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Study on The Relation between Dependency Rate and Saving in Korea

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Ⅰ. Introduction

1. Background of Study

Since the first 5- year economic development plan which started in 1962, Korea's economic achievement has been surprising. From 1960 to 1980 GNP per capita has increased about fourfold and manufacturing sector's share of GNP from 11 percent to 34 percent.

We can enumerate several economic and non-economic factors which made this rapid economic development possible. However it seems that the most important factor among them is a capital accumulation. Korea had been devastated by the Japanese during colonial period and, what is worse, by the Korean War. So there were not opportunities to accumulate capital. If we accept the general thinking that development is industrialization capital is necessary to build up machinery and equipments, and eventually it must be funded by capital accumulation, so capital accumulation is a necessary condition for the industrialization and economic development. It is believed that if the rate of capital accumulation is less than population growth rate, GNP per capita does not increase.

As mentioned above, at the initial stage of economic development, Korea was deficient of the necessary condition of modernization. So several alternatives were enacted to overcome the weakness of deficient capital.

During past, sources of gross domestic capital formation were as follows:

First, accumulation of capital in the capitalist sector maintaining subsistence wage level. According to Lewis, with unlimited supply of labor, capitalist sector can accumulate capital by high profit margin taking advantage of low subsistence wage level.

Second, taxation and saving by Government. Tax burden ratio in Korea was 15.9 percent in 1975, 19.3 percent in 1981, and government's saving ratio was 5.3 percent in 1975, 6.7 percent in 1981.

Third, enforced saving by inflation. Not only inflation supress consumption but also stimulates private investment. Generally inflation in Korea has been high.

Fourth, foreign capital inflow. It seems that foreign capital inflow contributed to capital accumulation especially in initial stage of economic development. But at the same time it is a matter of controversy.

From the above four sources, foreign capital share in total demestic capital formation is 83.5 percent in 1962, 42.6 percent in 1971, 30.4 percent in 1981. In spite of the decreasing tendency of foreign capital share, it is still high, and high dependency on foreign capital means that the economic development process is susceptible to external disturbing factors. Particularly Oil Shock a few years ago testified this fact.

According to revised fifth 5-year economic development plan(1984—1986), Korean economy is expected to increase houshold saving rate to 9.3 percent, and business saving rate to 11.7 percent, and the details are below.

Table 1. Saving Prospects by Sectors

(current price, %)

	1980	1983	1986
Gross Investment Rate	31.3	27.6	29.5
National Saving	21.9	24.4	29.3
Household	6.0	7.1	9.3
Business	10.1	10.2	11.7
Government	5.7	7.1	8.3
Foreign Saving Rate	9.4	2.9	0.2

Source : The Revised Fifth 5-Year Economic Development Plan, 1984~1986, The Korea Government, 1983

As mentioned above, national saving is naturally a very important factor for autarky. There are many factors which affect saving behavior.

By the way I cannot find a study which analyzes fully the relationship between domestic saving behavior and demographic transition. We can easily infer that if the proportion of population who only consume decrease saving rates will go up. We can see some studies about this. The changes in absolute size and composition of population are certainly related to the changes of domestic saving level, so I feel it is necessary to analyze it.

2. The Scope and Objectives of Study

We can easily infer that the more people who are to be supported by the working population there are, the lower the level of saving—which is the surplus from income excluding consumption — is. The dependency rate changes as the population growth pattern and consequently composition of population by age and sex change. In Korea we can find a study which analyzes only the relation between household saving behavior and the number of members of family by using household survey data, but not national data.

Particularly the timing effect and level effect of change in dependency rate on saving — the concept of these terms will be explained in Chapter Ⅲ — will be considered using Mason's extended life cycle saving model. Thereafter another dynamic saving function will be compared with the model with which we will begin the analysis deriving the long-run implication of it. In addition simultaneous determination of saving and investment will be considered to avoid the simultaneity bias in the estimation of coefficients of saving function.

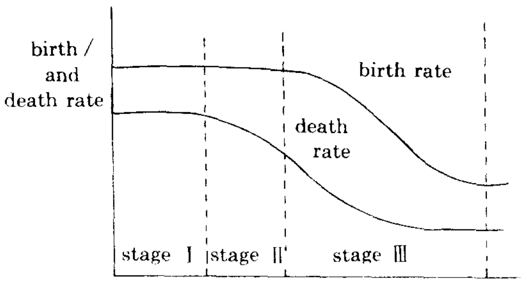
Ⅱ. Population and Economic Development

1. The Effects of Economic Development on Population Growth

Economic development influences population growth through one or more of the three determinants of poulation growth — namely, births, deaths, and immigration. Migration will not be discussed because it is not urgent objective of this study.

The classical economic theory of population growth (primarily associated with Malthus) held that any rise in incomes (particularly among the poor classes) tended to increase birth rates and (with more certainty and force) to decrease death rates. The course of events since Malthus' time, however, has led to gradual evolution of a theory that postulates a more complicated sequence of birth and death rates as typically associated with economic development. It is called the theory of "Demographic Transition" and it is summarized by the Figure 1.

Figure 1. The Demographic Transition



This figure is so familiar that I will omit the explanation. It is, however, criticized that this demographic transition theory only describes well the history of developed countries. Teitelbaum, for example, casts a doubt on the applicability of this theory to developing countries. His reason is that the theory fits well under conditions that the same process as did happen in Europe may be expected in developing countries, given those similarities and dissimilarities from the countries of 19th century Europe. For example, the Malaria eradication in Sri-Lanka that happened in 1947 contributed to a rapid increase in population growth. It is believed that this demographic change – very different from that which would have resulted from an increase in fertility – helped to produce an acceleration of economic growth, primarily through improvements in the quality of labor.

This example clearly shows a pattern of something different from the traditional demographic transition theory—in this case, reversed causality.

2. The Effects of Population Growth on Economic Development

There are three aspects of population growth that may be looked at separately in analyzing the effects of population growth on the growth of per capita income. These are a) the size of population, b) its growth rate, c) and its age distribution. The relation between population size and per capita income is the subject to which optimum population theory has been adressed. The principal point at issue is that of returns to scale, with the two opposing forces at work – economies of scale favoring a rising per capita income, and diminishing returns, a falling per capita income with larger population size. But because the shape of the curve relating output to labor force depends on the available techniques of population, which in turn depends on what skills the population possesses, it is very difficult to answer in any direction.

The significant feature of population growth as such is that a higher rate of population growth implies a higher level of needed investment to achieve a given per capita output, while there is nothing about faster growth that generates a greater supply of investible resources. Furthermore, when the supply of capital is inelastic, a higher rate of population growth forces the diversion of investment to duplicate existing facilities, preventing an increase in the capital available for each worker.

The third factor — distribution of population by age — turns out to be strongly influenced by the same elements that determine the rate of population growth. Persistent high levels of fertility give a broad-based distribution that tapers rapidly with age: persistent low level of fertility gives a narrow-based age distribution. Now let see the effects of dependency rates, — with the same resources and capital available, but with the lower birth rate (so lower dependency rates) — population should have higher per capita income as a direct result of having a higher fraction of its population eligible on account of age for productive work. Moreover a family with the same total income but with a larger number of children would surely tend to consume more and save less, other things being equal. Thus high dependency rates are believed to lower the national saving rates.

3. Population Trend and Population Policy in Korea

1) Populpation Size and Growth

The first modern Korea's census was conducted in 1925. From then until the end of World War II, five censuses covering all of Korea were taken at five-year intervals (except for the 1945 Census, which was carried out in 1944). From the establishments of the Republic of Korea in 1948 to the present, government has conducted seven censuses: in 1945, 1955, 1960, 1970, 1975, and 1980. Since the partition of the country in 1945, it has not been possible to follow the population trends of the entire peninsula. Thus while the data for the pre-1945 period represent the entire Korean peninsula, the data for the post-1945 period relate to only south Korea.

Between 1944 and 1949, the population increased from 15.9 to 22.0 million, corresponding to an extremely high annual growth rate of 4.7 percent. This abnormally high growth rate resulted from the return of Koreans to the country from overseas following the liberation of Korea in 1945. In contrast, the 1955 Census revealed an average growth rate of only 1 percent per annum between 1949 and 1955. This low rate of population growth resulted from the disruptions of Korea War period (1950-'53). The rate of natural increase (i, e., net increase exclusive of migration) during this period was estimated to be 0.7 percent, an extremely low figure. This rate was due to the large number of war casualities and, to a lesser extent, temporary lower birth rates.

The 1960 and 1966 Censuses showed that high birth rates had occurred during the 1955-'60 and 1960-'66 inter censal period, at 2.7 percent and 2.5 percent per annum, respectively. These high growth rates may be attributed to very high birth rates and reduced death rates caused by improved public health measures and better medical facilities. Since that time the population growth rates have shown a gradual, steady decline. In 1970, 31.4 million people were enumerated, and by 1975 the number had risen to 34.7 million. These figures correspond to intercensal growth rates of 2.3 and 1.8 percent perannum, respectively.

In summary, the Korean population showed moderately rapid increases to the year 1945. From 1945 to 1950 there was unusually rapid growth due to both immigration and natural increase. The highest natural growth rate was observed between the end of the post-Korean War period and the early 1960s when birth and growth rates began to decline. The population of Korea has more than doubled in the 30 years between 1945 and 1975.

2) Population Composition

Because of the Korean War and its aftermath and because of rapid population growth and migration, there have been a number of irregularities in the age and sex composition of the Korean population. Among those below the age of 25 in particular, we are now witnessing the effects of the postwar baby boom and of recently the falling fertility.

Starting in the early 1970s, the children born during the baby boom period began to enter the working age population, relieving the country of heavy dependency burdens. The percentage of the population 65 years old and older has remained rather stable, although the absolute number increased by 246,000 between 1966 and 1975. The old-age dependency ratio in 1975 was only 6.0.

The age composition of women in the reproduction years (along with differential marital fertility) strongly influences the future population composition of a country. During the period 1966 through 1980, women in the age bracket 15~49 increased not only in terms of absolute but also as a proportion of the total female population.

3) Evolution of Korean Population Policy

Since population policy in Korea evolved primarily in response to problems caused by high population growth rate, it has historically focused on the reduction of fertility through fertility control programs (mainly family planning) and supporting activities. Abundant funds were available from the outset to implement these policies given the keen international attention paid to rapid population growth in developing countries. In contrast, population distribution problems have generally been treated as relatively minor national problems. For this reason, the distribution aspects of the population problem began to receive attention much later, only after economic development and urbanization were in advanced stages.

Korean population policy has continued to evolve toward a complex and comprehensive statement of government's population goals in a number of socio-economic sectors. It is now relatively well integrated with the overall national socio-economic development plan. The attempt to define population quality and to set policy affecting this broad area remains as tasks to be confirmed in the future.

Ⅲ. Model and Data Analyses

1. Single Equation Model

Mason extended life-cycle model to cases in which both the level and the timing of consumption by households change. In short his model is;

$$s = a_0 + a_1 g$$

where

s : aggregate saving ratio

g : rate of growth of total income

The gist of his theory is that the demographic variables, for example dependency ratio, affect the both coefficients, a_0 and a_1. In other words, as demographic status changes, the saving function changes its slope and intercept. Mason called the intercept change the level effect and the slope change the timing effect.

He built up the model as follows. First of all, the unit of analysis is household, not the individual, and the equilibrium is assumed — rate of population growth and economic growth is constant. Consequently, the growth rates of household and of individual are identical. Likewise the growth rates of per capita and per husehold income are identical.

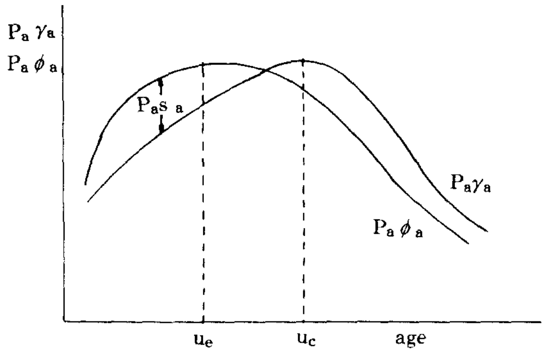
Each household is omniscient with respect to income at age a, Y_a, and its childbearing. The household's lifetime resources, V, are

$$V = \int_0^w P_a Y_a \, da \cdots\cdots (1)$$

where P_a is the probability that the household will survive to age a, then, $\phi_a = Y_a / V$ means the fraction of resources the household earns at age a. Likewise $\gamma_a = C_a / V$ is the fraction of resources the household consumes at age a. It follows, of course, that the fraction of lifetime resources saved at each age, $s_a = \phi_a - \gamma_a$.

There are two ways through which household consumption may be affected. First, the expected fraction of lifetime resources the 'average' household consumes, $L = \int P_a \gamma_a \, da$, may depend on the number of children reared. In other words, the household's consumption distribution, illust-

Figure 2. Household Distribution of Consumption and Earning



rated by Figure 2 may shift up or down. Second, the timing of consumption may be influenced, which can be measured by the mean age of consumption, u_c, where

$$u_c = \int a\ P_a \gamma_a\, da / \int P_a \gamma_a\, da \quad \cdots\cdots (2)$$

The mean age of consumption, shown in Figure 2, is an average age weighted by consumption. By definition the level of household earning, $\int P_a \phi_a da = 1$, hence, only the timing of household earning can change. The timing of earning by the household will be measured by the mean age of earning, u_e, where

$$u_e = \int a\ P_a \phi_a da / \int P_a \phi_a da \quad \cdots\cdots (3)$$

Of course, the household's pattern of saving is determined by its consumption and earning. A rise in the level of consumption, L, implies a reduction in the fraction of lifetime resources saved. A decline in the mean age of consumption (level held constant) implies a decline in saving at young age and compensating rise at older age. Finally, $u_e - u_c$ defines whether household saving is concentrated more heavily in younger ages or old ages. If $u_e < u_c$, the household generally earns its money before it spends.

The aggregate saving rate, s, at any point in time is :

$$s = \int V_a s_a da \quad \cdots\cdots (4)$$

where V_a is the ratio of average lifetime resources of all households currently aged a to national income and s is the ratio of total saving to total national income. Taking the total derivative of the saving rate given by above equation :

$$ds = \int dV_a s_a da + \int V_a ds_a da \quad \cdots\cdots (5)$$

Mason showed that $V_a = e^{-ga} P_a V_o$ under the assumption that rate of economic growth is constant.

The first term of right hand side of equation (5) isolates the changes in the distribution of resources across generations and captures the rate of growth effect. The second term isolates the changes in household saving and is called the dependency effect.

The following result is derived by Mason.

The growth effect is :

$$\partial s / \partial g = \int (\partial V_a / \partial g) s_a da$$
$$= (1-s)(u_c - u_e) \quad \cdots\cdots (6)$$

solving this differential equation:

$$s = Ae^{-(u_c - u_e)g} + 1 \quad \cdots\cdots (7)$$

$$\ln[1/(1-s)] = b_0 + b_1 g \quad \cdots\cdots (8)$$

Except for very high saving rates $\ln[1/(1-s)]$ is approximately equal to s. Here $b_0 = -\ln L$ where L is the fraction of resources consumed over its entire lifetime, i.e., the level of consumption.

The dependency effects are summarized as follows :

$$\partial s / \partial \gamma = -(1-s)(n - g\partial u_c) \quad \cdots\cdots (9)$$

where n : the increase in the fraction of resources the household expects to consume over its lifetime

Likewise

$$\partial s / \partial \phi = -(1-s)(g\partial u_e) \quad \cdots\cdots (10)$$

So we can get

$$\int V_a ds_a da = (1\text{-}s)[-n + g(\partial u_c - \partial u_e)] \cdots (11)$$

The final result is

$$ds = (1\text{-}s)\ [-n + g\partial(u_c - u_e) + (u_c - u_e)\partial g)] \cdots\cdots (12)$$

If demographic change affects the level of consumption n will change, and timing of consumption and earning, $(u_c - u_e)$ will change and growth rate change affects saving rate by interaction with $(u_c - u_e)$ (for details refer Mason).

The implication of this model is explained at the beginning of this chapter.

Then the following equation can be presented.

$$\ln[1/(1\text{-}s)] = b_0 + b_1 g \cdots\cdots (13)$$

and by assumption

$$b_0 = K_0 + K_1 D \cdots\cdots (14)$$

$$b_1 = K_2 + K_3 D \cdots\cdots (15)$$

where D is dependency rate.
Substituting b_0 and b_1, we get

$$\ln[1/(1\text{-}s)] = K_0 + K_1 D + K_2 g + K_3 D*g \cdots\cdots (16)$$

The regression result with OLS method is;

Table 2. Ordinary Least Squares Result

Dependent Var. : ln[1 / (1-s)]   (period '60–81)

indep. var.	b	SE(b)	T-value
D	−0.728	0.434	−1.676
g	−2.251	3.084	−0.730
D*g	3.635	4.720	0.770
constant	0.663	0.276	2.400

R^2 : 0.199 D-W : 0.459 Overall F : 1.416

D - W says that there is auto-correlation. So Cochrane-Orcutt iterative technique is used. Furthermore the correlation matrix shows that there is a high correlation between D*g and g. So there must be a problem of multicollinearity. Cochrane - Orcutt method is believed to relieve this problem a little. The results when Cochrane - Orcutt method is applied are as follows:

Table 3. Cochrane - Orcutt Method

Dependent Var. : ln[1 / (1-s)]

indep. var.	b	SE(b)	T-value
D	0.121	0.274	0.444
g	1.170	0.937	1.249
D*g	−2.341	1.466	−1.657
constant	0.187	0.181	1.031

R^2 : 0.864 D-W : 1.517 Overall F : 34.149

When we delete the insignificant variable D from the equation we get the following result:

Table 4. Ordinary Least Squares Result

Dependent Var. : ln[1 / (1-s)]

indep. var.	b	SE(b)	T-value
g	1.741	2.056	−0.846
D*g	−2.828	2.857	−0.989
constant	0.204	0.039	50143

R^2 : 0.006 D-W : 0.222 Overall F : 0.65

Here again C - O method is applied because the D - W value is too low:

Table 5. Cochrane-Orcutt Method

Dependent Var. : ln[1 / (1-s)]

indep. var.	b	SE(b)	T-value
g	1.004	0.837	1.198
D*g	−2.159	1.299	−1.162
constant	0.226	0.035	7.507

R^2 : 0.226 D-W : 1.505 Overall F : 53.65

In the above two cases, ρ which adjusts auto-correlation is about 0.790, and the t-value for ρ is more than 5 (with D: 5.82, without D: 5. 77)

However the transformed variables used in the Cochrane-Orcutt procedure are also highly correlated, the correlation matrix is:

Table 6. Correlation Matrix of Tansformed Variables

	$S-0.79^*S_{-1}$ (1)	$D^*g-0.79(D^*g)_{-1}$ (2)	$g-0.79^*g_{-1}$ (3)	$D-0.79^*D_{-1}$ (4)
(1)	1.000	−0.5791	−0.5361	−0.1258
(2)	−0.5791	1.0000	0.9877	0.0677
(3)	−0.5361	0.9877	1.0000	0.0486
(4)	−0.1258	0.0677	0.0486	1.0000

The high correlations shown above mean that Cochrane-Orcutt method cured the problem of auto-correlation but not of multicollinearity.

If we have no consideration for multicollinearity, we can say that although there is not level effect, but there does exist a timing effect. Nevertheless, the multicollinearity makes everything doubtful. So we cannot say this or that.

There must be another method for evaluating the timing effect and the level effect of dependency rate change.

Therefore the following transformations are contrived.(hereafter, all variables denote absolute values, not ratio)

Average propensity to save(APS) is :

$$APS = S / Y = b_0 + b_1(\triangle Y / Y) \cdots\cdots (17)$$

therefore:

$$S = b_0 Y + b_1 \triangle Y \cdots\cdots (18)$$

so,

$$S_{-1} = b_0 Y_{-1} + b_1 \triangle Y_{-1} \cdots\cdots (19)$$

(18)−(19) gives

$$\triangle S = b_0 \triangle Y + b_1(\triangle Y - \triangle Y_{-1}) \cdots\cdots (20)$$

Therefore marginal propensity to save(MPS) is:

$$MPS = \triangle S / \triangle Y = b_0 + b_1(\triangle Y - \triangle Y_{-1}) / (\triangle Y) \cdots\cdots (21)$$

solving the simultaneous equations (17) and (21) we get

$$b_0 = APS - b_1(\triangle Y / Y) \cdots\cdots (22)$$

$$b_1 = (MPS - APS) / [(\triangle Y - \triangle Y_{-1}) / \triangle Y - (\triangle Y / Y)] \cdots\cdots (23)$$

The calculated values of b_0 and b_1 are given in Table 7.

Table 7.

year	b_0	b_1
60	−0.0222	0.0023
61	−0.0204	0.5835
62	−0.0255	0.7597
63	−0.0149	0.5526
64	0.2050	−2.2650
65	0.0535	−0.1622
66	0.0479	0.0355
67	0.0609	−0.0886
68	0.0590	−0.0011
69	0.0565	0.0110
70	0.0598	−0.0299
71	−0.0011	1.0312
72	0.1909	−1.2586
73	0.1026	0.1122
74	0.1372	−0.1212
75	0.1656	−0.8609
76	0.1475	−0.0154
77	0.1458	−0.0013
78	0.1666	−0.2182
79	0.1442	−0.0287
80	0.1476	−0.0768
81	0.1580	−0.3320

Let apply the Mason's implication directly to the calculated values of coefficients, b_0 and b_1. The regression equations are as follows :

$$b_0 = a_0 + a_1 D \cdots\cdots (24)$$

and

$$b_1 = a_2 + a_3 D \cdots\cdots (25)$$

The results are below,

Table 8.

Dependent Var. : b_0

indep. var.	b	SE(b)	T-value
D	−0.410	0.345	−1.686
constant	0.377	0.175	2.153

R^2 : 0.136 D-W : 1.29 Overall F : 2.844

D - W statistic shows the symptom of auto - correlation, so Cochrane - Orcutt method is applied. The result is

Table 9.

Dependent Var. : b_0

indep. var.	b	SE(b)	T-value
D	−0.367	0.296	−1.241
constant	0.355	0.212	1.670

R^2 : 0.230 D-W : 2.26 Overall F : 5.00

From above results, we can see that dependency rate has negative coefficient and significant at 15 percent level. Although R^2 is unsatisfactory, overall F - value says that the model is significant at 5 percent level.

There fore, tentatively we can conclude that there is only a level effect.

Now for b_1:

Table 10.

Dependent Var. : b_1

indep. var.	b	SE(b)	T-value
D	0.8461	2.4453	0.346
constant	−0.7097	1.7654	−0.402

R^2 : 0.006 D-W : 2.34 Overall F : 0.12

This result shows that b_1 is not related to dependency rate change. In short, we can say that although the decrease of dependency ratio in Korea has contributed to increasing saving level, there is no evidence whether the decrease of dependency ratio postponed the timing of consumption.

Let's retrospect the model.

$$S / Y = b_0 + b_1(\triangle Y / Y)$$

This model says that when growth rate is increasing, the aggregate saving rate is increasing. So if we are to increase the saving rate, the economy must grow with acceleration. Korean saving data show a persistent increasing trend in spite of the fact that the growth rate has been relatively constant from 7 to 9 percent per annum. To test this model empirically, perhaps it is desirable to use cross - section data.

Cross - section study and time - series study has its own problems respectively. Cross - section data are subject to the greater range of variation in characteristics of data source but the lesser degree of interaction among the explanatory variables permits a much more accurate determination of regression coefficients than does time - series analysis.

Besides, too many variables in time - series regression model are liable to cause a multicollinearity. Unfortunately the cross-section data appropriate to the above model are not available. So hereafter the alternative saving function will be derived.

2. Simultaneous Equation Model

In this section, the model which is more appropriate to time series - data will be considered. In addition, the interaction between saving and investment will be analyzed at the same time.

Saving is not determined by alone itself. It is natural to consider that if there are many opportunities for investment and rate of return is high, the saving to fund the investment will increase. Of course, in modern world, savers and investors are not same. Between them there exists a capital market. Although the efficiency of capital market is very important to the analysis of saving and investment, we will concentrate on the interaction of saving and investment, because the consideration for efficiency of capital market may make this thesis out of point.

Saving and investment are connected by the relation $S = I - F$, where F is foreign capital inflow. Consequently, it is necessary to consider the simultaneous determination of S and I in order to avoid biases in the parameter estimates of saving function. To neglect this problem raises the question whether savings rates are low because people are unwilling to abstain from current consumption (e.g., due to high time preference because of "impatience" and / or demographic reasons) or whether low saving rates reflect low investment rates, caused perhaps by a low rate of return or a high user cost of capital. Clearly, the demand and supply determine jointly the level of saving. We can isolate the effects of the two sides if we estimate the saving and investment functions simultaneously.

1) Saving Function – Asset Accumulation Approach and Its Long-Run Implication

Let's begin with the theoretical foundation of saving function. This time, saving is interpreted as a process of asset accumulation. We can derive a saving function in the view of a demand for assets. Assume that the desired level of asset is a direct function of income and that the desired stock of asset is acquired over a fairly long period of time.

So the following model can be formulated. Assume that the desired stock of asset(A^*) is a function of income, and saving consists of a stock adjustment by which an individual closes the gap between desired and current asset to current saving. Then

$$A^* = P_0 + P_1Y_t \quad \cdots\cdots (26)$$

$$S_t = K(A^* - A_t) \quad \cdots\cdots (27)$$

that is :

$$S_t = K(P_0 + P_1Y_t - A_t) \quad \cdots\cdots (28)$$

The model becomes

$$S_t = a_0 + a_1A_t + a_2Y_t \quad \cdots\cdots (29)$$

$$(\text{a priori } a_1 < 0 \quad a_2 > 0)$$

$$dA_t / dt = S_t$$

Thus saving is linear function of assets and income, and the rate of change of assets at any moment of time is the savings at that moment.

Lets try to explore the long-run implication of this saving function.

<u>Assumption I</u>

$$dY / dt = m$$

where m is constant.

Under this assumption, we can derive following results. Solving above differential equation,

$$Y_t = mt + Y_0$$

so, growth rate of income at time t is $m/(mt+Y_0)$, where Y_0 is a income at time zero. Eventually the equation system becomes

$$S_t = a_0 + a_1A_t + a_2Y_t$$

$$dA_t / dt = S_t$$

$$dY_t / dt = m$$

We can obtain the time path of saving by solving the above differential equation system.

$$S_t = (-a_2m / a_1) * (1 - e^{a_1t})$$

thus

$$\lim_{t \to \infty} S_t = -a_2m / a_1$$

In the long-run, hence saving function may be presented as follows:

$$S / Y \propto \triangle Y / Y$$

This form is similar to the Mason's saving function in which he assumed the constant growth rate.

Assumption II

$(1/Y)(dY/dt) = g$

where g is a constant growth rate. The time path of income is given by

$Y_t = Y_0 e^{gt}$

The model becomes

$$S_t = a_0 + a_1 A_t + a_2 Y_0 e^{gt}$$

$$dA_t / dt = S_t$$

As before, we can get the following time path.

$$S_t = [1/(g-a_1)] a_2 (e^{a_1 t} + e^{gt})$$

The time limit of aggregate saving rate is

$$\lim_{t \to \infty} (S/Y)_t = [a_2/(g-a_1)]$$

We can conclude that when the growth rate of economy is constant, aggregate saving is also constant. Above two results under respective assumption indicate that Mason's model can be interpreted as steady state or long-run saving function basically. So we can affirm again that steady state saving model will fit well to cross-section data.

By the way, the saving function $S_t = a_0 + a_1 A_t + a_2 Y_t$ may be called a dynamic saving function. Because we can derive the following saving function, relaxing the assumption which was used to derive steady state function.

Because the data for asset are not available, let's transform the model :

$$S_t = a_0 + a_1 A_t + a_2 Y_t \cdots\cdots (30)$$

so,

$$S_{t-1} = a_0 + a_1 A_{t-1} + a_2 Y_{t-1} \cdots\cdots (31)$$

(30)-(31) gives

$$S_t = (1 + a_1) S_{t-1} + a_2 \triangle Y_t$$

The term on S_{t-1} permits us to capture rachet effects and the effects of lagged saving on current changes. The coefficient on $\triangle Y$ would show income responsiveness of saving and life-cycle effects.

The ordinary least square result for the above single equation is :

Table 11. OLS for Dynamic Saving Function

Dependent Var. : S

indep. var.	b	SE(b)	T-value
S_{-1}	0.875	0.023	37.80
$\triangle Y_t$	0.640	0.055	11.52

R^2 : 0.9871 D-W : 1.917 Overall F : 579.07

First of all, it seems that the model sucessfully explained the dependent variable, saving level, and all coefficient estimates are significant. Then let assume that dependency rates change has only a level effect,then run the regression involving the dependency rate in the equation.

Table 12. OLS for Dynamic Saving Function Including Dependency Rate

Deendent Var. : S

indep. var.	b	SE(b)	T-value
S_{-1}	0.853	0.035	24.129
$\triangle Y_t$	0.724	0.056	12.859
D	−11.517	5.807	−1.983

R^2 : 0.9912 D-W : 2.725 Overall F : 637.04

2) Investment Function — Leff and Sato Approach

Now the specification of investment function will be considered. An investment equation can be derived from a neoclassical production function. This would lead to an equation in which investment is a positive function of r, the rate of return to capital, and a negative function of i, the loan rate of interest. Because the time series observations for r is not available, the alternative investment equation is devised. At the same time, since our focus is on saving function, all we require of the investment function is that it helps to eliminate simultaneity bias in the parameter estimates.

Annual investment is asssumed to be a function of the lagged change of income (accelerator effects), of foreign capital inflow (part of which is presumably directed to investment), and reflecting the importance of monetary condition on investment, of the real stock of domestic credit. Furthermore this investment function can be thought to adjust saving to maintain the $S = I - F$ (F is a foreign capital inflow) equilibrium condition including two variables, domestic credit and income change. In Korea, level of international reserve is a very important policy interest. So when the level of import is high in a certain year, international reserve fall to a level which is unacceptable to policy makers. Reacting to the low level of reserves, the central bank tightens the supply of credit, which is institutionally practicable by raising reserve requirement in the banking system. This policy will also affect the increment of income. In passing, specification of the credit level permits us to capture the effects of balance of payment condition on economic adjustment in different years.

Investment function is presented as :

$$I = b_0 + b_1 CR + b_2 \triangle Y_{-1} + b_3 F$$

where :

I = investment

CR = real stock of domestic credit

Y = income change

The ordinary least square estimation of this equation is :

Table 13. OLS for Investment Function

Dependent Var. : I

indep. var.	b	SE(b)	T-value
CR	0.569	0.068	8.316
F	0.038	0.194	0.200
$\triangle Y_{-1}$	0.811	0.252	3.213

R^2 : 0.9701 D-W : 1.894 Overall F : 420.01

Finally the simultaneous equations are

$$S = a_1 S_{-1} + a_2 D + a_3 \triangle Y$$

$$I = b_0 + b_1 CR + b_2 F + b_3 \triangle Y_{-1}$$

$$I = S + F$$

The result of this equation system is :

Table 14. Estimation by Simultaneous Equation

indep. var.	b	SE(b)	T-value
S_{-1}	0.8903	0.0238	37.309
D	−2.2980	0.6623	−3.469
$\triangle Y$	0.8283	0.0623	13.284
CR	0.5864	0.0597	9.815
F	0.1077	0.1887	0.570
$\triangle Y_{-1}$	0.8419	0.2256	3.731

We can see that the parameter estimates in saving function are all significant and in accord with theoretical expectations. The coefficient of dependency rate is decreased in absolute value when compared with one in single equation. Simultaneous equation result shows that 1 percent decrease of dependency rate give rise to an increase of 2.29 billion won of saving. But we must be cautious in interpreting saving behavior, for the larger part of increase of our saving is a result of economic development.

Ⅳ. Conclusion

In this study, we mainly analyzed the saving behavior of our country, concentrating on the effects of dependency rate change. From 1960, dependency rate in Korea has showed a decreasing tendency owing to the government's family planning program and economic development. In the course of the transition—in this study, transition of population is summarized by change in dependency rate, it is believed that this transition certainly affected people's saving behavior.

According to Mason, decrease(increase) of dependency rate, especially in the growing economy, generally increases(decreases) domestic saving rates. The mechanism of the revelation of this effects is through timing effect and level effect. The timing effect means the change of mean consumption ages of households (due to changes of dependency rate) and the level effect means the change of the absolute portion of life - time resources consumed.

But Mason's model is thought to fit well cross - section data. So it is desirable to gather cross - section by survey and interview, because there is a high multicollinearity between time series data of independent variables which must exist in the model at the same time. So new testing method was contrived to see whether the change of dependency rate has shifted the national saving function. But this method was not very satisfactory, for the saving responds to several economic events – economic cycles, foreign capital inflow, interest rate changes, inflation – are believed to be as well as or perhaps greater than the dependency rate change. This problem causes the instability of coefficients of saving function in short period of time, and eventually new testing method gives a low R^2. Nevertheless, we can at least draw the conclusion that the changes of dependency rate have a level effect, but timing effect is suspicious.

In later part of data analyses, it is suggested that the unsatisfactory result of the Mason's model is partly due to the fact that the Mason's model assumes a long-run steady state equilibrium implicitly. So dynamic saving function was presented and it was proved that the long-run implication of this dynamic function is equal to the long-run steady state function with some reasonable assumptions. By this, we can see that it is necessary to be cautious in building up a certain model and applying it to a certain type – cross - section or time series – of data. In the dynamic saving function model it seems that dependency rate change has a significant effect on saving levels.

Lastly we set up a simultaneous equation system. In fact saving should be considered in two directions – supply and demand. For example, dependency rate is related to supply of saving, and demand for saving means an investment. Investment opportunities and needs determine the saving level along with the variables which act in the supply part. The result for this simultaneous equation model shows that there is clearly a negative relationship between saving and dependency level.

Still there are many things to be done. First, we cannot acertain the timing effect of dependency rate changes. There should be a more appropriate and dexterious model which can isolate the effect of demographic transition on saving.

Second, Korean economy is characterized by dual economy. There must be a difference in saving and consumption behaviors between rural and urban people. Furthermore there was a extensive domestic migration from rural to urban. It should have had significant effects on Korean economy.

Third, saving behavior of proprietors and wage earners may be different.

Fourth, the effect of demographic variables on economy and of economic variable should be considered at the same time. In reality, this is a difficult but important problem. It is certain that the effects of economic variable on demographic transition should be included in the simultaneous equation model.

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