)	Contribution of TFP (1)	Contribution of Factor Prices (2)	Contribution of Labor (3)
1991~2000	8.4	3.0	3.9	1.5
2001~2010	5.1	2.5	1.8	0.8
2011~2020	3.1	2.0	0.7	0.3
2021~2030	2.2	2.2	0.7	-0.7
2031~2040	1.3	2.1	0.2	-1.0
2041~2050	1.2	2.1	0.0	-0.9
2051~2060	1.3	2.1	0.3	-1.1

Thus, the change in the aggregate capital is attributed to the changes in TFP growth, changes in the components including the effects of changes in the factor prices, and changes in aggregate labor. Table 4 presents the decomposition of the growth rate of capital stock.

From about 3.1% per annum in the 2010s, the growth rate of capital demand is projected to be nearly 2.2% per annum in the 2020s and to decline further to 1.3% per annum by the 2050s. After 2020, the low growth of capital demand is attributable to the decrease in aggregate labor, because a gradual slowdown in TFP growth is assumed. Therefore, the demographic transition also contributes to the low GDP growth rate through the channel of capital accumulation by about –0.4% per annum in our baseline projection.[9]

In sum, the rapid demographic transition of Korea will place significant pressure on the GDP growth rate in the coming decades. First, the volume of aggregate labor supply is expected to shrink rapidly. Although the model economy includes a channel through which the female labor supply plays a greater role in the aggregate supply by a reasonable magnitude, the baseline projection shows that it is not enough to cancel the negative effects from the decrease in the working-age population, partly because the female population is also rapidly aging. Second, the decrease in the working-age population indirectly affects the GDP growth through the capital accumulation channel, as the decrease in the aggregate labor supply lowers the marginal productivity of capital.

V. Counterfactual Exercises

In the previous section, we examined the endogenous responses of the macro variables to the baseline projection assumptions. In this section, we separately examine the effects of exogenous variations in the decline in fertility, the increased life expectancy rate, and our assumption about the increase in female productivity.

[9]The contribution of capital in Table 2 is calculated as the growth rate of capital stock × the capital share (0.39).

A. *Decline in Fertility and Increased Life Expectancy Rate*

Our baseline projection indicates that Korea's demographic transition is projected to have a significant effect on the Korean economy for a considerable period of time in terms of the GDP growth rate. The demographic transition is progressing in two ways: a decline of the net fertility rate and increased survival probabilities, especially for the elderly population. The first lowers the aggregate labor supply, as does the demand for investment in the long- run. However, the second factor may have a positive effect on the economy with regard to the growth potential. The rise in survival probabilities is equivalent to prolonged life-expectancy such that the incentives to work and save before retirement increase, resulting in an increase in the aggregate labor supply and capital accumulation. In this subsection, we conduct counterfactual simulations to quantify these effects separately.

The first scenario (S1) sets the net fertility rate to zero % in the year 1991 and assumes that it will stay at that level indefinitely. We then calculate the new equilibrium path of this economy with other parameters held constant.[10] Table 5 presents the long-term GDP growth path under S1. Also shown in the parentheses is the baseline projection presented in the previous section. According to Statistics Korea, 686,000 children were born in 1991, but the number decreased to 449,000 in 2010. This declining trend is projected to continue, and 288,000 children are expected to be born in 2060. However, the difference in the number of children born in the 1990s is mostly negligible between the scenarios and noticeable differences in the model simulation appear in the 2020s. The absolute numbers of newborn children for both scenarios are shown in Figure 8.

In terms of the output growth rate, starting from the nearly identical results up to the 2000s, the gap starts to widen, on average, to 1.3%p per annum in the 2050s. The contribution of labor is projected to be 0.9%p higher and that of capital 0.4%p higher in the 2050s. In the model economy, people born in the 2000s, for example,

TABLE 5—GROWTH ACCOUNTING FOR S1

(Unit: %, %p)

Period	Output Growth Rate (1+2+3)	Contribution of Labor (1)	Contribution of Capital (2)	Contribution of TFP (3)
1991~2000	6.0(6.0)	1.0(1.0)	3.2(3.2)	1.8
2001~2010	4.0(4.0)	0.5(0.5)	2.0(2.0)	1.5
2011~2020	2.6(2.6)	0.2(0.2)	1.2(1.2)	1.2
2021~2030	2.2(1.8)	-0.1(-0.4)	1.0(0.8)	1.4
2031~2040	2.1(1.2)	-0.1(-0.6)	0.8(0.5)	1.3
2041~2050	2.4(1.2)	0.0(-0.6)	0.7(0.4)	1.3
2051~2060	2.4(1.1)	0.2(-0.7)	0.9(0.5)	1.3

Note: The numbers in parentheses are for the baseline scenario.

[10]The size of the representative household adjusts endogenously according to the changes in the population structure.

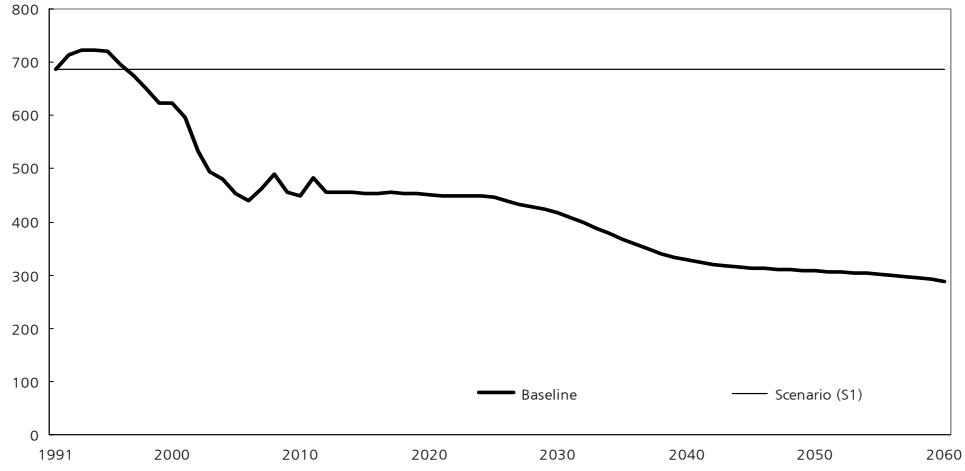

FIGURE 8. NUMBER OF NEWBORN CHILDREN

Source: Statistics Korea(2006).

TABLE 6—GROWTH ACCOUNTING FOR S2

(Unit: %, %p)

Period	Output Growth Rate (1+2+3)	Contribution of Labor (1)	Contribution of Capital (2)	Contribution of TFP (3)
1991~2000	5.9(6.0)	0.9(1.0)	3.2(3.2)	1.8
2001~2010	3.9(4.0)	0.4(0.5)	1.9(2.0)	1.5
2011~2020	2.4(2.6)	0.0(0.2)	1.1(1.2)	1.2
2021~2030	1.6(1.8)	-0.5(-0.4)	0.7(0.8)	1.4
2031~2040	1.0(1.2)	-0.7(-0.6)	0.4(0.5)	1.3
2041~2050	1.1(1.2)	-0.6(-0.6)	0.4(0.4)	1.3
2051~2060	1.1(1.1)	-0.7(-0.7)	0.5(0.5)	1.3

start working in the 2020s and stay in the labor market for 45 years. Therefore, the effect of the very low fertility rate starts to become visible very slowly, but its cumulative effect is astounding. Under S1, as percentage deviations from the baseline simulation in the same year, the aggregate labor supply is 4.8% higher and the level of output is 4.4% higher in 2030. These numbers will continue to increase to 43.8% and 40.1%, respectively, by 2060.

According to Statistics Korea, life expectancy was 71.7 years in 1991 and 80.8 years in 2010. It is projected to reach 88.6 years by 2060. In order to quantify the effects of the increased life expectancy rate, the second scenario (S2) assumes that the survival probabilities do not improve after 1991 such life expectancy is fixed at 71.7 years. Table 6 presents the long-term output growth path under S2. Also shown in the parentheses is the baseline projection presented in the previous section. Compared to the baseline projection, capital accumulation is slower because there is less of a need to save for retirement. A shorter life expectancy rate also encourages households to enjoy more leisure during the working years; thus the aggregate labor growth is relatively slow compared to the baseline simulation. For these reasons, the output growth rate is lower by approximately 0.1~0.2%p per

annum under S2. Under S2, as percentage deviations from the baseline simulation in the same year, the aggregate labor supply is smaller by 5.9% and the level of output lower by 6.2% in 2030. By 2060, the aggregate labor supply will be 7.9% below the baseline value and output 8.2% below the baseline value. Therefore, the effects of the increased life expectancy rate on the GDP growth rate partially offset the negative effects of Korea's low fertility rate, although this is limited.

Despite the fact that it is not specified in our model economy, there are other channels through which the rise in life expectancy affects output growth positively. For instance, the rise in life expectancy is closely related to the improvement in the health status of the elderly population. If the working period over the life cycle increase as people live longer, so does the incentive to acquire human capital in the early period of the life-cycle. The effect of additional human capital accumulation on output growth may be greater if the accumulation of human capital could spill over into the economy. Of course, it is difficult to quantify the growth effect through the human capital channel.

B. *Female Labor Supply*

The discussions thus far indicate that the decrease in the aggregate labor supply due to the persistently low fertility rate will be a major factor behind the low growth potential of the Korean economy in the coming decades. As the size of the labor force shrinks, the female labor supply will increase due to market forces given the scarcity of labor. In addition, because Korea's female labor participation rate is among the lowest all OECD member countries, as shown in Figure 9, there is sufficient room for improvement regarding the female labor supply.

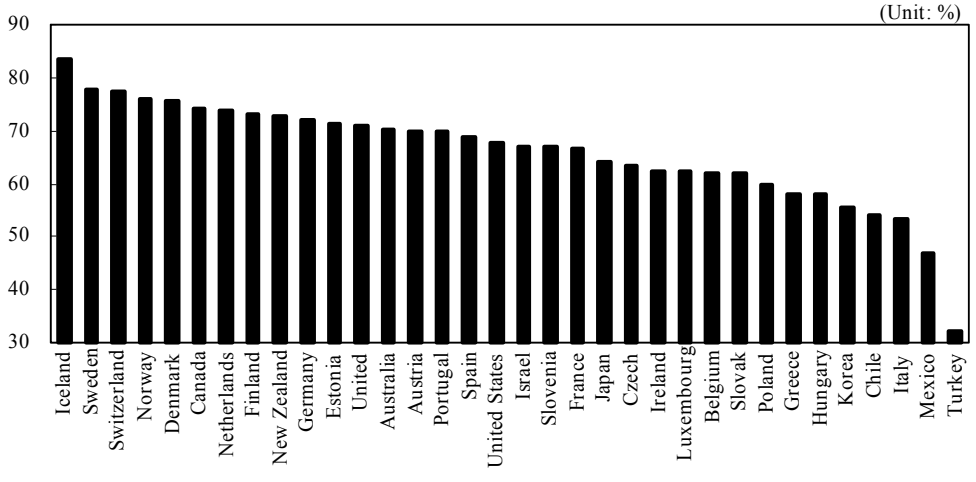

FIGURE 9. FEMALE LABOR MARKET PARTICIPATION RATE

Note: The labor market participation rate for working-age (15-64) females. The values are average values for 2010~2014.

Source: OECD. Stat.

TABLE 7—GROWTH ACCOUNTING FOR S3

(Unit: %, %p)

Period	Output Growth Rate (1+2+3)	Contribution of Labor (1)	Contribution of Capital (2)	Contribution of TFP (3)
1991~2000	6.0(6.0)	0.9(1.0)	3.2(3.2)	1.8
2001~2010	4.0(4.0)	0.5(0.5)	2.0(2.0)	1.5
2011~2020	2.5(2.6)	0.1(0.2)	1.2(1.2)	1.2
2021~2030	1.5(1.8)	-0.6(-0.4)	0.7(0.8)	1.4
2031~2040	0.9(1.2)	-0.8(-0.6)	0.4(0.5)	1.3
2041~2050	0.9(1.2)	-0.8(-0.6)	0.4(0.4)	1.3
2051~2060	0.9(1.1)	-0.8(-0.7)	0.4(0.5)	1.3

Note: The numbers in parentheses are for the baseline scenario.

Although our model does not have an explicit structure in which female workers choose whether to work or not, the baseline projection takes into account that the female labor will play a greater role in the future for with regard to aggregate labor supply. We assume that the age-productivity profile of female workers will increase and converge to that of male workers. In our model economy under the baseline scenario, the proportion of the female labor supply, in terms of the efficiency unit, will increase from 36% in 2013 to 47% in 2060. According to the Economically Active Population Survey, female workers took up approximately 42% of the total employment in 2013. Shin *et al.* (2013) reported that the proportion is projected to increase to 46% in 2060. Although these numbers are not directly comparable to the female labor supply in our model, we consider that our assumption regarding the role of the female labor supply in the future is somewhat optimistic as compared to that in Shin *et al.* (2013).

In order to quantify the consequences of our assumption, we conduct another simulation exercise in which we assume that the female age-productivity profile does not change after 2013. These results are reported in Table 7. Compared to the benchmark economy, the output growth rate is about 0.3%p lower in the upcoming decades because the contributions of labor and capital decrease by 0.2%p and 0.1%p, respectively. Under the alternative scenario, as percentage deviations from the baseline scenario in the same year, the aggregate labor supply is 13.8% smaller and the level of output is 10.8% lower in 2060. Moreover, when convergence in age-productivity is achieved, the output growth effect will vanish. For example, if we assume that female labor productivity increases twice as quickly relative to the baseline scenario, the level of output is only 0.9% greater than the baseline economy in 2060 and the difference converges to zero thereafter. However, output growth is faster during the period in which the female labor productivity increases.

Thus, we have concentrated on analyzing the implications of exogenous projection assumptions by deviating from the baseline scenario by considering the persistent low fertility (S1), improvement in life expectancy (S2), and the increase in female labor productivity (S3) in sequence. In order to gauge the relative importance of these assumptions for the baseline simulation in the long run and to view the results from a somewhat different angle, we conduct additional exercises.

We begin with a counterfactual exercise in which the growth rate of the new born population remains at zero percent after 1991, the survival probabilities do not improve after 1991, and the female age-productivity does not change after 2013.

TABLE 8—THE EFFECTS OF PROJECTION ASSUMPTIONS ON THE MACROECONOMIC VARIABLES

(Unit: %)

	M2	M3(S3)	M4(Baseline)
Output	-30.7	-24.9	-15.6
Capital	-28.1	-21.7	-16.3
Labor	-32.3	-26.9	-15.2

Note: All variables are reported as percentage deviations from M1 in the year 2060.
M1: No change
M2: No change + Low Fertility
M3: No change + Low Fertility + Life-expectancy
M4: No change + Low Fertility + Life-expectancy + Female Productivity

We refer to this set of model assumptions to as scenario M1. Starting with M1, scenario M2 replaces the zero new born population growth assumption with the baseline fertility assumption. To construct scenario M3, we add the longer life expectancy assumption to M2. Note that M2 coincides with S3. Lastly, scenario M4 is determined by adding the increase in the female labor productivity assumption to M3, which results in a set of assumptions identical to that of our baseline projection scenario. These results are reported in Table 8, in which all values are reported as percentage deviations from M1 in 2060.

This sequence of exercises shows that the macroeconomic effects of Korea's demographic transition are highly significant. Regarding output growth, the decrease in the working age population due to low fertility will pose a serious problem; as percentage deviations from M1 in 2060, the aggregate labor supply, capital stock, and output level are lower by 32.8%, 28.1% and 30.7%, respectively in 2060 under M2. Despite the fact that a longer life expectancy rate encourages economic agents to work and save more, the magnitude of the effect is limited; as percentage deviations from M1 in 2060, the aggregate labor supply, capital stock, and output level are correspondingly 26.9%, 21.7% and 24.9% lower in 2060 under M2. In addition, the increase in the female labor supply may partially offset the negative effects of the demographic transition; under M3, the aggregate labor supply, capital stock, and output level are likewise 15.2%, 16.3% and 15.6% lower than M1.

VI. Summary and Conclusion

The demographic change in Korea is expected to be rapid and drastic, at least for the next few decades. In this paper, we build an overlapping generation general equilibrium model to analyze the effects of the demographic changes on the GDP growth potential up to 2060. Under the assumption that the slowdown in the TFP growth rate will be only moderate in the future, remaining at 1.3% per annum, the growth rate of the Korean economy is projected to slow to 1.1% per annum in 2050s from 4.0% in 2000s. The shrinking workforce due to the decline in the fertility rate will play a significant role in the slowdown of the Korean economy. Moreover, although the increased life expectancy rate is expected to mitigate the negative effect, the magnitude of its effect turns out to be limited.

Our model is reasonably successful in reproducing the historical path of major

macro variables, but there are also limitations. First, the government sector is not specified. In future research, the model economy could be extended to investigate the implications of aging in Korea on the public pension system and fiscal policies. Second, we are silent on the determinants of the future growth of TFP. We simply assume that it is exogenous and will grow at a predetermined rate. However, its contribution to output growth is becoming more important. To analyze the effects of the demographic transition on output growth fully, we must investigate the validity of this exogeneity assumption. This is not an easy task, but it is of importance especially for Korea, which is aging at an unprecedented speed.

APPENDIX

If a household of age j in period t exits from the economy, it leaves its assets, $(1+r_t)a'(j-1,t-1)$, as an unintended bequest. We assume that the assets are distributed to its adult children's generation. If it has no adult children, it is distributed to all living households equally.

Let $s_{i,j,t}$ be the proportion of age-i adult children to all of the children born to the household of age j in period t. Then, we obtain $s_{i,j,t}$ by

$$s_{i,j,t} = m_{j-19+i,t-19+i} \Big/ \sum_{i=21}^{j-20} m_{j-19+i,t-19+i} \quad \text{if} \quad j-20 \geq 21$$

Let $s_{i,j,t}$ denote the amount of assets that a household of age i in period t receives from a household of age j in period t. Then,

$$bs_{i,j,t} = s_{i,j,t}\left(1+r_t\right)a'\left(j-1,t-1\right) \quad \text{if} \quad j-20 \geq 21$$

Therefore, the amount of assets the household of age j inherits in period t from its parent generation is

$$b_{i,t} = \sum_{j=20+i}^{J} bs_{i,j,t}\psi_{j-1,t-1}N_{j-1,t-1} / 2 + \sum_{j=22}^{40}\left(1+r_t\right)a'\left(j-1,t-1\right)\psi_{j-1,t-1}\left(N_{j-1,t-1}/2\right) \Big/ \sum_{k=21}^{J}\left(N_{k,t}/2\right)$$

where the second term donates the amount of assets distributed equally to all living households.

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How to Promote E-Commerce Exports to China: An Empirical Analysis†

By MIN JUNG KIM*

This paper focuses on the recent extraordinary growth of Chinese cross-border online shopping and draws implications for firm strategies and government policies in Korea to utilize the phenomenon as an opportunity to expand into a broader market via e-commerce exports. I conduct a survey of Chinese cross-border online consumers to identify constraining and determining factors during the stages of their purchase decisions of Korean products. Given the fact that Chinese cross-border online shopping is at the incipient stage and consumers have expressed a strong intent to repurchase, future strategies should focus on attracting new consumers. Accordingly, Korean firms should build a powerful brand image, improve product quality and post-purchase services, and take full advantage of the popularity of the Korean Wave. Meanwhile, the government must step up policy efforts by, for instance, improving e-commerce export statistics, simplifying logistics and clearance procedures, and building trust in Chinese consumers.

Key Word: E-commerce export, Cross-border online shopping, Corporate strategy, Purchase decision making
JEL Code: L1, L81, M3

I. Introduction

China's e-commerce has recently witnessed extensive growth, reaching 12.3 trillion yuan (2,103 trillion won) in gross merchandise value (GMV)[1] in 2014, owing to the nation's economic growth and internet dispersion. With China's

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[1]Gross merchandise value (GMV) is a term used in e-commerce to indicate a total sales value for goods sold through a particular e-commerce platform.

internet penetration rate hovering at around the 50% mark[2] and given the government's eagerness to promote e-commerce further, as expressed in the "Internet Plus" strategy, there is still sufficient room for additional growth. A particularly notable trend is that Chinese consumers are rushing to online retailers across the border. Cross-border e-commerce is booming around the globe, but the growth of China's cross-border online shopping has been exceptionally fast and is forecast to reach approximately 400 trillion won in 2018, according to the China E-Commerce Research Center.

Chinese consumers' enthusiasm for cross-border online shopping offers Korean manufacturers and e-commerce platforms increasingly more opportunities to engage in e-commerce exports, which will stretch the limitations of Korea's narrow domestic market. China accounts for 40% of Korea's e-commerce exports and provides numerous advantages, such as inexpensive logistics costs due to the close geographic proximity, duty-free benefits given the Korea-China FTA, and an amplification of the Korean Wave effect.

Hence, the time has come to seek out measures to use this opportunity more effectively, but sufficient data are not available with regard to Korea's e-commerce exports to China, limiting research in this area. This study thus conducts a survey of Chinese cross-border online shoppers' experiences of purchasing Korean products and presents implications pertaining to the corporate strategies of domestic manufacturers and e-commerce platforms and to government policies to boost e-commerce exports. The survey aims to enhance the understanding of the nation's consumers and, based on the analysis of consumer experiences, find problems related to each e-commerce export method and their solutions. Concretely speaking, I identify constraining and determining factors in the stages of decision making by Chinese consumers to purchase Korean products, i.e., interest, initial purchase, and repurchase, and compare Chinese platforms and Korean platforms. As a result, the strengths and weaknesses of Korean products and those of each platform are derived in views of (new) customer conversion and (existing) consumer retention, respectively.

First, Chinese cross-border online shopping is still in its infancy, and close to 99% of consumers with online shopping experience of Korean products have expressed their intent to repurchase, suggesting that emphasis should be placed on attracting new consumers (i.e., customer conversion) when establishing e-commerce export strategies. The analysis results show that quality factors are more important than price factors when Chinese consumers shop for Korean products online. Therefore, it is advised that Korean manufacturers should firstly establish a brand image that ensures that their products are both of a high quality level and authentic in order to draw interest and drive initial purchases and secondly make better use of word-of-mouth and reputation marketing so that their brands will be well regarded by Chinese consumers. In addition, given that the Korean Wave has been demonstrated to influence repurchases as well as initial purchase decisions, I suggest linking businesses with Korean contents in order to utilize the trend fully.

This paper also finds that Korean e-commerce platforms should make improvements in the areas of brand establishment, promotion, language, and

[2]According to CNNIC (2015), China's internet penetration rate rose from 10.5% in 2006 to 47.9% in 2014.

payment systems to expand e-commerce exports. Specifically, having the past experience of visiting or staying in Korea has been found to play an essential role in choosing Korean e-commerce platforms; therefore, efforts are needed to raise the reputation of Korean platforms among Chinese tourists during their visits to Korea.

With regard to an e-commerce export policy, I recommend that the government provide statistics on Korea's e-commerce exports through Chinese platforms, which will enable a precise assessment of the current status as well as more research and analysis. Moreover, simplifying the logistics and customs procedures will be of great help to Korean manufacturers in their efforts to offer competitive products to Chinese consumers. Lastly, because customer trust is critical in cross-border e-commerce, more policies must be devised to protect Chinese consumers as well as Korean export businesses.

The remainder of the paper is organized as follows. Section II describes the current state of China's e-commerce, especially cross-border online shopping, and Korea's e-commerce exports. Section III provides an overview of the related literature. The empirical analysis results of the survey on Chinese consumers' experiences of purchasing Korean products online are discussed in Section IV. Section V concludes the paper.

II. Industry Background

A. *China's E-Commerce*

One striking feature of the rise of China's e-commerce is the rapid growth of the online shopping market.[3] As shown in Figure 1, China's online shopping amounted to 2.8 trillion yuan (481 trillion won) in 2014 and overtook the US to stand at the top starting in 2013. Despite recording a mere 7% of the e-commerce market in 2009, China's online shopping is expected to reach 30% in 2018 and lead the growth of the entire industry. Before 2010, online shopping transactions were mostly C2C (consumer to consumer).[4] However, as the market matured, consumers grew more particular about the quality of the purchased goods, which led to the expansion of B2C (business to consumer). Accordingly, the proportion of B2C in online shopping is estimated to surpass 50% in 2015 and continue to rise afterwards, becoming a key growth engine (iResearch, 2015. 7. 27).

With the increase in B2C, China's cross-border online shopping[5] has increased so remarkably that a new word, 'Haitao,' was coined to describe Chinese cross-border online shoppers. The growth of cross-border online shopping is now

[3]E-Commerce is largely categorized into B2B (business to business) and online shopping; the latter refers to transactions between individual consumers and product or service sellers. Depending on whether the seller is a company or an individual, this type of online shopping is categorized as B2C (business to consumer) or C2C (consumer to consumer).

[4]According to iResearch (Oct. 22, 2013), B2C and C2C accounted for 7.8% and 92.2% of all online shopping transactions in 2009, respectively.

[5]Cross-border online shopping describes domestic consumers' direct purchases of foreign products via online platforms. This can be seen as a type of B2C, with the consumer as the buyer and a foreign company as the seller.

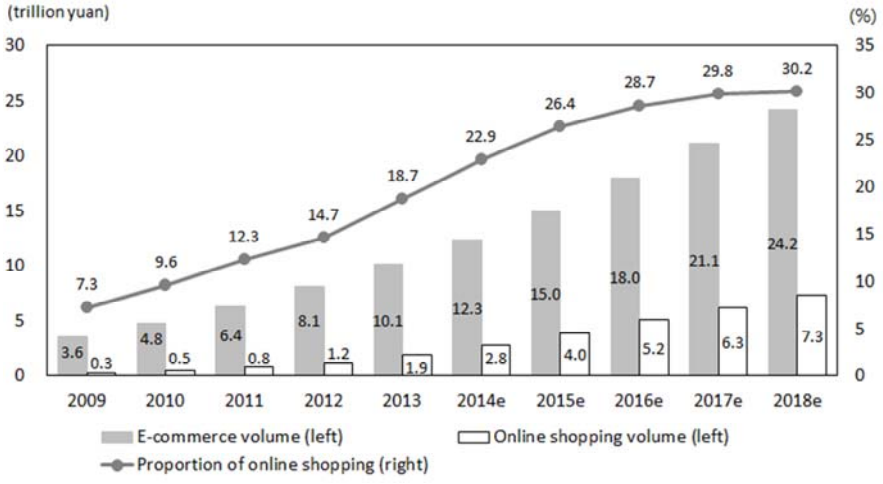

FIGURE 1. TRENDS IN CHINA'S E-COMMERCE AND ONLINE SHOPPING

Note: E-commerce and online shopping volumes are measured in terms of their gross merchandise value (GMV). Data for 2014-2018 are estimates.

Source: Data until 2010 are from iResearch (Oct. 22, 2013), and data after 2011 are from iResearch (Mar. 9, 2015).

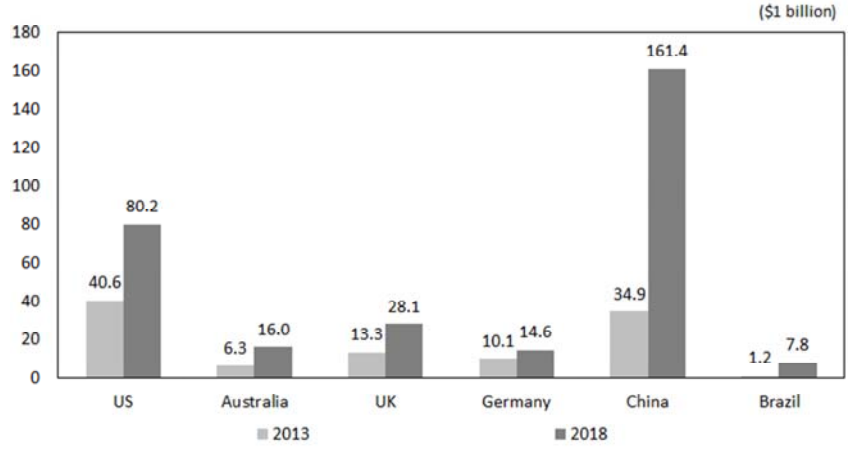

FIGURE 2. CROSS-BORDER ONLINE SHOPPING BY COUNTRY: CONSUMPTION ESTIMATES

Note: Calculated by multiplying the original amount in local currency by the respective exchange rate against the dollar (2013 annual average).

Source: PayPal (2013).

a global trend, but in China it has grown rapidly compared to that in other countries (Figure 2). As of 2013, US cross-border online shopping tops the list in terms of consumption size, followed closely by China. However, their positions are

TABLE 1— POPULAR CROSS-BORDER ONLINE SHOPPING DESTINATIONS OF HAITAO SHOPPERS

Country	Proportion (%)
US	84
Hong Kong	58
Japan	52
UK	43
Australia	39
Korea	37

Note: Proportion of Haitao shoppers who ever purchased online directly from each country.

Source: PayPal (2013).

highly likely to switch in the coming five years with China considerably outpacing the US at present.[6] Table 1 lists countries favored by Haitao shoppers arranged in the order of 'most frequently purchased'; Korea ranks sixth, meaning that 37% of Haitao consumers have purchased Korean products online.

B. *Korea's E-Commerce Exports*

Korea's e-commerce exports have expanded by more than 20-fold since 2010 to reach $44.6 million in 2014, and this figure is expected to triple for 2015 (Figure 3). It remains low compared to the size of e-commerce imports, which stood at $1,544.9 million in 2014. However, statistics compiled by the Korea Customs Service on e-commerce exports do not provide an understanding of the current situation, as exporters are not obliged to report exports of items valued below two million won. Given that most e-commerce exports are small B2C transactions, more than 90% of e-commerce export goods are omitted from these statistics.[7] In actual fact, Korean online retailers exported 582.0 billion won worth of goods in 2014,[8] ten times more than the records released by the Korea Customs Service, according to the Ministry of Trade, Industry and Energy and the Korea Online Shopping Association.

Table 2 shows that China is Korea's largest e-commerce export market, accounting for 42.2% of all e-commerce exports. China's portion in Korea's e-commerce exports is even more impressive for clothing (94.7%) and beauty and fashion items (nearly 70%), which are top export consumer goods. This means that China is a vital component in Korea's e-commerce exports, and its importance is likely to increase in the coming years.

Korean manufacturers hoping to export online to Chinese consumers can use either a Chinese e-commerce platform or a Korean one. A Chinese platform has certain merits, such as high traffic flows from existing users, a friendly platform

[6]The China E-Commerce Research Center presented the optimistic projection that Chinese cross-border online shopping will reach 418 trillion won in 2018.

[7]Meanwhile, e-commerce imports of low-priced products are also subject to a simplified clearance procedure, but they are not left out of the statistics.

[8]This is the result of a survey of major online retailers (eBay Korea, Lotte.com, 11ST) and two web-hosting companies (Cafe24, Makeshop). If the coverage broadens, the actual size is expected to be larger.

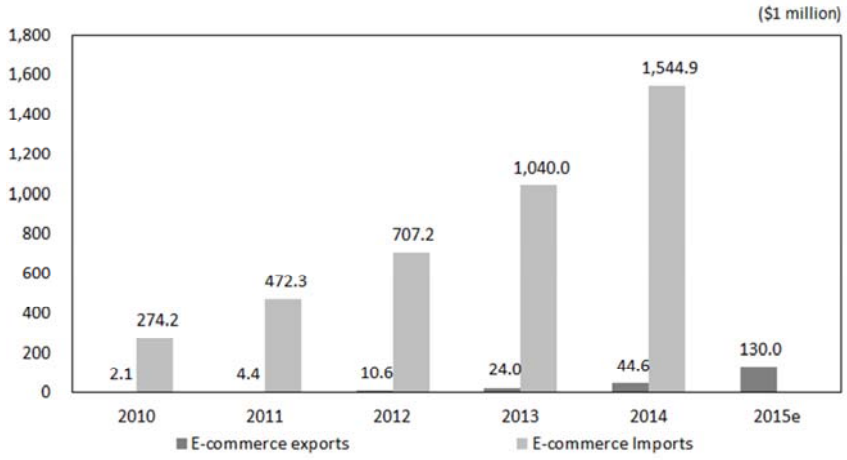

FIGURE 3. TRENDS IN KOREA'S E-COMMERCE EXPORTS AND IMPORTS

Note: Data for e-commerce exports in 2015 are estimates.

Source: E-commerce exports data from Korea Customs Service's press release (Oct. 29, 2015), E-commerce imports data from Korea Customs Service's press release (Jul. 13, 2015)

TABLE 2— KOREA'S E-COMMERCE EXPORTS: TOP PRODUCTS AND PARTNER COUNTRIES

Product	E-commerce exports (million dollar)	Top markets	
		Country	Proportion (%)
Total	108.3	China	42.2
		Singapore	21.1
		US	17.2
Clothing	29.1	China	94.7
Beauty items	11.5	China	73.1
Fashion items	6.5	China	68.9

Note: 1) As of Sep. 2014 - Aug. 2015. 2) Proportion of each country in Korea's total e-commerce exports (amount) of each product.

Source: Press release, Korea Customs Service (Oct. 29, 2015).

design customized to Chinese consumers, and secured consumer trust. However, there are also flaws, such as limited opportunities for brand exposure due to competition from other countries and difficulties in communication with Chinese platform representatives due to the language barrier. Therefore, using a Korean platform could be more beneficial to Korean manufacturers in terms of marketing and cost-saving.

A deep understanding and comparison of approaches towards e-commerce exports is fundamental to Korean companies who wish to take full advantage of China's e-commerce boom. To such an end, precise statistical data on e-commerce exports must initially be compiled; the clearance data of the Korea Customs Service is inadequate if used to identify actual e-commerce exports. In recognition

of this, Statistics Korea started to release statistics on reverse direct purchases[9] in late 2015 based on corporate surveys of major domestic online retailers. However, given the possibility that most e-commerce exports are being driven by Chinese platforms, there are limitations due to the lack of information on e-commerce exports via Chinese platforms.

III. Literature Review

There is a dearth of research on how Korea should avail itself of the development of Chinese e-commerce, though there are a few studies. First, Kim *et al.* (2013) illustrated the current status and patterns of the overseas expansion of businesses in the Chinese Internet industry, including e-commerce, and studied how Korea should respond and cooperate with China. They observed the pattern by which major Internet firms in China emerged under the protective environment offered by the Chinese government given the vast size of the domestic market and then expanded overseas to spur more growth afterwards. It was noted that strategic alliances have been used to obtain content (referred to as a "technology-seeking" or "content-seeking" expansion pattern) in Korea, while Chinese capital enjoys a jump in size through large-scale M&As of local businesses (referred to as an "asset-seeking" or a "market seeking" expansion pattern) in other countries. The paper concluded that Chinese e-commerce companies do not have a great enough incentive to operate in Korea due to its limited market size and that they are instead looking to acquire more quality goods from Korea.

I concur with the view that it is important to consider the incentives of Chinese e-commerce firms to attain Korean products. This paper provides strategic suggestions for businesses and policy implications, focusing on the trend of the expansion of Chinese cross-border online shopping, to turn the phenomenon into a valuable opportunity for e-commerce exports. E-commerce exports have exhibited modest numbers, and locating reliable statistics can be difficult. Hence, not many studies have been conducted on e-commerce export strategies, and all existing works employed survey methods.

Chang (2015) conducted a survey of consumers in the United States, Japan, China, Indonesia, and Vietnam to look into purchase determinants in relation to online shopping and customer satisfaction with regard to Korean products. According to Chang, overseas consumers were most likely to buy online cosmetic goods and clothing from among available Korean products, and factors such as quality, payment security, and seller trustworthiness were found to be most important in all five countries. Each country demonstrated certain preferential differences: consumers in the Unites States and Japan chose price as the key factor, while product authenticity was considered important in China, whereas convenience of the return process was considered important in Indonesia and Vietnam. Chang adopted an ordered probit model with the dependent variable as an indicator as to whether a customer would buy more Korean products in the future

[9]Reverse direct purchase describes overseas consumers shopping on Korean websites to purchase Korean products, meaning e-commerce exports through Korean platforms.

(decrease, status quo, increase) and with the independent variables as various levels of satisfactions with price, product, supplementary service, and online service of Korean products. The results showed that instead of price, product characteristics such as quality, design, brand image and online service characteristics such as authenticity, descriptions written in the local language, payment security, and purchase reviews played a more integral role in driving sales.

This paper is also relevant to the research stream on cross-border e-commerce or cross-border online shopping. Most researchers in these areas also utilized surveys due to the lack of official records on cross-border trades via online shopping. Gomez-Herrera *et al.* (2013; 2014) constructed data using a survey on domestic and cross-border B2C online shopping in 27 European Union countries to compare online and offline transactions. They found that the traditional gravity model holds explanatory power even in online cross-border trades and that the transaction costs of online trades related to geographic distance have drastically decreased compared to the case of offline trades. In contrast, transaction costs incurred by the language barrier during online trades have increased compared to the offline channel, and system requirements such as online payment and delivery capabilities now play critical roles.

Baybars and Tanyeri (2011) categorized the deterrents in cross-border online shopping as those related to security and trust, language, cross-border payments, cross-border logistics, and regulation and administrative systems. Based on the TAM (Technology Acceptance Model), they used a survey to test their hypotheses that the perceived problems related to cross-border online shopping will affect attitudes, attitudes will affect the intent to purchase, and the intent to purchase will affect actual purchase decisions. They showed via a t-test that a consumer group with experience in cross-border online shopping has a better perception compared to a group without experience in all of the categories above except for regulation and administrative systems. Baybars and Tanyeri interpreted this difference in the two groups as resulting from the experience of cross-border online shopping, but it appears that they made the mistake of neglecting possible reverse causality.

In addition, IPC (2010) used a survey in the US and seven European countries, and PayPal (2013) used a survey in six major countries, including the US, the UK, and China, to expound the current status and prospects of cross-border online shopping. IPC (2010) interestingly found that cross-border online shopping consumers have more experience and purchase more frequently online compared to domestic online shopping consumers. Moreover, related to delivery, clearly indicating delivery fees on the product page, giving notifications about when products are shipped, and providing various shipping and return options were shown to be important. According to PayPal (2013), the most critical reason that consumers avoid cross-border online shopping is a concern about identity theft and fraud, i.e., trust issues. Therefore, most consumers seek buyer protection systems in overseas purchases; specifically, consumers in China and Brazil were reported to be more sensitive to these issues.

This study also adopted a survey method to overcome the lack of proper data, studying Chinese consumers with cross-border online shopping experience by examining purchase factors and satisfaction levels with regard to Korean products in an effort to enhance our understanding of Chinese consumers, who may differ

from Koreans. However, this study sets itself apart from prior studies in two aspects. First, it identifies decision-making stages, such as the interest, initial purchase and repurchase stages, and systematically explores encouraging and discouraging factors. Second, by analyzing Chinese consumers' shopping experiences, it provides strategy implications for e-commerce platforms as well as merchandisers in Korea who aspire to export their goods online.

Finally, the body of marketing and information systems literature on e-commerce includes much research about the influential factors of individual propensity, trust, purchase (intent), customer satisfaction, repurchase (intent), and loyalty and the relationships among them. For example, Kim *et al.* (2009) proved the two sets of hypotheses that connect trust, perceived risk and benefit, intent to purchase, and real purchases as well as pre-purchase expectations, satisfaction, and intent to repurchase. Kuan *et al.* (2008) compared the effects of the website quality on the initial intent to purchase and subsequent intent to purchase, concluding that one must focus on system quality (e.g., website design quality) for customer conversion and service quality for customer retention. Moreover, Shankar *et al.* (2003) proved that loyalty and satisfaction are positively related and that the association is reinforced more in online environments than offline. Posselt and Gerstner (2005) uncovered that post-purchase service has a stronger impact on repurchase intent than pre-purchase service.

The survey design adopted here is related to this line of discussions. I also structure the stages of purchase decision making and examine which factors affect each stage. This paper contributes to the literature by applying the research method to the new environment of cross-border online shopping and identifying influential factors that are unique to the online purchases of foreign products.

IV. Empirical Analysis

A. *Survey Design*

This study analyzed the results of a survey conducted on Chinese cross-border online shoppers about their experiences purchasing Korean products. The survey was conducted online with Chinese panels through Macromill Embrain, one of the largest online research providers, during the period of October 8-20, 2015. A total of 3,000 respondents with cross-border online shopping experience were surveyed (1,000 per group for three types). These were Type A, consisting of those who have never purchased Korean products online; Type B, who have purchased Korean products only via Chinese platforms; and Type C, who have purchased Korean products via Korean platforms.[10] Table 3 summarizes the demographics of the survey respondents.

[10]Comparing purchasing experiences via Chinese and Korean platforms may produce more reasonable results if the survey is conducted on Chinese consumers with the experience of either of the two platforms. However, cases involving the use of only Korean platforms are expected to be rare, suggesting difficulties when attempting to conduct such a survey. Thus, anyone with Korean-platform-use experience was classified as Type C and was asked questions about their purchasing experiences via Korean platforms.

TABLE 3—DEMOGRAPHIC PROFILE OF THE SURVEY SAMPLE

Variable	Category	Proportion (%)	Variable	Category	Proportion (%)
Gender	Male	30.0	Marital status	Single	31.2
	Female	70.0		Married	68.6
Age	20-29	56.0		Other	0.2
	30-39	37.0	Experience of visiting Korea	Yes	59.3
	40-49	7.0		No	40.7
Number of children	0	37.7	Experience of staying in Korea	Yes	25.4
	1	54.5		No	74.6
	2	6.3	Education	High school	5.7
	3	1.0		Undergraduate	5.6
	4	0.4		College degree	80.6
	5 and more	0.1		Graduate degree	8.1
Monthly household income (RMB)	Under 2,000	1.2	Occupation	Undergraduate/ Graduate student	6.7
	2,000-4,000	5.0		Office worker	37.9
	4,000-6,000	9.6		Sales/Promotion/ Service	6.6
	6,000-8,000	8.2		Freelancer	7.2
	8,000-10,000	16.0		Production worker	3.6
	10,000-12,500	14.9		Manager	27.8
	12,500-15,000	13.9		Business owner	2.9
	15,000-17,500	10.5		Housewife	1.1
	17,500-20,000	7.4		Government officer	4.7
	20,000 and over	13.3		Unemployed/Other	1.5

Note: 1) This sample includes all 3,000 survey respondents. 2) Experiences of visiting Korea were limited to the last five years.

According to the quota sampling survey[11] of each type, Type B (Chinese platform user) respondents filled the quota (1,000) first. At the same instance, the number of Type C (Korean platform user) respondents totaled 886, implying that Chinese consumers are more likely to only use Chinese platforms when purchasing Koreans products online rather than using Korean platforms. Moreover, among Type C respondents, 88.7% reported that they also use Chinese platforms. Together, it can be assumed that Chinese consumers' online shopping for Korean products is substantially driven by Chinese platforms.

B. *Corporate Strategy to Induce an Initial Purchase*

This subsection directly looks into the reasons why respondents chose not to buy (Type A) and to buy (Type B and C) Korean products online and establishes a model of the determinants of their purchase decision-making process. In doing so,

[11]Unlike random sampling, in quota sampling, respondents are selected according to certain conditions. In this study, Types A, B and C each had a quota of 1,000 respondents, and the survey remained open only until answers are received from 1,000 respondents. As a result, once the type fills the quota and the survey of that specific type closes, there is no means of determining its distribution state in the population, representing a limitation of this sampling method. In recognition of this, I added extra data on responses of other types when one type reached its quota, meaning that I traced the number of respondents in each type during the same survey period such that the distribution state of each type can be assumed to some degree.

a corporate strategy can be developed that draws Chinese consumers' interest and induces the initial purchase of a Korean product.

1. Reasons for Purchases and Non-purchases

Table 4 and Table 5 present the results of the survey of Chinese consumers who have never purchased Korean products online (Type A). Among the Type A respondents, those who have visited a shopping website to buy Korean products – Type A2: interest but no purchase - (86.4%), and those who have never visited a shopping website – Type A1: no interest - (13.6%), are likely to have different reasons with regard to why they did not buy and their future purchase intentions; hence, their answers are given separately in each table. First, 57.4% of those showing "no interest" (Table 4) and 98.5% of those showing "interest but no purchase" (Table 5) answered positively when asked whether they would buy if certain obstacles were removed, highlighting the different possibilities of an expansion of e-commerce exports to new Chinese consumers.

However, regardless of an interest in the online purchase of Korean products, the improvements needed to capture new Chinese consumers do not differ greatly in the two cases. When asked about why they did not have interest in (Type A1) or did not buy (Type A2) Korean products online, nearly half of the respondents reported that they had no knowledge of Korean brands (47.8% in Table 4 and 45.1% in Table 5), implying that a lack of awareness of Korean brands is the largest obstacle to the initial purchase. Other major obstacles preventing the initial online purchase of Korean products include a lack of trust in authenticity (32.4% in Table 4) and concerns over post-purchase services, i.e., exchanges, refunds and after-sales service (henceforth AS) (25.7% in Table 4 and 33.2% in Table 5).

Meanwhile, brand preference, superior quality, and product authenticity are the reasons why Chinese consumers purchased Korean products online among the Type B and Type C respondents (Table 6). Table 7 reports the results from the question about the importance of influential factors when purchasing products

TABLE 4—REASONS FOR NOT HAVING CONSIDERED PURCHASING KOREAN PRODUCTS ONLINE IN THE CASE OF "NO INTEREST"

Answers	Proportion (%)
	No interest (Type A1)
Lack of knowledge of Korean brands	47.8
Lack of trust concerning the authenticity of Korean products	32.4
Poor image of Korea	26.5
Concerns about exchange, refunds, and AS	25.7
Lack of trust concerning the quality of Korean products	16.2
Will purchase later	57.4

Note: 1) Multiple-choice questions (max. three choices) were used; hence, the total may not equal 100. 2) There were more selectable answers in the survey, but the above table lists the five answers with the highest number of responses.

TABLE 5—REASONS FOR NOT HAVING PURCHASED KOREAN PRODUCTS ONLINE IN THE CASE OF "INTEREST BUT NO PURCHASE"

Answers	Proportion (%)
	Interest but no purchase (Type A2)
Lack of knowledge of Korean brands	45.1
Concerns about exchanges, refunds, and AS	33.2
Insufficient or inaccurate information about products	28.8
High shipping costs	27.8
High product price	23.0
Will purchase later	98.5

Note: 1) Multiple-choice questions (max. three choices) were used; hence, the total may not equal 100. 2) There were more selectable answers in the survey, but the above table lists the five answers with the highest number of responses.

TABLE 6— REASONS FOR PURCHASING KOREAN PRODUCTS ONLINE

Answers	Proportion (%)	
	Chinese platform user (Type B)	Korean platform user (Type C)
Preference for Korean brands	42.0	51.2
Superior quality of Korean products	35.7	39.5
Authenticity of products	34.9	37.7
Less expensive than similar Chinese products	22.1	27.9
Lack of product availability in China	27.7	25.6

Note: 1) Multiple-choice questions (max. three choices) were used; hence, the total may not equal 100. 2) There were more selectable answers in the survey, but the above table lists the five answers with the highest number of responses.

TABLE 7— DIFFERENCES IN THE IMPORTANCE OF FACTORS INFLUENCING ONLINE PURCHASES

Influencing factors	No purchase (Type A)	Chinese platform user (Type B)	Korean platform user (Type C)
Product quality	4.657	4.735	4.604
Authenticity	4.613	4.723	4.571
Post-purchase services	4.224	4.270	4.208
Platform awareness and credibility	4.155	4.173	4.157
User reviews & comments	4.148	4.137	4.118
Product brand	4.071	4.126	4.194
Platform convenience	4.003	3.987	4.023
Product price	3.961	3.906	3.935
Product design	3.827	3.732	3.949
Product variety	3.790	3.699	3.900
Sales rank	3.542	3.579	3.764
Advertisement	3.141	3.116	3.474

Note: 1) The importance of influential factors was measured using a Likert scale (1 for not important at all - 5 for very important). 2) There were more influential factors included in the survey, but the above table lists only those with an average importance value of four or more or those used in the estimation in Table 8.

online,[12] and respondents, regardless of consumer type – i.e., regardless of the online purchase experience of Korean products or the platform type used, reported that product quality, authenticity and post-purchase services were the most important factors, in line with the results given in Tables 4-6. Moreover, Chinese consumers place a high value on user reviews and brands regarding products and awareness, credibility and convenience regarding platforms.

2. Model Analysis of the Determinants of the Decision to Purchase

Here, the model is analyzed with regard to the determinants of online purchase decisions by Chinese consumers of Korean products and the platform choice based on the survey results. Table 8 reports the estimated results from the multinomial logit model used here to examine how demographic characteristics and online purchase-influencing factors affect the decision to purchase. The dependent variable is a categorical variable that is either 'not purchasing Korean products online (but purchasing other foreign products online)', 'purchasing Korean products via Chinese platforms' and 'purchasing Korean products via Korean platforms', and the base outcome is set to be 'not purchasing Korean products online.'

First, Model (1) in Table 8 indicates the estimation using the variables pertaining to the importance of purchasing factors only, excluding demographic variables. The results show that the more price-sensitive Chinese consumers are, the less likely they are to purchase Korean products online (note that the coefficients for product price on both Chinese and Korean platforms are significantly negative), while the more they care about sales rank, the more likely they are to purchase Korean products online (see that the coefficients for sales rank on both Chinese and Korean platforms are significantly positive). Moreover, as authenticity is considered as more important, they are more likely to choose Chinese platforms and less likely to choose Korean platforms. Furthermore, the probability of using Korean platforms increases when the brand and advertisements are seen as more important and when user reviews and comments are seen as less important.

The results reported in Table 8 can show in which areas each platform is relatively strong to induce initial purchases from Chinese consumers, at least indirectly.[13] If Korean platforms have a positive (resp. negative) coefficient of the importance of a specific purchasing factor, it can be said that the platform has strength (resp. weakness) for that factor.[14] According to this interpretation, Korean products are not competitive in the eyes of Chinese consumers in terms of product price because the estimation results show that price-sensitive consumers are less

[12]Measured using a Likert scale (1 for not important at all - 5 for very important). Refer to Kim (2015) for further details.

[13]Ideally, it would be easier to interpret the results if I an economic analysis was conducted using variables for platform characteristics and the average characteristics of products and consumers on each platform as independent variables. However, due to limitations in the current data, it was not feasible to conduct such an analysis.

[14]This is due to the selection effect. In an extreme case where a consumer values only one certain purchasing factor, if he has chosen a product among many options, the selected product should then be superior to the others for that purchasing factor. The same interpretation can be applied to more general cases in which consumers consider multiple purchasing factors simultaneously.

TABLE 8— ESTIMATION RESULTS OF ONLINE PURCHASE DECISIONS FOR KOREAN PRODUCTS

Choice	Variables	Model (1)			Model (2)			Model (3)		
		Estimate	S.E.		Estimate	S.E.		Estimate	S.E.	
Chinese platform	(Demographics)									
	Dummy for being married				-0.046	0.116		-0.043	0.115	
	Number of preschool children				-0.172	0.090	*	-0.183	0.090	**
	Education				-0.185	0.078	**	-0.190	0.078	**
	Income				-0.021	0.021		-0.025	0.021	
	Dummy for visiting Korea				-0.003	0.110		0.167	0.107	
	Dummy for offline purchase				0.987	0.117	***			
	Korean video viewing frequency				0.135	0.025	***	0.177	0.024	***
	Dummy for staying in Korea				-0.170	0.135		-0.114	0.135	
	(Importance of purchasing factors)									
	Product price	-0.129	0.064	**	-0.069	0.067		-0.097	0.066	
	Brand	0.063	0.071		0.018	0.076		0.030	0.074	
	Authenticity	0.405	0.091	***	0.352	0.096	***	0.381	0.094	***
	Product Design	-0.193	0.069	***	-0.211	0.072	***	-0.202	0.071	***
	User reviews & comments	-0.081	0.072		-0.112	0.074		-0.078	0.073	
	Sales rank	0.115	0.065	*	0.122	0.068	*	0.106	0.067	
	Advertisement	0.040	0.062		0.026	0.066		0.025	0.065	
	Product variety	-0.166	0.063	***	-0.198	0.067	***	-0.186	0.065	***
	(Constant)	-0.489	0.474		-0.862	0.549		-0.718	0.538	
Korean platform	(Demographics)									
	Dummy for being married				-0.092	0.126		-0.084	0.124	
	Number of preschool children				0.028	0.091		0.025	0.091	
	Education				-0.141	0.085	*	-0.145	0.085	*
	Income				0.018	0.023		0.015	0.023	
	Dummy for visiting Korea				1.287	0.130	***	1.521	0.127	***
	Dummy for offline purchase				1.435	0.156	***			
	Korean video viewing frequency				0.129	0.029	***	0.177	0.028	***
	Dummy for staying in Korea				0.441	0.124	***	0.517	0.122	***
	(Importance of purchasing factors)									
	Product price	-0.116	0.067	*	0.017	0.073		-0.017	0.072	
	Brand	0.193	0.076	**	0.080	0.085		0.094	0.082	
	Authenticity	-0.148	0.082	*	-0.121	0.091		-0.100	0.087	
	Product Design	0.063	0.072		-0.095	0.079		-0.075	0.078	
	User reviews & comments	-0.267	0.074	***	-0.227	0.084	***	-0.181	0.081	**
	Sales rank	0.229	0.068	***	0.190	0.074	***	0.175	0.073	**
	Advertisement	0.408	0.067	***	0.291	0.074	***	0.290	0.071	***
	Product variety	-0.026	0.067		-0.122	0.074	*	-0.116	0.072	
	(Constant)	-0.886	0.452	**	-2.501	0.574	***	-2.077	0.549	***

Note: 1) The sample includes all 3,000 survey respondents (1,000 with no experience of buying Korean products online, 1,000 Chinese platform users, and 1,000 Korean platform users). 2) Results of the multinomial logit model with the base outcome set to 'not purchasing Korean products online'. 3) ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

likely to purchase Korean products online. Likewise, it can be interpreted that Korean platforms are strong in acquiring products of brands well known to Chinese consumers but weak in user reviews and comments. Specifically, these results present the possibility that Chinese consumers may trust (and choose) Chinese platforms more than Korean platforms in terms of their ability to provide authentic goods.

Models (2) and (3) include demographic variables in addition to purchasing factors. Model (2) includes a dummy variable for offline purchases, i.e., whether the respondents have bought Korean goods offline in China, and the estimated coefficient is statistically significant and positive. However, because its causality is not clear and thus endogeneity may be present, Model (3) was finally selected. According to the results, the frequency of watching Korean videos was positively correlated with the probability of choosing each platform. The marginal effects, calculated using the estimated results, can be interpreted to mean that a nearly twofold increase in frequency equals a 4%p increase in the likelihood of buying Korean products online (a 2%p increase in purchase probability via the Chinese and Korean platforms, respectively).[15] Of course, the tendency to watch Korean videos is not completely free from endogeneity issues, but this implies that the Korean Wave may actually be influential with regard to the online purchase of Korean products.

In addition, the decision as to whether to use Korean platforms to buy Korean products is positively and significantly correlated with the user's experience of visiting or staying in Korea. Likewise, the calculated marginal effect shows that when users have been to Korea, they are 27%p (visit) and 11%p (stay) more likely to buy Korean products via Korean platforms. This implies that Korean platforms should focus their marketing efforts on Chinese tourists during their visits to Korea. Among the variables pertaining to the importance of purchasing factors, product price and brand lose significance after controlling for demographic characteristics. When put together, to attract new Chinese consumers, Korean platforms should overcome the identified weaknesses of Chinese language support for user reviews and comments and verification system for product authenticity.

C. *Corporate Strategy to Promote Repurchases*

While the above subsection deals with corporate strategy from the perspective of attracting new consumers (customer conversion), this subsection explores the retention of existing consumers (customer retention). I compare Chinese consumers' satisfaction levels with the buying of Korean products via Chinese and Korean platforms and then conduct a model analysis of the influence of the satisfaction level on their intent to repurchase.

[15]Strictly speaking, it is the marginal effect of a one-unit increase in the variable for the frequency of viewing a Korean video. This variable is a categorical variable defined by '1=Never watched,' '2=Less than once a year,'…, '9=Once every 2-3 days' and '10=More than once a day.' A one-unit increase in this variable is equivalent to an increase of 1.7-2.8 times in the actual viewing frequency.

1. Satisfaction and Repurchase Intention

Table 9 compares how satisfied Chinese consumers were after having used either a Chinese or a Korean platform to purchase Korean products. Chinese platform users (Type B) showed the highest level of satisfaction in the order of payment convenience, product quality, platform convenience, the speed and safety of delivery, and product variety, while Korean platform users (Type C) showed the highest level of satisfaction in the order of product quality, product variety, payment convenience, product design, accuracy and sufficiency of product information. When the two platform types are compared, Chinese platforms exhibited a higher satisfaction level in the areas of payment and platform convenience, while Korean platforms exhibited a higher satisfaction level for the product characteristics of price, quality, and design and for the platform characteristics of accuracy/sufficiency of information and product variety. Korean platforms also showed a higher overall level of satisfaction.

Next, Figure 4 presents the results of a survey of Chinese consumers who have

TABLE 9— DIFFERENCES IN SATISFACTION LEVELS BY ITEM

Variables	Chinese platform user (Type B)	Korean platform user (Type C)
Overall	4.102	4.197
Payment convenience	4.213	4.068
Product quality	4.081	4.249
Platform convenience	4.071	4.015
Speed and safety of delivery	4.042	4.028
Product variety	4.022	4.088
Accuracy and sufficiency of product information	3.948	4.050
Product price	3.850	4.007
Product design	3.821	4.051

Note: 1) Measured using a Likert scale (1 for very unsatisfied - 5 for very satisfied). 2) There were more items included in the survey, but the above table lists only those with a satisfaction level of 4 or over.

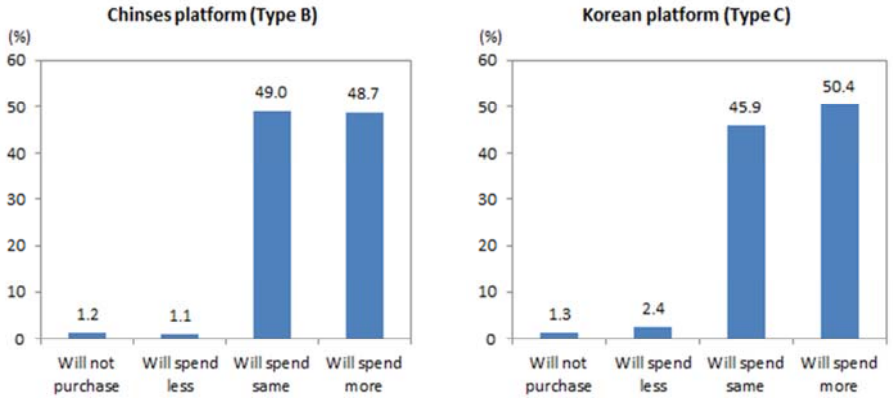

FIGURE 4. INTENT TO REPURCHASE AND INCREASE SPENDING

purchased Korean products online when asked about repurchase intentions. Surprisingly, nearly 99% answered positively regardless of which platform they used, and most intended to maintain or increase their amounts of purchases.

2. Model Analysis of the Determinants of Repurchase Intention

Preceding studies (see, e.g., Kim *et al.*, 2009) have found that satisfaction with previous purchase experiences significantly affects intent to repurchase in e-commerce. As such, this study conducts a model analysis to determine if satisfaction affects intent to repurchase for Chinese consumers' online purchases of Korean products as well and of the factors that determine the overall satisfaction level in an effort to suggest effective corporate strategies on how to retain existing consumers. The estimation results of how the satisfaction level with online purchases of Korean products influences repurchase intentions are reported in Table 10. The dependent variable is a ordinal variable that has a value of 1 to 4, as follows: 1=Will not repurchase, 2=Will spend less, 3=Will spend the same amount, and 4=Will spend more, and ordered logit models are run separately for Chinese platform users (Type B) and Korean platform users (Type C).

First, Model (1) in Table 10 presents the estimation results for intended future purchases using all satisfaction levels by item as well as the overall level, analyzed separately for Chinese and Korean platform users. The overall level of satisfaction has a significantly positive influence on future expected spending on both platforms. On the other hand, satisfaction levels for each item do not have a significant effect, except for platform convenience on Chinese platforms, and product quality, accuracy/sufficiency of product information, and payment convenience on Korean platforms. The overall satisfaction level should be determined as a result of aggregating each item score such that detailed satisfaction levels by item do not appear to provide additional information in explaining repurchase intent once the overall satisfaction level is included in the model.

Hence, Models (2) and (3) in Table 10 do not include item-specific variables, only including the overall score along with the demographic variables. Demographic variables were added to the model for expected future spending because the evaluation criteria for satisfaction may differ according to demographics, and these variables may represent differences in the purchased products to some degree. Model (2) presents the results when using all demographic characteristics except for the offline purchase dummy (excluded due to the endogeneity issue, as in Table 8), and the frequency of viewing Korean contents is estimated to be the only significant predictor on both platforms among variables for experiences related to Korea. Intuitively, consumers' experiences of visiting or staying in Korea may affect their initial purchases of Korean products, but their repurchases may be affected more by previous buying experiences or their continued viewing of Korean videos.

Model (3) was finally selected, which only includes the frequency of viewing Korean contents. The analysis results show that overall satisfaction with previous purchases still has a positive influence on consumers' intentions to spend more on future purchases, proving the hypothesis, as in prior studies. It was also found that frequent viewers of Korean videos are more willing to repurchase or spend more,

TABLE 10— ESTIMATION RESULTS OF EXPECTED SPENDING ON KOREAN PRODUCTS IN FUTURE ONLINE PURCHASES

Market	Variables	Model (1)		
		Estimate	S.E.	
Chinese platform	(Satisfaction level by item)			
	Overall	0.487	0.166	***
	Product price	-0.005	0.126	
	Delivery cost	0.027	0.114	
	Speed and safety of delivery	-0.050	0.115	
	Product quality	0.032	0.137	
	Product design	0.051	0.113	
	Accuracy and sufficiency of product information	-0.100	0.117	
	Product variety	0.162	0.109	
	Payment convenience	0.017	0.118	
	Customs procedure	-0.153	0.103	
	Platform convenience	0.242	0.122	**
	Additional service	0.106	0.103	
	Post-purchase services	0.101	0.107	
	Cutoff 1	-0.775	0.766	-
	Cutoff 2	-0.109	0.744	-
	Cutoff 3	3.777	0.722	-
Korean platform	(Satisfaction level by item)			
	Overall	0.254	0.128	**
	Product price	-0.013	0.117	
	Delivery cost	-0.082	0.104	
	Speed and safety of delivery	0.115	0.107	
	Product quality	0.271	0.118	**
	Product design	0.060	0.111	
	Accuracy and sufficiency of product information	0.181	0.110	*
	Chinese language support	-0.060	0.111	
	Product variety	0.066	0.119	
	Payment convenience	-0.195	0.101	*
	Customs procedure	0.149	0.123	
	Platform convenience	0.058	0.104	
	Additional service	0.100	0.114	
	Post-purchase services	0.143	0.094	
	Cutoff 1	-0.111	0.722	-
	Cutoff 2	0.970	0.630	-
	Cutoff 3	4.358	0.635	-

Note: 1) The estimation was conducted separately for the 1,000 Chinese platform users (Type B) and the 1,000 Korean platform users (Type C). 2) Results of the ordered logit model 3) ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

leading to the conclusion that the Korean Wave may have a positive impact on repurchases as well as initial purchases. According to the estimates, when consumers approximately double their viewing frequency of Korean videos, the probabilities of repurchasing and spending more increase by 0.4%p and 7%p respectively, for each platform. Again, these findings are not completely free from the endogeneity problem.

This leads to the question of what affects Chinese consumers' overall satisfaction

TABLE 10 (*CONTINUED*)

Market	Variables	Model (2)			Model (3)		
		Estimate	S.E.		Estimate	S.E.	
Chinese platform	(Demographics)						
	Dummy for being married	0.265	0.166		0.282	0.165	*
	Number of preschool children	-0.002	0.141		0.013	0.139	
	Education	-0.028	0.101		-0.006	0.101	
	Income	0.004	0.030		0.025	0.028	
	Dummy for visiting Korea	0.350	0.153	**			
	Korean video viewing frequency	0.311	0.042	***	0.325	0.041	***
	Dummy for staying in Korea	0.072	0.198				
	(Satisfaction level)						
	Overall	0.572	0.143	***	0.602	0.141	***
	Cutoff 1	0.264	0.783	-	0.534	0.771	-
	Cutoff 2	0.943	0.760	-	1.214	0.746	-
	Cutoff 3	5.051	0.754	-	5.309	0.744	-
Korean platform	(Demographics)						
	Dummy for being married	0.646	0.165	***	0.639	0.164	***
	Number of preschool children	-0.119	0.118		-0.129	0.118	
	Education	0.169	0.120		0.165	0.121	
	Income	0.103	0.031	***	0.101	0.031	***
	Dummy for visiting Korea	-0.121	0.217				
	Korean video viewing frequency	0.334	0.045	***	0.324	0.045	***
	Dummy for staying in Korea	-0.187	0.138				
	(Satisfaction level)						
	Overall	0.375	0.104	***	0.375	0.104	***
	Cutoff 1	0.962	0.684	-	1.051	0.678	-
	Cutoff 2	2.063	0.621	-	2.152	0.615	-
	Cutoff 3	5.600	0.640	-	5.681	0.636	-

Note: 1) The estimation was conducted separately for the 1,000 Chinese platform users (Type B) and the 1,000 Korean platform users (Type C). 2) Results of the ordered logit model. 3) ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

TABLE 11— ANALYSIS OF CHINESE CONSUMERS' OVERALL SATISFACTION LEVELS WITH ONLINE PURCHASE OF KOREAN PRODUCTS

Variables	Chinese platform (Type B)			Korean platform (Type C)		
	Estimate	S.E.		Estimate	S.E.	
Product quality	0.213	0.026	***	0.127	0.029	***
Product price	0.160	0.025	***	0.111	0.028	***
Accuracy and sufficiency of product information	0.064	0.025	**	0.088	0.028	***
Post-purchase services	0.048	0.022	**	0.036	0.029	
Speed and safety of delivery	0.045	0.024	*	0.027	0.027	
Payment convenience	0.043	0.024	*	0.056	0.030	*
Product design	0.040	0.025		0.049	0.028	*
Delivery cost	0.039	0.023	*	0.057	0.026	**
Platform convenience	0.027	0.025		0.061	0.030	**
Customs procedure	0.026	0.022		0.085	0.026	***

Note: 1) Results of a normal regression analysis of overall satisfaction on its sub-variables are presented. Separate estimations for Chinese platform users (Type B) and Korean platform users (Type C) were made. 2) ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

TABLE 11 (*CONTINUED*)

Variables	Chinese platform (Type B)		Korean platform (Type C)		
	Estimate	S.E.	Estimate	S.E.	
Additional service	0.002	0.021	0.005	0.028	
Product variety	-0.011	0.023	0.078	0.028	***
Chinese language support	-	-	0.053	0.025	**
Adjusted R^2	0.308		0.354		

Note: 1) Results of a normal regression analysis of overall satisfaction on its sub-variables are presented. Separate estimations for Chinese platform users (Type B) and Korean platform users (Type C) were made. 2) ***, ** and * denote significance levels of 1%, 5% and 10%, respectively.

most significantly when purchasing Korean products online. Table 11 presents the results from a normal regression analysis of overall satisfaction on its sub-variables (detailed satisfaction levels by item), separately for Chinese and Korean platform users. In both platforms, the answers were product quality and price, fundamental factors of any product. Other than these two factors, information accuracy and sufficiency was also significant, suggesting that sufficient information on products should be made available to Chinese consumers.

V. Concluding Remarks

A. *Summary of Discussions*

Overall, it appears that product quality plays a more significant role than price with regard to Chinese consumers' decision-making on an initial online purchase of Korean products, revealing that to attract more new Chinese consumers, Korean manufacturers should focus on building and marketing a powerful brand image which ensures product quality and authenticity, even if price competitiveness is slightly weakened. Moreover, a system that can guarantee post-purchase services in collaboration with platforms must be established while also taking full advantage of the Korean Wave. Additionally, Korean platforms should focus their marketing efforts on guaranteeing that they are fully embedded in the minds of Chinese tourists visiting Korea.

Product quality and the Korean Wave must also be emphasized, not only to attract more Chinese consumers but also to maintain existing consumers. In addition, product price and information provision, although not as important as product quality, can affect the overall satisfaction level of Chinese consumers; hence, they must not be overlooked.

Generally, e-commerce growth occurs by initially being driven by the expansion of consumers, followed by an increase in purchase frequency and volume levels. Given the fact that Chinese cross-border online shopping is in its infancy, customer conversion should be prioritized over consumer retention. Moreover, 99% of Chinese consumers who purchased Korean products online expressed their intent to repurchase, meaning that once they buy a Korean product, they are very likely to buy again. This also serves to highlight the importance of approaching new consumers.

B. *Policy Suggestions*

Although the Korean government has devised various support policies, establishing appropriate statistics on e-commerce exports is of the greatest urgency. The data released by Statistics Korea on e-commerce exports provide information only on e-commerce exports conducted via Korean platforms. This study finds that at present, e-commerce exports via Chinese platforms are considerable and as such, correlating statistics takes precedence. Improvements are possible through collaborations with China Customs to reduce cases of e-commerce export records being excluded from official statistics and providing exporters certain incentives to report simplified export declarations.

Reform of the settlement system[16] has laid the foundation for Chinese consumers to gain better access to Korean platforms; therefore, support should be given to manufacturers in the form of simplified logistics and clearance systems so that they can present competitive products to Chinese consumers. With reference to logistics, where an economy of scale is prevalent, it would be meaningful to consider establishing additional joint logistics centers in China to encourage SME e-commerce exports. Other efforts include the formation of an automated processing system that transfers transaction records to the Korea Customs Service's export reporting system to ease the manufacturing exporters' burden of administrative procedural costs, which could also contribute to improving e-commerce export statistics surveys and their efficiency. Furthermore, consistent efforts must be made to exempt tariffs and import reporting on Korean e-commerce products entering Chinese customs for clearance.

Various policies are currently in place to protect Korean exporters' overseas IPR and to resolve relevant disputes. However, these policies are mostly centered on the protection of Korean companies. As such, there is a need to reflect the perspectives of Chinese consumers, as consumer trust is a vital component in cross-border online shopping as well as in general e-commerce transactions. Moreover, as product authenticity and post-purchase services guarantee are critical in decision-making processes of Chinese consumers' decision-making processes, the possibility of developing a government-level system and assessing its effectiveness should be explored. Lastly, it is important to build a consensus with China on consumer issues arising from the growth in cross-border online shopping.

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[16]This is inclusive of the abolition of the mandatory use of authorized certificates for online purchases using credit cards (May 2014), the mitigation of several user identification regulations and the adoption of easy payment services (Dec. 2014), and launch of a non-ActiveX online payment service (Apr. 2015).

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Revisiting Social Discount Rates for Public Investment†

By JOONHYUK SONG*

This paper aims to estimate the social discount rate (SDR) rather than dig into its theoretical foundation. As SDRs can be derived by investigating both the rate of return on investment and the social time preference rate, we estimate the marginal productivity of both private and public capital and the time preference rate based on the Euler equation. In order to provide a single representative SDR, the weighted averages of the marginal productivity and time preference rate, whose weights are determined by the flow of funds data reflecting the social demand of funds, are presented. Based on the empirical results, we argue that the marginal productivity of private capital stands in the middle of the 3% range while that of public capital varies from 4.5% to 8.6%, with the time preference rate showing a decreasing trend from 3.2% in the early 2000s to 1.2% by around 2030. The single representative SDR or the weighted SDR is estimated to be approximately 3.0~4.5% and expected to continue its downward trend for the foreseeable future.

Key Word: Social Discount Rate, Opportunity Cost of Capital, Rate of Time Preference
JEL Code: H5, H8

I. Introduction

Social overhead capital (SOC) is not only an important production factor for economic growth but also a public good that provides public services which have the potential to increase social welfare. A lack of social overhead capital can lead to the deterioration of national competitiveness due to the increase in logistics costs, while an excessive supply of social overhead capital can lead to distortions in how resources are allocated, lower efficiency of public investments, and increased levels of national debt. Therefore, deciding how much to invest, how to allocate

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the determined investment resources to which businesses, and maximizing the efficiency of the investment are key issues. The discount rate in social overhead capital supply decisions, also referred to as the social discount rate (SDR), is related to the economic feasibility analysis of the public investment project. It is the most important parameter when calculating the benefit-cost ratio. Nevertheless, there is no practical agreement on the rationale and method of analysis with regard to setting the SDR and analysis period such that they can be applied to the economic feasibility analysis of public investment projects.

Owing to the nature of these types of investment projects, the costs are concentrated in the initial stage of the project, whereas the benefits are realized gradually throughout the analysis period after the project costs are paid beforehand. Therefore, if the SDR exceeds an appropriate level, a project can be mistaken as economically unjustifiable via a cost-benefit analysis despite the fact that it may be in fact economically feasible, thus resulting in social underinvestment. In contrast, if the SDR is lower than an appropriate level, the project is approved even if it is not economically feasible, which leads to a waste of resources due to the excessive social investment. In particular, this problem is more severe in public projects, which must consider congestion costs due to road construction and environmental gains from the construction of parks and similar projects compared to private projects, which only consider the opportunity cost of capital through cash inflows and outflows.

In most feasibility studies in Korea, the SDR of the Preliminary Feasibility Study by the Korea Development Institute (KDI) is used. KDI has gradually adjusted the SDR to reflect the characteristics of the project and to account for changes in economic conditions (Korea Development Institute, 2008). When the first survey was introduced in 1999, the real SDR of 7.5% was applied to all types of projects, except for a water resource development project,[1] and this was lowered to 6.5% in 2004.[2] Since 2008, a SDR of 5.5% has been applied to reflect changes in the capital market due to low interest rates and low growth.[3] However, as the population growth rate is declining due to low fertility and given that population aging is becoming more obvious, it is expected that the growth potential of the economy will be lowered as the accumulation of physical capital decelerates due to the low interest rates and saving rates. As shown in Figure 1, the SDR used by KDI has been consistently higher than the Korea Treasury Bond (KTB) interest rate since 2000, and it can be confirmed that the interest gap between the KTB and the SDR is widening. Considering this situation, it is necessary to examine whether the current SDR is appropriate.

As the nature of public projects reflects the investment and economic conditions of the time, it is desirable for the SDR also to change over time. However, in practice, using different SDRs every year will lead to significant confusion considering that the profitability of the same project will change from year to year.

[1]For water sector projects, a social discount rate of 6.0% has been applied, considering that these projects should be considered as lasting longer than other sector projects.

[2]For water sector projects, a social discount rate of 6.5% was applied for the first 30 years of operation, after which 5.0% was applied for the following 20 years.

[3]For water sector projects, a social discount rate of 5.5% was applied for the first 30 years of operation, after which 4.5% was applied for the following 20 years.

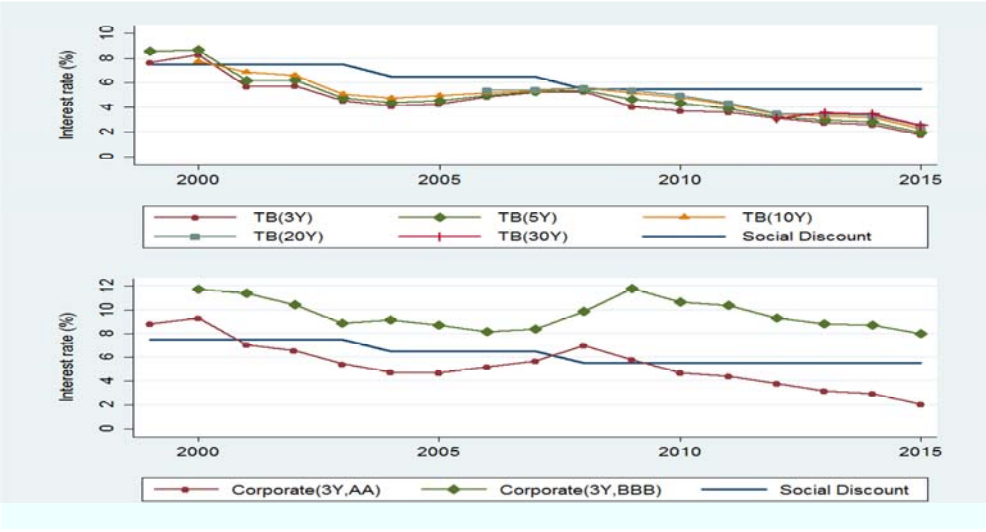

FIGURE 1. KDI SDR AND MARKET RATES

Note: Social Discount indicates KDI SDR.

Source: Bank of Korea ECOS.

However, if the economic conditions or the investment environment change over time, an adjustment of the SDR will be inevitable. This paper focuses on estimating the SDR by reflecting policies and practical demand levels rather than the theoretical aspects of the SDR. In addition to monetary benefits and costs, there are no clear criteria regarding how to set social opportunity costs in economic analyses of public projects to which non-monetary benefits and costs must be added4. The SDR varies depending on the economic conditions and the assumptions of the model; hence, care is necessary when interpreting these estimates and their real-life implications. Although different models may result in different SDRs, we argue that the comparison between different social investment projects should be made with the same model to measure the economic effectiveness and to rank the order of the social desirability of the candidate projects.

In this paper, we propose three methods to estimate the SDR: (1) the rate of return on investment, (2) the rate of time preference, and (3) the weighted average of rate of returns and time preference. In principle, if the source of public investment comes from a reduction in consumption, the time preference rate should then be used, whereas if it comes from a reduction in investment, it is reasonable to use the return on investment for the SDR. However, in actuality it is challenging to discern the funding sources of public investments. For this reason, it is inevitable to conjecture that the source of public investment comes partly from a decrease in consumption and partly from a decrease in investment. Under this assumption, one

[4]According to Baumol (1968), the opportunity cost of public investment introduces the question of whose sacrifice is necessary for the investment resources to be financed under the constraints of available resources. For public investments, where the funds used for the project come from a reduction in private consumption, consumers' time preferences should be used for the social discount rate, and the pre-tax return on the investment should be used as the social discount rate when the funds used are from private investment.

needs to devise the weighted average of the rate of return from private investment and rate of time preference, whose weights should be determined by the relative amounts of funds between consumption and investment.

This paper is organized as follows. Chapter II explains the key parameters in the evaluation of public investment projects and Chapter III introduces the empirical models used to estimate the SDR. Section IV presents the data and discusses the results from the empirical analysis. Finally, Section V summarizes the discussion and provides conclusions.

II. SDR: Overview

The discount rate is a factor used to convert the future benefits and costs to the value of a specific reference date to determine whether to conduct business or to prioritize an investment. There are various discount factors depending on the purpose of use and the subject of application. Although the primary goal of this paper is to estimate the working values of the SDR, there will be limitations when attempting to interpret the results of the empirical analyses without a clear understanding of the theoretical background of the SDR. The following is a brief description to provide a conceptual understanding of the SDR, as well as the difference between the private discount rate and the SDR.

A. *Measurement of the SDR*

The SDR discussed in this paper is the discount rate applied to public projects carried out by public institutions for the public interest, whereas the financial discount rate is mainly applied in corporate investments and is also commonly referred to as the return on investment. The SDR is distinguished from the financial return only for individual economic entities in that it reflects incidental and indirect benefits and external effects from a social point of view as well as direct benefits from the performance of specific projects (Lee *et al.*, 2001). Moreover, in the cost-benefit analysis, which evaluates the economic feasibility of public projects using the SDR, the benefit and cost of the cash equivalent should be taken into account despite the fact that direct cash flows do not occur. This differs from the corporate investment case, where only cash inflows and outflows are accounted for in project evaluations.[5]

Regarding the SDR, the appropriate level and trend of real interest rates have been investigated and documented in the literature. Wicksell (1934) argues that the real interest rate is determined by the demand for capital, which is closely related to the marginal productivity of capital.6 In contrast, Fisher (1930) stresses that supply-side factors are more important than the level of capital demand and that

[5]Dasgupta *et al.* (1982) argue that the social discount rate used in discounting public projects should be adjusted so that it is lower than that used in private projects. Sen (1982) also holds that it should be set lower than the private investment return.

[6]The real interest rate is derived by subtracting the depreciation from the marginal productivity of the capital. In this case, the method used to measure the depreciation is another issue in empirical analysis.

real interest rates are determined by the time preferences of consumers. However, time preference rate is subjective and varies from person to person; therefore, there is a considerable amount of debate on how to determine a single time preference rate that represents that of the whole society. In relation to the concept of the SDR, Lind *et al.* (1982) summarize the arguments and research contents of the literature, as outlined below.

First, the SDR is the social rate of the time preference, which is the rate at which society is willing to exchange consumption now for consumption in the future.

Second, the SDR is the consumption rate of interest, which is the rate at which individual consumers are willing to exchange consumption now for consumption in the future.

Third, the SDR is the marginal rate of return on investment in the private sector.

Fourth, the SDR is the opportunity cost of public investment, i.e., the value of private consumption and investment foregone as a result of that investment.

Fifth, the SDR is the risk price of public investment, which is related to the degree to which variation in the outcome of a public project will affect variation in the payoff from the nation's total assets.

Looking closely at these definitions, it can be seen that the first, second, third, and fourth cases are related to each other. Generally, economic agents apply discount rates for two reasons. First, consumption of one unit of goods at the present time provides greater utility than that of one unit of goods in the future. Second, in terms of investment, as opposed to consumption, one unit of goods is invested at present because it is regarded that it could produce more than one unit of goods tomorrow. Here, the first and second definitions refer to the rate of time preference in terms of consumption or savings and the third and fourth represent the rate of return in terms of investment.

Dasgupta and Pearce (1972) argue that it should reflect the temporal substitution of consumption and recommend using the social rate of time preference (SRTP) as the SDR. More specifically, the SRTP is expressed as follows,

$$\text{SRTP} = \rho + \mu \cdot g, \tag{1}$$

where ρ is the time preference rate, μ is the marginal utility elasticity of consumption (or the reciprocal of the intertemporal substitution or the replacement rate between periods of consumption) and g is the growth rate of consumption per person.

According to this method, the per capita consumption growth rate is relatively easy to derive from the data. Therefore, how accurately ρ and μ are estimated from the data in the calculation of SRTP is important. In the KDI guideline (2008), which is widely used as the basis of economic analyses of public projects, the SDR is derived using the SRTP.[7]

On the other hand, those who place greater emphasis on the investor's point of view argue for the use of the rate of return on investment as the SDR. In a complete

[7]Sen (1961), Marglin (1963a, 1963b), and Kay (1972), among others, advocate for the SRTP for the social discount rate.

market, the rate of return on investment is identical to the social opportunity cost of capital (SOCC).[8]

The SRTP and SOCC are perceived to be identical when the market is complete; however, in actuality, it is difficult to assume that these assumptions are established. Hence, the time preference rate and the investment return will generally differ from each other. Which is more desirable as the SDR, i.e., the rate of time preference or the rate of return on investment is an important issue.9 The SDR has been discussed since 1960, but there is a lack of a clear rationale with regard to the concept, and there are many difficulties in practical applications. Therefore, SDRs have been applied according to social agreement and necessity depending on the period and country. In recent years, rather than selecting one from between the SRTP and SOCC, the trend has been to determine the SDR using a weighted average, where the weights are determined from the foregone investment and consumption activities.[10]

B. *SDR vs. Private Discount Rate*

The question of whether the private discount rate can be used as the SDR has been the subject of research by many scholars.[11] In numerous economic and public policy models, a discount rate is determined in two ways. First, analysts use a discount rate to calculate the net present value of national economic benefits and costs for alternative policies or investments. To compute the social value of these benefits from a national perspective, one must discount using an appropriate rate for such a calculation; that is, it is necessary to use the social rate of discount. Second, these models occasionally use a discount rate in order to imitate the behavior of private sector investment, evaluating private investment alternatives by means of a discount rate equal to the required rate of return on investment in the private sector. A major open question is whether the social rate should be identical to the required rate of return on private investment.

Figure 2 shows the difference between the private rates and the SDRs.[12] Investment demand and savings are denoted by the solid lines of D and S, respectively, as a function of the interest rate. A higher interest rate is associated with lower investment demand because business opportunities which can guarantee profits exceeding the interest rate are rare. On the other hand, as the interest rate increases, the investment supply increases because the increase in the benefits of lending funds to investors through savings instead of consumption and consuming its return during the next time period will be higher than time preference rate. If the market is perfect and complete[13] and hence there is no market friction or

[8]Mishan (1967), Baumol (1968), and Diamond and Mirrlees (1971), among others, favor the SOC for the social discount rate.

[9]Baumol (1968) argues that the SRTP would be lower than the SOCC due to the presence of market distortions such as externalities and taxes, among others.

[10]See Spackman (2011) for further discussion on the social discount rates for European countries.

[11]See Eckstein (1957), Sen (1957, 1967, 1968), Feldstein (1964), Arrow (1966) and Baumol (1968).

[12]A part of the argument shown here is borrowed from Oak (2002).

[13]The market is referred to as complete when all the possible future states can be traded, while it is considered as perfect when sources of market friction, such as taxes and transaction costs, are absent.

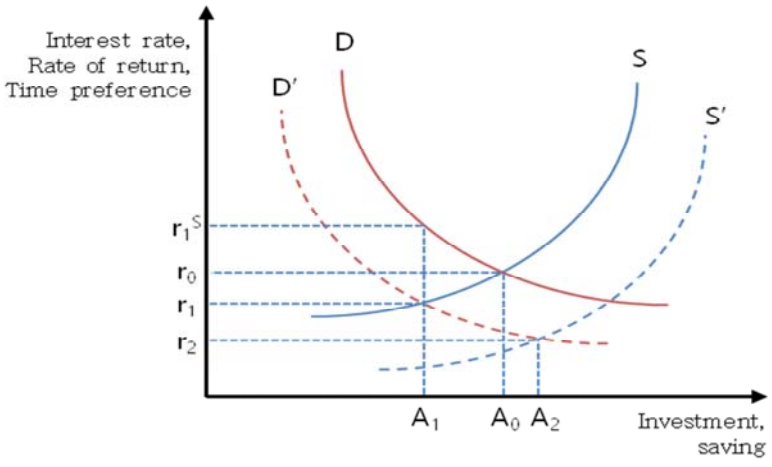

FIGURE 2. FINANCIAL MARKET EQUILIBRIUM

informational asymmetry, the market interest rate (r_0) determined as the rate of return on private investment and the time preference rate coincide with each other, and socially desirable savings and investment decisions (A_0) are made at that level. The market interest rate at this time will eventually become identical to the SDR.

However, if the market is incomplete, there is a gap between the market interest rate and the SDR. For example, if the government levies taxes on private investment, the after-tax return on investment becomes lower than the pre-tax return on investment such that the private investment return will be lower than the social investment return. In Figure 2, the imposition of taxes will cause the investment demand to shift from D to D'. Given that there is no change in the saving function, it is given as S, as before. The new investment demand curve and the saving curve are met at, and the market interest rate is determined at, r_1. The investment demand curve shifted to D' due to the imposition of taxes, but taxation is merely a transfer of wealth and is thus not effective from a social point of view. As the investment demand curve from the social point of view is still D, the return on social investment becomes r_1^s. Hence, the return on social investment exceeds the (social) time preference rate.

On the other hand, a gap between the SOCC and the SRTP can be observed even when there is a difference between the private time preference rate and the social time preference rate. For example, even if there is no market distortion due to taxation, the social saving function shifts down to S' when the social time preference rate is lower than the private time preference rate. The market interest rate is r_0 and the saving and investment meets at A_0 as in the original case, but the social time preference rate at this point is lower than the private time preference rate r_0. Thus, in this respect, there is a gap between the social investment return and the social time preference rate.

Can we determine which is larger among the social and private discount rates, let alone the magnitude? Many scholars have argued that the SDR should be lower than the private discount rate. Among others, Lind *et al.* (1982) suggested the following three rationales.

First, the state should be responsible not only for the current but also for future generations; hence, the discount rate should be selected considering the benefits of future generations (Super-responsibility argument).

Second, current civil servants or politicians are more interested in the welfare of future generations than their daily market activities (Dual-role argument).

Third, under a given preference system, members of the current generation are more likely to engage in collective agreements to save for future generations, even if they do not individually do so (Isolation argument).

Baumol (1968) argues that individuals do not place greater value on future benefits because they have a short-sighted view of social choice, and that in the case of public works, businesses of various sizes and forms operate at the same time. Hence, he claims that that the SDR will be lower than the private discount rate because it has the advantage of lowering the risk premium compared to private projects, as the government can reduce the risk by diversifying its investment opportunities.

C. *Weighted Average of the SDR*

It is difficult to determine a priori whether demand-side factors that emphasize time preference rates and supply-side factors that emphasize the marginal productivity of capital are more important when measuring SDRs. As equilibrium in an economy is determined by supply and demand, the discount rate that determines the social price of public investment will also be determined in terms of supply and demand. Hence, it would be natural to consider that the SDR should include both supply and demand factors. If the market is complete, the social and private SOCC and SRTP will then coincide with each other and one single SDR will exist in the economy. More often than not, we encounter incomplete market environments triggered by taxes or other types of market distortion.

Theoretically speaking, if the source of public investment comes from a reduction in consumption, the time preference rate should then be used, and if it comes from a reduction in investment, it is reasonable to use the return on investment for the SDR. However, it is difficult to determine the funding source of public investments in reality. Hence, we assume that part of the funding comes from a decrease in consumption and part of it from a decrease in investment. Under this assumption, the weighted average of the rate of return from private investment and the rate of time preference should be considered as reasonable measures of the SDR. The remaining task is to determine the weights. The weighted average of the SDR for a public investment project whose funding comes both from consumption and investment can be found by the following equation,

$$I_c SRTP + I_p SOCC = \left(I_c + I_p \right) WSDR,$$

where I_c and I_p denote the amounts of funding from consumption and investment financed for the public project, respectively, and WSDR indicates the weighted average of the SDR applicable to the project. Rewriting the equation by isolating the WSDR, the following equation is obtained:

$$\text{WSDR} = \frac{I_c}{I_c + I_p} SRTP + \frac{I_p}{I_c + I_p} SOCC$$

$$= w_c SRTP + w_p SOCC$$

Here, $w_c = \frac{I_c}{I_c + I_p}$ and $w_p = \frac{I_p}{I_c + I_p}$. As it is difficult to distinguish the incremental monetary contributions of consumption and investment for the project, we apply the ratio of the total use of funds between household and corporate sectors to compute the weights.

III. Empirical Models

As there is no single model that can cover all sorts of views on the SDR, we construct various empirical models to estimate the SDR and propose the weighted average of these estimates.[14] We start by estimating a production function to find rate of return on investment. This can be regarded as estimating the demand schedule in the loanable funds market. We then estimate the rate of time preference based on the Euler equation. This can be seen as the supply schedule in the loanable funds market. Finally, we present the weight average of the two, where the weight is given by the total funds used by households and firms in flow of funds data collected by the Bank of Korea.

A. *Marginal Productivity Using a Production Function*

In the following paragraphs, we attempt to estimate the production function of Cobb-Douglas, composed of private and social overhead capital. This follows Doi and Ihori (2009), as shown below.[15]

$$Y_t = e^{A_t + \varepsilon_t} K_t^{\alpha_1} G_t^{\alpha_2} L_t^{\beta}$$

[14]Shin *et al.* (2013) estimate real interest rates using a production function approach. They propose that the real interest rate was 2.6% in 2006 ~ 2010 but that the interest rate subsequently will fall and then reverse its course and rise after 2071.

[15]It is possible to consider adding the lagged variables of capital in the estimation using the production function. However, as the capital stock has accumulated with past investments, the explanatory power of the additional a time lag is not high. Moreover, additional constraints should be added in order to allow non-negative productivity parameters, which will lower the efficiency of the estimates. Thus, we adopt the estimation model of Song (2016).

In this equation, Y_t is the real GDP at time t, A_t denotes the technological progress, L_t is the economic activity population at time t, K_t represents the private capital stock at time t, and G_t denotes the social overhead capital at time t. In addition, ε_t is the measurement error or production function shock unobserved by econometricians.[16]

Dividing both sides of the production function by the economically active population and taking the log, we have the following:[17]

$$\ln y_t = A_t + \alpha_1 \ln k_t + \alpha_2 \ln g_t + \varepsilon_t \tag{2}$$

Typically, macroeconomic variables are known to have unit roots. Therefore, it is common to take the difference and use first-order residuals rather than the level of these variables,

$$\mathrm{dln}\ y_t = dlnA_t + \alpha_1 \mathrm{dln}k_t + \alpha_2 \mathrm{dln}g_t + \varepsilon_t - \eta\varepsilon_{t-1}, \tag{3}$$

where η implies the MA (1), or the cross-autocorrelation of the errors. The cross-autocorrelation in the error term occurs due to differencing. In this case, the marginal productivity of private and social overhead capital can be calculated using the equation below.

$$MP_{K,t} = \frac{\partial Y_t}{\partial K_t} = \alpha_1 \frac{Y_t}{K_t}, \quad MP_{G,t} = \frac{\partial Y_t}{\partial G_t} = \alpha_2 \frac{Y_t}{G_t} \tag{4}$$

The Cobb-Douglas function is most widely used as a primary method to determine the productivity of capital, as it is easy to apply in an empirical analysis. Capital can produce outcome at the cost of a fraction of it, which is called the depreciation rate. Therefore, in order to determine the rate of return from the investment, one needs to subtract the depreciation rate from marginal productivity;

i.e.,

$$r_{i,t} = MP_{i,t} - \delta_i, \quad i = K, G, \tag{5}$$

where $r_{i,t}$ is the return on the investment of capital and δ_i is the depreciation rate of the capital.

B. *Time Preference Rate using the Euler Equation*

In order to estimate the SRTP, we need the values for ρ and μ, as shown in

[16]Since Cobb-Douglas is a production function, it is reasonable to regard Y_t as the real output rather than the real GDP, which is the sum of the added value. However, because the production function covered in this paper does not include intermediate goods, Y_t indicates the real GDP.

[17]Variables divided by the economically active population are shown in lower case.

Eq. (1). The conventional method is to calibrate those values separately from different sets of data and combine them to estimate SRTP afterwards; hence, this method is subject to the question whether those values are consistent with each other. In the following paragraphs, we show that these values can be estimated jointly from the Euler equation.

Consider the Ramsey growth model, which that maximizes a typical household's life-time utility under the intertemporal budget constraint,

$$\max \int_0^{\infty} U(c_t) e^{-\rho t} dt$$

$$\text{s.t. } \dot{k}_t = f(k_t) - \delta k_t - c_t$$

where $U(\cdot)$ is invariant over time with $U'(\cdot) > 0$ (i.e., the marginal utility for consumption is positive) and $U''(\cdot) < 0$ (i.e., a decrease in the marginal utility). In addition, ρ is the utility discount rate reflecting the pure time preference, δ is the capital depreciation rate, c_t denotes consumption at time t, $f(\cdot)$ is the production function, and $\dot{k}_t$ represents the net investment at time t. The first-order condition of utility maximization is summarized as follows.

$$U'(c_t)\left(f'(k_t) - \delta\right) + U''(c_t)\dot{c}_t - \rho U'(c_t) = 0 \tag{6}$$

where, $\dot{c}_t$ represents the changes in consumption at time t. If the utility function takes the form of CRRA (constant relative risk aversion), the above equation can be simplified as follows,

$$r = f'(k_t) - \delta = \rho + \mu g \tag{7}$$

where r is the interest rate on savings and $\mu = \frac{U''}{U'} c$ is the elasticity of marginal utility on consumption, or the reciprocal of the rate of substitution over time. Let $g = \dot{c}_t / c_t$ represent the growth rate of per-capita consumption. The above formula essentially takes a form identical to that of the SRTP, and if we have the discount rate for time (ρ) and the marginal rate of substitution for time (μ), we can derive the discount rate based on time preference with a reasonable assumption about the future consumption growth rate. In order to estimate the model, the utility maximization problem is set up under discrete time rather than continuous time. That is, the representative household solves the problem of maximizing the lifetime utility function under uncertainty, as follows.

$$E_0 \sum_{t=0}^{\infty} \beta^t U(C_t), \quad 0 < \beta < 1$$

$$C_{\mathrm{t}} + \sum_{i=1}^{k} P_{it} B_{it} = \sum_{i=1}^{k} (1 + r_{it}) B_{it-1} + Y_t$$

In these equations, β is a discount factor with the relationship $\beta = \frac{1}{1+\rho}$ with discount rate ρ. P_{it} and B_{it} denote the price and quantity of an asset i at time t, respectively, and Y_t represents non-asset income at time t. Under the given budget constraint, the necessary conditions for maximizing one's lifetime utility are expressed by the Euler equation:

$$U'(C_{\mathrm{t}}) = \beta E_t \left[(1 + r_{i,t+1}) U'(C_{t+1}) \right], \quad i = 1, \ldots, k \tag{8}$$

For the empirical analysis, the introduction of an explicit utility function is required. In this case, $U(C_t) = \frac{C_t^{1-\mu}}{1-\mu}$ is used, where the degree of relative risk aversion is constant. Substituting this equation into the Euler equation, we have the following equation:

$$E_t \left[\beta \left(\frac{C_{t+1}}{C_t} \right)^{-\mu} (1 + r_{i,t+1}) - 1 \right] = 0 \tag{9}$$

This equation shows that there is a close relationship between asset returns and the consumption growth rate. Using this, we can derive the discount rate reflecting the time preference by estimating β and μ. The quarterly discount factor (β) can be transformed into the annual discount rate, ρ, and can be derived using the following relationship.[18]

$$\frac{1}{1+\rho} = \beta^4$$

Finally, the final time preference rate, SRTP, can be determined from Equation (1).

[18]As the Euler equations are estimated using quarterly data, we need to quadruple β to back out the annualized discount rate.

IV. Estimation Results

A. *Data*

In order to examine the marginal productivity of capital through the Cobb-Douglas production function, we used annual data of 1970-2013 for private capital stock and public capital stock on the national balance sheet filed by the Bank of Korea. For the estimation of the Euler equations, the data on per capita consumption, CPI inflation, treasury bond yields, corporate bond yields, and stock returns are available from the second quarter of 1995. Therefore, in the analysis, the quarters from 1995 - Q2 to 2016 - Q1 were used. Table 1 shows the basic statistics of the data used in the analysis.

TABLE 1—SUMMARY STATISTICS

(UNIT: MILLION WON, %)

Variables	Obs.	Mean	Median	S.D.	Min	Max
Real GDP per economically active population	44	22.882	21.572	12.499	6.147	44.010
Private capital per economically active population	44	86.316	70.581	63.286	10.163	197.545
Social overhead capital per economically active population	44	30.201	22.931	22.932	3.422	70.602
Household consumption growth rate	85	0.835	0.797	3.359	-13.693	9.121
Household consumption (seasonal adjusted) growth Rate	85	0.821	0.945	2.033	-13.792	3.952
KOSPI index return	85	2.093	0.836	16.865	-41.848	81.252
CPI growth rate	85	0.759	0.664	0.756	-0.421	5.257
3-year KTB interest rate	84	5.943	4.800	3.554	1.534	16.340
3-year corporate bond (AA) interest rate	85	6.878	5.490	3.884	1.980	20.710

Note: Public capital data is only available as the annual frequency.

Source: Statistics Korea, Bank of Korea.

B. *Discount Rate Estimation Using a Production Function*

Table 2 shows the estimation results of the Cobb-Douglas function.[19] The production elasticity of private capital is 0.2774, the elasticity of social overhead capital is 0.15, and both elasticity rates are statistically significant at the 10% level. The sign of the coefficient of MA, on the other hand, met the expectations but the statistical significance was low.

Previous studies have shown that the elasticity of social overhead capital is 0.245 according to an analysis using data from 1968 to 2000. Another study found it to be 0.302 (Ryu, 2005b). This difference stems from the use of the public capital of the government sector in that study. On the other hand, Ryu (2008) re-estimated the elasticity of production using the capital stock of the government sector from 1968 to 2005, finding that the elasticity is 0.439 for OLS and 0.277 for 2SLS. In Kang (2006), the elasticity of public capital was estimated using macroeconomic data from 1970 to 2004 with a production function approach. The elasticity of

[19]The test results of the validity of constant returns to the scale production function are included in Appendix 1.

TABLE 2—LIKELIHOOD FUNCTION ESTIMATES

Variable	Coefficient	Std. Err	p-value
DL_PK	0.2774	0.1426	0.0547
DL_GK	0.1501	0.0001	0.0000
MA(1)	-0.0385	0.1777	0.4186
constant	0.0159	0.0107	0.0987

Note: DL_PK denotes the logarithmic difference of the private capital/economically active population, DL_GK is the logarithm of the social overhead capital/economically active population, and MA (1) is the estimate of $-\eta$.

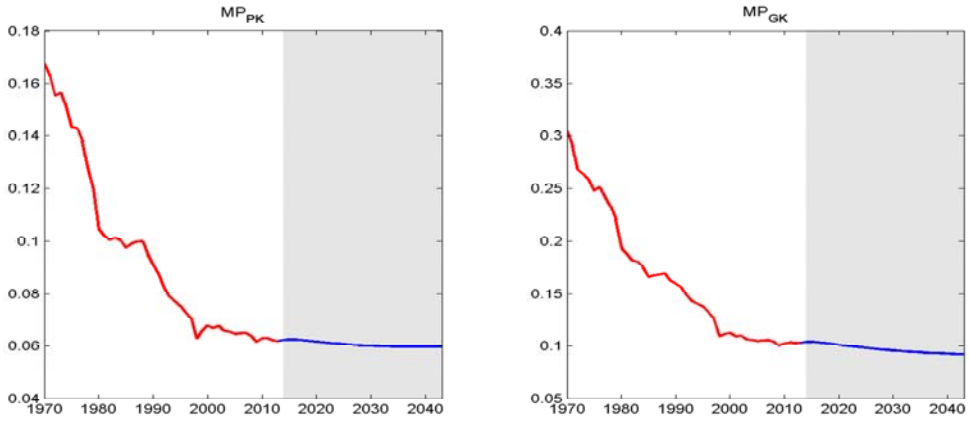

FIGURE 3. MARGINAL PRODUCTIVITY TREND AND FORECASTS OF PRIVATE AND SOCIAL OVERHEAD CAPITAL

Note: The shaded areas represent the period in which the marginal productivity of capital is predicted (2014-2043).

public capital at the regression using level variables was as high as 0.43. The elasticity of public capital ranges from -0.0075 to 0.1858 when using first-order differencing to make the variables stationary. The social overhead capital estimated in this paper is lower than that of Ryu (2005a, 2005b, 2008), but the value exists within the interval indicated in the study by Kang (2006). Moreover, while the capital stock derived from the permanent inventory method has been used in most studies thus far, the data employed in the current work is national balance sheet capital stock data, where the depreciation rate is computed based on the age-price function of the asset. This also likely contributes to the differences in the elasticity estimates between the current work and other studies. In addition, the period covered by the data and the estimation model are other factors contributing to the difference.

Based on the estimation results, the marginal productivity of private and social overhead capital can be easily calculated. These results are shown in Figure 3 and Table 3.[20] The marginal productivity of private capital, which had exceeded 16% in the early 1970s, reached 6% in 2000. In the early 1970s, marginal productivity

[20]The future economic activity population, per capita output, private capital stock, and social overhead capital stock, which are necessary to determine the marginal productivity, are derived using the VAR. Estimation results of the VAR model are included in Appendix 2.

TABLE 3—MARGINAL PRODUCTIVITY FORECASTS OF PRIVATE CAPITAL (MPPK) AND SOCIAL OVERHEAD CAPITAL (MPGK)

Years Ahead	Year	MPPK	MPGK
1	2014	0.0622	0.1035
2	2015	0.0623	0.1036
3	2016	0.0622	0.1032
4	2017	0.0621	0.1027
5	2018	0.0619	0.1021
10	2023	0.0609	0.0988
15	2028	0.0601	0.0961
20	2033	0.0597	0.0941
30	2043	0.0597	0.0915

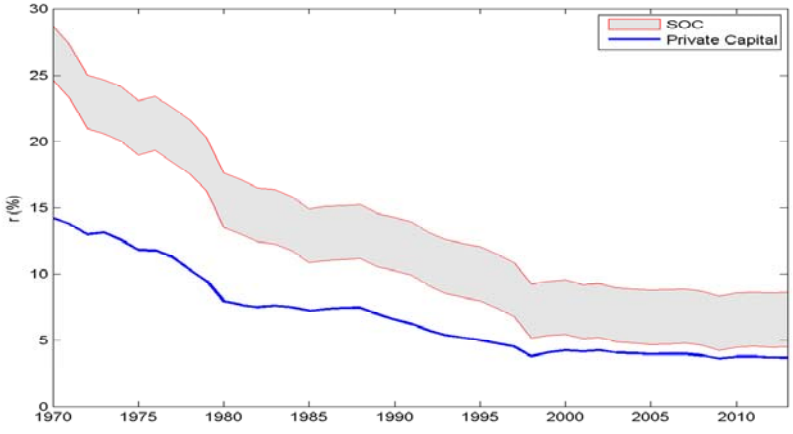

FIGURE 4. SOCIAL OVERHEAD CAPITAL AND PRIVATE CAPITAL DISCOUNT RATE

exceeded 30% due to insufficient social overhead capital, but it has recently declined to 10%. Although the productivity coefficient of private capital is twice as high as that of social overhead capital, the marginal productivity of private capital is lower than that of social overhead capital due to the difference in the size of the capital stock.

On the other hand, depreciation rates should be subtracted to derive the return on investment of capital. There is little research on appropriate depreciation rates for social overhead capital, while private capital generally uses 2.5% per annum. Cho *et al.* (2012) discussed the depreciation rates for the social overhead cost, but their study is limited to only certain selected sectors. Hence, in this paper, we apply the depreciation rate of 2.5% for private capital, as is done in most conventional studies. For social overhead capital, we attempt to minimize the arbitrariness involved in choosing depreciation rates by presenting the band rather the specific value of the depreciation rate, while the maximum (water and sewage: 5.7%) and minimum (rail: 1.6%) values of the depreciation rate are used to derive the return on social overhead capital. Figure 4 presents the return on investment of the private and social overhead capital net depreciation rates. Private investment returns have fallen to 3% since 2005. On the other hand, in the case of social overhead capital, under the minimum depreciation rate, the return on investment is 8.6% as of 2013,

while under the maximum depreciation rate, the return on investment of social overhead capital is 4.5%.

C. *Estimation of the Discount Rate Using the Euler Equation*

Due to the nonlinear nature of the Euler equation used to estimate these parameters, we employ the GMM method. Compared to MLE, GMM does not require distributional assumptions other than the moment conditions, and this is a required condition to estimate the Euler equation. In order to implement GMM as proposed by Hansen (1982), it is necessary to derive the residual equation from the Euler equation. The residual term from the Euler equation, which is u_t, can be expressed as follows:

$$u_t = f\left(X_{t+1}, b\right) = \left[\beta\left(\frac{C_{t+1}}{C_t}\right)^{-\mu}\left(1+r_{i,t+1}\right)-1\right] \tag{10}$$

Suppose that there are m parameters to be estimated when there are n assets to be invested; then, $f : R^{n+1} \times R^m \to R^n$. According to the Euler equation, we have $\mathrm{E_t}\left[u_{t+1}\right] = 0$. In order to use GMM, a set of instrumental variables should be introduced. Here, the following set of instruments in line with Hansen and Singleton (1988) is used.

$$z_t = \left[1, \frac{C_t}{C_{t-1}},\ r^f_{t-1},\ r^e_{t-1},\ r^b_{t-1}\right]$$

In this equation, r^f denotes the three-month government bond yield, r^e is the stock price return, and r^b is the three-month corporate bond yield. The orthogonalization conditions using these instruments are as follows,

$$E\left[h\left(X_{t+1}, Z_t, b\right)\right] = 0$$

$$h\left(X_{t+1},\ Z_t, b\right) \equiv f\left(X_{t+1}, b\right),$$

where $b = \left[\beta, \mu\right]$. If the residual equation is defined as $g_0 = E\left[h\left(X_{t+1}, z_t, b\right)\right]$, then $\mathrm{g}_0\left(b_0\right) = 0$, where the sample analog is simply as follows:

$$g_T\left(b\right) = \frac{1}{T}\sum_{t=1}^{T} h\left(X_{t+1}, Z_t, b\right)$$

With the sample residual equation defined above, we can establish the following quadratic function and minimize it with respect to b.

$$J_T(b) = g_T(b)' W_T g_T(b)$$

Here, W_T is a weighting matrix, which can be derived using an asymptotic variance-covariance matrix.

$$W_T = \left[\sum_{j=-k+1}^{K-1} \frac{1}{T} \sum_{t=1+j}^{T} h\left(X_{t+n}, Z_t, b_t\right) h\left(X_{t+n-j}, Z_{t-j}, b_t\right)' \right]^{-1}$$

The estimated b_T is a consistent estimator. Additionally, under this coefficient, the objective function has an asymptotic chi-square distribution with the degree of freedom being the difference between the number of moment equations (q) and the parameter to be estimated (m),

$$T \cdot J_T(b_T) = T \cdot g_T(b_T)' W_T g_T(b_T) \rightarrow^d \chi^2(q-m) \tag{11}$$

where T denotes the number of observations. In order to run the estimate using actual data, the value of W_T is necessary to estimate b. Hence, a two-step estimation method is used. In the first step, we set $W_T = I$ and estimate b. In the second step, we compute W_T based on b as estimated in the first step. The objective function is then adjusted using W_T from the last step, after which b is finally re-estimated.

The resulting estimates of (β, μ) using this method are shown in Table 4. β and μ are estimated as 0.9944 and 0.7644, respectively. The p-values are significantly low for both values, indicating statistical significance. On the other hand, over-identification tests that examine the validity of additional instrument variables were rejected at the 5% significance level, suggesting that the moments from the additional instrument variables were not significant.

The discount rates can be derived based on these estimation results, as shown in Table 5. When the growth rates are known *a priori*, the interest rate in the steady state is determined as $r = \rho + \mu g$, where $\rho = \beta^{-4} - 1$. Given that we have already found β and μ by means of GMM estimations, we can derive the corresponding values of r by changing g. Hence, to recover the discount rates, we only need to make assumptions about the growth rates. In this paper, we

TABLE 4—GMM ESTIMATES

Variable	Coefficients	Std. Err	p-value
β	0.9944	0.0013	0.0000
μ	0.7644	0.0032	0.0000
Over-id Test (Hansen's J test)		64.6604	
x^2 (0.05, df=14)		22.3620	

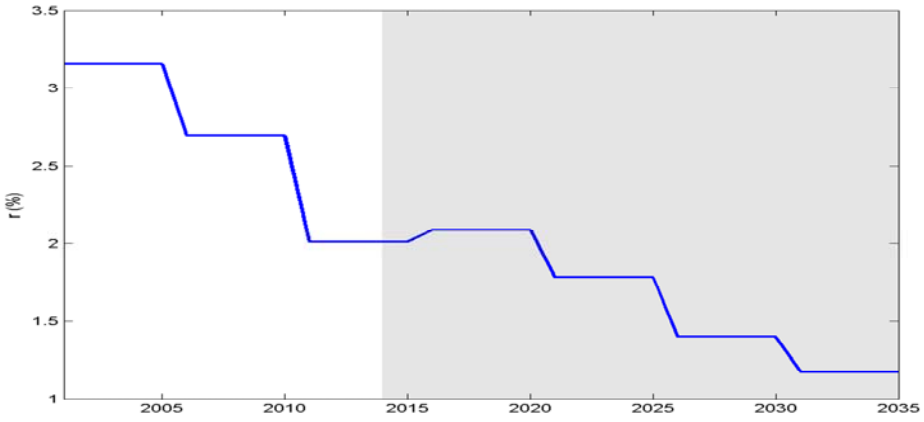

FIGURE 5. DISCOUNT RATE (r) BASED ON TIME PREFERENCE

TABLE 5—DISCOUNT RATE FORECASTS

Years	Potential growth rate*	r(%)
2001~2005	4.1	3.1567
2006~2010	3.5	2.6981
2011~2015	2.6	2.0102
2016~2020	2.7	2.0866
2021~2025	2.3	1.7809
2026~2030	1.8	1.3987
2031~2035	1.5	1.1694

Note: Kwon and Cho (2014).

attempt to compute the discount rate using the potential growth rate of Korea until 2035 as presented by Kwon and Cho (2014). As a result, the discount rate reflecting the time preference was 3.2% in 2001 ~ 2005, and the discount rate decreased as the potential growth rate declined for every subsequent year. This rate dropped to 1.2% in the period of 2031~2035. These results are shown in Figure 5.

D. *Weighted Average Discount Rate*

In this case, we want to derive the weighted average SDR of the investment return of the enterprise and the time preference rate of the household. The weights used here are derived from the Bank of Korea's financial circulation table and the proportion of corporate fund operations (see Table 6 below). Of course, the weights presented here are only one from among the sets of selectable weights and are not held to be perfect. However, as economic entities allocate or adjust investment funds as usefully as possible, it would be preferable to use weightings based on the fund operation scale if it is necessary to weigh the different discount rates of private enterprises and households, as this ensures the use of a good proxy for foregone consumption and investment. The weighted average discount rate derived from these weights is shown in Figure 6.[21] Using the weighted average of private

[21]After 2016, the same weighting is used for 2015.

TABLE 6—SHARE OF HOUSEHOLD AND CORPORATE FUND OPERATIONS

(UNIT: BILLION WON)

Year	Private firm	Households and NPO	Private firm weight (%)	Households weight (%)
2010	86,987.4	142,016.0	38.0	62.0
2011	67,365.1	161,626.8	29.4	70.6
2012	55,425.5	127,083.8	30.4	69.6
2013	84,773.7	153,045.0	35.6	64.4
2014	96,411.8	171,782.5	35.9	64.1
2015	92,368.6	226,855.3	28.9	71.1

Note: ECOS, Bank of Korea.

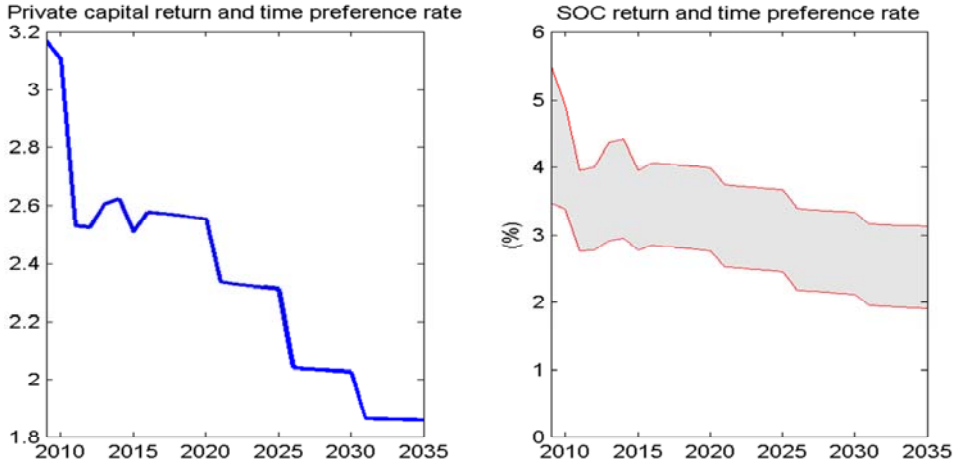

FIGURE 6. WEIGHTED AVERAGE OF THE INVESTMENT RETURN AND TIME PREFERENCE RATE

capital investment returns and time preference rates, it falls from 2.5% in 2015 to 1.85% in 2035. The weighted average between social overhead capital investment returns and time preference rates is expected to be adjusted from 2.8% to 3.9% in 2015 to 1.9% to 3.1% in 2035.[22]

V. Conclusion

In this paper, the concept of the SDR, which is the most important key parameter in any analysis of the economic feasibility of a public investment project, is discussed and the social preference rate is estimated using data based on a theoretical model considering the investment return rate and the time preference rate.

The estimation results are summarized as follows. The return on investment from private capital has remained at approximately 3% since 2005, and the return on investment of social overhead capital ranges from 4.5% to 8.6% depending on

[22]Interested readers can request the specific results.

the depreciation rate. On the other hand, when the time preference rate is used, the discount rate in the early 2000s is 3.2%, and this rate declines when the potential growth rate decreases. Over the long term, the discount rate is reduced to 1.2% in 2030. Although the results differ somewhat depending on the model and assumptions used in the analysis, the discount rate is usually in the range of 3.0 ~ 4.5% and is expected to fall below 3% over the longer term. This suggests that a SDR of at least 1% p must be downgraded from the standard rate which is currently used in public projects.

As the nature of public projects reflects the investment and economic conditions, it is desirable for the SDR also to change over time. However, in practical terms, if different SDRs are used each year, the profitability of the same project will change from year to year. Moreover, if economic conditions or the investment environment change over a certain period of time, an adjustment of the SDR becomes inevitable. The purpose of this study is to estimate the SDR in the current situation by reflecting policies and practical demand levels[23]. In addition to financial benefits and costs, there are no clear criteria with regard to setting the opportunity cost in an economic analysis of a public works project when non-monetary benefits and costs should be added. Under this situation, practitioners' direct and indirect experience and areas of specialty related to the recognition and measurement of benefits and costs of the candidate project can become a non-negligible factor in determining which discount rate will be applied to the public project. Hence, it is important to understand that there are inherent limitations when attempting to pin down a single SDR and conduct robustness checks by applying different values of the SDR to determine the sensitivity of the benefit-cost ratio to the discount rate. Most researchers agree with the necessity of recalibrating the SDR level, but researchers are likely to have different viewpoints in relation to the specific scope of adjustment of the incumbent discount rate. However, I hope that this article contributes to the creation of a platform for academic and practical discussions of these topics.

APPENDIX

A1. *Test of the Constant Returns to Scale Production Function*

In this section, we conduct a test to verify whether the return to scale is constant, i.e., CRS. If the production function is not CRS, then we have $\alpha_1 + \alpha_2 + \beta \neq 1$. Therefore, even if both sides are divided by the economically active population, the population does not disappear from the equation; therefore, equation (3) becomes

$$dln\, y_t = A + \alpha_1 dlnk_t + \alpha_2 dlng_t + \gamma dlnL_t \varepsilon_t - \eta \varepsilon_{t-1},$$

[23]The news search hits on public projects stand at 116 for 2016 compared to 59 for 2010 when public project and KDI are used as search keywords. When one uses public project as a single keyword, the hits stand at 655 in 2016, almost doubled from the 334 hits for 2010 (www.kinds.or.kr). We believe this reflects the policies and social demand levels for the SDR.

TABLE A1—LIKELIHOOD FUNCTION ESTIMATES

Variable	Coefficient	Std. Err	p-value
DL_PK	0.2054	0.1439	0.1017
DL_GK	0.1452	0.0002	0.0000
DL_LR	0.4771	0.2999	0.0814
MA(1)	-0.0705	0.1769	0.3519
constant	0.0105	0.0108	0.1826

Note: DL_PK is the logarithmic difference of private capital / economy population, DL_GK is social overhead capital / economically active population, DL_LR is the logarithm of economic activity population, and MA (1) denotes the MA term, $-\eta$.

where $\gamma = \alpha_1 + \alpha_2 + \beta - 1$. Therefore, we can check whether γ is statistically significant through MA(1)-MLE, and the validity of the CRS assumption can be examined. The estimation result is shown in Table A1. The estimate of the logarithmic population is 0.4771, which is quite high, but the significance probability is 0.0814, which is rejected at the statistical significance level of 5%.

The magnitude of the parameter is economically too significant to ignore the effect of the economically active population. We argue that the population variable reflects the characteristics of human capital rather than simply the labor force itself.

A2. *Forecast Using the VAR Model*

In order to predict the marginal productivity trend of capital, we estimate the following 3-variate VAR model with the real GDP (y_t), private capital stock (k_t) and social overhead capital stock (g_t),

$$X_t = \mu + \pi_1 X_{t-1} + \pi_2 X_{t-2} + \cdots + \pi_p X_{t-p} + \epsilon_t,$$

where $X_t = \begin{pmatrix} \Delta \ln y_t \\ \Delta \ln k_t \\ \Delta \ln g_t \end{pmatrix}$, μ is a constant vector of 3 × 1, $\{\pi_i\}_{i=1}^{p}$ is a coefficient matrix of 3 × 3, and ϵ_t represents a residual vector of 3 × 1. The results of the VAR model estimation are shown in Table A2.

TABLE A2—VAR ESTIMATES

Dependent Variable	$\Delta \ln y_t$	$\Delta \ln k_t$	$\Delta \ln g_t$
$\Delta \ln y_{t-1}$	0.003	0.124	0.064
$\Delta \ln k_{t-1}$	-0.316	0.988***	0.353*
$\Delta \ln g_{t-1}$	0.605*	-0.217	0.468**
Constant	0.024*	0.009	0.008

Note: *** p<0.01, ** p<0.05, * p<0.1 The optimal lag order is set to 1 based on AIC.

A3. *Estimated Parameters of the Marginal Utility Elasticity of Consumption*

Table A3 summarizes the previous empirical results for the marginal utility elasticity of consumption as required to derive the SDR using the Ramsey growth model.

TABLE A3—MARGINAL UTILITY ELASTICITY OF CONSUMPTION ESTIMATES

Research	Method	μ
Korea Development Institute (2008)	Savings behavior	0.54~1.16
Min (2016)	Savings behavior	0.02~0.29
	Structure of personal income tax rate	0.85~1.18

In order to determine μ, previous studies mainly used individual saving behavior (Scott, 1989). Calibrating μ to satisfy the equation below, we can find the marginal utility elasticity of consumption,[25]

$$\frac{S}{Y}=\left[\left(\frac{1}{\mu}\right)(r-\rho)-y\right]/\left[r-y\right]$$

where $\frac{S}{Y}$ is the saving rate, r is the real interest rate, ρ is the utility discount rate, and y is the expected growth rate of income.

Because the saving behavior method calculates μ such that it meets the stipulations of the equation based on the saving rate, there is a problem when attempting to find a representative value of the saving rate which has relatively large variation and a trend change. In contrast, the Euler equation approach adopted in this paper is more advantageous in that it can find a more stable μ to realize a parameter consistent with market data and can jointly estimate the marginal utility elasticity and time discount rate.

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[25]See Pearce and Ulph (1999) for an additional discussion.

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