Can Greying East Asia Reduce its Current Account Surplus?

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I. Introduction

Global imbalance today contributes to trade tensions especially for the United States and her trading partners with the large current account surplus at an expense of the United States' huge current account deficit. This situation of global imbalances persists for decades and become more intensified since 2001 when China joined the World Trade Organization. Since then, China along with other Eastern Asian export-oriented countries hold a large current account surplus as a result of being the manufacturing centers of the world and with the foreign currencies earned, these countries became the major supplies of world savings. On the other hand, the countries importing such manufacturing goods such as the United States faces the large current account deficit (see figure 1) and became net borrowers of the world. However, such a trend in large surplus could be reversed as these countries especially China, South Korea, and Thailand are entering an aging society. The United Nations projected (as shown in figure 2) that by 2025, these countries will see a sharp decline in prime-age savers, defined as population aged 45 – 64, and a sharp rise in the elderly population as those savers enter the retirement. This population shift could result in a decline in national savings and thus worsen the countries' current account balance given a relatively stable level of investment. This study is not only to quantitatively study relationships between demographic transition and current account balance but also attempt to analyze such relationships in given different sets of characteristics of economies. For example, responses to a shift in demography in advanced economies such as Japan or Germany may differ from those in an emerging economy such as China or Thailand because of the different saving behaviors. The main contribution of this paper is thus the gauging of current account balance sensitivity to aging in heterogenous saving patterns across the group of countries especially those with significant current account surplus and rapidly aging population. The paper provides an alternative forecast for the level of the current account balance to GDP for China, Thailand, and South Korea using the technique of Panel Vector Autoregressive (PVAR).

II. Literature Review

In studying the relationship between demographic transition and current account balance, we need to examine the relationship between demographic structure and national saving rate, and the saving rate and current account balance. The first relationship is usually explained by the life cycle hypothesis by Modigliani (1966). The hypothesis states that consumers save up during their working age and dissave after their retirement, and thus, at the aggregate level, an aging country is likely to see a surge in the aggregate saving before it enters into the aging society which is usually defined as having an elderly population (aged 65 and over) more than 20% of the total population. Once the country enters such a scenario, it sees a decline in aggregate saving. While the latter relationship can be a direct result from national accounting identity in the equation (1), that is, an increase in the aggregate saving increases the current account balance given no change in aggregate investment.

$$\text{Current Account Balance} = X - M = S - I \tag{1}$$

A. The Studies of Demography and Current Account

There are two main approaches to study the association between demographic change and current account – theoretical-driven and data-driven approaches. For theoretical strategy, several studies utilized dynamic macroeconomic models such as the Overlapping Generations Model (Brooks, 2003), Ramsey-style Neoclassical Growth Model (Domeij & Flodén, 2006), and Life Cycle Model (Barany, Coeurdacier & Guibaud, 2016). They modified the models to account for intergenerational transfers, pension systems, and inter-country interactions, and calibrated those models with the actual data to get the estimated parameters in the model. The data simulated from all the studies performs well (i.e. acceptable deviation from the actual data) and confirms that the current account balance follows the life-cycle hypothesis with an aged country becomes deficit and a country with a larger proportion of prime-age population gaining surplus. For the data-driven approaches, many studies employed panel data methods to study the relationship, for instance, Higgins (1998) finds a significant contribution of a demographic shift, especially from the young and old dependency ratio. The study estimated that over the thirty years, in several countries, the age structure changes affected the current account balance above six percent of the country's GDP. The recent working paper by Dao and Jones (2018) focused on prime-age savers as a proportion of the total population and find a positive significant relationship between the proportion and improvement in the current account balance. Nevertheless, Graff, Tang, and Zhang (2015), using conventional panel data techniques with more control variables such as openness, financial development, education, etc., suggest that the relationship between old-age dependency and the current account balance exists but the magnitude of influence is substantially smaller.

B. Potential Heterogeneity in the Magnitude of Relationship

With those previous studies on demography and current account, it is suspected that demographic impacts on the current account balance might differ among the countries according to variations in characteristics. To construct appropriate models for the countries in this study, specifically China, Thailand, and South Korea, such models must take these variations into account. Based on the collections of literature in this area, four main country-specific characteristics may have played significant roles in the magnitude of demographic impact. The four characteristics are as follows:

1. *Longevity* – the life expectancy of a country can influent its aggregate saving rate in two ways. The first is that when an individual expects to live a long period after her retirement, she tends to save more, and thus, an increase in life expectancy should increase the national saving rate. The second way is that the longer the individuals live past their retirement, the higher the dissaving, and hence, a rise in life expectancy could contribute to a drop in the national saving rate. Empirically, Li, Zhang, and Zhang (2007) estimate a fixed-effect cross-country panel data and find a positive association between life expectancy and saving. From this evidence, the higher life expectancy may intensify the effect of demographic change on the current account balance through higher rates of saving.

2. *Pension System* – a country with a more developed pension system tends to have a higher national saving rate since the system often requires or even incentivized its citizens to save during their working age. Chai and Kim (2018) argue that with a rising life expectancy, the impact of changes in demography on private savings is intensified under a more generous pension system. Moreover, Bloom, et. al. (2006) conclude that if a system incentivizes

retirements at an early age, the saving rate will be higher as a result of preparations for a longer retirement. In general, the more developed pension system, the higher saving rate can be expected, and therefore, leads to a higher impact of demography on the current account balance. This is in line with the simulation of capital flows given demographic changes by Barany, Coeurdacier, and Guibaud (2018) that when they replaced their calibrated social security coverage parameter by zero, the capital export coefficients became smaller. This means that such the demographic impacts will be stronger given a highly developed social security system.

3. *Financial Openness* – the degree of capital mobility could influent the magnitude and speed of current account balance changes. Chinn and Ito (2005) find that for advanced economies, the higher degree of openness associates with the lower capital account balance. In the contrary, for emerging economies where many of which have current account surpluses, the more open the financial account associates with the higher current account balance. Mendoza, Quadrini, and Rios-Rull (2009) observed that since the financial globalization as measured by a significant increase in the Chinn-Ito financial openness index, the United States sees a large decline in the net foreign asset position. The results of their model also suggested that higher capital mobility leads to a more severe global imbalance. According to these pieces of evidence, it is plausible that a higher degree of openness would lead to a stronger impact of aging on current account positions.

4. *Financial Development* – The higher level of financial institutions and financial markets development associates with a higher saving rate in developed countries and emerging economy countries. (Chinn & Ito, 2005) With the complexity of the financial system, the flow of funds can occur easily as sources of funds become more accessible, and given a high degree of

financial openness, a country with sophisticated financial markets can increase borrowings and reduce savings rapidly. (Mendoza, Quadrini, & Rios-Rull, 2009) This, therefore, is likely that a country with deeper financial markets will suffer a larger decrease in current account surplus from the aging population.

It is therefore susceptible that the magnitude of a relationship between demographic and the current account balance may vary especially among the advanced and emerging economy.

III. The Expected Results

I. The demographic shift significantly contributes to a change in current account balance through a change in the aggregate saving level, more explicitly, a shock in the ratio of prime-aged savers, and a positive shock in old-age dependency ratio should lead to or associate with an improve, and a worsening in the current account balance, respectively.

II. The relationship in I. should be *stronger* in the sub-group classified by (or when interacted by) *higher* degrees of longevity, development of social security system financial openness, and financial market development.

The result from II. will give us an insight into the outlook of Asian countries' trade surpluses soon where the society is aged. For example, with the United Nation’s population projections, the trend of current account balances can be projected according to the estimated results. This method of projections differs from other current studies that instead of projecting based on each country, this study employs panel data of several countries with similar characteristics as the targeted country. The inclusion of other countries in the projection has an advantage that it allows the prior experience of other countries, for example, Asian countries have not faced a decline in working-age population while those European counterparts have already seen it, to inform how the targeted country reacts to the demographic shifts, given that the countries included in the panel have similar key characteristics to the targeted country.

IV. Data

A. Main Variables

In this study, the main variables are demographic (prime-age savers population and old dependency ratio), aggregate saving rate, and current account balance. There are also other potential variables to be included in the model for a more robust result such as GDP, investment, inflation, real interest rate, and nominal exchange rates. These variables are publicly available via the World Bank's World Development Indicators (WDI). Data for all countries (the coverage of countries can be found in table 4, note that the table represents the raw data before cleaning). This study employs annual data as opposed to quarterly data since variations in demography cannot be captured quarterly and the face that annual data is more complete than the quarterly data. The sample panel data is from 1969 to 2018, 50 years, with all 183 countries in the WDI database. The countries are to be dropped if its series of data is not sufficiently long or that it consists of missing periods. This is to have a large sample as technically possible to preserve variations in demography because later those countries will be divided into sub-groups, and the variations are expected to be smaller.

The summary of the variables used in this study can be found in table 1, and summary statistics can be found in table 2. The pair-wise correlation is shown in table 3 noticing that age dependency and young dependency ratio are negatively correlated with the current account balance. The prime-age saver population (16 – 64 years old as a percentage of the total population) is positively correlated with the current account balance. The old dependency ratio and the current account balance exhibit a slightly positive relationship which is contradicting to the theory. This may be because the old dependency ratio is generally low in the Sub Saharan African (SSA) region where most of the countries have a current account deficit. The pattern of current account balance depends substantially on the stage of industrial development and therefore, the countries' income will be control in the estimation. The scatter plot of the old dependency ratio, prime-age savers, and current account balances can be found in Figures 3 and 4, respectively. It can be observed that with no control variables, the relationship is ambiguous on the scatter plots and the variation in demography only rises after 2000.

B. Control Variables to account for Heterogeneity

The control variables are used for characterizing countries in 4 aspects. The summary of the variables used in this study can be found in table 1, and summary statistics can be found in table 2.

Longevity – The life expectancy at birth is available for every country and period in this study, this panel is obtained from the WDI.

Pension System – Tentatively, the coverage of social security (% of the total population) will be used to assess a country's development of the pension system. The data is obtained from The World Bank's Atlas of Social Protection and is aggregated from household surveys. The data only available for 2 – 3 observations per country.

Financial Openness – The Ito-Chinn Index of Financial Openness will be used. The data is roughly cover one-third of the total observations in the main variables. The alternative measurement of Financial Openness is Wang-Jahan Capital Account Openness Index (Wang & Jahan, 2016) and will be used to those two indices deviate significantly.

Financial Development – The financial deepening variable (M2 to GDP) will be used as a proxy to assessed the country's financial development because the data is largely available for the most of observations in the main variables. The control for money demand can be achieved through including the real interest rates into the system in the extended PVAR models.

V. Empirical Strategy

A. The Dynamic System: The PVAR Model

The past studies either employed a theoretical-driven technique by constructing a macroeconomic model then use actual data to calibrate and simulate the result or the data-driven technique by panel data models. Each technique has some limitations, for the theoretical approach, the relationship is pre-determined and can sometimes not relevant to the actual data. For panel models, identification can be a potential problem such as the channel to which demographic influences the current account. The econometric model of this study follows the technique employed by Kim and Lee (2007). According to them, to strike the balance between the two methods, the dynamic panel data will be employed. This approach allows us to use large panel data to gauge the relationship between demographic changes and the current account balance while preserving a dynamic aspect of the relationship.

For the baseline PVAR model, the endogenous variables in the system are current account as a percentage of GDP, gross savings minus gross fixed capital formation as a percentage of GDP, and prime savers (age 45 – 64) as a percentage of the total population. The estimation is based on all the data points in the 49-year period for 183 countries to allow for variations in the demographic macroeconomic characteristics. The problem with incorporating all possible data points is that the panel is highly unbalanced with a large number of countries

(N) but a small number of time periods (T) and the option for empirical strategy is therefore limited. The pre-estimation process includes Im–Pesaran–Shin panel unit root test (Im, Pesaran, & Shin, 2003) to determine whether the variables are stationary, and the result suggests that only prime saver variable is not stationary at level. The next natural step is to test for panel cointegration but since the panel is highly unbalanced, the Im–Pesaran–Shin panel is not likely to detect any cointegration, and the results confirm that there is no cointegration. The most straightforward method for dealing with the non-stationary is to take the first difference, however, the loss in data points from the first difference is significant because of the missing period within the same country. Instead of the first difference method, the forward orthogonal deviation (FOD) transformation developed by Arellano and Bover (1995). The transformation is given by

$$z_{\mathrm{it}} = \left(y_{\mathrm{it}} - \frac{\sum_{l=1}^{T} y_{\mathrm{it}+l}}{T} \right) \sqrt{\frac{T}{T+1}} \qquad (2)$$

Where T is the number of forwarding periods used in the transformation
y is a data point in the time series
z is a FOD-transformed instrument for y

The FOD transformation helps decrease the loss of data points and provides a valid and relevant instrument for the variables in the system. In this case, the period T above is 3 because of the short time series. The estimation invokes GMM but with instruments suggested by Holtz-Eakin, Newey, and Rosen (1988). The lag of PVAR is determined by maximizing the overall coefficient of determination (CD) which indicates the proportion of variations in the variables explained by the model to the total variations. The determined lag is one and this is reasonable given that the panel is unbalanced and a relatively short period of time comparing to the number of countries. With this determined lag, the next step is to test whether the PVAR is stable, i.e., the modulus of unit roots for each equation is strictly less than one. This estimated PVAR is however not stable even after the FOD transformation at any forward periods used. The problematic equation is the prime saver equation as the series is not stationary at the FOD transformation which is equivalent to the first difference. To cope with the instability, the PVAR then includes GDP per capita as an exogenous variable attached to each equation to control for the stage of development of the countries. The rationale for this control is that GDP per capita and prime savers proportion are strongly correlated with high-income countries usually have a higher proportion of prime savers relative to low-income countries. The GDP per capita control makes the PVAR stable, and therefore, any further PVAR estimated will employ this specification that is,

$$\mathbf{Z}_{\mathrm{it}} = \mathrm{C}_{\mathrm{i}} + \mathrm{C}_{\mathrm{t}} + \mathbf{Z}_{\mathrm{it}-1}\beta + \mathbf{X}_{\mathrm{it}}\gamma + \varepsilon_t \tag{3}$$

$$(1 - \mathrm{L}\beta)\mathbf{Z}_{\mathrm{it}} = \mathrm{C}_{\mathrm{i}} + \mathrm{C}_{\mathrm{t}} + \mathbf{X}_{\mathrm{it}}\gamma + \epsilon_t \tag{4}$$

where **Z** is a vector of FOD-transformed endogenous variables
Ci is a vector of country fixed effects
C_t is a vector of time fixed effects
X is a vector of exogenous variables

Equation (2) shows the structural model specification and equation (3) shows the reduced form equation. The parameters β and γ are estimated in the reduced form model by Holtz-Eakin-Newey-Rosen-style GMM. The estimated parameters, however, cannot be directly interpreted because of endogeneity of the system, and thus the Granger Causality Test is deployed to determine the Granger causality among the variables. Then, if the estimated system is stable, we can analyze the dynamic response of a shock in demography by the impulse-response function (IRF). The standard errors and confidence intervals of the estimated IRF parameters (i.e. the MA parameters) are estimated by the Monte Carlo simulation. The projection of the current account will be based on the estimated IRF where the shock will be normalized into the multiples of standard deviation in demographic shifts.

B. Heterogeneity in the Relationships: The Static Panel Estimation

To inspect the variation in demographic impact on the current account balance given the variation in country macroeconomic characteristics, the countries, as opposed to individual observations, will be divided into groups according to the 4 characteristics to maintain balances of the panel. Each characteristic variables of each country will be averaged over time to classify countries into the 3 groups, the top 33%, the middle 33%, and the bottom 33%, and the cutoffs for each group can be found in table 5. The middle 33% group is the control group while the top 33% is a group that represents the countries with strong characteristics in each category and the bottom 33% represents ones with weak characteristics. The PVAR can still be used in estimating the demographic impact in each group, however, the statistical inference is the main challenge. Such the method can only provide an estimate of the impacts for each subset of countries, but the estimations of impacts cannot be compared between the groups and that we cannot formally test how the different characteristics play a role in the demographic impacts. In this case, therefore, the classical panel data model is employed to estimate the difference in demographic impacts among groups. Even though such the model cannot provide the dynamic nature of the impacts, however, the model provides a direct interpretation of how differences in the characteristics affect demographic impacts through the interaction terms. The dynamic panel data models are also in consideration because such the models can preserve dynamic aspects of the impacts, however, the models require large amounts of instruments to avoid exogeneity problems. Given the limitation of data and to preserve variations among countries and times, the dynamic models are not to be used in this study. The specification for the panel data model is presented in equation (5).

$$\mathbf{y}_{\mathrm{it}} = \alpha_{\mathrm{i}} + \beta \mathbf{x}_{\mathrm{it}} + \lambda \mathbf{x}_{\mathrm{it}} \mathrm{d}_{\mathrm{i}} + \gamma \mathrm{d}_{\mathrm{i}} + \theta w_{\mathrm{it}} + \varepsilon_{\mathrm{it}} \tag{5}$$

where y and x are the current account balance and the demographic variables
α is a country fixed or random effect
d is a dummy variable indicating the characteristic group that a country belongs to
w is the set of control variables other than the focused characteristics

The statistical inference given the model is written in this way is straightforward as we can conduct a t-test on the estimated parameter λ. If λ is statistically significant, then we can infer that the demographic impact is not indifferent given that a country belongs to the different characteristic groups. In this panel data model, we focus on the estimated parameter λ that tells us whether the impacts are different among the group of characteristics. The statistical significance of λ will provide important insights about which countries to be included in the projections for the East Asian countries.

C. The Projections

The sample data used for the current account balance projections for East Asian countries (in this study, will be China, Thailand, and South Korea) will be drawn from any countries that have similar characteristics to the projected country (this method is borrowed from the concept of the Synthetic Control Method). The construction of sample data as opposed to using only projected country data is because of the two reasons. The first is to increase the number of observations to make the estimation more robust because the whole series for the projected country may not be used since the structure of a country is likely to change at any point in time series. The second is to account for the fact that many East Asian countries have not faced a decline in the working-age population as opposed to the European countries. Given that the impact of rising and declining in the working-age population may not be symmetric, having variations in both directions could help improve the quality of the projection. The demographic data used in projections of the current account balances are obtained from the population projections by the United Nations. The projection can be done by imposing the projection of demographic shock on IRF obtained from the PVAR estimation from the constructed sample data.

The impulse-response function obtained from the estimation of the PVAR model projects the demographic impacts on the current account balance. The results from the static panel model will be used in selecting the countries that will be included in PVAR for the projections. Only the characteristics that significantly influence the demographic impacts will be considered when selecting a sub-sample of the PVAR projections. If such the characteristics contribute to the deviation in the impacts, the countries of which process those characteristics that are different from the targeted country will be *excluded* from the estimation. This procedure, however, is less than ideal but can preserve the most data points and therefore can account for variations in demographic trends among the countries that at least should have a similar magnitude of impact. After estimating the PVAR for each targeted country, the IRF projects how one standard deviation shock in demographics impacts the current account balance.

VI. Results

A: The PVAR

The explicit form of the PVAR is given by

$$\begin{bmatrix} \text{Prime Savers}_{\text{it}} \\ \text{Saving} - \text{Investment}_{\text{it}} \\ \text{Current Account}_{\text{it}} \end{bmatrix} = C_i + C_t + \beta \begin{bmatrix} \text{Prime Savers}_{\text{it}-1} \\ \text{Saving} - \text{Investment}_{\text{it}-1} \\ \text{Current Account}_{\text{it}-1} \end{bmatrix} + \gamma \text{GDP}_{\text{it}} + \varepsilon_{\text{it}} \tag{6}$$

where Ci is a vector of country fixed effects
C_t is a vector of time fixed effects
Note that all the variables in the vector are FOD-transformed at the forward period = 3

Using all available data, the PVAR incorporates 3,658 country-year from a total of 167 countries with each country has an average data length of 21.9 years. The estimated PVAR is stable with all unit-roots less than one in both real and imaginary spaces.

Table 6 shows the results of the Granger Causality Test, test results for the estimated model are in the middle column. With prime savers ratio, saving-investment to GDP, and, current account balance to GDP, starting from the prime saver equation, the tests suggest that both saving-investment to GDP and current account balance to GDP significantly affects the prime saver ratio. This is unexpected given that the prime saver ratio, as a demographic shift variable, should be determined outside the model, yet, the vector autoregressive model treats the variable as endogenous. However, this endogeneity is not likely to influence the precision of the projections as such the Granger causality though is statistically significant at a 1% level, but the magnitude of such causality is negligibly small in economic sense from suggestions of the IRF in figure 5. The second equation focuses on saving minus investment to GDP ratio. The tests indicate that the prime saver ratio, as well as the current account balance to GDP, have Granger causalities on the saving minus investment to GDP ratio at a 5% level of significance. Again, however, the latter Granger causality is not expected but can practically occur through the adjustments in exchange rates and interest rates. The third equation focuses on the current account balance to GDP ratio. The prime saver ratio has a Granger Causality on the current account balance at a 10% level of significance while the saving-investment does not exhibit such a causality, however, the extended model seems to better capture this causality.

For the robustness of the results, the tests for the other two specifications of the PVAR are shown in the left and right columns of table 6. The first column of the table shows test results for the model that excludes saving-investment and still exhibits Granger causality at a 1% level of significance. The last column shows the extended version of the baseline model where real interest rate (an average of nominal policy rate minus inflation rate within a year) and exchange rate are included (using the Real Effective Exchange Rate: REER would be optimal but due to the limitations of data, a one-year-period appreciation/depreciation of local currencies against the US dollar is used instead). This model can be specifically written as:

$$\begin{bmatrix} \text{Prime Savers}_{\text{it}} \\ \text{Saving} - \text{Investment}_{\text{it}} \\ \text{Current Account}_{\text{it}} \\ \text{Real Interest Rate}_{\text{it}} \\ \text{Exchange Rate}_{\text{it}} \end{bmatrix} C_i + C_t + \beta \begin{bmatrix} \text{Prime Savers}_{\text{it}-1} \\ \text{Saving} - \text{Investment}_{\text{it}-1} \\ \text{Current Account}_{\text{it}-1} \\ \text{Real Interest Rate}_{\text{it}-1} \\ \text{Exchange Rate}_{\text{it}-1} \end{bmatrix} + \gamma \text{GDP}_{\text{it}} + \varepsilon_{\text{it}} \tag{7}$$

The tests suggest that the prime saver ratio has Granger causal on all of the macroeconomic variables in the model at a 5% level of significance. Note that results from the extended models may not be precise because of the severely unbalanced panel arises from more data point missing.

The impulse-response function constructed from the baseline model (equation 6) helps us gauge how the shock in demography contributes to changes in other macroeconomic variables over time. In this case, the focus is on how net savings and current account balance response to one-standard-deviation shock in prime saver ratio. Figure 5 shows the plot of responses given shocks in a variable where the line plot shows the expected value of the response in terms of standard deviation and the shaded area shows the 95% confidence interval of the response. The bottom left figure shows the main result: a one-standard-deviation shock in prime saver ratio leads to a significant increase in current account balance but not spontaneously. Starting in one year after the shock, the current account balance increases at the increasing rate with the peak at year 5 where the balance increases approximately 51% of the standard deviation of the current account balance of the whole panel. After year 5, the response then gradually dies down reaching 1% of the standard deviation roughly between the years 20 and 21. The 95% confidence interval is large and the lower bound is just below zero, however, the lower bound of 90% confidence interval is above zero indicating that the response is statistically significant in all periods at a 10% level. The bottom middle plot in figure 5 shows how the saving minus investment to GDP ratio responds to a one-standard-deviation shock increase in prime saver ratio. The dynamic property of the IRF is similar to the one of current account balance, nevertheless, the magnitude of response is larger with the peak of the IRF at well above a standard deviation in the net saving ratio. The peak year is, however, is about one year earlier than the peak of the current account's response and the pace of rising in the response is faster. This is according to the theoretical expectation, that is, an increase in prime saver population proportion affects aggregate savings first and then follows by an increase in the current account balance.

B. The Static Panel Estimation

The static panel model deploys all the available data points and also introduces several general control variables including the GDP growth, FDI to GDP ratio, and the manufacturing proportion of GDP. The control characteristics comprising life expectancy, social security coverage, capital openness, and financial deepening, are included in the form of dummy variables. As mentioned in the previous section, the countries are divided into three groups according to the characteristics with the middle 33% group as the baseline. The interaction terms of those group characteristics are also included. The full model can be written as:

$$\begin{aligned}\text{current account}_{\text{it}} &= \alpha_{\text{i}} + \beta\text{primesaver}_{\text{it}} + \lambda_{\text{top}}\text{primesaver}_{\text{it}} \times \text{top33\%}_{\text{i}} + \gamma_{\text{top}}\text{top33\%}_{\text{i}} + \lambda_{\text{bottom}}\text{primesaver}_{\text{it}} \times \text{bottom33\%}_{\text{i}} \\ &+ \gamma_{\text{bottom}}\text{bottom33\%}_{\text{i}} + \theta\text{controls}_{\text{it}} + \varepsilon_{\text{it}} \qquad (8)\end{aligned}$$

To determine whether the fixed effects or random effects are appropriate, the panel models are estimated and are tested using the Hausman Test. The group dummy variables already control the fixed effects of the country's time-invariant characteristics, and thus, the Hausman Test suggests a random-effects model. In table 7, the equation (9) is the baseline with no characteristic control. The equation (10), (11), (12), and (13) are just the baseline with the dummy for each characteristic, and the last equation includes all of the dummies at once. Note that the last equation is likely to suffer multicollinearity problems because each characteristic highly correlates with others, and hence, this equation will be used for just the robustness check for the previous equations.

The first estimated equation shows that all of the control variables are statistically significant at the 10% level and the signs of estimated parameters are as expected. The current account balance to GDP tends to be higher in a growing industrialized country as observed from the positive associations of GDP growth, manufacturing proportion of national output, and the current account balance. The country with a higher proportion of foreign direct investments to GDP tends to have a lower current account balance as these countries import great values of consumption and capital goods. The (overall) R-squared though is low at just below 7%, however, it is a reasonable level for this type of study. The next 4 estimated equations show no improvement in the R-squared given that they include characteristic dummy, nevertheless, the interaction terms in some equations are statistically significant, and thus can provide additional insights. Equation (10) shows that demographic impacts on the current account balance in the countries with lower life expectancy are likely to be lower than those of other groups. The equation (11) displayed the fact that the higher coverage of the social security program, the higher the demographic impact can be expected. The equation (12) shows no meaningful variations of demographic impact given level of capital openness. This may be according to the multicollinearity of the capital account openness and other control variables, and the method of grouping which does not allow for year-on-year variations in capital movement policies. The equation (13) suggests that the shallowness of the financial markets associates with a higher demographic impact on the current account balance. This could imply that with less developed financial systems individuals in the prime saver age tend to save more because of the lack of accessibility to the productive assets in the markets. Equation (14) suggests similar results to the previous four equations, nonetheless, some estimated coefficients become less significant statistically due to multicollinearity.

The results from the panel estimation indicate that the factors that contribute to a larger demographic impact on the current account balance are a higher coverage of social security programs and shallower finance while the factors that contribute to a smaller demographic impact are a lower life expectancy at birth and lower coverage of social security programs.

VII. Projections

China, South Korea, and Thailand are the three focused economies in this study. The panel deployed for the projections depends on the characteristics of each economy which is illustrated in table 8, and by using the methodology discussed in the previous section the datasets deployed for the projections are according to table 9. The table shows the excluded countries given the country of interest, note that the dataset used in projecting China's and Thailand's current account balance due to demographic shifts will be the same. This is because China and Thailand share almost all the characteristics except that for capital control where China has relatively low financial openness compared to Thailand. The projection for South Korea will use the slightly different dataset from those two countries according to the difference in a level of social security program coverage.

The inputs for the projections are the demographic cohort forecasts of the year 2040 by The United Nations' Department of Economic and Social Affairs. The change in prime saver proportion to the population is normalized by the standard deviations of prime savers of the selected datasets for each country. The normalized shocks are then multiplied by the coefficient of the IRF in each period to get the magnitude of the current account response in each period. The obtained current account responses are in the unit of standard deviation for the whole dataset and thus to retrieve the response magnitude for the projected country, the response magnitude is converted to the country-specific standard deviation by using a relative weight. The relative weight is a proportion of country-specific standard deviation in current account balance to GDP to the one of the overall dataset, for example, South Korea has low volatility in the current account balance is thus the calculated weight for the country is strictly less than one.

Figure 6 shows the projection results of changes in the current account due to demographic shocks. With the projection starting 2040, the projections show decreases in the current account balance as a percentage of GDP due to decreases in prime saver proportion. The forecast horizon is 50 years and the reason for such a long horizon is due to the dynamic property of the model. Even though magnitudes of the current account response might not be large, for example, the forecast for China indicates that at the peak of response the impact is just about 0.1% of its GDP. However, the forecast shows that such impacts persist even after decades for all of the countries. While the impact is relatively small for China, South Korea and Thailand see a larger demographic impact with South Korea at the peak reaching 1% of its GDP. The persistence in the current account response due to demographic transition is owing to the dynamic of the prime saver population cohort itself. In this model, the demographic is not completely exogenous, it has its response for the shock as the decrease in prime saver cohort is a continuous process. This process, therefore, contributes to the persistence of the current account response that the response takes a very long time period to die down and suggests that such the demographic change shifts down the level of current account balance permanently.

Projections for the three countries are different in terms of magnitude but the dynamic features are similar as discussed above. The projection suggests that the 20-year accumulated current account balance to GDP responses to the demographic changes in 2040 is 1.57% drop for China, 11.25% drop for Thailand and 16.71% drop for South Korea. The variations of magnitude of response are largely thanks to the initial magnitude of the reduction of prime-age saver population or the shock that is imposed on the model. This directly reflects the pace of population aging with South Korea having the most rapid pace among all followed by Thailand and China. For South Korea in 2041, a year after the shock is imposed, the current account balance to GDP ratio tends to fall by about 0.5% and the size of reduction increases until reaching 1% in four years later, and after that, the impact slowly dies down but persists for decades. For Thailand, the forecast path is similar to the one of South Korea with the first-period response in 2041 at 0.25% and the peak in 2046 at 0.7%, one-year later than South Korea. For China, the response is smaller, and this is owing to the slow pace of aging in China compared to the other two countries. The first-period response is close to zero and the peak is at 2047, the latest of all countries, where the country about 0.1% drop in the current account balance to the GDP ratio due to demographic changes.

VIII. Conclusion

This study shows that the aging population can reduce current account surpluses through a reduction in aggregate savings. The panel vector autoregressive model (PVAR) can also account for the dynamic properties of the demographic shift, particularly a shock in prime-age saver (45 – 64 years old) population. The impulse-response function indicates that the responses of current account balance persist for more than 20 years after the shock is realized, and the peak of such the responses occur about 5 years after the shock. The magnitude of responses is not large with the maximum response about a half standard deviation of the current account to GDP ratio given a standard deviation shock in prime saver population proportion. The magnitude of impact furthermore depends on the characteristics of the macroeconomy. To be specific, a country with lower life expectancy and lower social security program coverage tends to present a weaker demographic impact on the current account balance to GDP ratio whereas a country with higher social security coverage and shallower finance tends to exhibit a stronger impact. Based on these findings, China will see a relatively small demographic impact on the current account compared to the impact on the current account for South Korea and Thailand. On annual basis, South Korea is likely to see, on the average of a 20-year period after the shock, a drop in the current account to GDP ratio at 0.84%, while such the average drops are 0.56% for Thailand, and 0.07% for China. While the size of decreases may not be large, the demographic impacts tend to last for at least 20 years after the shock, and this implies that a shift in demography leads to a permanent shift in the level of the current account balance to GDP. With these projected values, the greying East Asia is not sufficient to erase total amount of the current account surpluses in East Asian countries, however, these countries, soon, will experience a "new normal" on the level of current account surpluses due to the level shifts implied by the projections. The new normal in this case is the situation where these countries cannot expect the same natural level of current account surplus. The lower level of the current account balance to GDP will be the new normal and such the new norm will arrive as soon as 2040.

The study builds on the number of works of literature in the area to provide an extensive study regarding the demography and current account. It attempts to take advantage of the unconventional method of PVAR and use it extensively, however, with limitations in data, the estimations are still far from optimality. The unbalanced panel is the key challenge in this study because it complicates the implementation of PVAR estimation largely since the model is dynamic, and the long and complete time series are required. With these limitations in mind, it is fair to say that the estimates may not be precise that they should dictate how the policy response be, or how should we establish the "new normal" for those countries. There are caveats about how the forecasts should be interpreted. First, the forecasts only show the changes due to demography while do not address any other key factors that play important roles in determining the nation's external balance. Second, since the PVAR provides only a loose structure of the model, the results can be sensitive given that more restrictions are imposed. This specification of PVAR thus may only provide one among many possible forecasts. And third, the study focuses on the partial equilibrium and thus does not address how the surpluses and deficits in the current accounts balanced out. For example, if one country sees a current account surplus, such a surplus must be a deficit for some countries. But even with the precision and interpretation issues, this study shows roughly the trajectories of the current account balance in the near future given the demographic trends and. This study furthermore analyzes how those trajectories vary among the countries given differences in economic characteristics based on large numbers of past studies.

This study is only one of the puzzle pieces that tell us how the future in global imbalances should look like given this huge wave demographic shift. The further questions that can be built on this study include the study of dynamic panel method that addresses the problem of the large panel but short time series, how to address for the other regions of the world where the demography is at a different stage, how would their current account balances change, and what kind of policies that are appropriate given the projections. This study again does not attempt to answer whether the current account surpluses should be eliminated or maintained but to give insights into the future. The question of “should” the global imbalances exist cannot be informed by this study and is subjected to the long way of debates.

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Appendix: Tables and Figures

Table 1: Summary of Variables Used in This Study

	Variables	Source
Main Variables in PVAR		
Demography	Prime-age (16 - 64) population (% of total population) Prime-age (41 – 64) saver (% of total population) Old Age (65 and over) dependency ratio	WDI
Current Account	Current Account Balance (BoP basis, USD) Current Account Balance (% of GDP)	WDI
Other Endogenous Variables in VAR	Gross Savings (level and % of GDP) Gross Capital Formation (level and % of GDP) GDP Real Interest Rate Inflation Rate	WDI
Control Variables for Classifications		
Pension	Coverage of Social Security Program (% Population) Mandatory old-age income security programs (Indexing TBD) (Universal, Non-universal, Retirement Age, Early Pensionable Age) Pension Fund Assets (% of GDP)	The Atlas of Social Protection World Bank's *Global Financial Development*
Longevity	Life expectancy at birth Life expectancy at age of 65	WDI
Financial Development	Financial Deepening (M2-to-GDP) Bank Accounts per 1,000 People	World Bank's *Global Financial Development*
Capital Openness	Ito-Chinn Index	Chinn, Ito (2008)
Region Control		World Bank
Income Group		World Bank

Table 2: Descriptive Statistics of Variables Used in This Study

Variable	Observation (County-year)	Mean	Std. Dev.	Min	Max
Demographic Variables					
Dependency Ratio	8957	70.42	20.45	15.74	120.52
Old Dependency Ratio	8957	10.54	6.49	0.80	46.17
Young Dependency Ratio	8957	59.88	24.74	14.87	112.37
Young Population Ratio	8960	59.54	7.18	45.35	86.40
Old Population Ratio	8960	6.53	4.56	0.69	27.58
Employment-to-Population Ratio	4928	57.75	11.64	28.76	88.99
Current Account Variables					
Current Account Balance to GDP	6083	-3.09	10.69	-240.52	62.30
Current Account Balance (Million USD)	6155	-118.00	37700.00	-806000.00	421000.00
Other Potential Variables in PVAR (to maintain economic structure)					
Gross Saving (% GDP)	6792	23.61	8.61	-13.41	89.38
Gross Investment (% GDP)	5338	21.27	12.35	-236.27	100.67
GDP (Constant Million USD)	7614	281,000	1,090,000	117	17,900,000
Exchange Rate (LCU to USD)	7869	854,704	75,800,000	0	6,720,000,000
Real Interest Rate	4011	6.60	28.67	-97.62	1158.03
Inflation	7580	36.70	462.11	-36.56	26765.86
Variable for Controlling Category - *Longevity*					
Life Expectancy at Birth	8737	65.17	10.69	18.91	84.68
Variable for Controlling Category - *Pension*					
Coverage of Social Insurance	282	21.17	18.49	0.37	59.52
Coverage of Social Safety Net	298	35.61	23.43	0.51	99.83
Variable for Controlling Category - *Financial Development*					
Financial Deepening (M2-to-GDP)	6377	46.87	37.02	2.86	395.67
Bank Account (% population)	416	54.14	30.66	0.40	100.00
Market Capitalization (% GDP)	2123	60.03	96.21	0.05	1273.25
Variable for Controlling Category - *Capital Account Openness*					
Ito-Chinn Index (-2 to 2)	6857	0.01	1.54	-1.92	2.35
Ito-Chinn Index (0 to 1)	6857	0.45	0.36	0.00	1.00
Variable for Controlling Category - *Current Account Characteristics*					
Export (% GDP)	7147	37.44	27.34	0.01	228.99
Net FDI Inflow (% GDP)	7058	3.52	11.10	-58.32	451.72
Manufacturing (% GDP)	6222	13.40	8.61	0.00	192.00

Table 3: Pairwise Correlation of the Main Variables

	agedep	olddep	you~ep	pri~e	curgdp	savgdp	invgdp
Dependency Ratio: agedep	1.00						
Old Dependency Ratio: olddep	-0.57	1.00					
Young Dependency Ratio: youngdep	0.98	-0.73	1.00				
Prime-age Saver Population: primesave	-0.81	0.87	-0.90	1.00			
Current Account to GDP: curgdp	**-0.20**	**0.08**	**-0.18**	**0.16**	1.00		
Savings to GDP: savgdp	-0.31	0.06	-0.26	0.19	0.64	1.00	
Investment to GDP: invgdp	-0.24	0.05	-0.21	0.14	-0.21	0.43	1.00

Table 4: Coverage of Countries

Region	**Income Group**				
	Low	**Lower-Middle**	**Upper-Middle**	**High**	**Total**
East Asia and Pacific	0	13	6	8	**27**
Europe and Central Asia	1	4	14	28	**47**
Latin America	1	4	18	9	**32**
Middle East and North Africa	2	4	6	8	**20**
North America	0	0	0	2	**2**
South Asia	2	4	2	0	**8**
Sub-Saharan Africa	23	17	6	1	**47**
Total	**29**	**46**	**52**	**56**	**183**

Note: the region is defined by the World Bank.

Table 5: The cutoffs for the classification of countries into subgroups

Percentiles	**Life Expectancy**	**Social Insurance Coverage**	**Financial Openness**	**Financial Deepening**
33%	61.459	6.626981	-1.210019	26.63833
67%	71.267	31.87976	1.06519	50.20963

Table 6: The Granger Causality Test Results

Equation / Excluded Variables	Two-Variable			Baseline			Extended Model		
	chi2	df	prob	chi2	df	prob	chi2	df	prob
Prime Saver									
Saving-Investment	66.51	1	0.00	7.35	1	0.01	57.59	1	0.00
Current Account				36.23	1	0.00	113.24	1	0.00
Real Interest Rate							18.65	1	0.00
Nominal Exchange Rate							44.96	1	0.00
ALL	66.51	1	0.00	36.88	2	0.00	255.24	4	0.00
Saving-Investment									
Prime Saver				6.55	1	**0.01**	4.98	1	**0.03**
Current Account				4.07	1	0.04	197.74	1	0.00
Real Interest Rate							1.57	1	0.21
Nominal Exchange Rate							0.14	1	0.71
ALL				10.98	2	0.00	1251.3	4	0.00
Current Account									
Prime Saver	12.13	1	**0.00**	3.10	1	**0.08**	3.86	1	**0.05**
Saving-Investment				1.37	1	0.24	41.56	1	0.00
Real Interest Rate							1.78	1	0.18
Nominal Exchange Rate							0.06	1	0.81
ALL	12.13	1	0.00	4.33	2	0.12	48.39	4	0.00
Real Interest Rate									
Prime Saver							5.52	1	0.02
Saving-Investment							0.02	1	0.90
Current Account							23.65	1	0.00
Nominal Exchange Rate							7.23	1	0.01
ALL							49.77	4	0.00
Nominal Exchange Rate									
Prime Saver							4.36	1	0.04
Saving-Investment							0.10	1	0.75
Current Account							5.37	1	0.02
Real Interest Rate							8.16	1	0.00
ALL							8.75	4	0.07

Table 7: The Panel Data Models

	(9)	(10)	(11)	(12)	(13)	(6)
	Current Account Balance to GDP					
Prime Saver (% of total population)	0.293*** (0.0404)	0.288*** (0.043)	0.288*** (0.0427)	0.286*** (0.0418)	0.275*** (0.0422)	0.301*** (0.0441)
GDP Growth (%)	0.0498* (0.0232)	0.0535* (0.0233)	0.0467* (0.0232)	0.0505* (0.0233)	0.0434 (0.0233)	0.0385 (0.0232)
FDI (% GDP)	-0.096*** (0.00894)	-0.095*** (0.00896)	-0.097*** (0.00894)	-0.095*** (0.00896)	-0.096*** (0.00894)	-0.097*** (0.0089)
Manufacturing (% GDP)	0.0622** (0.0215)	0.0608** (0.0216)	0.0637** (0.0216)	0.0626** (0.0215)	0.0600** (0.0215)	0.0679** (0.0216)
Dummy for Top 33% Countries for Life Expectancy X Prime Saver		-0.0893 (0.14)				-0.514* (0.234)
Dummy for Bottom 33% Countries for Life Expectancy X Prime Saver		**-0.386**** **(0.197)**				-0.740* (0.292)
Dummy for Top 33% Countries for Life Expectancy		0.0109 (1.455)				0.695 (1.768)
Dummy for Bottom 33% Countries for Life Expectancy		-1.536 (1.458)				-0.0622 (1.972)
Dummy for Top 33% Countries for Social Security Coverage X Prime Saver			**0.703***** **(0.15)**			0.901*** (0.19)
Dummy for Bottom 33% Countries for Social Security Coverage X Prime Saver			**-0.515*** **(0.209)**			-0.842** (0.302)
Dummy for Top 33% Countries for Social Security Coverage			-2.006 (1.415)			-3.152* (1.555)
Dummy for Bottom 33% Countries for Social Security Coverage			-2.389 (1.544)			-1.45 (2.034)
Dummy for Top 33% Countries for Capital Openness X Prime Saver				0.0728 (0.144)		0.359 (0.203)
Continue the next page						

Dummy for Bottom 33% Countries for Capital Openness X Prime Saver				-0.138 (0.144)		-0.114 (0.193)
Dummy for Top 33% Countries for Capital Account Openness				1.59 (1.531)		1.082 (1.621)
Dummy for Bottom 33% Countries for Capital Account Openness				0.135 (1.408)		0.406 (1.533)
Dummy for Top 33% Countries for Financial Deepening X Prime Saver					-0.167 (0.116)	-0.304 (0.185)
Dummy for Bottom 33% Countries for Financial Deepening X Prime Saver					0.814*** (0.2)	1.463*** (0.264)
Dummy for Top 33% Countries for Financial Deepening					1.395 (1.398)	1.364 (1.573)
Dummy for Bottom 33% Countries for Financial Deepening					-0.869 (1.509)	-0.627 (1.714)
Constant Term	-8.083*** (0.959)	-7.427*** -1.292	-6.922*** -1.207	-8.488*** -1.327	-8.034*** -1.278	-7.861*** -1.74
Country-year	5,089	5,084	5,084	5,084	5,084	5,084
R-sq	0.0696	0.0627	0.0673	0.0723	0.0666	0.0704

Standard errors in parentheses
* p<0.05, ** p<0.01, *** p<0.001

Table 8: Classification of the focused Countries

Country	Life Expectancy	Social Security	Financial Openness	Financial Deepening
China	Middle 33%	Top 33%	Bottom 33%	Middle 33%
Thailand	Middle 33%	Top 33%	Middle 33%	Middle 33%
South Korea	Top 33%	Middle 33%	Middle 33%	Middle 33%

Table 9: Classification of the Countries excluded in the projection for each focused country

Country/ Excluded Countries	Life Expectancy	Social Security	Financial Openness	Financial Deepening
China	Bottom 33%	Bottom 66%	None	Bottom 33%
Thailand	Bottom 33%	Bottom 66%	None	Bottom 33%
South Korea	Bottom 33%	Bottom 33% and Top 33%	None	Bottom 33%

Figure 1: Current Account Balance to GDP of China and United States

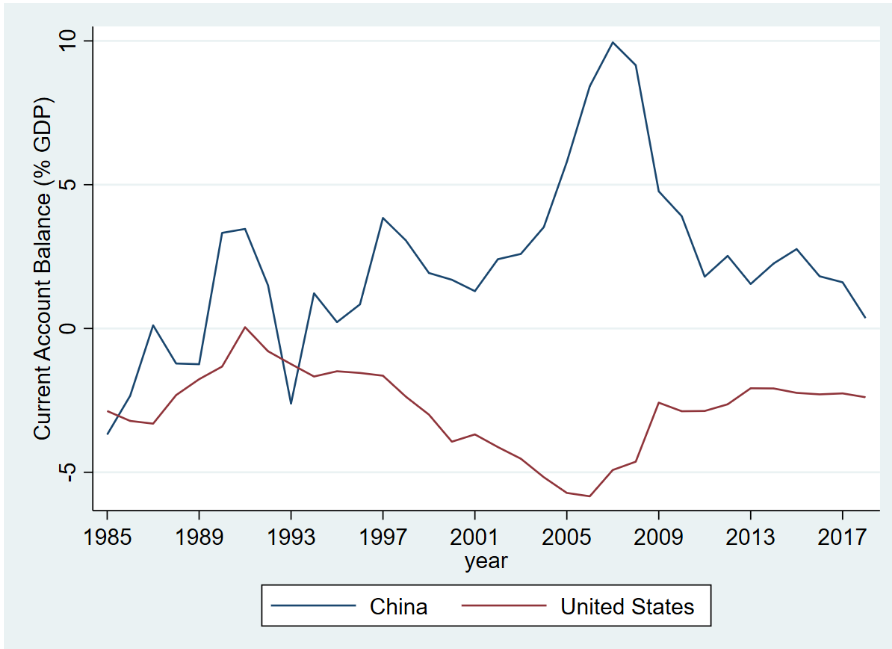

Figure 2: Population Projections of Eastern and South-Eastern Asia

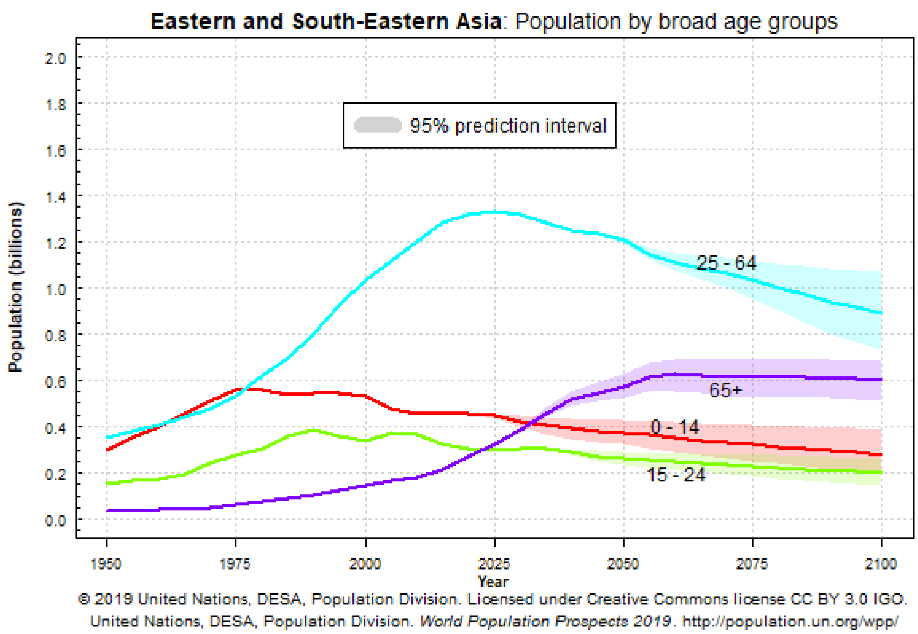

Figure 3: Scatter Plot of Current Account Balance and Old Dependency Ratio

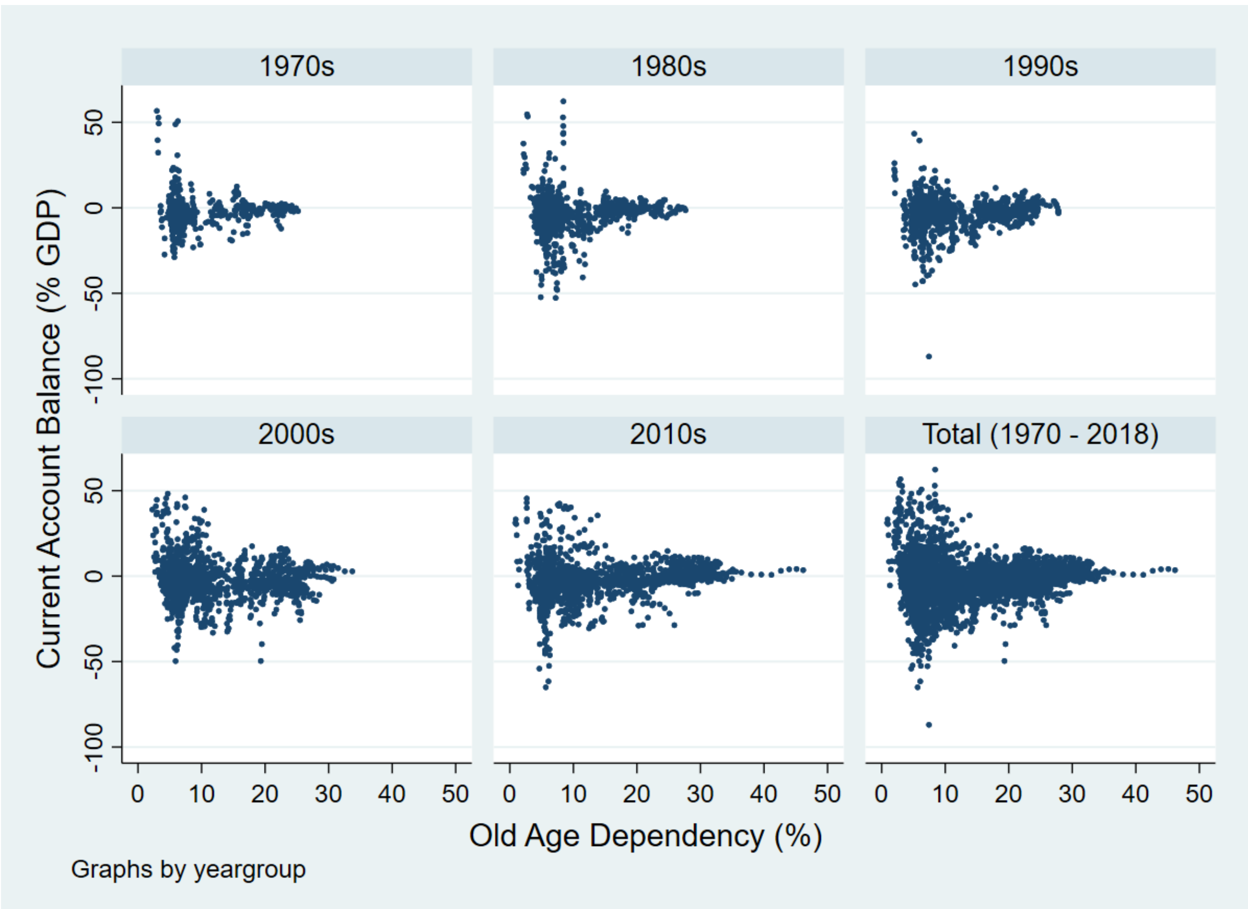

Figure 4: Scatter Plot of Current Account Balance and Prime Age Savers

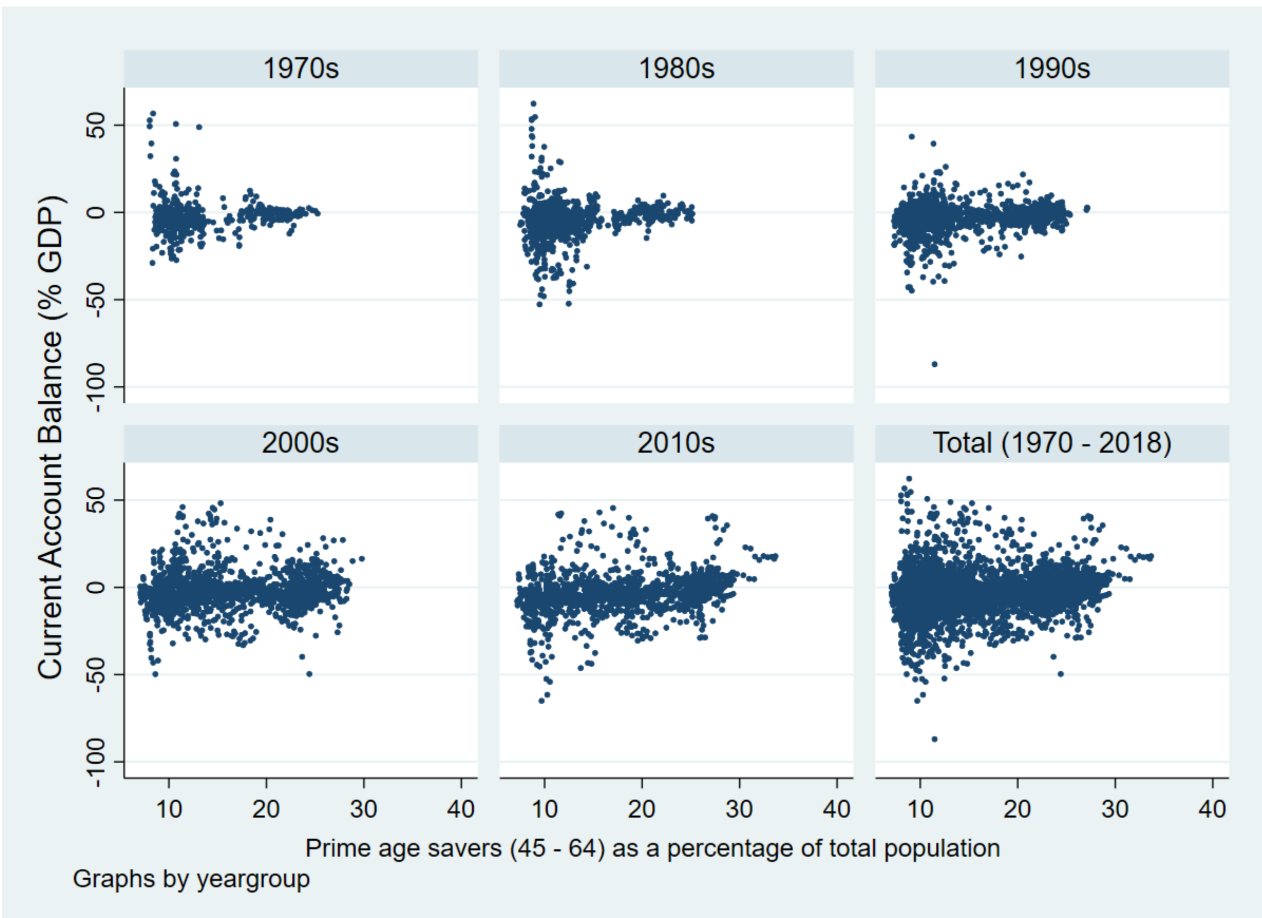

Figure 5: The Impulse-response Diagram for the Baseline PVAR Model

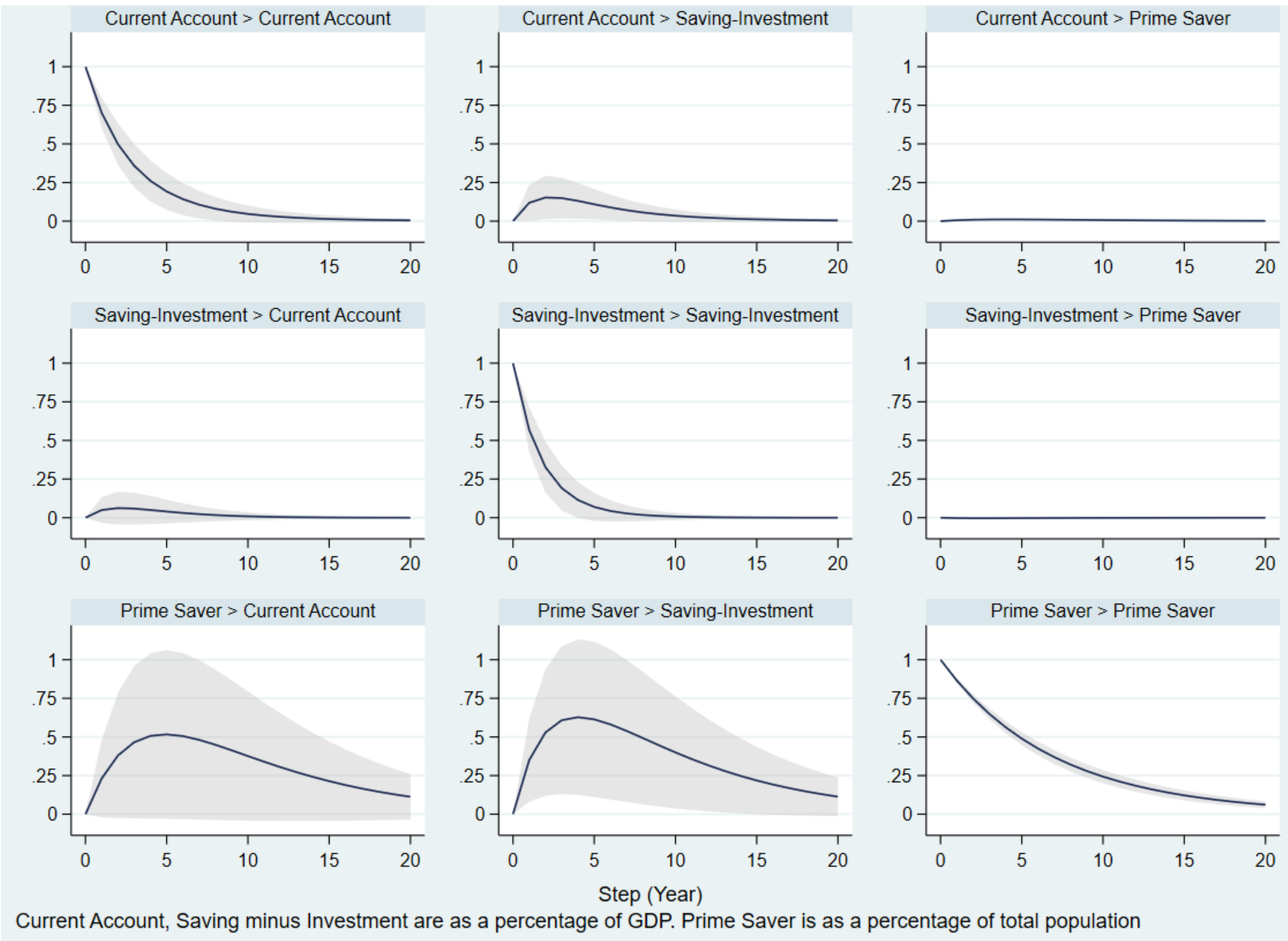

Figure 6: The Projection Results