# Population Aging and Financial Markets: A Cross-Country Study

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Population aging may have different effects on different assets. We investigate the effect of population aging on financial markets by evaluating how population aging affects the size of asset markets. The regression analysis using a cross-country data reveals that although aggregate saving rates will decline significantly as the size of the elderly population continues to rise, aggregate savings themselves will keep increasing for a while as the working age population increases their savings in preparation for the elongated retirement life. The regression analysis also demonstrates that the proportion of the elderly population is positively correlated with the size of the bond market, while the positive relationship with the size of the stock market is not so evident. Such a finding implies that although a general asset price meltdown is not likely, some asset markets will be more adversely affected by population aging.

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## I. Introduction

One of the challenges facing the world economy is the aging of population. Many countries are experiencing a continuous rise in the size of the elderly population relative to that of the working age population as the post-war baby boomers reach the retirement age and the fertility rate declines.[1] The majority of OECD member countries have already become aged societies, and countries such as Japan, Germany, and Sweden will soon develop into super-aged societies.

There are also many countries that are still at an earlier stage of demographic transition, with the working age population growing rapidly due to a lower infant mortality rate. For these countries, population aging is not an immediate policy concern. Their immediate concern lies with how to maximize the demographic dividend by utilizing the growth potential provided by the rapidly growing working age population. However, sooner or later these countries will have to cope with the challenges of population aging. It is unlikely that their demographic dividend will be very long-lived as their demographic transition is proceeding more rapidly than the developed countries. Once these countries enter the stage of aging society, population aging is expected to proceed rapidly, as we can see in the cases of Korea and Japan.[2]

Population aging is expected to have a significant effect on economic growth, labor markets, public finance, and financial markets. Firstly, the aging population slows down economic growth. Not only does the size of the working age population decrease, but labor productivity may also decrease as the average age of the labor force continues to rise. Moreover, national savings and net capital

[1] The ratio of the elderly population aged 65 years and over to total population is generally used as a measure of aging, with a society with a ratio of 7 percent or more classified as an aging society, 14 percent or more an aged society, and 20 percent or more a super-aged society.

[2] As shown in Table 1, Korea only became an aging society as of 2000, but due to its rapid pace of aging, it is projected to become an aged society in 2018, and a super-aged society in 2026. Whereas it took 115 years for France to develop from an aging to an aged society, Korea is making the same change within a mere 18 year period. The reasons for the rapidity of Korea's aging are increased life expectancy and the aging of the baby boom generation born after the Korean War combined with a simultaneous decline in the youth population due to a sharp decline in the birth rate.

formation decrease as the size of the elderly population with low or negative propensity to save increases. Without sustained improvement in the total factor productivity or the labor force participation rate, output growth will slow down. Thus, countries with aging populations are faced with the task of how to maintain the growth momentum of the past.

The aging population also poses a threat to fiscal soundness and sustainability. Increased expenditure for health care, social security and the pension system, combined with a smaller tax base, places heavy burdens on fiscal soundness. The fiscal sustainability problem also raises the issue of unequal burden on the current and future generations, as the future generations must necessarily bear the heavier fiscal burden. Because of the short-termism of incumbent governments, this intergenerational transfer problem is difficult to prevent.

Population aging is also expected to have noticeable effects on financial markets and financial industries as well. Although financial markets will initially benefit from the increased saving and asset demand of the baby boom generation for retirement, aggregate saving will decline once the baby boomers start to retire, putting downward pressure on asset prices (Poterba 2001). Even if there is no general financial asset meltdown, the prices of some assets may be more adversely affected by the aging population than those of the others. People in their working ages are willing to hold riskier portfolio because they are able to cover the losses with their labor income. This, in turn, would mean that retirement of the baby boomers would put downward pressure on the prices of assets with higher risks such as equities. Even if there is to be no general sell-off of financial assets, asset holders may become exposed to a greater risk as financial markets become more volatile.

Previous literature such as Poterba (2001) and Davis and Li (2003) that tried to identify the effect of population aging on individual asset returns showed mixed results regarding the effect of population aging on bonds and equities. Evaluation of the effect of population aging on asset prices through the regression of asset returns on the demographic variables becomes complicated by the fact that the supply as well as the demand of financial assets can be affected by the change in the age structure of population. In this paper, we used the market size instead of the asset price or return. Since the market size reflects the asset price as well as the supply, we believe that using the market size as the dependent variable will be able to reveal the effect of population aging on asset markets more clearly.

This paper intends to evaluate the effect of population aging on financial markets. Through regression analysis using cross-country panel data, we estimate the effect of population aging on aggregate savings, asset returns and the size of asset markets. The paper is organized as follows. In Chapter II, we investigate how population aging affects aggregate savings, domestic investment and current account. Chapter III estimates the effects of population aging on the returns on equities and bonds. Chapter IV examines how the size of capital markets and the relative size of stock and bond markets are related to population aging. Chapter V concludes.

## II. Saving and Investment

The standard theory for analyzing the impact of changes in the age structure of population such as aging on aggregate savings is the lifecycle income theory of consumption. This theory, developed by Modigliani, Ando, and Brumberg begins from the hypothesis that people will take their lifetime income into consideration when deciding their consumption level. An average consumer has a lifetime income pattern of a very low level of income prior to employment, a rise in income level during adult years due to earnings from employment, and a lower level of income in late life when earnings decline after retirement. Despite such age-related changes in income, consumers desire to maintain generally stable consumption over the lifetime. As a result, the savings and the saving rate of each consumer will likely maintain a lifecycle pattern similar to the lifecycle pattern of income. In particular, the saving rate during the post-retirement late life will be very low compared to that of adult years when money must be saved in preparation for consumption after retirement.

Such a lifecycle income theory forecasts a decline in the overall saving rate when the proportion of elderly population increases. This is because the saving rates during late life are low relative to the saving rates in the youth and adult years. The empirical studies that analysed the effect of demographic changes on the aggregate saving rates with cross-country data provide supports in favor of the life-cycle theory. Weil (1994), Masson, Bayoumi, and Samiei (1995, 1998), Bosworth (1993), and Bosworth and Keys (2004), using cross country data, found a strong positive relationship between the share of middle-aged people and the aggregate saving rate and a strong negative relationship between the share of the elderly people and the aggregate saving rate.

On the other hand, the empirical studies that examined the lifecycle pattern of saving rates using household survey data have repeatedly found that elderly households do maintain rather high savings rates for some time after retirement, contradicting the prediction of the life-cycle theory. When the saving rate per age group is actually calculated using household survey data, however, it can be observed that elderly households do maintain quite a high saving rate for some time after retirement. Using household survey data from 4 countries, the United States, United Kingdom, Taiwan, and Thailand, Deaton and Paxson (1997) discovered that the lifetime savings pattern did not conform to the projections of the lifecycle income theory of consumption. For the United Kingdom and Thailand in particular, they discovered that the elderly maintained a level of savings similar to that of their youth and adult years. The lifecycle saving pattern derived from the Korean urban household survey data by Park and Rhee (2005) also reveals that high saving rates are sustained even after the age of 65.

Such results can yield two opposite interpretations. On the one hand, they may be interpreted as meaning that the projections of the lifetime income theory are flawed with regard to the elderly population's propensity to save. On the other hand, they may represent a sampling bias due to the use of survey data with the household as the survey unit rather than the individual.

As regards the first interpretation, a considerable amount of research, in fact, indicates that consumption decreases around retirement. Banks, Blundell, and Tanner (1998) revealed that households decrease consumption as retirement approaches, and Bernheim, Skinner, and Weinberg (1997) have shown that following retirement, many elements of consumption declined sharply. Hurd and Rohwedder (2003) also revealed that both actual and anticipated spending declined at retirement. The post-retirement uncertainty pointed out by Carroll (1997), as well as the precautionary motive and the bequest motive are offered as the explanation for the discrepancy of the observed savings behavior from the prediction of the standard lifecycle income theory of consumption.

On the other hand, there have been arguments that the phenomenon of continued high savings after retirement derives mainly from a sampling bias, and not because the lifecycle income theory of consumption does not apply to this case. The saving rate of the elderly may appear to be high because the elderly households extracted as samples in the household survey are generally those with incomes high enough to allow them to form an independent household. In other words, the discrepancy arises because the lifecycle consumption theory uses the individual as the unit of analysis, whereas the data used to determine the lifecycle savings pattern is based on a survey with the household as the unit.

In fact, Deaton and Paxson (2000) adopted the methodology of Chesher (1998) to estimate individual savings curves by age group using household income and consumption data from Thailand and Taiwan, and discovered a clear trend of drastic decline in the saving rate following retirement. Thus, while the use of household income and consumption data to determine the age-saving rate profile will find that the saving rate hardly decreases during 60 to 75 years of age, individual savings curves will reveal a sharp decline, and even negative savings, in the saving rate from 60 years onwards. Such results support the sampling bias interpretation that the saving rates of the elderly are overestimated due to the sampling bias inherent in household survey data.

This paper seeks to estimate the impact of aging on national savings through regression analysis using a country-level panel data. There may be some criticism about using such an aggregate data to estimate the effects of population age structure. However, the objective of this research is not to determine the influence on the saving rate by age group, but rather the influence on the average saving rate of the entire economy, and the use of aggregate data is therefore quite meaningful.

Moreover, there are also problems associated with using survey data to determine the impact of aging. As previously mentioned, the individual's lifecycle savings pattern is in need to estimate the impact of aging using a microeconomic data. Consequently, it becomes necessary to convert household income and consumption survey data into individual income and consumption data. Yet there is no guarantee that such conversion can yield accurate estimations of individual income and consumption. Another problematic aspect of using survey data is that the lifecycle savings curve itself can change over time. According to the estimation of lifecycle savings curves in Korea by Park and Rhee (2005) which applied the synthetic cohort method to the data from the 1970-1993 *Annual Report on the Family Income and Expenditure Survey*, not only did the household lifecycle savings curve in Korea make a significant upward movement during the sample period, the curve also showed noticeable changes in the shape such as the lowering of the age constituting the peak of the curve. Park and Rhee (2005) argued that such changes in the lifecycle savings curve are greatly influenced by demographic variables including decreases in the birth rate and the young age dependency ratio, increases in life expectancy, and decreases in expected number of children. According to their arguments, Korea's aging process is becoming an additional change factor of demographic variables, and thus the possibility that this process will alter the lifecycle savings curve cannot be ignored. If the effect on aggregate savings is estimated by considering only the change in age structure and excluding the expected changes in the shape of the lifecycle savings curve, the estimates may well be inaccurate. Therefore, to estimate the change in average savings for the entire economy rather than any effects on savings by age group, it becomes useful to use aggregated data such as country-level panel data.

The data used in this analysis are annual panel data from 86 countries between the years 1975 and 2002. To mitigate the influence of economic fluctuation and measurement error, all variables except *per capita* GDP use the 5-year average.[3] The data used in the actual estimation, therefore, comprise of 86 countries over six periods. Analysis using this country data is expected to clarify the long-term relationship between the saving rate and population variables.

As used in this research, the saving rate is measured by the ratio of gross domestic savings to GDP. Gross domestic savings includes corporate and public savings as well as household savings. Thus the estimates will reflect not only the impact of aging on household savings but the impact on public savings through the demand for social security and pension payments.

Consumption theory and existing empirical analysis were referenced to select the explanatory variables, and the variables concerning population age structure, income, and the government's

[3] The last period constitutes a 3-year average from 2000 to 2002.

fiscal and monetary policies were selected. The young age and old age dependency ratios are used as variables regarding population age structure. The old age dependency ratio is defined as the ratio of the population aged 65 years and over to the population aged 15 to 64 years. Since an increase in this ratio represents the relative increase in the proportion of the low-saving elderly population, it is expected to result in a decrease in the gross domestic saving rate. Similarly, the young age dependency ratio is defined as the ratio of the 0-14 year population to the 15-64 year population, and its increase is expected to decrease the gross saving rate.

*Per capita* GDP and economic growth rate are used as income variables. The log value of purchasing power parity-adjusted *per capita* GDP is used for *per capita* GDP, and the *per capita* GDP growth rate for the economic growth rate. *Per capita* GDP growth is expected to increase the saving rate, while the effect of the economic growth rate on savings remains unclear. This is because according to the lifecycle income theory of consumption, a rise in the economic growth rate can have two opposite effects on the overall savings rate. That is, a higher rate of economic growth, by increasing the income of the youth and adult population who have a higher propensity to save, can raise the aggregate saving rate, whereas it can also lead to a decrease in the aggregate saving rate as it increases the consumption of the youth population by increasing their anticipated lifecycle income.

Fiscal and monetary policy variables include the fiscal surplus ratio, the inflation rate, and the total liquidity ratio (M3/GDP). The government's fiscal surplus divided by GDP is used as the fiscal surplus ratio. As public savings, a fiscal surplus becomes part of national savings, and an increase in the fiscal surplus ratio is therefore expected to increase the national saving rate. If the Ricardian equivalence principle applies, however, the national saving rate will stay unchanged as households that perceive the budget surplus to imply a future decrease in their tax burden will subsequently decrease their savings. The degree to which the fiscal surplus ratio affects the aggregate saving rate is thus contingent on the Ricardian equivalence principle.

The rise of the inflation rate affects the saving rate through the fall of the real interest rate. In this situation, if the substitution effect from the change in the interest rate exceeds the income effect, a higher inflation will decrease the saving rate. We used the consumer

**TABLE 1**
REGRESSION RESULTS FOR THE SAVING RATE

| Explanatory Variables | Coefficients (*t*-statistics) | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| Old age dependency ratio | -0.860***<br>(-4.689) | -0.846***<br>(-4.662) | -0.799***<br>(-4.304) | -0.790***<br>(-4.311) |
| Youth dependency ratio | -0.213***<br>(-3.875) | -0.197***<br>(-3.586) | -0.200***<br>(-3.611) | -0.185***<br>(-3.343) |
| *Per capita* GDP | 5.387***<br>(6.442) | 5.097***<br>(5.753) | 6.131***<br>(6.481) | 5.867***<br>(5.809) |
| Growth rate | 0.246<br>(1.156) | 0.373**<br>(2.119) | 0.174<br>(0.827) | 0.332*<br>(1.891) |
| Government saving/GDP | 0.351***<br>(3.739) | 0.341***<br>(3.671) | 0.371***<br>(3.918) | 0.357<br>(3.830) |
| Inflation rate | 0.000<br>(0.285) | 0.000<br>(0.001) | -0.001<br>(-0.314) | -0.001<br>(-0.656) |
| Liquidity/GDP | -0.016<br>(-0.723) | -0.018<br>(-0.827) | -0.009<br>(-0.436) | -0.011<br>(-0.513) |
| African dummy | | -2.480<br>(-1.248) | | -2.296<br>(-1.147) |
| High income dummy | | | -3.571<br>(-1.599) | -3.522<br>(-1.592) |

Note: *, **, and *** mean that the null hypothesis of zero coefficient can be rejected at the significance level of 10%, 5%, and 1%, respectively.

price index to measure the inflation rate, while the M3 to GDP ratio is used as a variable indicating the development level of the financial markets. The development of the financial markets, by mitigating liquidity restrictions, is expected to decrease the overall savings rate.

Table 1 displays the results of the estimation using the panel data of 86 countries during 6 periods. In light of the simultaneity bias arising from the endogenous nature of such variables as the economic growth rate, the inflation rate, and the M3 to GDP ratio, a three-stage least squares method using instrumental variables has been applied. The lagged explanatory variables are used as the instrumental variables. The estimates given in Table 1 generally show results consistent with theoretical projections. They indicate that the saving rate rises in conjunction with the *per capita* income level, and that the economic growth rate also increases the saving rate.

**TABLE 2**
COMPARISON WITH THE ESTIMATES FROM OTHER STUDIES

| Author | Samples | Old Age Dependency | Young Age Dependency | Savings |
|---|---|---|---|---|
| Feldstein | Industrial countries | -1.21 | -0.77 | Private saving |
| Masson *et al.* | High income and developing countries | -0.25 | 0.25 | Private saving |
| Weil | Industrial countries | -0.5 | -0.27 | Private saving |
| Horioka | Japan | -1.03 | -0.29 | Private saving |
| Schmidt-Hebbel *et al.* | 10 developing countries | -0.48 | -0.48 | Household saving |
| Ling & Peng | East Asia | -0.6 | -0.4 | National saving |
| Modigliani & Sterling | Industrial countries | -0.51 | -0.2 | Private saving |
| Heller & Symansky | Emerging countries in Asia | -1.54 | -4.4 | Private saving |

Upon analyzing the relationship between fiscal-monetary variables and the saving rate, it first becomes clear that a fiscal surplus has a noticeable positive correlation with the saving rate. That is, a 1 percent point increase in the fiscal surplus ratio will lead to a 0.35 percent point increase in gross domestic savings. Meanwhile, the inflation rate has no significant relationship with the saving rate, nor does the total liquidity ratio indicating the development level of the financial markets seem to have no significant relationship with the saving rate.

With regard to the effect of population variables, both the young age dependency ratio and old age dependency ratio have a noticeable effect on the saving rate. A rise in either ratio decreases the saving rate, and this is consistent with the predictions of the lifecycle income theory of consumption. Specifically, a 1 percent point increase in the young age and old age dependency ratios will decrease the aggregate saving rate by 0.21 percent point and 0.86 percent point respectively. These numbers are comparable to the estimates in the former studies

Table 2 summarizes the coefficients of the old age dependency and

**TABLE 3**
REGRESSION RESULTS FOR THE INVESTMENT RATE

| Explanatory Variable | Coefficients (*t*-statistics) | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| Old age dependency ratio | -0.237** (-2.377) | -0.249** (2.515) | -0.165* (-1.650) | -0.177* (-1.782) |
| Young age dependency ratio | -0.007 (-0.220) | -0.012 (-0.390) | -0.002 (-0.076) | -0.008 (-0.289) |
| *Per capita* GDP | 0.738 (1.503) | 0.499 (0.977) | 1.502*** (2.804) | 1.345** (2.389) |
| Growth rate | 1.046*** (6.504) | 0.890*** (6.088) | 0.960*** (6.299) | 0.827*** (5.924) |
| Government Savings/GDP | 0.037 (0.694) | 0.039 (0.728) | 0.054 (1.030) | 0.055 (1.045) |
| Inflation rate | -0.003** (-1.992) | -0.003* (-1.897) | -0.002* (-1.676) | -0.002 (-1.498) |
| Total liquidity/ GDP | 0.048*** (3.613) | 0.050*** (3.807) | 0.056 (4.317) | 0.058 (4.487) |
| African dummy | | -0.742 (-0.734) | | -0.307 (-0.308) |
| High income dummy | | | -3.947*** (-3.364) | -3.948*** (-3.353) |

Note: *, **, and *** mean that the null hypothesis of zero coefficient can be rejected at the significance level of 10%, 5%, and 1%, respectively.

young age dependency ratios estimated by previous studies that used cross country panel data. As we can see in the table, the estimates vary quite widely depending on the sample. In general, an increase in the old age dependency has a larger effect on saving rates than that in the young age dependency. In addition, changes in the age structure of population have larger effects on saving rates in Asian countries and emerging market economies.

Table 3 shows the result of the regression where the investment rate is used as the dependent variable. Like the regression for the saving rate, population variables have a significant effect on the investment rate. While the young age dependency ratio has virtually no effect on the investment rate, the old age dependency ratio is shown to decrease the investment rate. This implies that as the supply of labor and the average labor productivity decrease due to population aging, the economic prospect becomes pessimistic, with a

**TABLE 4**
REGRESSION RESULTS FOR THE CURRENT ACCOUNT/GDP RATIO

| Explanatory Variable | Coefficients ($t$-statistics) | | | |
|---|---|---|---|---|
| | I | II | III | IV |
| Old age dependency ratio | -0.276** (-2.165) | -0.269** (-2.139) | -0.336** (-2.585) | -0.327** (-2.532) |
| Young age dependency ratio | -0.072** (-2.002) | -0.070* (-1.966) | -0.077** (-2.132) | -0.072** (-2.034) |
| *Per capita* GDP | 1.384** (2.427) | 1.580*** (2.635) | 0.883 (1.368) | 1.054 (1.547) |
| Growth rate | -0.343* (-1.770) | -0.236 (-1.344) | -0.314* (-1.662) | -0.209 (-1.218) |
| Government savings/GDP | 0.437*** (6.317) | 0.426*** (6.161) | 0.423*** (6.119) | 0.414*** (5.993) |
| Inflation rate | 0.000 (-0.090) | 0.000 (-0.188) | -0.001 (-0.510) | -0.001 (-0.721) |
| Total liquidity/ GDP | 0.035** (2.251) | 0.033** (2.122) | 0.031* (1.966) | 0.028* (1.796) |
| African dummy | | 0.829 (0.664) | | 0.491 (0.392) |
| High income dummy | | | 2.699* (1.825) | 2.623* (1.780) |

Note: *, **, and *** mean that the null hypothesis of zero coefficient can be rejected at the significance level of 10%, 5%, and 1%, respectively.

subsequent contraction in investment. Declining investment in turn implies a decrease in the supply of financial assets to finance investment. Thus, if population aging decreases not only savings but also investment and its related demand for capital, it would be too rash to conclude that aging will necessarily decrease asset prices.[4]

Because aging lowers both the saving rate and the investment rate, the effect of aging on the current account balance becomes dependent on which rate declines more. Table 4 displays estimation results using the current account balance to GDP ratio as the dependent variable. The estimate for the coefficient of the old age

[4] Such a conclusion is also consistent with the findings of Brooks (2006). Using the cross-country panel data for bond and equity prices, Brooks finds that it is unlikely that asset prices will suffer abrupt declines when the baby boomers retire. Instead, he finds that real financial asset prices may continue to rise as populations age.

**TABLE 5**

SIMULATION OF THE EFFECT OF POPULATION CHANGE (% POINTS)

| | 2005 | | 2030 | | Change in Saving Rate | Change in Investment Rate |
|---|---|---|---|---|---|---|
| | Young Age | Old Age | Young Age | Old Age | | |
| Japan | 21.1 | 29.7 | 20.6 | 52.7 | -18.1 | -4.1 |
| U.S.A. | 32.1 | 18.5 | 31.6 | 32.9 | -11.2 | -2.5 |
| Italy | 17.6 | 24.8 | 15.6 | 37.5 | -9.6 | -2.2 |
| France | 28.2 | 25.0 | 27.3 | 39.3 | -11.2 | -2.5 |
| China | 30.8 | 10.6 | 25.6 | 23.9 | -9.5 | -2.3 |
| India | 51.0 | 8.5 | 34.0 | 13.9 | -1.2 | -0.8 |
| Korea | 26.6 | 12.7 | 17.3 | 37.2 | -17.7 | -4.3 |

dependency ratio shows that aging negatively affects the current account balance implying that the decline in the saving rate caused by aging is greater than the decline in the investment rate. Such results indicate that because of the decrease in the saving rate and increase in government expenditure, aged countries are likely to become debtors in the global capital markets. Aged countries, however, are likely to have accumulated foreign assets through high savings and current account surpluses in the process of aging. As a result, population aging will not make these countries net debtors all of a sudden.

One can estimate the influence of changes in population composition would yield on saving rates by using the coefficient estimates from the regression analysis. The calculative results of the estimated changes in saving and investment rates of 2030 in comparison with 2005 using the estimated results in Table 1 and 3 are shown in Table 5. According to the simulation results, population aging is expected to bring about a significant drop in the domestic saving in most of the countries. The decline in the investment and saving rates is the sharpest in Japan and Korea, which is attributed to their relatively rapid population aging.

One should be careful, however, in interpreting the simulation results provided in Table 5. The estimation of changes in saving rates rests on the premise that the other economic variables would remain constant. In reality, many variables, such as GDP *per capita*, economic growth rate, public saving rate and so forth, would vary over time as the economy grows and as the demographic structure changes. As a result, actual changes in the saving and investment could differ from the estimated results shown in Table 5 according to how the aforementioned variables would react. Thus, the estimated results in Table 5 should not be used as the forecasts for the saving and investment rates but only as an indicative estimate of the direct effect of population aging on saving and investment rates.

Dekle (2006) has estimated how aging in Japan and Korea would affect investment and saving rates by using a dynamic general equilibrium model of a small open economy. The result shows that in the case of Korea a 0% point and a 9% point drop in the saving rate is expected in 2025 and 2040 respectively. Meanwhile, it shows a 2% point and a 5% point decrease in investment rates in 2025 and 2040 respectively. In the case of Japan, the saving rate decreases by 7% points and 11% points, while the investment rate increases by 2% points and 0% points in 2025 and 2040 respectively.

## III. Population Aging and Asset Returns

The effect of aging on individual asset prices can be identified by investigating the relationship between asset returns and age structure variables. Poterba (2001) has analyzed the relationship between the proportion of the population aged 40-64 years and the rate of return on financial assets such as stocks and bonds. He has found that while there is no significant relationship between asset returns and the proportion of the population aged 40-64 years *per se*, the first difference of the proportion of this population has a positive correlation with asset returns. This suggests that the short-term increase in the proportion of the high-saving 40-64 year population may contribute to a rise in asset prices. Such a relationship between the age structure and asset returns, however, is not consistently found in all periods and countries. Some periods in the United States do not show such a relationship, while it is evident that the size of the 40-64 year population is unrelated to the returns from stock investment in the United Kingdom and Canada.

On the other hand, Davis and Li (2003) show more clearly that the age structure of population affects interest rates. Using yields to maturity (YTM) instead of holding period returns as the dependent variable, they discovered that an increase in the proportion of the 20-39 year population increased the YTM of long-term bonds, whereas an increase in the proportion of the 40-64 year population

**TABLE 6**

REGRESSION RESULTS FOR REAL INTEREST RATES

| Variables | Coefficients (*t*-statistics) | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| 40-64/15-64 | -0.426*** (-3.500) | -0.314*** (-3.582) | -0.319*** (-3.711) | -0.404*** (-3.815) | -0.314*** (-2.771) | -0.325*** (-2.951) |
| 65+/15-64 | 0.254* (1.701) | 0.062 (0.535) | 0.084 (0.737) | 0.006 (0.047) | 0.275* (1.782) | 0.301* (2.000) |
| GDP growth | 0.295* (1.778) | | 0.297* (1.934) | | | 0.345** (2.069) |
| *Per capita* GDP | 3.189* (1.795) | | | 2.254 (1.490) | | |
| Liquidity/GDP | -0.027 (-1.182) | | | | -0.014 (-0.655) | -0.011 (-0.502) |
| Adjusted *R*-squared | 0.341 | 0.281 | 0.307 | 0.293 | 0.272 | 0.314 |

Note: *, **, and *** mean that the null hypothesis of zero coefficient can be rejected at the significance level of 10%, 5%, and 1%, respectively.

decreased it. These results are also consistent with the prediction of the standard economic principle that an increase in the youth population will raise the interest rate due to the mortgage demand, whereas an increase in the adult population can lower the interest rate through increased savings and increased demand for financial assets.

This paper uses a country-level panel data to investigate the effect of the age structure of population on asset returns. The data used in the analysis is the annual panel data consisting of 25 countries from 1980 to 2002 acquired from *Datastream and International Financial Statistics*. To reduce the effects of business cycle and measurement error, all variables except *per capita* GDP are using the 5-year average, with the last period using the 3-year average from 2000 to 2002. Therefore, data used in the actual estimation are derived from 25 countries over five periods. The model is estimated with fixed country effects.

Table 6 shows the results of the regression analysis using the real YTM of government bonds as the dependent variable. The real YTM was calculated as the *ex post* real YTM by subtracting the inflation rate from the nominal YTM. The regression results reveal that an increase in the proportion of the high-savings 40-64 year population

**TABLE 7**
REGRESSION RESULTS FOR REAL STOCK RETURNS

| Explanatory Variable | Coefficients (*t*-statistics) | | | | | |
|---|---|---|---|---|---|---|
| | I | II | III | IV | V | VI |
| 40-64/15-64 | -0.002<br>(-0.120) | -0.013<br>(-1.195) | -0.016<br>(-1.480) | -0.003<br>(-0.235) | -0.005<br>(-0.325) | -0.008<br>(-0.587) |
| 65+/15-64 | -0.007<br>(-0.356) | -0.029*<br>(-1.821) | -0.021<br>(-1.380) | -0.024<br>(-1.385) | -0.015<br>(-0.704) | -0.009<br>(-0.443) |
| Growth rate | 0.052***<br>(2.953) | | 0.057***<br>(3.459) | | | 0.051***<br>(2.915) |
| *Per capita* GDP | -0.184<br>(-0.583) | | | -0.263<br>(-1.052) | | |
| Total liquidity/ GDP | -0.001<br>(-0.297) | | | | -0.003<br>(-0.908) | -0.002<br>(-0.598) |
| Adjusted *R*-squared | 0.171 | 0.098 | 0.205 | 0.100 | 0.078 | 0.180 |

Note: *, **, and *** mean that the null hypothesis of zero coefficient can be rejected at the significance level of 10%, 5%, and 1%, respectively.

leads to a decrease in real interest rates. Thus, an increase in the proportion of the high-savings 40-64 year population leads to an increase in aggregate savings and demand for bonds with a subsequent decrease in interest rates, while an increase in the proportion of aged population of 65 years and over will contrastingly decrease aggregate savings and demand for bonds with a subsequent increase real interest rates. The effect of the population aging on real interest rates, however, differs with the model specification. As can be seen in Table 6, the proportion of the elderly population does not have a significant effect on real interest rates in models II, III, and IV.

Table 7 shows the regression results with real stock returns as the dependent variable. The stock returns are calculated as the one-year holding period returns. According to the regression results, a few variables have statistically significant effects on real stock returns. Both of economic growth rates and real interest rates have positive effects on stock returns. On the other side, higher inflation lowers real stock returns, implying that stock investment does not provide a complete hedge over the inflation risk.

However, population composition variables such as the proportion of population aged 40-64 and the proportion of population aged 65 and over do not show a strong relationship with real stock returns.

In model II alone, the proportion of population aged 65 and over has a negative relationship with real stock returns.

The finding that the population between the age 40 and 64 who have a higher tendency to invest in stocks and own greater financial wealth does not actually correlate with real stock returns coincides with what Poterba (2001) found using data for the U.S., the U.K., and Canada. However the finding that the population composition does not have a correlation with the returns on assets may not be because changes in population age composition did not have any effect on asset prices but may well be due to the fact that the supply of assets rapidly adjusted to the changes in asset prices. That is to say, if the asset markets are efficient and the supply of assets is very elastic to the rise of asset prices caused by the change in the age structure of population, then the rise of asset prices would induce an immediate increase in the supply of assets, thus not reflecting any real changes in the asset prices.

The findings of Poterba (2001), according to which the proportion of population between the age 40 and 64 by itself does not affect the real stock returns but the first difference of this proportion has a positive correlation with the real stock returns support the aforementioned interpretation. If the rise of the population aged 40-64 who has a higher propensity to save happens rapidly, then despite the rise in asset prices, the supply of assets will not able to meet the increased demand, resulting in the short term increase in asset prices and real asset returns.

In conclusion, the aforementioned findings make it difficult to conclude that the absence of correlation between the population composition variables and the real stock returns necessarily means that the changes in population composition do not affect asset prices. To comprehend how the changes of population composition affect the asset market, it is necessary to analyze the relationship between the population composition and the size of the asset markets in addition to the relationship between the population composition and the real returns.

## IV. Population Aging and the Size of Financial Markets

As discussed in the previous chapter, evaluation of the effect of population aging on asset prices through the regression of asset

**TABLE 8**
THE SIZE OF BOND MARKETS

| Explanatory Variable | Coefficient ($t$-statistics) | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| Proportion of population over 65 | 8.708*** (8.185) | 7.785*** (6.600) | 8.792*** (8.893) | 7.951*** (7.170) | |
| Contractual savings/GDP | | | 0.078** (2.076) | 0.054 (1.564) | 0.096*** (2.663) |
| *Per capita* GDP | | 10.208 (1.301) | | 15.522** (2.377) | 42.397*** (6.374) |
| Adjusted $R$-squared | 0.952 | 0.952 | 0.965 | 0.966 | 0.956 |

Note: *, **, and *** mean that the null hypothesis of zero coefficient can be rejected at the significance level of 10%, 5%, and 1%, respectively.

returns on the demographic variables becomes complicated by the fact that the supply as well as the demand of financial assets can be affected by the change in the age structure of population. Instead of estimating the effect on asset returns, we estimate the effect of population aging on the size of financial markets using the 25 country panel data covering the period from 1980 to 2001. The model is estimated with country specific fixed effects.

Table 8 shows the results of the regression analysis with the ratio of the bond market size to GDP as the dependent variable. The size of the bond market is measured as the total amount of bonds outstanding. As shown in the table, an increase in the population aged 65 and over increases the size of the bond market. The positive correlation between the proportion of the elderly population and the size of bond market does not change if we add other explanatory variables such as *per capita* GDP and the ratio of contractual savings to GDP. The contractual saving is measured as the sum of contributions to the public and private pension plans and the assets of life insurance companies.

The nexus between population aging and the size of the bond market can be explained in terms of both supply and demand. In the latter's case, the elderly prefer safe assets to risky assets and as a result will increase the weight of bonds in their total asset holdings, thereby increasing the demand for bonds. Meanwhile, the increase in the issuance of public bonds by governments to meet the rise in the

**TABLE 9**
THE SIZE OF STOCK MARKETS

| Explanatory Variable | Coefficient (*t*-statistics) | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| Proportion of population over 65 | 11.607*** (8.674) | 5.603*** (3.066) | 3.170 (1.124) | -0.919 (-0.291) | |
| Contractual savings/GDP | | | 0.932*** (11.332) | 0.840*** (9.390) | 0.833*** (9.268) |
| *Per capita* GDP | | 57.986*** (3.387) | | 43.928*** (3.675) | 41.505*** (4.626) |
| Adjusted $R$-squared | 0.573 | 0.587 | 0.764 | 0.774 | 0.774 |

Note: *, **, and *** mean that the null hypothesis of zero coefficient can be rejected at the significance level of 10%, 5%, and 1%, respectively.

public expenditure for the elderly results in the increase in the supply of bonds.

The positive correlation between the size of the market and population aging is not so apparent in stock markets as opposed to bond markets. Table 9 shows the regression results with the size of stock markets as the dependent variable. The size of stock markets is measured by the aggregated value of the listed stocks over GDP. In model I, in which only the population composition was considered as the explanatory variable, an increase in the elderly population considerably increases the size of stock markets. On the other hand, model III, in which the measure of contractual savings is added as an explanatory variable, the size of the elderly population does have a statistically significant influence on the size of stock markets. Meanwhile, in model IV, in which the ratio of contractual savings to GDP and *per capita* GDP are added, population aging reduces the size of stock markets relative to GDP, albeit insignificantly.

The fact that population aging has an asymmetrical effect on the size of stock markets and bond markets can be made more apparent by the regression analysis with the size of stock markets relative to the size of bond markets used as the dependent variable. Table 10 shows that in the case of model IV which includes both the contractual savings and *per capita* GDP as explanatory variables, an increase in the elderly population decreases the size of stock markets relative to that of bond markets. Such an asymmetrical effect that

**TABLE 10**

THE RATIO OF THE EQUITY MARKET SIZE/BOND MARKET SIZE

| Explanatory Variable | Coefficient ($t$-statistics) | | | | |
|---|---|---|---|---|---|
| | I | II | III | IV | V |
| Proportion of population over 65 | 10.655** (2.079) | -1.684 (-0.387) | -3.618 (-0.702) | -7.917* (-1.819) | |
| Contractual savings/GDP | | | 1.343*** (7.353) | 1.221*** (5.566) | 1.179*** (5.573) |
| *Per capita* GDP | | 170.206*** (4.221) | | 79.983* (1.810) | 53.231 (1.163) |
| Adjusted $R$-squared | 0.602 | 0.622 | 0.695 | 0.698 | 0.697 |

Note: *, **, and *** mean that the null hypothesis of zero coefficient can be rejected at the significance level of 10%, 5%, and 1%, respectively.

population aging has on the size of stock and bond markets can be attributed to the preference of the aged in the low-risk bonds.[5]

## IV. Conclusion

Population aging may have different effects on different assets. We investigate the effect of population aging on financial markets through a regression analysis using a cross-country panel data. Instead of using the asset prices or returns as the dependent variable, we use the asset market size. We believe that use of the market size as the dependent variable will be able to reveal the effect of population aging on asset markets more clearly since the market size reflects changes in asset supply as well as asset prices.

The regression analysis demonstrates that the proportion of the elderly population is positively correlated with the size of the bond market, whereas the positive relationship with the size of the stock market is not so evident. Such a finding implies that although a general asset price meltdown is not likely, equity markets will be more adversely affected by population aging.

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[5] Through a regression analysis on the size of financial markets, Davis (2006) also finds that population aging affects the size of bond markets favorably but not the size of equity markets.

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