
Demographic Changes, Saving, and Current Account in East Asia*

Soyoung Kim

Department of Economics
Korea University
Anam-Dong, Sungbuk-Gu,
Seoul, 136-701
Republic of Korea
soyoungkim@korea.ac.kr

Jong-Wha Lee

Department of Economics
Korea University and the
Australian National University
jongwha@korea.ac.kr

Abstract

This paper analyzes the empirical relationships among demographic changes, saving, and current account balances in East Asia. The panel Vector-Auto Regressive (VAR) model shows that an increase in the dependency rate, especially the elderly dependency rate, significantly lowers saving rates and subsequently worsens current account balances. The result implies that the future aging of the population in East Asia would have a significant impact on global capital flows and current account imbalances.

I. Introduction

Over the last three decades, the major industrialized countries have experienced large increases in elderly population because of the drop in fertility rates and of the baby boom generation becoming older. The aging of the population is expected to accelerate over the next 3 decades. For advanced countries as a whole, the old dependency rate, or the share of elderly population aged 65 and above in total population, is forecasted to increase from 15 percent in 2005 to 26 percent in 2050.

East Asian economies have also experienced rapid demographic changes, with Japan as the well-known case. Since 1995, Japan has become an “aged society” with the old dependency rate of 14 percent or higher, and is forecasted to become a “super-aged society” by 2025 with the old dependency rate of over 20 percent. The aging process is also fast in emerging Asian economies such as Hong

* We are grateful to the participants at the September 2006 Asian Economic Panel meeting, Keio University, Tokyo, for helpful comments.

Kong, South Korea, Singapore, and Taiwan, which are expected to turn into “super-aged societies” by 2025.

The purpose of this paper is to investigate empirically the implications of demographic changes in East Asia, in particular, focusing on saving rates and current account balances. In theory, the fast-aging population and the shrinking labor force will have a significant impact on national saving and investment. The current account is, by definition, identical to the imbalance between national saving and domestic investment. Therefore, a saving–investment imbalance in an individual country determines its current account balance and net capital flow. It is an important question if the demographic change has a significant impact on current account balances or net capital flows in East Asia. In recent years, enlarging global current account imbalances have been one of the major concerns in the international community. The global imbalances are characterized by continued accumulation of current account surpluses in East Asia mirrored by sustained current account deficits in the United States. The East Asian current account surplus reflects their saving–investment imbalances due to a savings glut or investment drought. Eichengreen (2005) suggests that because of population aging, East Asia will have lower saving rates and thereby reduce the imbalances. Despite this conjecture, not many studies attempt to assess empirically the effects of demographic changes on saving rates and current account balances in East Asia.

Compared to past studies, our empirical works have two distinct features in methodology. First, most of past empirical studies that analyze the macroeconomic effects of demographic changes have adopted either cross-country regressions or simulation approaches. The cross-country regression approach is mostly static in its nature, although it is a data-based method. On the other hand, the simulation approach, although showing dynamics, is less data-oriented. On the contrary, this paper adopts the panel Vector-Auto Regressive (VAR) framework, which can combine two nice features of previous studies: the empirical evidence provided here is data-oriented and dynamic in its nature. Second, by examining the effects of demographic changes on many related macroeconomic variables, we further explore the detailed transmission and consequence of demographic changes. For example, we examine the effects on private saving, public saving, investment, interest rate, real exchange rate, and GDP in order to infer the detailed transmission of demographic changes on national saving.

This paper is organized as follows. Section 2 describes the trend of demographic changes and the current accounts in the world. Section 3 explains economic theories on the effects of demographic changes on saving and current account. Section 4 reviews previous empirical studies on the links between demographic change, saving,

and current account. Section 5 introduces our data set consisting of 10 East Asian economies and empirical methodology of a panel VAR model. In section 6, we present and discuss the estimation results of demographic effects on saving, current account, and other macroeconomic variables. Concluding remarks follow in section 7.

2. Demographic changes and current account in the world and East Asia

2.1 Demographic transition

One of the most important demographic changes is the aging of the world's population. Most industrialized countries experienced a dramatic rise in births immediately following World War II. Subsequently, fertility rates dropped (Figure 1). As the baby boom generation begins to retire, these countries face a significant population aging. The share of the population aged 65 and older (elderly dependency rate) has increased steadily in advanced countries (Figure 2). The aging process has been most spectacular in Japan. The share of Japanese elderly population aged 65 and above increased from 7.1 percent in 1970 to 19.7 percent in 2005.

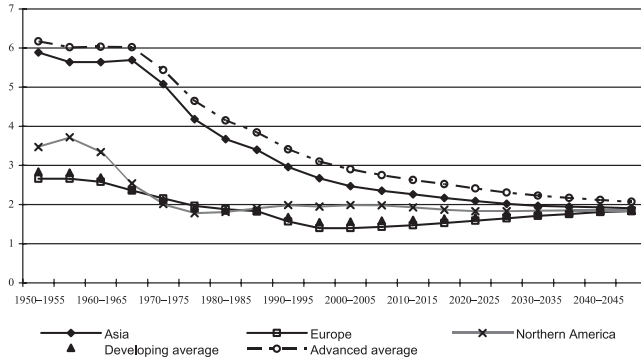
Figure 3 shows the trend of the share of young dependent population aged 14 and under (youth dependency rate). The share has declined steadily since 1960 in advanced countries as a whole, changing from 28 percent in 1960 to 17 percent in 2005. As the rise in the elderly dependency rate begins to surpass the decline in the young dependency rate in recent years, the total dependency rate declines in many advanced countries. In other words, the share of working-age population (aged between 15 and 64) begins to shrink. The trend of increasing aged population and shrinking working-age population is expected to continue in advanced countries over the next several decades. Japan will experience the most rapid aging process among advanced countries, with an elderly dependency rate of over 35 percent in 2050. The downward trend of the working-age population share will also be most spectacular in Japan: the working-age population share is forecasted to decrease from about 66 percent in 2005 to 51 percent in 2050.

Most developing countries are only at the beginning stages of the demographic transition characterized by an increase in life expectancy followed by declining fertility rates. In most developing countries, the share of the elderly population has not increased for the last several decades (Figure 2). Reflecting their higher fertility rates and slow aging process, the share of the working-age population has continued to increase since 1970 in developing countries as a whole (Figure 3).

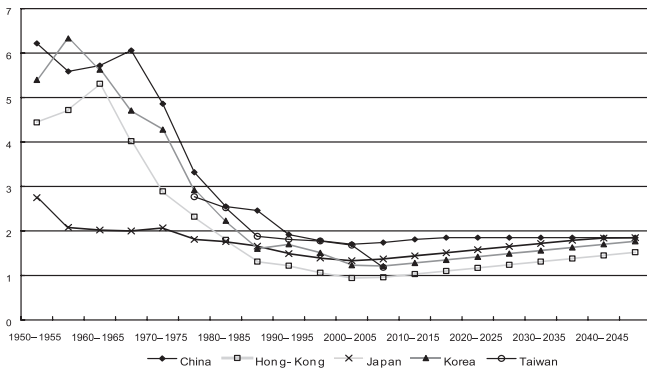
Over the next several decades, most developing countries are expected to experience an increase in old-age population, but as the decline in young-dependency rate

Figure 1. Trend of fertility rates (children per woman), 1950–2050

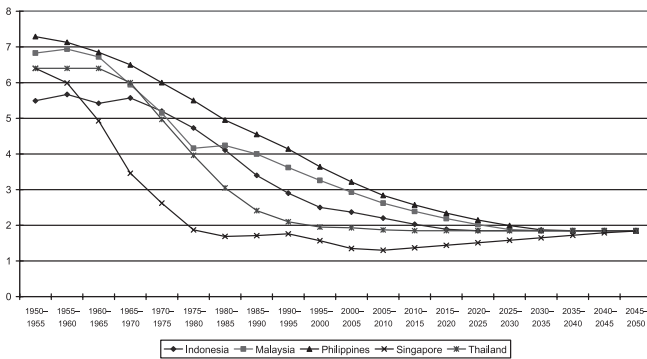
A. Groups and Regions



B. Northeast Asia



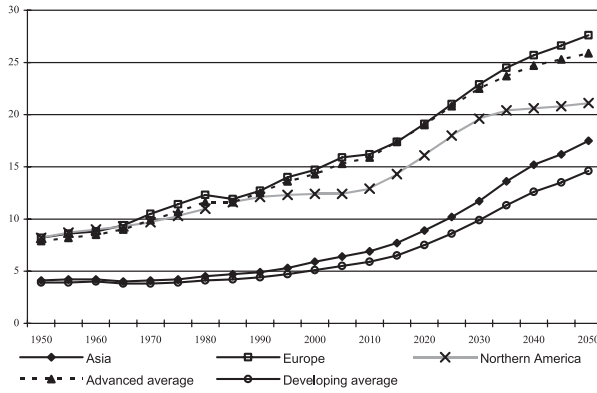
C. Southeast Asia



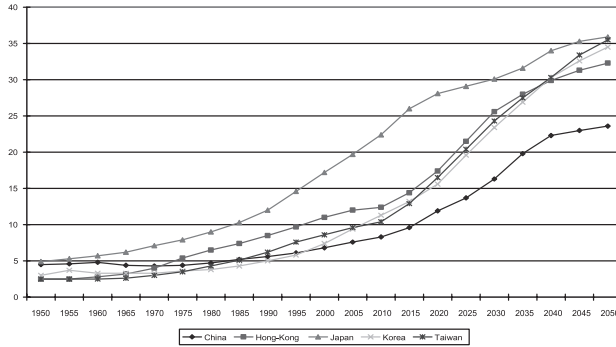
Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision. *Taiwan*, Statistical Yearbook of the Republic of China, 2004.

Figure 2. Trend of elderly dependency (percent of the population aged 65 and above), 1950–2050

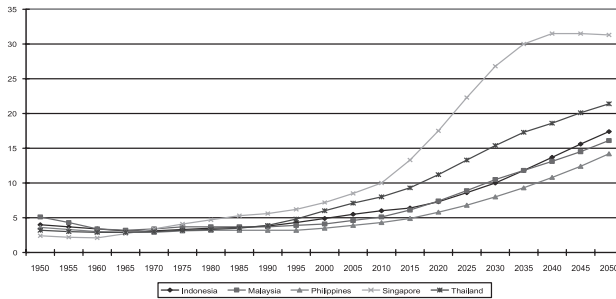
A. Groups and Regions



B. Northeast Asia



C. Southeast Asia



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision. *Taiwan*, Statistical Yearbook of The Republic of China, 2004.

is faster than a slower increase in old-age population, they continue to experience an increase in the working-age population share (Figure 4). However, a number of developing economies, particularly in East Asia, are predicted to begin the fast-aging process soon. In East Asia, fertility rates continued to decline over the last decades. The fertility rates are currently below 2.0 in most East Asian economies except Indonesia, Malaysia, and The Philippines. The share of young-age dependent population has continuously declined since 1970 (Figure 3). Population aging has already begun in many East Asian economies. In 2005, the share of elderly population is over 9 percent in Korea and Taiwan, 8.5 percent in Singapore, and 7.6 percent in China. The fast-aging processes are expected to accelerate. In 2050, the share of the elderly population will increase to 35 percent in Korea and Taiwan, 31 percent in Singapore, and 24 percent in China (Figure 2).

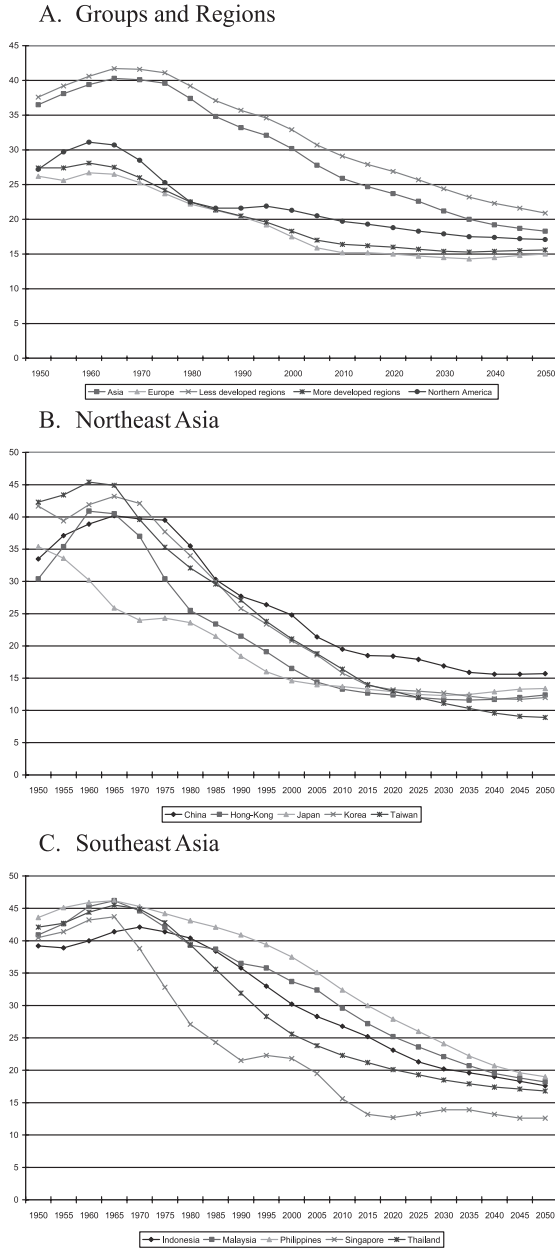
The population aging, combined with a relatively stable trend of youth dependency rate in the future, will lead to a decrease in working-age population share. Figure 4 shows that the share of the working-age population is forecasted to decrease from 2010 in most East Asian economies. It is expected to decline from 73 percent in 2010 to 54 percent in 2050 in Korea and from 72 percent to 61 percent in China over the same period.

2.2 Current account balances

In recent years, there have been increasing concerns regarding the growing global current account imbalances. The industrial countries as a whole have continued to show current account deficits or net capital inflows, mainly due to the U.S. sustained current account deficits (Figure 5). In the United States, current account deficits widened significantly since the 1990s. In 2004, the U.S. deficit stood at \$666 billion, up from \$136 billion in 1997. It amounted to 5.7 percent of GDP, increasing from 1.6 percent 7 years earlier. In contrast, Japan has persistently accumulated a large amount of current account surpluses. In 2004, Japan had a current account surplus of \$172 billion, amounting to 3.7 percent of GDP. Emerging market economies in East Asia also had big surpluses, especially since the 1997–1998 Asian financial crisis (Figure 6). The four East Asian emerging economies as a group had a surplus of \$90 billion, or 7.1 percent of their GDP. The ASEAN-4 economies as a group had a surplus of \$28 billion, or 4.4 percent of their GDP. China also had a surplus of about \$70 billion in 2004 or 4.2 percent of GDP.

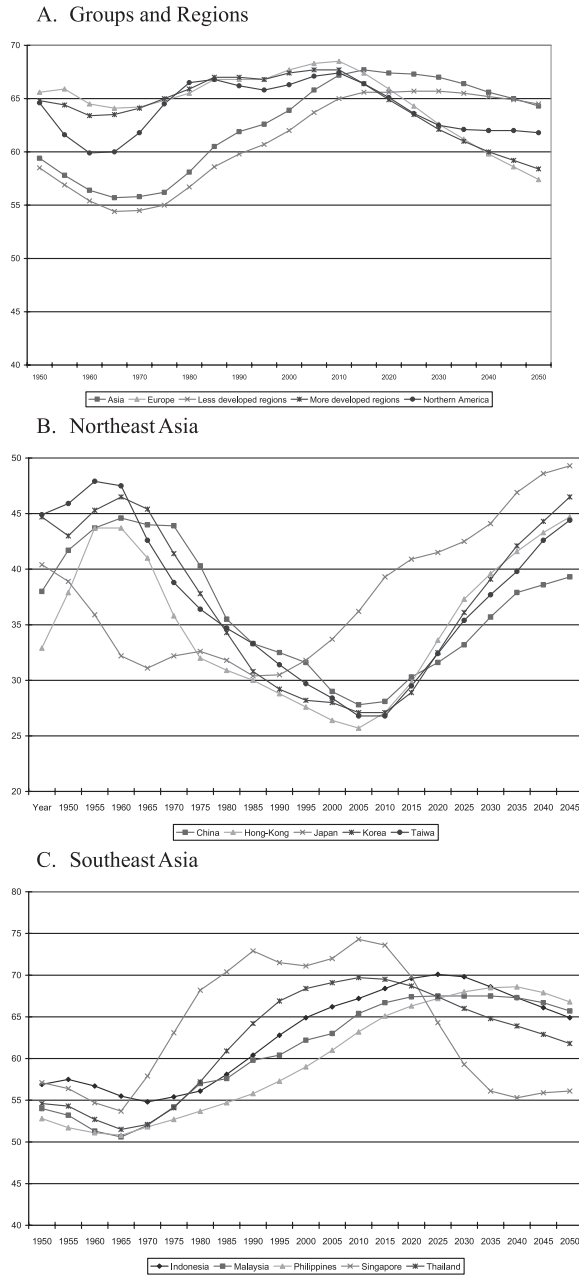
The global imbalances in the current account can be interpreted as showing the disparities in the saving and investment in each region and country. In particular, the massive East Asian current account surpluses reflect high saving rates relative to investment in East Asia. Except for China, East Asian economies have experienced a secular downward trend in both saving and investment rates since the mid 1990s

Figure 3. Trend of youth dependency (percent of the population aged 14 and under), 1950–2050

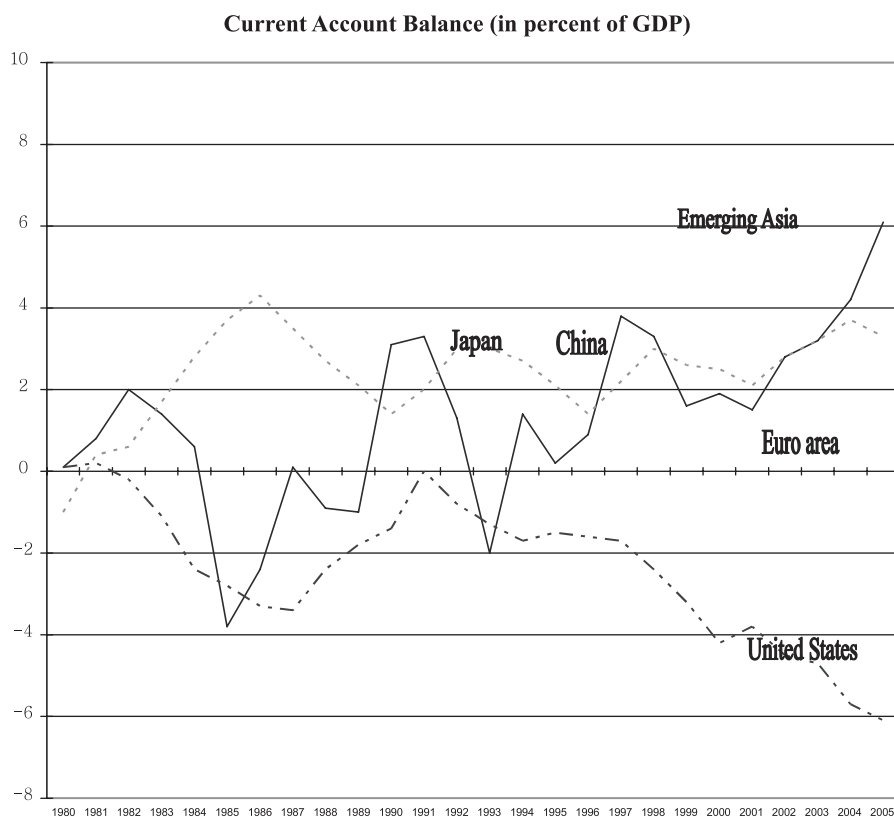


Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision. *Taiwan*, Statistical Yearbook of The Republic of China, 2004.

Figure 4. Trend of working-age population (percent of total population), 1950–2050



Source: Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat, World Population Prospects: The 2004 Revision. *Taiwan*, Statistical Yearbook of the Republic of China, 2004.

Figure 5. Changes in global current account balances, 1980–2005

Source: IMF, *World Economic Outlook database*, September 2005.

Note: Emerging Asia-East Asian NIES plus ASEAN-4.

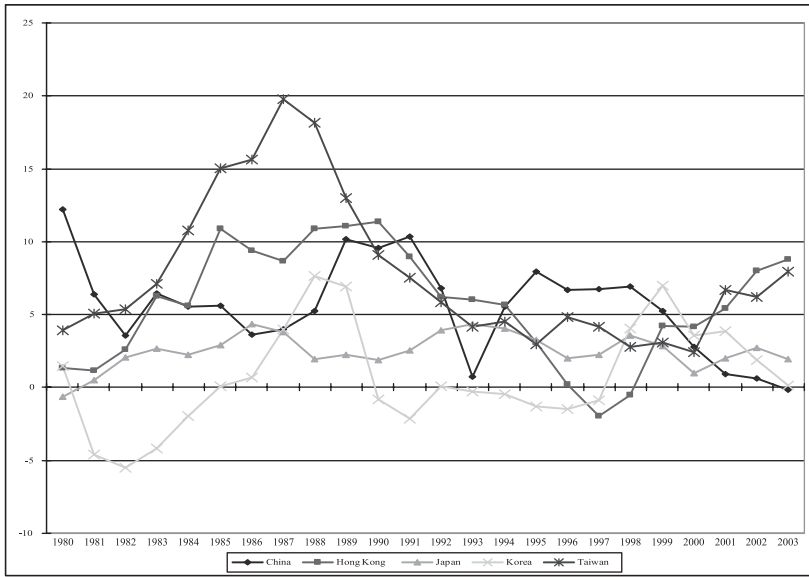
(Figures 7 and 8). However, investment rates fell dramatically after the financial crisis, with their declines surpassing the declines in savings. In a group of four East Asian Newly Industrialized Economies (NIES), investment rates dropped from 31.6 percent in 1997 to 23.0 percent of GDP in 2003, whereas the national saving rate decreased from 32.3 percent to 29.4 percent over the same period.

3. Theoretical review

In theory, a change of population age structure has significant effects on various components of the current account. More precisely, an increase in youth and elderly dependency rates affects saving and investment, and thereby the current account.

Figure 6. Current account in East Asia (as a percentage of GDP), 1980–2003

A. Northeast Asia



B. Southeast Asia

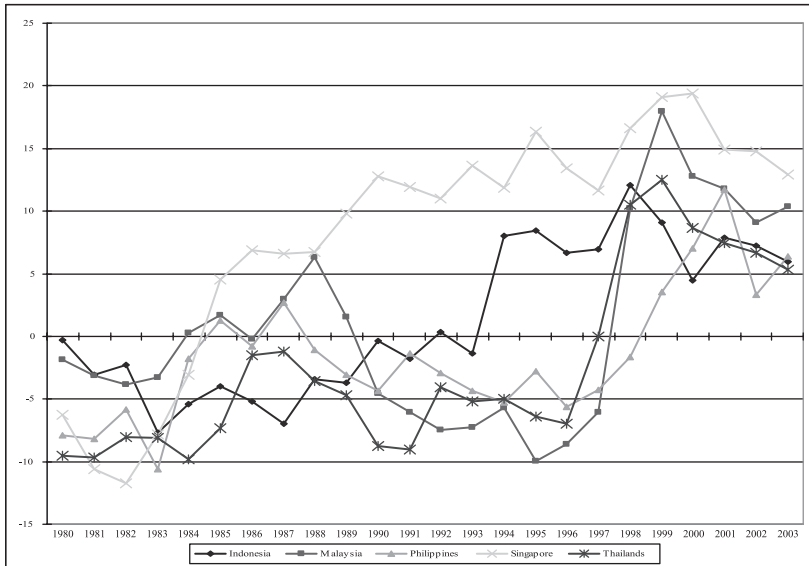
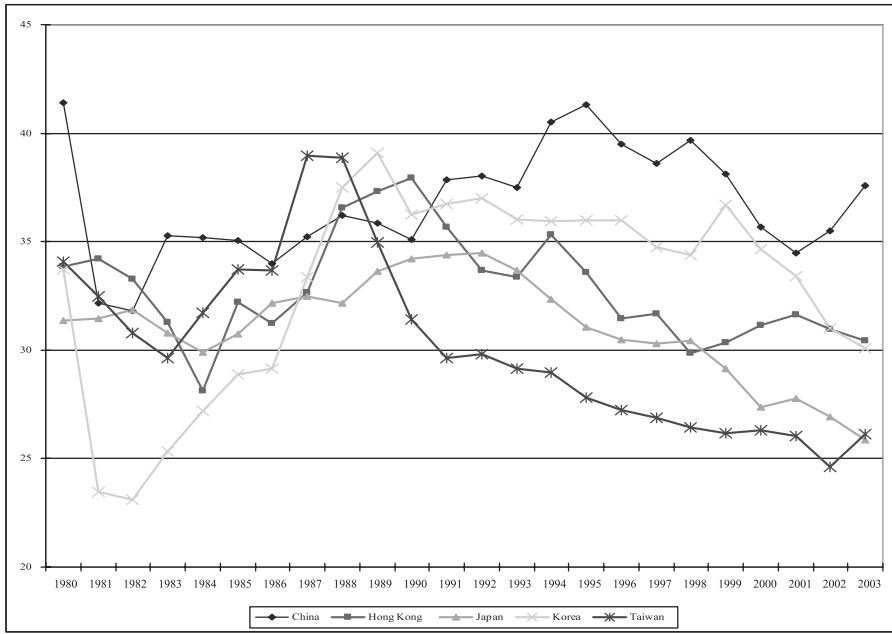


Figure 7. Saving in East Asia (as a percentage of GDP), 1980–2003

A. Northeast Asia



B. Southeast Asia

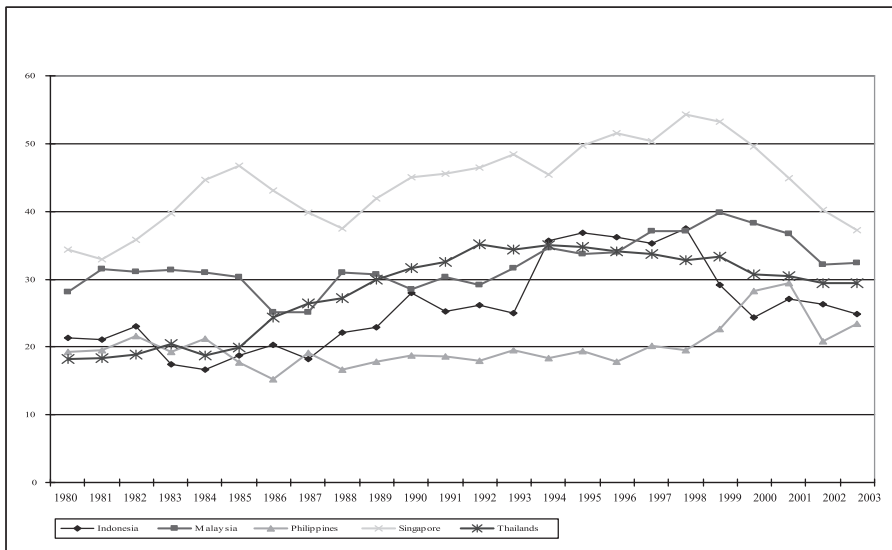
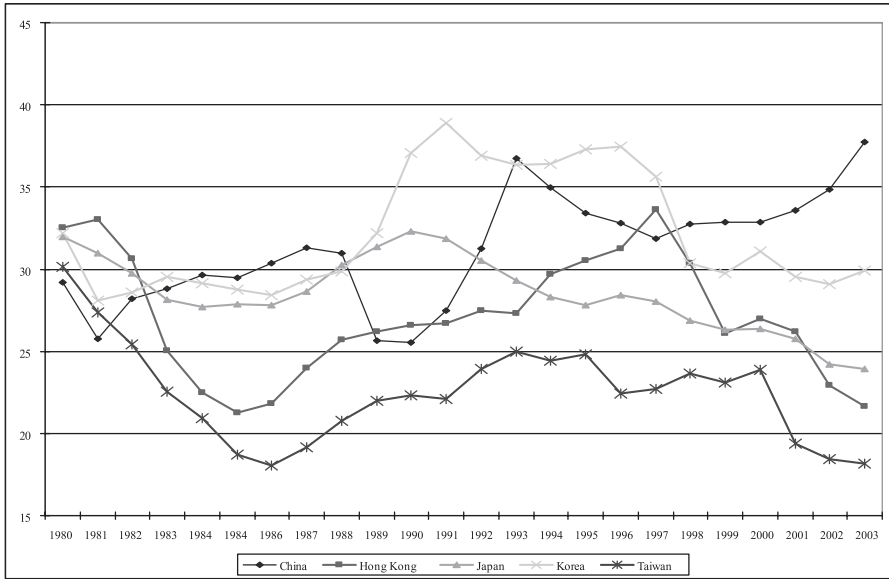
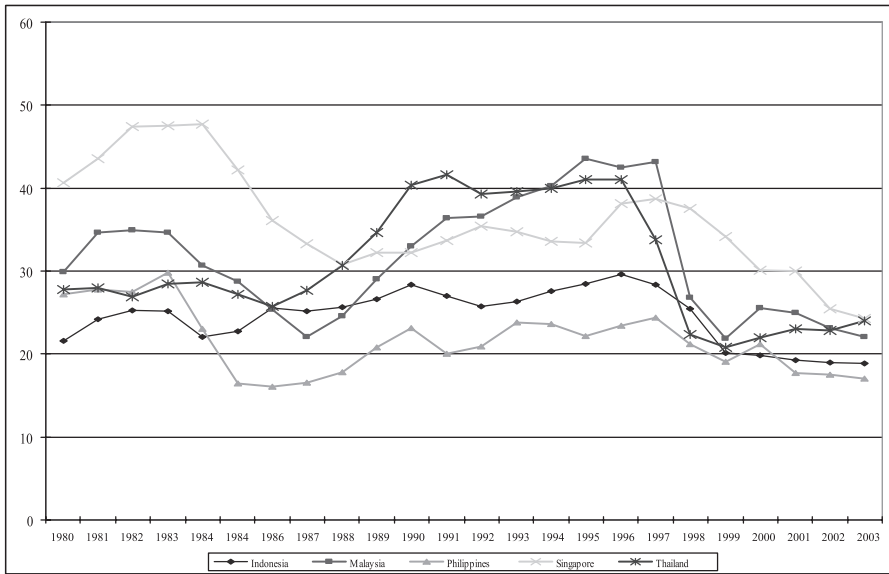


Figure 8. Investment in East Asia (as a percentage of GDP), 1980–2003

A. Northeast Asia



B. Southeast Asia



One of the most important consequences of an increase in dependency rate, frequently discussed in past theoretical studies, is the decrease in private saving. At the core of saving theory is the life-cycle hypothesis, which presumes that individuals pass through three broad phases of savings and consumption during their lifetimes. If the household's labor income is hump-shaped—low in young age, rising, and then falling in old age—then consumption smoothing implies that saving rates are high in their productive middle ages and low in young and old age (Modigliani 1970). Hence, in an economy as a whole, the theory predicts that saving rate tends to be lower when the share of the youth and old-age dependent in total population becomes higher.

Other theories expand the life cycle theory to include the influence of other factors. Carroll (1997) highlights the role of uncertainty for precautionary saving. The uncertainty in the timing of retirement and death can exert major influence on the pace of dissaving among the old and retirees. Leaving bequests to children will also tend to dampen the decline in saving during retirement.

Public saving is also likely to drop with increased dependency rates. A smaller work force can result in lower tax revenues. If the government does not change its fiscal arrangements—a social security plan, for example—an increase in dependents, particularly elderly people, will increase public spending. Therefore, public saving is likely to fall. In fact, the increase in the elderly population has been raising pressures on pension, health, and other areas of public spending, deteriorating fiscal positions in almost all advanced countries.

An increase in dependency rates is also expected to affect negatively the demand for domestic investment. Slower labor force growth and lower expected output growth will decrease the rates of return to investment. Unless (labor-augmenting) technological progress accelerates, domestic investment demand must decline. However, in the short run, it can happen that investment increases because of the need to substitute capital for a falling supply of labor input.

The current account is equal to the difference between saving and investment, and to net capital flows, though a non-negligible size of statistical discrepancy is often found in the actual data. The effect of the dependency variables on the current account is simply equal to the net of their negative effects on saving and domestic investment. Hence, the relative force of changes in national saving and domestic investment determines the impact of the increased dependency on current account balance. An increase in dependency rates, if it lowered national saving rates faster than domestic investment, would affect the current account adversely.

Higgins (1988) argues that the demographic “center for gravity” for investment demand should be earlier in the age distribution than that for savings supply. Investment demand is related positively to the share of the youth, or labor-force growth, whereas savings supply is most closely related to the share of mature adults (close to retirement ages). This implies that when the youth dependency rate rises initially, investment demand can increase, while saving declines. Then, as the age distribution shifts toward the middle age, saving increases and investment demand declines, thereby pushing current account into surplus. Eventually, an increase in the elderly dependency rate would cause saving to fall, surpassing investment demand decline, thereby pushing the current account into a deficit.

The magnitude of the current account adjustment to saving and investment imbalance depends critically on the extent of the country’s openness. In a closed economy, aggregate national saving and aggregate domestic investment move together.¹ A fall in the saving rate would lead to a shortage of funds in the financial market, and would raise the price of funds, or the real interest rate. In turn, the real interest rate fall would decrease investments. Hence, no change would occur to the current account balance. In a small open economy with perfect capital mobility, a fall in saving rate would lead to the current account deficit as the increase in the gap between domestic saving and investment is filled by an increase in net capital inflows. In intermediate cases (for example, a large open economy or an open economy with imperfect capital mobility), real interest rate increases, investment falls, and current account worsening may be observed altogether.

4. Empirical links between demographic change, saving, and current account

This section briefly reviews the existing empirical literature analyzing the impact of demographic changes on saving and current account balances.²

Many studies have investigated empirically the impacts of population age structure on saving and current accounts. Most of the empirical literature in this area has adopted four distinct approaches: 1) regressions using a repeated cross-section data; 2) regressions using macroeconomic time-series data for a broad cross-section of countries; 3) simulations of a multi-region general equilibrium model; and a 4) VAR approach.

1 If financial markets are imperfect, agents may need to save more in order to undertake lumpy physical capital investment in the future. See Liu and Wing (1994) for the discussion of this “investment-motivated saving” hypothesis in the context of Taiwan’s experience.

2 Part of this survey is drawn from Kim and Lee (2007). See Bosworth, Bryant, and Burtless (2004) and Helliwell (2004) for detailed surveys.

A number of empirical studies on demographics and saving have used repeated cross-section data observed at different points of time to create the saving profiles of synthetic cohorts over time. Several country studies based on household survey data find that household saving remains unexpected among the elderly population, contradicting the life-cycle hypothesis. Deaton and Paxson (1997) construct a synthetic cohort-based measure of the age profile of saving for four countries including the United States, Britain, Taiwan, and Thailand, and find the data for Britain and Thailand do not coincide well with the predictions of the life-cycle model. This may support the precautionary or bequest motives of saving. In fact, several studies such as Bernheim, Skinner, and Weinberg (2001) and Banks, Blundell, and Tanner (1998) find that people tend to decrease consumption expenditures substantially when retired.

There has been skepticism of the use of household survey data. The old-age households that are counted as independent samples in household surveys are mostly wealthy elderly who do not need to live with younger household members. This tends to generate an upward bias of the elderly saving rate when income and saving are positively correlated. Demery and Duck (2006) construct a sample that adjusts household saving into saving rates of individual household members in Britain and find evidence of a pronounced hump-shaped pattern of individual saving rates, supporting the life-cycle theory. Microeconomic survey studies are not always consistent in treating accumulation and decumulation of saving in a pension program. The estimate of saving depends critically on whether household income includes the contributions to the pension system as well as the benefit from it. For example, many studies based on household surveys ignore contributions to a pension plan when workers are active and include a benefit (often annuity) as retirement income. Jappelli and Modigliani (1998) and other researchers argue that this treatment is incorrect and that contributions to a pension plan should be counted as saving and the annuity benefit must be excluded from retirement income. This new treatment contributes to a pronounced hump-shaped pattern in saving rates over the life cycle.

Most empirical studies based on an econometric approach using macroeconomic time-series data have found a strong negative link between dependency rates and saving rates (Leff 1969; Weil 1994; Masson, Beyoumi, and Samiei 1998; Edwards 1995; and Higgins 1988). For instance, Weil uses a panel data set of 14 industrial countries over the period between 1960 and 1985, and finds evidence supporting that both the share of young-age and that of the elderly population have strong and statistically significant negative effects on the private saving rates. He adopts the fixed-effect estimation technique that controls for the influences from unobserved country-specific factors on the saving rates.

In an empirical study utilizing a panel data set of more than 100 countries, Higgins (1988) finds that the youth and old age dependency rates have a strong negative effect on the national saving rate, domestic investment, and the current account balance. The estimated demographic effects are quite large. For instance, the favorable demographic swing in Japan over the period between the early 1950s and the early 1980s was found to be responsible for the increase in Japanese national saving by 5.6 percent and that of current accounts by 7.1 percent of GDP, respectively. Over the next two decades until 2025, he projects that the major industrial countries including Japan will experience substantial current account surpluses as the decline in investment demand exceeds the drop in saving. Higgins also finds that the estimated demographic effects are larger for more open economies, which is consistent with the implication of the Feldstein–Horioka proposition.

Chinn and Prasad (2003) and Luhrman (2003) use cross-country panel data to investigate the determinants of the current account. Chinn and Prasad, using a large sample for 18 industrial and 71 developing countries between 1971 and 1995, find a higher dependency rate. In particular, the youth dependency rate has a significant negative effect on current accounts among developing countries.

Luhrmann also finds that countries with higher youth and elderly dependency rates tend to import more capital from abroad, that is, current account deficits. She also finds evidence that anticipated demographic changes affect current account balances significantly. In particular, future declines in youth dependency rates are strongly associated with anticipated capital outflows or current account surpluses. The projections based on the estimates show that due to the future demographic changes in the world, Japan, France, and the United States are all expected to experience negative current account balance swings between 2000 and 2020, which will be mostly driven by the anticipated future declines in youth dependency rate in developing regions.

The econometric approach based on macroeconomic data investigates the relationship between demographic variables and current account separately, rather than as a part of the integrated economic system. To address this issue, recent studies have used calibrated general equilibrium models to examine the relationship between demographic changes and current account.

Several studies focus on Japan, the fastest-aging society to assess the impact of demographic changes on saving, investment, and current account (Horioka 1992; Faruqee and Mühleisen 2003; Dekle 2004; McKibbin and Nguyen 2004; and McKibbin 2005). For instance, Dekle uses a small open economy Ramsey-type growth model to project the impact of demographic changes on Japanese saving and

capital flows. As population aging depresses saving, Japan is expected to import capital amounting to 15 percent of GDP in 2015. Contrastingly, McKibbin, by using a multi-country general-equilibrium model (MSG3), forecasts that global demographic changes will contribute to current account surpluses in Japan between 2005 and 2050, although the surplus declines over time. In this global general equilibrium simulation, Japanese capital outflows are stimulated by the strong demand for capital from developing countries where labor force increases and rates of return to capital remain high.

There have been quite a few studies that use multi-region calibrated general equilibrium models to examine the effects of global demographic changes. Feroli (2003) simulates a multi-region overlapping generations (OLG) model, which is calibrated to match the demographic differences among the major industrialized economies over the past 50 years. Feroli finds demographic changes can explain the substantial part of long-term capital flows or current account trends experienced by the G-7 nations, such as the size and timing of the U.S. current account deficits and Japanese current account surpluses.

Brooks (2003) analyzes the global impact of population aging, using a calibrated multi-region OLG model with perfect capital mobility to simulate the general equilibrium effects of projected population trends on international capital flows. He finds that retirement saving by aging baby boomers will raise the supply of savings substantially above investment demand in both North America and the European Union, making both regions substantial capital exporters to other regions by 2010. Beyond 2010, however, population aging will eventually make both regions become capital importers.

IMF (2004) introduces simulation results from a multiregional macroeconomic model—the INGENUE world model—which explicitly incorporates the age structure of the population and a pension system in each region. The results suggest that the demographic changes projected over the next 50 years will decrease aggregate saving rates in Europe and Japan. Pension systems contribute significantly to this decline due to the increase in additional pension expenditures to the retirees. The saving decline causes substantial deterioration of the current account in these regions.

The multi-country general equilibrium models, however, often provide different projections, which are the result of the differences in assumptions and model structures. For instance, the simulation results with the MSG model in Batini, Callen, and McKibbin (2006) show that in most of the industrialized countries population aging

will lead to an improvement in current accounts because investment declines more sharply than saving. Similarly, Bryant (2004) presents a simulation result of a two-region model, supporting that the country with lower dependency rates exports capital to the country with the more active population. These predictions contrast to those of other simulation studies.

Cross-country regressions, although data-based, are mostly static in their nature. On the other hand, the simulation approach, although showing dynamics, is hard to view as data-oriented empirical evidence. Kim and Lee (2007) adopt another method of a panel VAR model to analyze demographic effects on saving rate and current account balances in the G-7 countries. This framework can combine the nice features of previous empirical methodologies; the empirical evidence provided here is data-oriented and dynamic in its nature. It also allows incorporating interactions between the demographics and macro variables in an integrated framework. The estimation results from the panel VAR model show that an increase in dependency rate significantly lowers saving rates, especially public saving rates, resulting in deteriorating current account balances in the G-7 countries.

5. Empirical methodology and data

5.1 Panel VAR modeling

We examine the effects of an increase in the dependency rate on the components of the current account using panel VAR models. VAR models provide a useful methodology to investigate the issue. First, dynamic effects can be inferred from VAR models. Second, some interactions between the demographics and macro-variables can be allowed in the VAR model, although most past studies assume an exogenous process for the demographics. Demographic changes may not depend much on the current economic activity level, but demographic change may be influenced by lagged economic activity level. For example, prolonged recession may result in a high death ratio or low birth rate. Third, VAR models are relatively free of ad hoc identifying assumptions, so that data-oriented empirical results can be provided. On the other hand, we developed the panel model for East Asian countries, instead of constructing the model for each country, because the data points are relatively short and the VAR model for each country would suffer from the degree of freedom problem.

Let us assume that an economy i ($i = 1, 2, \dots, 10$) is described by the following structural form equation:

$$G(L)y_i^i = d_i + e_i^i \quad (1)$$

where $G(L)$ is a matrix polynomial in the lag operator L , y_t^i is an $m \times 1$ data vector, d_t and d^i are $m \times 1$ constant matrices, m is the number of variables in the model, and e_t^i denotes a vector of structural disturbances. By assuming that structural disturbances are mutually uncorrelated, $\text{var}(e_t^i)$ can be denoted by Λ , which is a diagonal matrix where diagonal elements are the variances of structural disturbances. The individual fixed effect, d^i , is introduced to control for the country-specific factors that are not included in the model but affect saving rates, the current account, and other macroeconomic variables. The time fixed effect, d_t , is introduced to control for the global factors that are not included in the model but affect the current account and its component.

We pooled the data and estimated the following reduced form panel VAR with the time fixed and individual fixed effects:

$$y_t^i = c_t + c^i + B(L)y_{t-1}^i + u_t^i, \quad (2)$$

where c_t and c^i are $m \times 1$ constant matrices, $B(L)$ is a matrix polynomial in the lag operator L , and $\text{var}(u_t^i) = \Sigma$.

To recover the parameters in the structural form equation from the estimated parameters in the reduced form equation, popular recursive restrictions on contemporaneous structural parameters are imposed, which is proposed by Sims (1980). For more details on the methodology, refer to Kim and Lee (2007). Finally, note that our statistical inference is not affected by the presence of non-stationary data because we follow a Bayesian inference (see Sims 1988 and Sims and Uhlig 1991).³

5.2 Basic model

In the basic model, the data vector, y_t^i , is $\{\text{DEP}, \text{RGDP}, \text{SAV}, \text{CUR}, \text{RIR}\}$ where DEP is the dependency rate (the percentage of a sum of population aged 65 and above and aged 14 and below in the total population), RGDP is a log of real GDP per capita, SAV is the national saving rates (the sum of private and government saving, percent of GDP), CUR is the current account (percent of GDP), and RIR is the (ex post) real interest rate (percent). A constant is included and two lags were selected based on Schwartz criterion.

We included DEP, SAV, and CUR because they are the main variables of our interests. A change in the population age structure is expected to influence saving and

³ Specifically, we generate the standard error bands based on a Bayesian method, as described in the RATS Manual.

current account. Because current account is, by definition, equal to the saving–investment imbalance, domestic investment is excluded in the model, but its change can be inferred from the net of the changes in saving and current account. Note that we first focus on the effects of total dependency rate shocks, instead of analyzing the effects of elderly dependency rate shocks and the effects of youth dependency rate shocks separately, because the theory is better established for the effects of total dependency rate changes. The extended model analyzes the effects of elderly dependency rate shocks and the effects of youth dependency rate shocks separately.

Real GDP (RGDP) is included because it is the single best measure of economic activities, and it is regarded as an important determinant of saving and investment rates. In addition, the effects of demographic changes on RGDP may help us to infer how demographic changes affect saving and current account. The real interest rate (RIR) is included because it is likely to affect various components of current account, such as saving and investments. In addition, RIR may also provide an important clue on the transmission mechanism of demographic changes.

Our basic model assumes a recursive structure on the contemporaneous relation among variables. The ordering is {DEP, RGDP, SAV, CUR, RIR}, where contemporaneously exogenous ones are ordered first. This assumption is not completely unreasonable. A change in the dependency rates is likely to affect economic variables contemporaneously. On the other hand, the economic variables might affect the DEP in the end, but not contemporaneously. Economic conditions may affect birth rates, but the effect will take at least a year as the gestation period is approximately 9 months. It may be more controversial whether economic conditions would affect the death rate and, in turn, affect the elderly dependency rate contemporaneously.

However, a temporary change in economic conditions may not affect the death rate much, although a prolonged change in economic conditions may. Therefore, the contemporaneous effects of the economic variables on the dependency rate may be minor. Further, the changes in the elderly dependency rate are likely to be the results of the population aging process (such as longer life expectancy in general), rather than the results of immediate death rate changes due to changes in economic conditions. At least we can say that this assumption of contemporaneous exogeneity is weaker than the assumption of most previous studies. (Most past studies assumed that demographic variables are fully exogenous to other economic variables.) Finally, notice that the ordering of the other variables does not matter when we examine the effects of shocks to the DEP.⁴

⁴ Refer to Christiano, Eichenbaum, and Evans (1999).

5.3 Extended model

We constructed extended models to examine the effects on other relevant variables and to infer further the transmission of demographic changes on saving and current account. The extended model adds a new variable to the basic model: {DEP, RGDP, SAV, CUR, RIR, X}, where X is the new variable. First, we included private and public saving one by one in order to examine the effects on the component of the saving X. Second, private consumption and government consumption are included one by one in order to further infer the private consumer decision and government behavior. Finally, the real exchange rate is included in order to infer the transmission mechanism and the consequence of the demographic changes on external balances.

We also constructed another extended model to infer the effects of changes in two dependency rates, the elderly dependency rate and the youth dependency rate, separately. With these models, we would like to examine whether the effects of the changes in the two dependency rates are different and whether the results in the basic model are robust. The extended model is constructed as {DEPO, DEPY, RGDP, SAV, CUR, RIR}, where DEPO is the elderly dependency rate and DEPY is the youth dependency rate. There is no definitive theory on the ordering between DEPO and DEPY. Therefore, we also experimented with the alternative ordering of {DEPY, DEPO, RGDP, SAV, CUR, RIR}.

5.4 Data

We consider 10 East Asian countries: Hong Kong, Taiwan, South Korea, Singapore, Malaysia, Indonesia, The Philippines, Japan, China, and Thailand. Annual data are used. The estimation period is 1981–2003.

Most data series including total population, youth dependency rate (population, ages 0–14, percent of total), elderly dependency rate (population, ages 65 and above, percent of total), GDP in the current domestic currency unit and constant domestic currency unit, gross investment in current domestic currency unit, private consumption in constant domestic currency unit, government consumption in constant domestic currency unit, (ex post) real interest rates, and real effective exchange rate are obtained from the World Bank, *World Development Indicator*. Investment rate is constructed by dividing gross investment in current domestic currency unit by GDP in current domestic currency unit. Gross national saving rates (gross national saving/GDP), private saving rates (private saving/GDP), and public saving rates (government saving/GDP) were obtained from the IMF, *World Economic Outlook*. The current account balances (as a ratio to GDP) are constructed by the saving rates subtracted by investment rates (that is, the ratio of gross investment in current domestic currency unit to GDP in current domestic currency unit).

Some exceptions follow. The real effective exchange rate for Hong Kong, Korea, and Taiwan is obtained from *Bank for International Settlements*. The real effective exchange rate for Indonesia and Thailand is constructed by weighting the real exchange rates against the United States and Japan (using trade weights), where the real exchange rates are constructed by using the nominal exchange rate and GDP deflator. The real interest rates for Hong Kong, Indonesia, Malaysia, and Taiwan are constructed by subtracting the GDP deflator inflation rate from the nominal interest rate. The nominal interest rates are obtained from the Web site of *Asian Development Bank*. Commercial Bill rate is used for Hong Kong whereas a 12-month time deposit rate is used for other countries. Other data series of Taiwan are obtained from *National Statistics*.

6. Estimation results

6.1 Basic results

Figure 9 reports the basic results and the impulse responses to shocks to the dependency rate (DEP) over a 25-year period with 90 percent probability bands for the basic five-variable VAR model. The responding variable names are denoted at the top of each graph. The responses of RGDP are in terms of percent changes whereas others are in terms of percentage point changes. Note that we also calculate the responses of investment, by subtracting the current account from the saving.⁵ From the responses of DEP, we can infer the nature of the shocks. The point estimate shows that the dependency rate increases by approximately 0.07 percentage point in a year, further increases to approximately 0.38 percentage point in 10 years, and then decreases over time, returning to the initial level in approximately 23 years.⁶

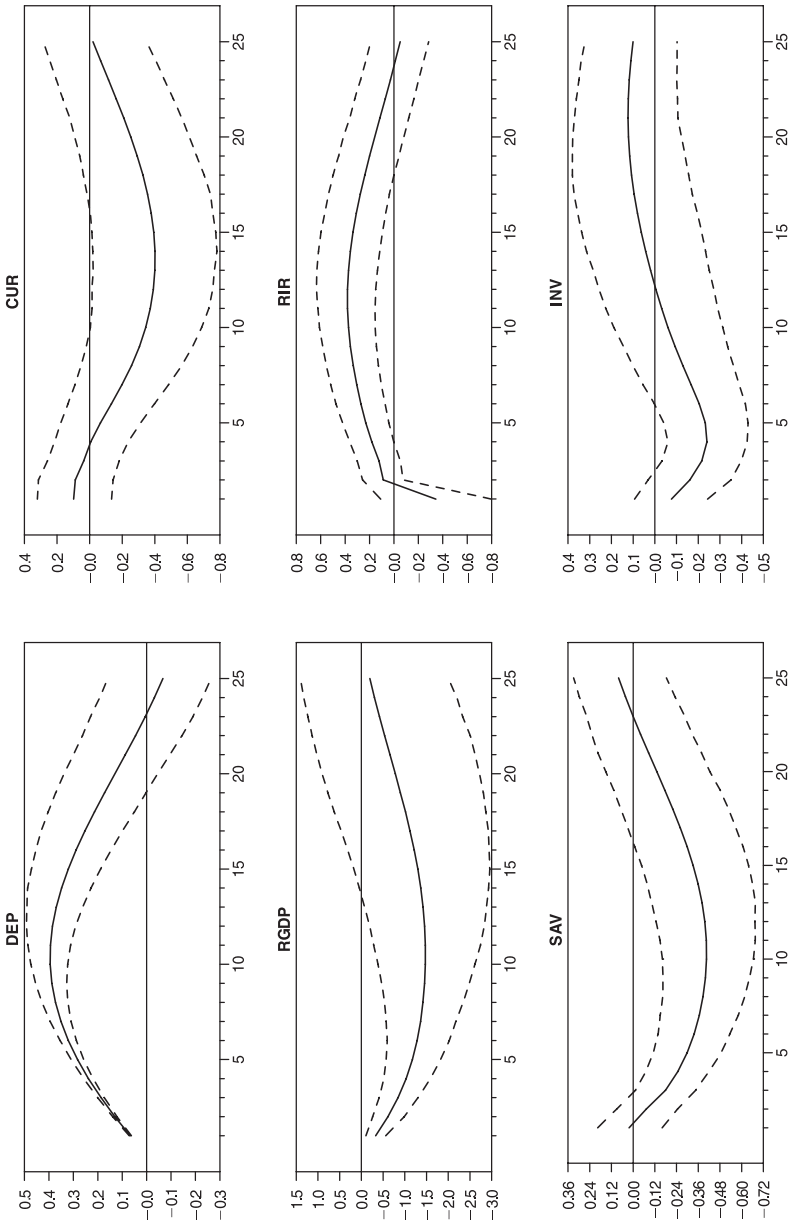
In response to such DEP shocks, real per capita GDP decreases over time. The maximum negative effect, approximately a 1.5 percent drop, is found in approximately 10 years and reverts to the initial level in approximately 25 years. The drop in RGDP up to 10 years is different from zero with at least 95 percent probability. The decrease in real per capita GDP is consistent with the theoretical prediction; as the dependency rate increases and fewer people earn (labor) income, the real GDP per capita is likely to drop.⁷

⁵ For each draw, investment rate responses are calculated by subtracting current account from saving, and then the error bands are constructed.

⁶ The temporary nature of the dependency rate shocks is not surprising because the empirical model controls the global factor by introducing the time fixed effect.

⁷ The multi-country simulation models predict the decreased working population will cause substantial declines in real GDP of advanced countries. For instance, Batini, Callen, and McKibbin (2006) forecast that the level of Japanese GDP in 2050 will be 30 percent lower than would have been the case without the impact of demographic transition.

Figure 9. Impulse responses to dependency rate shocks: basic model



Both saving and investment rates decline. The decrease in saving rates is especially strong. Saving rates decrease over time. The maximum effect of approximately 0.4 percentage point decline is found in 10 years, and then reverts to the initial level in approximately 23 years. The decrease in the saving rates from 4- to 14-year horizons is different from zero with a 95 percent probability.

Investment rates also decline, but the size and the persistence of the decline are smaller than that of the saving rate. The decline is significantly different from zero only at a 4-year horizon with 95 percent probability.

The current account also declined, because the saving rate fall is larger and more persistent than the investment rate. The current account decreases over time. The maximum decline of 0.4 percentage point is found in about 14 years. Then, it increases back to the initial level in 25 years. However, the decline is not significantly different from zero at any horizon with 95 percent probability, but it is significantly different from zero from 10- to 15-year horizons with 90 percent probability.⁸

The estimates show that a substantial demographic effect exists on the saving and current account. For instance, Japan and Singapore had a faster increase in the total dependency rate in the 1990s (compared to other countries and its own past), which would have had a similar magnitude of a saving and current account rate fall (compared to other countries and its own past).

These responses of saving, investment, and the current account are consistent with the theory. The life-cycle theory (and the fiscal arrangements in these countries) predicts the decline in saving rates as the dependency rate increases. The current account deterioration can be also found when saving rates decline in the economy relative to investment rate with internationally mobile capital.

The real interest rate decreases on impact but the decrease is not significantly different from zero. From the second year after the shock, the real interest rate increases over time, and the maximum effect of 0.3 percent is found in approximately 12 years. The rises in the real interest rate from 5 to 16 years horizon are different from zero with at least 95 percent probability. The rise in the real interest rate may be understood because of a decrease in the supply of loanable funds in the economy, which is shown by the drop in the saving rate.

These responses to the shocks to dependency rate in East Asian countries are qualitatively similar to those in G-7 countries, reported by Kim and Lee (2007). Kim and

⁸ The result is available from the authors.

Table 1. Forecast error variance decomposition: contribution of dependency rate shocks

Horizon	DEP	RGDP	SAV	CUR	RIR	INV
5 year	94.8	4.4	2.3	0.9	1.4	2.2
<i>St. Error</i>	2.6	3.0	1.8	1.0	1.2	1.9
10 year	81.4	8.4	8.1	3.3	3.5	3.6
<i>St. Error</i>	7.0	5.9	5.5	3.0	2.3	3.1
15 year	68.0	11.5	12.7	7.4	5.8	4.8
<i>St. Error</i>	10.3	8.6	8.4	6.3	3.7	3.7
25 year	52.8	14.1	14.8	10.7	7.2	7.1
<i>St. Error</i>	13.0	9.9	9.0	8.3	4.6	5.3

Lee found that real GDP, saving rate, and investment rate decrease in response to a positive shock to dependency rate, and that the current account also decreases because saving rate decreases more than investment rate. However, the response of the real interest rate is qualitatively different. The real interest rate does not change much in G-7 countries, but the real interest rate increases significantly in East Asian countries. G-7 countries have been more open to international financial markets than East Asian countries, which may explain the differences in the results.

Finally, we report the forecast error variance decomposition results in Table 1 to infer the role of the dependency rate shocks when explaining fluctuations of macroeconomic variables. For the long horizons, the dependency rate shocks explain substantial parts of real GDP, saving, and current account fluctuations. The dependency rate shocks explain over 14 percent of saving rate and real GDP fluctuations and over 10 percent of current account fluctuations for the 25-year horizon.

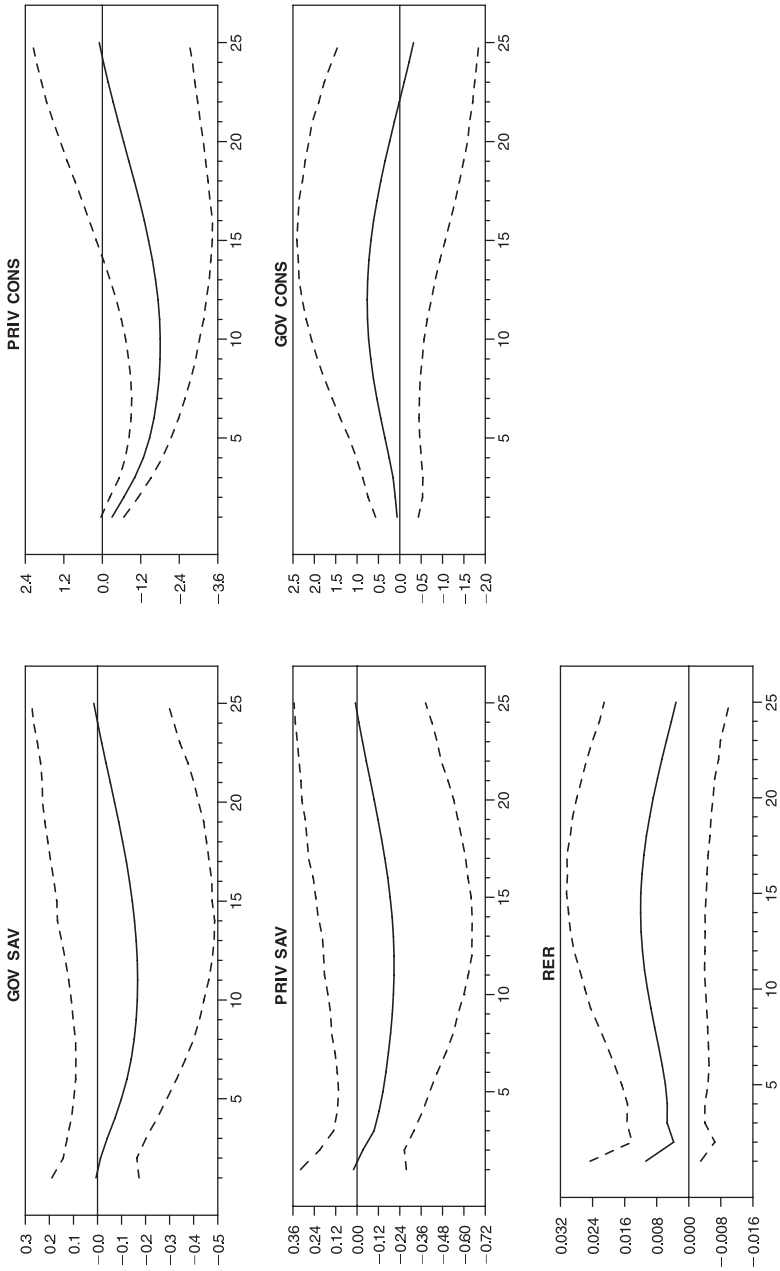
6.2 Results of the extended model

Figure 10 reports the impulse responses of other macro variables of interests for the extended model. As discussed in section 5, an additional variable is added in the basic model. The responses of the private saving rate (PRIV SAV, percent of GDP), government saving rate (GOV SAV, percent of GDP), real exchange rate (RER), real government consumption per capita (GOV CONS), and real private consumption per capita (PRIV CONS) are reported. Notice that the responses of the private saving rate and government saving rates are in terms of percentage point changes, whereas the additional variables are in terms of percentage changes.⁹

Both private and government saving decrease. The decreases are not different from zero with 95 percent probability, but they are at a 6- and 7-year horizon with at least

⁹ Note that the impulse responses of the original five variables in the extended models are similar to those in the basic five-variable model.

Figure 10. Impulse responses to dependency rate shocks: extended model



84 percent probability. The maximum declines are found in about 10 years. The maximum decline of private saving is approximately 0.22 percentage point whereas that of government saving is approximately 0.17 percentage point. Real government consumption increases over time, and the maximum increase of approximately 0.6 percent is found in about 11 years. As dependency rate increases, government needs to spend more to support dependents, which may lead to an increase in government consumption. This increase in government consumption, in turn, leads to the decrease in government saving. On the other hand, real private consumption decreases sharply. The maximum decrease of approximately 1.8 percent will be seen in about 10 years.

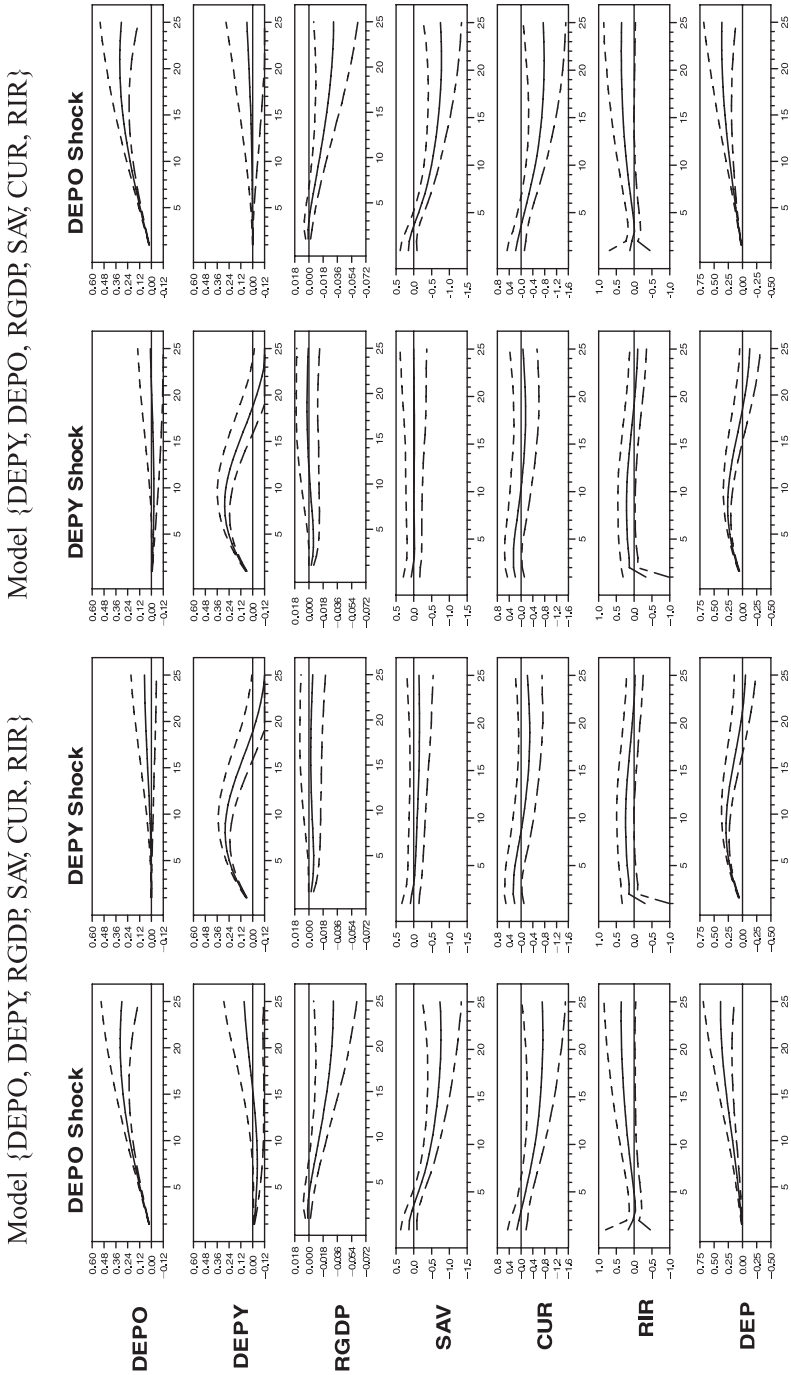
These results are somewhat different from the results of G-7 in Kim and Lee (2007). In G-7 countries, the saving decline is mostly driven by the decline in government saving (instead of the decline in private saving). This may be related to the social security system. In G-7 countries that have a good social security system, the government can take over the burden of decline in income due to an increase in the dependency rate, which may result in a decline in government saving but no changes in private saving. On the other hand, in many East Asian countries, which do not have a good social security system, the government cannot take over the entire burden, and as a result, private saving also declines.

Finally, the real exchange rate tends to appreciate, which may be explained by the increase in the real interest rate. This result is also different from the long run depreciation results of G-7 countries found in Kim and Lee (2005).

Figure 11 reports impulse responses in the extended model that both the elderly dependency rate and the youth dependency rate are included in the model, by replacing the total dependency rate. The first and the second columns show the responses to the elderly dependency rate shocks and the youth dependency rate shocks, respectively, in the model {DEPO, DEPY, RGDP, SAV, CUR, RIR} and the third and the fourth columns show the responses to the youth dependency rate shocks and the elderly dependency rate shocks, respectively, in the model of {DEPY, DEPO, RGDP, SAV, CUR, RIR}. In addition to the responses of the six variables, we also report the responses of the total dependency rate by adding the responses of the elderly dependency rate and the youth dependency rate. The responding variables are denoted at the far left with the name of shocks and the model names reported at the top. In order to compare easily the four cases, the same scale is applied to all graphs in the same row.

Elderly dependency rate shocks have stronger effects on most variables than youth dependency rate shocks. Elderly dependency rate shocks substantially decrease real

Figure 11. Impulse responses to elderly dependency rate and youth dependency rate shocks: extended model



GDP, saving, and the current account. The point estimate shows that over approximately 20 years, an increase of the elderly dependency rate by approximately 0.25 percentage point is associated with a decrease of saving rate by 0.8 percentage point and current account balance by 0.8 percentage point. On the other hand, youth dependency rate shocks have only small effects on those variables. These results are quite different from the results of G-7 countries in Kim and Lee (2005). The elderly dependency rate shocks mostly drive the changes in the real GDP, saving rate, and the current account in East Asian countries whereas both elderly and youth dependency rate shocks are responsible for the changes in those variables. This result seems to be partly due to the persistence of the shocks; elderly dependency rate shocks are more persistent than youth dependency rate shocks. In addition, the results may be related to different cultural and economic environments. For example, income during retirement is low in East Asia, which may lead to a larger effect of elderly dependency rate on private saving. As another example, parents in East Asia may be more eager to save money for their children, which may lead to a smaller effect of youth dependency rate on private saving.

7. Concluding remarks

This paper examined the effects of demographic changes on saving and current account in 10 East Asian economies between 1981 and 2003. The panel VAR estimations show that an increase in dependency rate has a strong association with saving decline and current account deterioration. Our finding suggests that the rapidly aging population and subsequent rise in dependency rates in East Asia over the next decade might cause substantial deterioration in saving rates and current account. However, the precise magnitude of a future impact would depend on the adjustments that private agents and national governments could make in anticipation of the demographic changes, for example, an increase in private saving, pension reforms, a migration to more productive countries, and extension of retirement age. In particular, East Asian economies would eventually have to face the two problems that are now confounding the advanced countries: how to reform the pension schemes and long-term health-care systems. The East Asian adjustments to these demographic changes will change future saving rates, especially future public saving rates, and future current account balances.

From a global perspective, such aging-related pressures on the current accounts in East Asia might be at least partly offset by the favorable effect of the increased working population in other regions. Globally, the net capital inflows in East Asia as well as advanced countries should be met by the net capital outflows in other developing countries. However, because the pace and timing of population aging will

vary much among countries, the consequences of global demographic changes on international capital markets would be more complicated. It might happen that fast-aging nations decrease the supply of global saving substantially below global investment demand in the world. This shortage of global supply of loanable funds would cause a higher cost of capital and subsequent drop in investment and real output. Clearly, much interesting research remains to be done in future research on the impact of demographic changes on current account imbalances across countries and regions.

References

- Banks, James, Richard Blundell, and Sarah Tanner. 1998. Is There Retirement-Savings Puzzle? *American Economic Review* 91(4), 769–788.
- Batini, Nicoletta, Tim Callen, and Warwick McKibbin. 2006. The Global Impact of Demographic Change. IMF Working Paper No. wp/06/9. Washington, DC: IMF.
- Bernheim, D., J. Skinner, and S. Weinberg. 2001. What Accounts for the Variations in Retirement Wealth among U.S. Households? *American Economic Review* 91, pp. 832–857.
- Bosworth, Barry, Ralph C. Bryant, and Gary Burtless. 2004. The Impact of Aging on Financial Markets and the Economy: A Survey. Working Paper No. CRR WP 2004–23. Boston: Center for Retirement Research at Boston.
- Brooks, Robin. 2003. Population Aging and Global Capital Flows in a Parallel Universe. *IMF Staff Papers* 50 (2):200–221.
- Bryant, Ralph C. 2004. Cross-Border Macroeconomic Implications of Demographic Change. Brookings Discussion Papers in International Economics No. 166. Washington, DC: The Brookings Institution.
- Carroll, Christopher D. 1997. Buffer Stock Saving and the Life Cycle/Permanent Income Hypothesis. *Quarterly Journal of Economics* 112:1–55.
- Chinn, Menzie D., and Eswar S. Prasad. 2003. Medium-term Determinants of Current Account in Industrial and Developing Countries: An Empirical Exploration. *Journal of International Economics* 59 (1):47–76.
- Christiano, L., M. Eichenbaum, and C. Evans. 1999. Monetary Policy Shocks: What Have We Learned and to What End? In *Handbook of Macroeconomics*, vol. 1A, edited by John B. Taylor and Michael Woodford, pp. 65–148. Amsterdam: North-Holland.
- Deaton, Angus, and Christina Paxson. 1997. The Effects of Economic and Population Growth on National Saving and Inequality. *Demography* 34:97–114.
- Dekle, Robert. 2004. Financing Consumption in an Aging Japan: The Roles of Foreign Capital Inflows and Immigration. NBER Working Paper No. 10781. Cambridge, MA: National Bureau of Economic Research.
- Demery, D., and N. W. Duck. 2006. Savings-age Profiles in the U.K. *Journal of Population Economics* 19 (3), pp. 521–541.
- Edwards, Sebastian. 1995. Why Are Saving Rates so Different Across Countries? An Interna-

tional Comparative Analysis. NBER Working Paper No. 507. Cambridge, MA: National Bureau of Economic Research.

Eichengreen, Barry. 2005. The Blind Men and the Elephant. Paper presented at The Tokyo Club Foundation's Macroeconomic Research Conference on the Future of International Capital Flows, 21–22 November, Kyoto.

Faruqee, Hamid, and Martin Mühleisen. 2003. Population Aging in Japan: Demographic Shock and Fiscal Sustainability. *Japan and the World Economy* 15:185–210.

Feroli, Michael. 2003. Capital Flows among the G-7 Nations: A Demographic Perspective, *Finance and Economics Discussion Series* 2003-54. Washington, DC: Board of Governors of the Federal Reserve System.

Helliwell, John F. 2004. Demographic Changes and International Factor Mobility. NBER Working Paper No. 10945. Cambridge, MA: National Bureau of Economic Research.

Higgins, Matthew. 1988. Demography, National Saving, and International Capital Flows. *International Economic Review* 39:343–369.

Horioka, Charles. 1992. Future Trends in Japan's Saving Rate and the Implications Thereof for Japan's External Imbalance. *Japan and the World Economy* 3:307–330.

International Monetary Fund (IMF). 2004. *World Economic Outlook*. September. Washington, DC: International Monetary Fund.

Jappelli, Tullio, and Franco Modigliani. 1998. The Aging-Saving Profile and the Life-Cycle Hypothesis. CSEF Working Paper No. 09. Salerno, Italy: Centre for Studies in Economics and Finance.

Kim, Soyoun, and Jong-Wha Lee. (2007). Demographic Changes, Saving, and Current Account: An Analysis of Panel VAR Model. *Japan and the World Economy* forthcoming.

Leff, N. H. 1969. Dependency Rates and Saving Rates. *American Economic Review* 59, pp. 886–896.

Liu, Liang-Yn, and Wing Thye Woo. 1994. Saving Behavior under Imperfect Financial Markets and the Current Account Consequences. *The Economic Journal* 104 (May):512–527.

Luhrmann, Melanie. 2003. Demographic Change, Foresight and International Capital Flows. Mannheim Research Institute for the Economics of Aging? MEA Discussion Paper Series No. 03038. University of Mannheim, Germany.

McKibbin, Warwick. 2005. Global Demographic Change and Japanese Macroeconomic Performance. Brookings Discussion Papers in International Economics No. 169. Washington, DC: The Brookings Institution.

McKibbin, W., and J. Nguyen. 2004. Modelling Global Demographic Change: Results for Japan. Paper presented at the Conference on the International Collaborations Project, Tokyo.

Masson, Paul R., Tamim Bayoumi, and Hossein Samiei. 1998. International Evidence on the Determinants of Private Saving. *World Bank Economic Review* 12:483–501.

Modigliani, Franco. 1970. The Life-Cycle Hypothesis of Saving and Inter-country Differences in Saving Ratios. In *Induction, Growth, and Trade*, edited by W. A. Eltis, pp. 197–225. London: Clarendon Press.

- Sims, Christopher A. 1980. Macroeconomics and Reality. *Econometrica* 48:1–48.
- Sims, Christopher A. 1988. Bayesian Skepticism on Unit Root Econometrics. *Journal of Economic Dynamics and Control* 12:463–474.
- Sims, Christopher A., and Harald Uhlig. 1991. Understanding Unit Rooters: A Helicopter Tour. *Econometrica* 59:1591–1599.
- Weil, David N. 1994. The Saving of the Elderly in Micro and Macro Data. *Quarterly Journal of Economics* 109:55–81.