The Impact of Aging on Saving and Investment Rates in Korea: Projections Using a Small Open Economy Model

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I. Introduction

The saving rate of Korea is among the highest in the world. The high saving provided the funds needed to finance corporate investment in plant and equipment, and public investment in infrastructure. This investment in turn allowed Korea to incorporate the latest technologies into the production process, and raised living standards through better public infrastructure, both in cities and in rural areas.

Over the next three decades, the population of Korea will be aging rapidly. In Korea, the population aging will accelerate after 2025; by 2040, around 30 percent of the population will be 65 and above. The main reason for this aging is the fall in the total fertility rate (completed births per family).

In this paper, we revisit the issue of the impact of demographic change on the saving-investment balance and the current account of Korea. There is widespread belief that aging will lead to a major shift in the saving-investment balance and the current account of Korea. We show that this belief is largely true. For Korea, we show that population aging will lower both total saving (private and government) and total investment (private and public) rates–especially drastically after 2025. Until sometime after 2025, however, Korea is expected to maintain relatively high total saving rates, and run current account surpluses, thus accumulating net external assets. Although after 2025, Korean saving rates are gradually expected to dip below investment rates, the external assets accumulated earlier should provide enough capital income so that Korea is projected to run current account surpluses even after 2025.

We also compare Korea's future saving-investment balance with Japan's future saving-investment balance. In Japan, saving rates are expected to start falling around 2005. In Korea, saving rates will start falling about 20 years later, since in Korea, the demographic transition–falling fertility rates–happened about two to three decades later than in Japan. What is remarkable about our projections is that contrary to the usual post-World War II pattern, Korea will be supplying international capital to Japan from around 2025 to perhaps around 2040–a very surprising turn of events.

II. Korean Saving and Investment

Korea is well known for its high saving, and even higher investment rates (Table 1). Private saving rates (the sum of household and corporate saving rates) increased sharply from about 19 percent to over 33 percent in the late 1980s and early 1990s, while government saving rates have remained steady at about 4-5 percent, except for the period between 2001 and 2003 (Table 1). Government saving rates between 2001 and 2003 sharply increased; as fiscal tightening proceeded apace, following the currency crisis. Total investment rates have been impressive, especially in the 1990s, but plummeted in the post-crisis period between 2001 and 2003.

Household saving appears to respond most directly to income (GDP) gains, demographic factors, and real interest rates. Household saving rates have risen relative to income in ratchet fashion, suggestive of the permanent income model of consumption (Collins and Park, 1989). Econometric work has shown the importance of high average growth rates of GDP as an explanation for the impressive rise in household saving: and the large swings in real growth rates of GDP as an explanation of the cyclical fluctuations of saving rates (Collins and Park, 1989). The high average real GDP gains of the 1970s and 1980s sharply raised household saving rates, while the sharp dip in real GDP in the 1990s (owing to the currency crisis), sharply decreased household saving rates in the subsequent period (2001-2003).

The continuous declines in population growth rates, from 3.0 percent per annum in 1960 to 2.0 percent per annum in the 1970s lowered dependency ratios, helping boost household saving rates during the 1970s. The surge in domestic saving between 1985 and 1995 was also aided by high domestic after-tax real interest rates. The development of non-bank financial intermediaries replaced the curb market and offered high real returns for savers. The government's policy of applying a low flat tax rate on most interest income also raised after-tax real returns (Kim and Leipziger, 1991).

Private saving was also boosted by strong *corporate saving*. Corporate saving (not depicted) averaged around 7 to 8 percent in the 1970s and 1980s, boosted by lower tax burdens and a booming economy. In addition, during the 1970s and early 1980s, corporations were urged by the government to accumulate their own investment funds, through management rationalization and the upward adjustment of sales prices (Kim and Leipziger, 1991).

Government saving (exclusive of public investment) has generally remained high in Korea, because of low government expenditures, and buoyant tax revenues. A notable feature of Korea's pattern of government expenditure is the low proportion spent on wages and salaries. Tax revenues increased from 10 percent of GDP in the early 1960s to about 20 percent in the mid-1980s, and thereafter. This growth was helped by the creation of the Office of National Tax Administration, which was created for effective tax enforcement. The introduction of the Value Added Tax in 1977 also boosted tax revenues significantly (Kim and Leipziger, 1991). In the late 1990s, the Korean government embarked on belt tightening measures, partly to pay back IMF loans, which resulted in larger fiscal surpluses.

Korean total investment in the 1970s was aided by strong government infrastructure spending, which averaged more than 1/3 of total investment. Total investment was also boosted by the Heavy and Chemical Industry drive of the 1970s. Not only were public resources directly mobilized for Heavy and Chemical Industry financing (so-called "policy loans"), but even more significantly, banks were directed by the government to lend to industry, often at preferential rates. The high investment rates in the 1980s to the early 1990s were driven by the *chaebols* strategy of competing for market share in mature industries, and of diversifying into new industries, often unrelated to the core business of the group. In this period, corporations financed their expansion mainly by borrowing in foreign currencies from domestic financial institutions. The late 1990s currency crisis led to an investment collapse in both private and public investment between 2001 and 2003.

Reflecting these developments in saving and investment rates, *net export surpluses* (as a percentage of GDP) were sharply negative in the 1970s, positive in the 1980s, slightly negative in the 1990s, while bouncing back to be slightly positive in 2001-2003.

III. Korean Aging and the Potential Impact on Total Saving and Investment

Figure 1 plots the United Nation's projections of Korea's elderly population; and the percentage of the Korean total population that is elderly.[1] The Korean population is expected to peak at a little over 50 million in 2025, then gradually decline. The percentage of the population over the age of 65 is expected to increase, from about 5 percent in 2000 to over 15 percent in 2025, and then double to over 28 percent in 2040. Declining fertility is the principal source of

[1]The demographic data are from United Nations (1998).

these changing demographic patterns. Moreover, Korea has allowed almost no immigrants, who, especially in English-speaking countries, have helped to keep the population young. These trends have important implications for the demographic structure of the population over the next half-century.

The Support Ratio

Demographic shifts affect the economy's consumption opportunities because they change the relative sizes of the self-supporting and dependent populations. Following Cutler, Poterba, Sheiner, and Summers (1990), I summarize these changes by the support ratio, denoted by α, which is defined as the effective labor force, LF, divided by the number of consumers, CON,

$$\alpha = LF / CON.$$

The first issue in measuring the support ratio concerns the relative consumption needs of people at different ages. I assume that all people have identical resource needs so that:

$$CON = \sum_{i=1}^{99} N_i \ ,$$

where N_i is the number of people of age i.

The second issue concerns the effective labor force. The first measure LF1 assumes that all people aged 20-64 are in the labor force, while individuals under 19 or over 65 are not:

$$LF1 = \sum_{i=20}^{64} N_i .$$

This measure is used by the United Nations in projecting the future labor force.

The second measure, LF2, recognizes that both human capital and labor force participation rates vary by age. In principle, data on the average 1990 earnings of people of each age (measured in 5-year intervals) and sex (W_{ij} , where i is age, and j=M or F, female) can be used, along with data on age- and sex-specific labor force participation rates (PR_{ij}), to calculate:

$$LF2 = \sum_{i=15}^{80} (W_{iM} * PR_{iM} * N_{iM} + W_{iM} * PR_{iW} * N_{iw}) \ .$$

This measure assumes that earnings accurately reflect a worker's human capital. If age-earnings profiles are humped-shaped, then labor productivity peaks in middle-age. Thus, this measure recognizes that human capital of a society with a high fraction of people in middle age is higher than that of a society with many older workers, whose earnings and labor-force participation rates decline.

In practice, the patterns in the two support ratios differed very little for some countries that I examined (Dekle, 2005). Given the similarity in the two support ratios, I focus on the simpler measure, LF1.

The support ratio for Korea using LF1 decreases from *0.63* in 2000 to *0.62* in 2025, and *0.53* in 2050. Compared to the population aging, the decline in the Korean support ratio between 2000 and 2025 is negligible. This is because although the fraction of those over the age of 65 is rising, the fraction of those under age 20 is falling, thus, keeping the support ratio constant. That is, the fraction of the sustaining population in Korea remains robust, despite the population aging, because of the rapid decline in the young, school age population.

IV. Demographic Change, the Optimal Saving-Investment Balance, and the Current Account in Korea

To simulate the impact of demographic change on the future optimal Saving-Investment balances of Korea, here we adopt the neoclassical framework and assume that consumers maximize (lifetime) utility, and firms maximize firm value. Households base their consumption on both current and future income. Thus, consumption can be detached from current income; households adjust their saving to keep consumption growth constant into the future.

Specifically, in our simulations, we adopt the standard small-country, open capital markets, Ramsey optimal-growth model (Barro and Sali-i-Martin, 1995, ch. 3). With the model, we can examine how a society should adjust its optimal saving and investment rate policies in response to changes in demographic variables. We simulate the model using plausible parameter values and the projected future paths of the support ratio and the growth rate of the labor force. Given our perfect international capital mobility and small-country assumptions, the determination of optimal saving and investment can be analyzed separately.

Optimal Investment Rates

We assume that firms maximize the present discounted value of profits:

$$V = \int_0^{\infty} e^{-rt}[Y_t - w_t \hat{L}_t - adc_t]d\tau \ , \qquad (1)$$

where Y_t is gross output, r is the world real rate of interest, w_t is wages, $\hat{L}_t$ is the effective labor force, and adc_t are adjustment costs to changing the capital stock, such as retooling and downtime.

Effective labor and capital grow according to:

$$\hat{L}_t = L_0 e^{(n_t + g)t} \tag{2}$$

$$\frac{dK_t}{dt} = I_t - \delta K_t \tag{3}$$

where n_t is the rate of labor supply growth, g is the constant rate of labor augmenting technical progress, I_t is the gross investment rate, and δ is the constant depreciation rate.

We maximize (1), given the constraints (2) and (3), and simulate the model using plausible parameter values for Korea. For labor-augmenting technical progress, g, we take 0.012 (=labor share (0.70)*TFP Growth (0.017)). That is, labor-augmenting technical progress of 1.2 per cent implies a growth rate of total factor productivity of 1.7 percent for Korea's labor share of 0.70. For the real interest rate r, we take 0.06, which is close to the real interest rate for Korea in the 1990s. For the capital depreciation rate, δ, we take 0.13, which is the capital depreciation rate for high investment countries such as Korea (Hayashi, 1986). For the path of n_t, we take values from United Nations Korean labor force projections. Details of the simulation are given in the Appendix.

Table 2 depicts the projected investment rates from 2000 to 2040. The projected values for the investment rates are normalized so that the investment rate for 2000 is equal to the average value of the investment rates between 1990 and 2000. From Table 2, we can see that total investment rates remain close to their current level until 2025.[2] The investment rate is projected to fall more sharply after 2025, as the labor force growth rate declines sharply. In general, however, the investment rate is not very sensitive to changes in labor force growth rates, although it is quite sensitive to changes in real interest rates (which is assumed constant). A fall in the labor force growth rate lowers both output and the capital needed to equip workers, leaving the capital-labor ratio steady. With a steady capital-labor ratio, the investment rate is also steady.

Optimal Saving Rates

The saving rate is determined from "forward-looking" household behavior. Assume that households wish to maximize their lifetime utility, U, given by:

$$U = \int_0^\infty \frac{c^{1-\theta}}{(1-\theta)} e^{zt} e^{-\rho t} dt \qquad (4)$$

where c is consumption per capita, z is the rate of growth in the population, $\frac{1}{\theta}$ is the intertemporal elasticity of substitution, and ρ is the pure rate of time preference. This formulation of household preferences assumes that households are dynastic–they care about their

[2]Our projections assume that the economy is always, or on average, at full-employment. The decline in investment rates between 2001-2003 probably reflect the severe recession in the Korean economy in the late 1990s.

children's and grandchildren's welfare (utility) as much as their own.

$$\dot{a}_t = \alpha_t w_t + r a_t - c_t - z_t a_t \qquad (5)$$

where a_t is total assets per person or per capita. This budget constraint says that growth in assets (per person) is higher, the higher the wages, w_t, the support ratio, α_t, and the interest rate, r. The growth in assets per person is lower, the higher the consumption, and the population growth rate, z_t.

Note that,

$$\frac{\dot{\alpha}}{\alpha} = n_t - z_t\,;$$

that is, the change in the support ratio is equal to the labor-force growth rate minus the population growth rate.

From (4) and (5), we explicitly simulate the growth and level of per-capita consumption and the saving rate, using plausible values for the parameters, θ and ρ and the government's demographic projections (LF1) for n_t and z_t (and thus, α_t). Details are given in the Appendix.

Table 2 depicts the projected optimal saving rates from 2000 to 2040. The projected values of the saving rates are normalized so that the saving rate for 2000 is equal to the average value of the saving rates between 1990 to 2000. The optimal total saving rate remains constant at about 36 percent of GDP until 2025.[3] It then sharply falls to 27 percent of GDP in 2040. This pattern is a result of shifts in the support ratio. As shown in the Appendix, optimal consumption per capita always grows at a constant rate of g (=1.2 percent), but output per capita growth is affected by shifts in the support ratio. The Korean support ratio is constant between 2000 and 2025 at about 0.64, but falls sharply after 2025 to about 0.53. As the support ratio declines between 2025 and 2040, output per capita falls, the consumption-output ratio rises, and the saving rate falls.

Taken together, the overall results show that future demographic trends will affect the optimal saving rate much more than the optimal investment rate. In an open economy, investment rates are primarily determined by international real interest rates, which are set outside of Korea, and not by demographic variables. Thus, future Korean net exports will be determined largely by movements in Korean saving. Optimal Korean saving behavior implies a relatively flat saving profile until about 2025, and then a sharp decline to 2040.

Net Export Surpluses and Net Foreign Debt

From our simulated path of Korean and saving and investment rates, we can simulate the future path of Korea's net export surplus, and net foreign debt.

The net export surplus-GDP ratio is equal to:

[3]As shown in Table 1, actual total saving rates in 2001-2003 were 32 percent, which is lower than our projections by about 4 percentage points. Our projections assume that the economy is always at full-employment. However, in reality there was a deep recession in Korea, owing to the crisis, which depressed saving rates in the 2001-2003 period.

$$\frac{NX_t}{Y_t} = \frac{S_t}{Y_t} - \frac{I_t}{Y_t}$$

and the current account surplus (change in net foreign debt)-GDP ratio is equal to:

$$\frac{-\dot{D}_t}{Y_t} = \frac{NX_t}{Y_t} - r * \frac{D_t}{Y_t},$$

where D_t is net foreign debt, and $-rD_t$ is net factor income from abroad.

Corresponding to the slight rise in total saving rates and the slight fall in total investment rates between 2000 and 2025, the Korean net export surplus to GDP ratio rises slightly between 2025 and 2040 (not depicted). The sharper decline in total saving rates compared to total investment rates between 2025 and 2040, however, leads to Korea's net export surplus to GDP ratio to turn negative between 2025 and 2040.

Table 2 also depicts the trends in the net foreign assets-GDP ratio, and the current account-GDP ratio. Until 2025, the positive net export surplus, and the interest income from net foreign assets boost Korea's current account-GDP ratio to almost 2 percent. After 2025, although net export surpluses turn negative, the interest income from Korea's net foreign assets is still sufficient to bring Korea's current account into positive territory, resulting in increasing net foreign assets. However, after 2040, Korea's net foreign assets are projected to decline rapidly, as total saving rates fall sharply below total investment rates.

V. Comparisons with Future Japanese Saving and Investment Rates

Japan is another country that is aging very rapidly. The main difference with Korean aging, is that Japanese aging is happening about 25 years earlier. While in Korea, the percentage of the population over the age of 65 reaches about 25 percent in 2040, that percentage is reached in only 2015 in Japan. This suggests that the deterioration in saving rates and in current accounts will occur much sooner in Japan.

Table 3 depicts the projections of Japanese investment and saving rates from 2000 to 2040, using the same analytical model as that for Korea (as above).[4] Japan's population aging occurs most rapidly between 2000 and 2025; Japan's support ratio will decline from the current 0.62 to 0.55 in 2025. Japan's total investment ratio will remain steady at around 29-31 percent for the next 40 years.[5] Corresponding to the sharp declines in the support ratio, Japan's total saving rate will fall from the current 31 percent to 24 percent in 2025, and to 20 percent in 2040.

Thus, Japan's current account will turn to deficit by 2025, and the current account deficit will increase to -5 percent of GDP by 2040. With these high current account deficits, Japan's net foreign asset position will decline from 94 percent of GDP in 2025 to 67 percent of GDP in 2040. What is remarkable about these projections for Korea and Japan is that contrary to the usual post-World War II pattern, Korea may be supplying international capital to Japan from around 2025 to perhaps around 2040, which is a very surprising turn of events.

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[4]The small country assumption may not be valid for Japan. Since Japan is a large part of the global economy, a cut in Japanese saving may raise world interest rates, leading to a fall in Japanese physical investment, and a smaller Japanese current account deficit.

[5]Recall that in our model, investment rates are driven mainly by global real interest rates.

VI. Conclusion.

In Korea, the rapid aging of the population underway is expected to lower both total saving and investment rates, especially drastically after 2025. Until sometime after 2025, however, Korea is expected to maintain relatively high total saving rates and run current account surpluses, thus accumulating net external assets. In Japan, total saving rates are expected to start falling around 2015. In Korea, total saving rates will start to sharply decline about 25 years later–in 2040. This is because in Korea, the demographic transition–falling fertility rates–happened about two to three decades after Japan's demographic transition.

Korean total saving rates will start to dip slightly below total investment rates around 2025. However, the external assets accumulated earlier should allow Korea to earn enough capital income from abroad, so that the country should be able to run current account surpluses even after 2025, perhaps to around 2040. What is remarkable about our projections is that Korea may be supplying international capital to Japan from around 2025 to perhaps around 2040.

Appendix

Simulation of the Optimal Investment Rate.

The investment rate is determined from firm behavior. Assume that Korean firms produce using a production function of:

$$Y_t = K_t^{\gamma} \hat{L}_t^{1-\gamma} \,,$$

where γ is the capital share. Capital and effective labor grow according to:

$$\hat{L}_t = L_o e^{(n_t + g)t} \qquad \text{(A1)}$$

$$\frac{dK_t}{dt} = \dot{K}_t = I_t - \delta K_t \qquad \text{(A2)}$$

where n_t is the rate of labor supply growth, which in our framework changes over time, g is the constant rate of labor-augmenting technical progress, I_t is the gross investment rate, and δ is the constant depreciation rate.

In addition, it is assumed that firms face adjustment costs to changing their capital stock such as retooling and downtime:

$$adj\cos t = I * [I + b/2 * I / K].$$

We assume that firms maximize the present discounted value of profits:

$$V = \int_0^{\infty} e^{-rt} [K_t^{\gamma} \hat{L}_t^{1-\gamma} - I_t * (1 + b/2 * I_t / K_t)] d\tau$$

subject to equation (A2), where r is the international real rate of interest.

The optimal paths of the capital stock per effective labor and the shadow value of capital (Tobin's q) are:

$$\frac{d\hat{k}}{dt} = \hat{i} - (g+n+\delta)*\hat{k} = [(q-1)/b - (g+n+\delta)]*\hat{k} \qquad \text{(A3)}$$

$$\frac{dq}{dt} = (r+\delta)*q - [\gamma\hat{k}^{\gamma-1} + \frac{(q-1)^2}{2b}] \qquad \text{(A4)}$$

Equations (A3) and (A4) imply steady-state values of $\hat{k}$ and q of:

$$\gamma\hat{k}^{\gamma-1} = r+\delta+b*(g+n+\delta)*[r+\delta-(1/2)*(g+n+\delta)] \qquad \text{(A5)}$$

$$q = 1+b*(g+n+\delta) \qquad \text{(A6)}$$

We discretize differential equations (A3) and (A4), to find the levels of steady-state capital per effective labor and q in an earlier year that will lead the economy to the terminal steady-state levels $\hat{k}$ and q in 2050 (given by (A5) and (A6)). For the parameters used in the simulations, we take values culled from the literature. For $\gamma, g, \delta, r, a, b$ we use 0.30, 0.012, 0.13, 0.06, 0.35, and 6. The values are fairly standard, except for the high value of the depreciation rate, δ (Hayashi, 1986).

Our simulation strategy is to start from 2050 and simulate backwards, using the values of the labor force growth rate n_t for that year all the way back to 2000. The data for n_t are available for Korea (from the United Nations) only in 2025 and 2040. We interpolate for n_t for each 5 year interval–2005, 2010,..2030, 2035; and use these interpolated values, along with the data for 2025 and 2040 in our simulations. As it turned out, given our parameter values, new steady states were reached in about 5 years for all n_t. For example, given n_t between 2050 and 2045, and the steady state values of $\hat{k}$ and q from (A3) and (A4), steady states of $\hat{k}_{2045}$ and q_{2045} were reached in about 5 years. Now with these $\hat{k}_{2045}$ and q_{2045} as starting values, and with n_t between 2045 and 2040, steady states of $\hat{k}_{2040}$ and q_{2040} were achieved in 2040, and so on. This process was repeated every 5 years until 2000.

Finally, from the paths of $\hat{k}_t$ and q, we can calculate investment per effective labor (from (A3)), and output per effective labor (from the production function), and thereby calculate the investment rate (investment/output).

Simulation of the Optimal Saving Rate.

From (4) and (5) in the text, it can be shown that the growth in per-capita consumption is constant and equal to:

$$\frac{\dot{c}}{c} = \frac{1}{\theta} * (r - \rho)$$

and that consumption per capita at time 0 (in our case, year 2000) depends in a complicated way on the parameters of the lifetime utility function, and the entire future paths of n_t, α_t, and w_t.

For convenience, rather than simulating the path of consumption per capita, we simulate the path of consumption per effective labor, $\hat{c}_t$. In addition, to prevent consumption per effective labor from approaching zero asymptotically, we assume that $r = \rho + \theta g$. In this case, it can be shown from (4) and (5) in the text that along the optimal path,

$$\frac{d\hat{c}_t}{\hat{c}_t} = \frac{-\dot{\alpha}_t}{\alpha}$$

Thus, consumption per effective labor falls when the support ratio rises.

For parameter values, we assume that $\theta = 3$ and $\rho = 0.024$, and that the projected demographic values for 2050 persist as the economy's final steady-state. Finally, using our consumption per effective labor and output per effective labor projections from above, we simulate the future path of the optimal saving rate. We assume that the labor growth rate (n_t) and the population growth rate (z_t) have already been anticipated by Korean households in the year 2000. Thus, the simulated values for optimal consumption and saving in 2000 are the actual values in that year (=average of consumption and saving between 1990 and 2000).

Table 1: Korea: Saving and Investment and Net Exports

	Private Saving 1/	Government Saving 1/	Investment 1/	Net Export Surplus 1/	GDP Growth Rate 2/
1970-80	19	4	27	-5	10
1981-85	24	5	29	0	13
1986-90	33	5	31	6	14
1991-95	32	4	37	-1	11
1996-00	31	5	37	-1	2
2001-03	20	12	31	1	5

1/ In Percent of GDP.
2/ Real Growth Rate
Source: Bank of Korea, National Accounts.

Table 2: Korea: Projections of Investment and Saving Rates, Current Account, and Net External Assets
(as percent of GDP)

	Support Ratio	Investment 1/ Ratio	Saving 1/ Rate	Current 1/ Account	Net Foreign 1/ Assets
2000	0.63	37	36	0	8
2025	0.62	35	36	2	23
2040	0.53	30	27	1	69

1/ As percent of GDP.

Table 3: Japan: Projections of Investment and Saving Rates, Current Account, and Net External Assets
(as percent of GDP)

	Support Ratio	Investment 1/ Ratio	Saving 1/ Rate	Current 1/ Account	Net Foreign 1/ Assets
2000	0.62	29	31	4	25
2025	0.55	31	24	-1	94
2040	0.52	29	20	-5	67

1/ As percent of GDP.

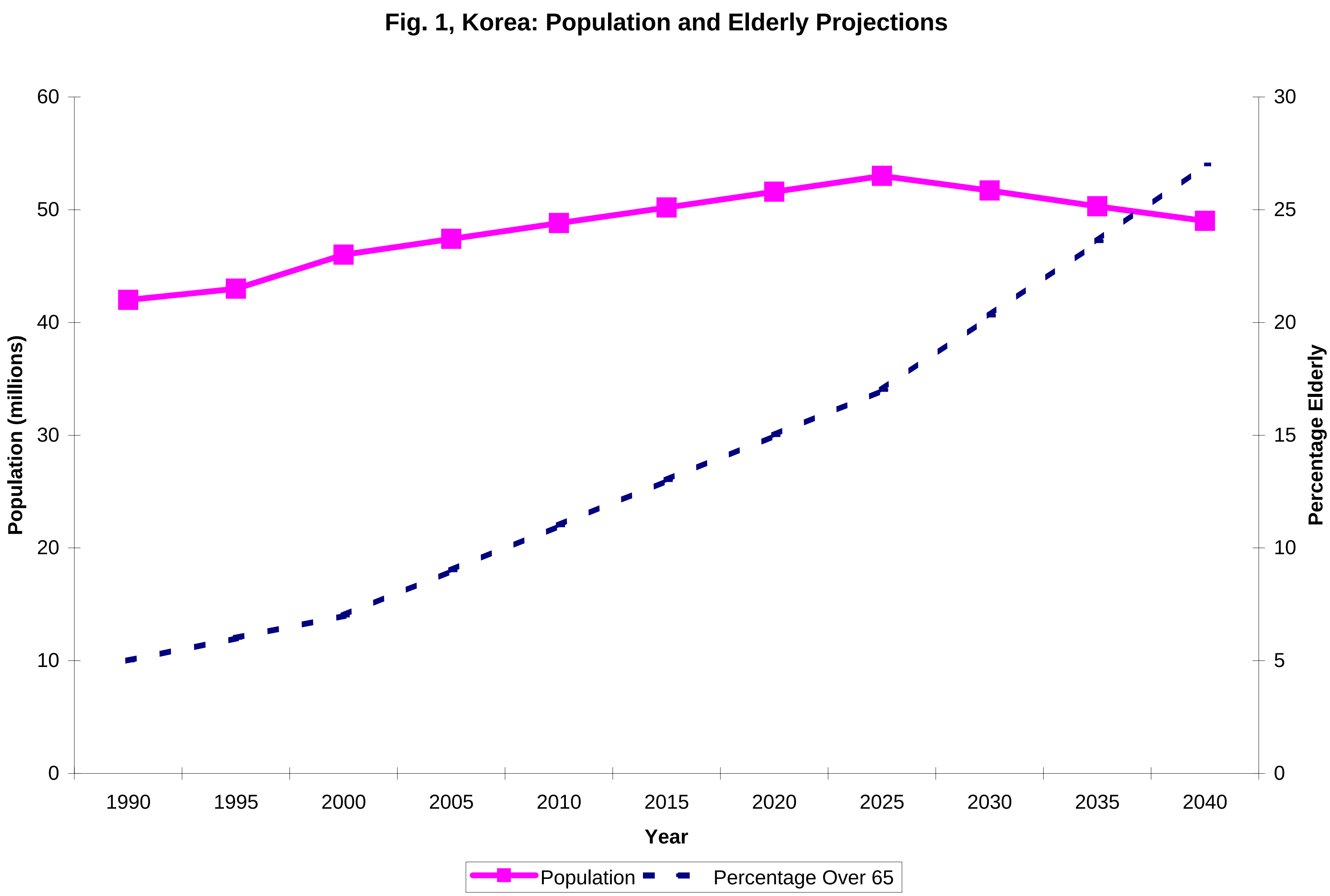
Fig. 1, Korea: Population and Elderly Projections
Population (millions)
Percentage Elderly
60
50
40
30
20
10
0
30
25
20
15
10
5
0
1990
1995
2000
2005
2010
2015
2020
2025
2030
2035
2040
Year
Population
Percentage Over 65

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