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## Demographic transition for economic development in Taipei, China: Literature and policy implications

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**ADB Working Paper Series**

**DEMOGRAPHIC TRANSITION FOR  
ECONOMIC DEVELOPMENT IN  
TAIPEI, CHINA: LITERATURE AND  
POLICY IMPLICATIONS**

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**Abstract**

As an economy with a population of 23 million, Taipei,China is enjoying the demographic dividend of economic growth resulting from a shift in the population age structure, but an increasingly aged population could be bad for the economy. As an international comparison, its population is aging faster than that of most members of the Asian Development Bank and other advanced economies. Based on the literature, this paper contributes to the evaluation of the impact of aging on economic growth and volatility using relevant data and then concludes with the government policies relevant to the prospective aging problem. At the current stage, the situation is not as bad as expected. An aging workforce with positive productivity has no negative impact on economic growth. The old-age dependency ratio has a significantly negative effect on economic development, but appropriate foreign labor immigration and elderly long-term care policies can mitigate it. Higher education attainment still works to support economic growth in the long run. Besides, an increase in longevity first enhances and then erodes net foreign assets, and high old-age dependency ratios cause investments to respond strongly to technology shocks because individuals prefer to save more for retirement in aging societies. However, population aging has a minor influence on the dynamics of the macroeconomic variables. Nevertheless, the government should be cautious and allocate resources to help labor-intensive and low-skilled industries transform into more innovation-oriented and knowledge-intensive ones. Social welfare support must also become an important aspect of the social security framework.

**Keywords:** population aging; economic growth; net foreign assets; demographic policy; health care; Taipei,China

**JEL Classification:** J11, J18

## Contents

1.	INTRODUCTION.....	1
2.	IMPACT ON ECONOMIC GROWTH .....	3
3.	IMPACT ON ECONOMIC AND FINANCIAL STABILITY .....	6
4.	CONCLUSION AND POLICY RECOMMENDATIONS.....	11
	REFERENCES .....	14
	APPENDIX: MODELING AND CALIBRATION .....	16

## 1. INTRODUCTION

Taipei,China, an economy with 23 million inhabitants, is enjoying the demographic dividend of economic growth resulting from a shift in the population age structure, but an increasingly aged population could be bad for the future economy. A decade ago, officials sent a warning signal that a population decline is irreversible (Wang et al. 2009). The school-age population and working-age population will be in decline, and the proportion of middle-aged and older workers will be increasing. As Table 1 indicates, the age structure of developed economies naturally becomes older, but the speed of this progression is worrying. An aging population places a significant burden on society. The dependency ratio, the number of dependents compared with the working-age population, has been increasing since 2012. In 2020, there are 40 dependents for every 100 members of the working-age population to support. With the rapid growth of the elderly population, projections indicate that the number of dependents will increase to 102.0 by 2070 (National Development Council 2020). Besides, Taipei,China has the lowest fertility rate in the world, while the aging trend heralds the possible collapse of its social insurance system. In 2020, there are approximately 4.5 people of working age supporting one elderly person. By 2070, the number will have fallen to 1.2 people of working age supporting one elderly person. As a result, the island has been struggling with a shortage of human resources for home care and manufacturing jobs. Around 261,457 foreign nationals worked in the personal care industry in 2019, mostly from Indonesia and the Philippines (Chang 2020). The fertility rate is also not particularly optimistic, failing to meet the requirement of maximized consumption.

**Table 1: Demographic Facts and Projections in Taipei,China**

Year	Population (Thousand)	Fertility Rate	Dependency Ratio	Potential Support Ratio	Age 65+ Ratio	Median Age
1985	19,310	1.88	53.0	12.9	5.1	25.1
2018	23,590	1.09	37.9	5.0	14.5	41.6
2070	15,814	1.20	102.0	1.2	41.6	58.2

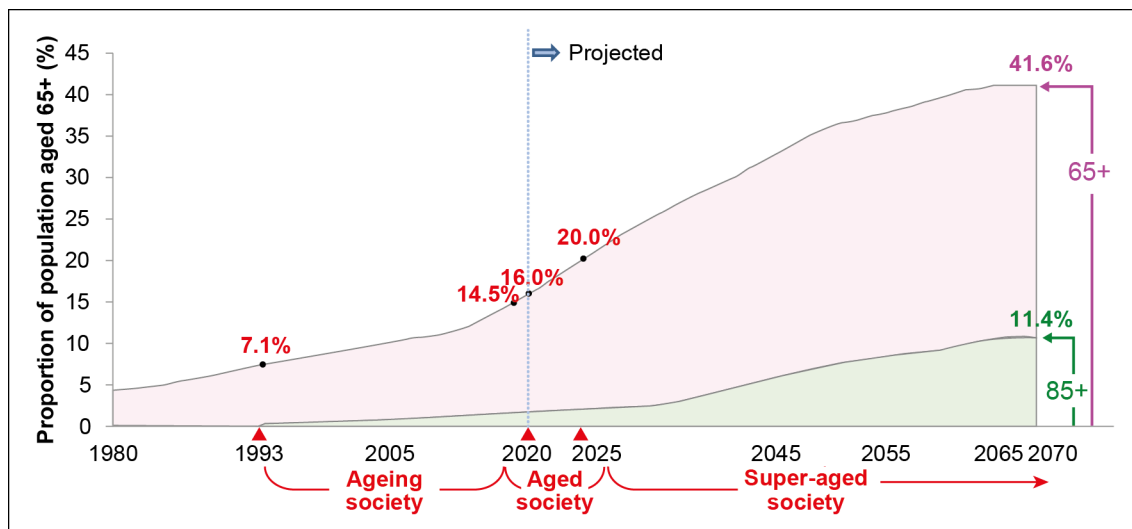
Note: Medium-variant projections after 2017.

Source: National Development Council (2018, 2020); authors' compilation.

Population dynamics is a foundational element of national development, while age structure change is the key determinant. To understand future demographic development trends, the National Development Council has prepared long-range population projections biennially since 2006. Figure 1 depicts the authority's concern (National Development Council 2018, 2020). It became an aging society in 1993 (7.1%), reaching the second stage in March 2018 (14.5%), and the projection shows that it will be a super-aged society in 2025 (20%). The National Development Council (2020) released the newest population projections on 18 August 2020; they are almost the same as the previous version, except for the following points. First, as the Ministry of Interior (2020) indicated, in 2020, the natural rate of population growth will become negative two years earlier (2022 → 2020) due to COVID-19. Second, the super-aged society will be forthcoming one year earlier (2026 → 2025). Third, the population bonus (ratio of the population aged 15–64 to the total population > 66.7%) will extend for one more year (2026 → 2027), which also implies that the demographic dividend will disappear in 2028. By 2070, the super-aged ratio will be, *ceteris paribus*, 41.6%, which is higher than Japan's 38%, Singapore's 36%, and the People's Republic of China's (PRC's) 30% in 2050–2075 according to the United Nations' (2019) recent estimation. The government

has upgraded the dramatic population aging as a national security concern, involving issues from sustainable economics to financial and social stability.

**Figure 1: Speed of Population Aging**



Source: The National Development Council's (2018, 2020) medium-variant projections; authors' compilation.

As an international comparison, the World Health Organization (WHO) defined aging, aged, and hyper-aged societies as ones in which more than 7%, 14%, and 20% of the population are aged 65 years or above, respectively. As Table 2 indicates, the population is aging at a rapid rate. The expectation is that the aged society will transition into a hyper-aged society within eight years, which is faster not only than advanced economies, such as Japan (11 years), Canada (14 years), the United States (16 years), France (29 years), Germany (37 years), and the United Kingdom (51 years), but also than emerging markets, like the PRC (10 years) and the Republic of Korea (9 years).

**Table 2: From Aging and Aged to Hyper-aged Societies: An International Comparison**

Economies	Population Aged 65+ (%)		
	7%	14%	20%
Taipei, China	1993	2018	2025
Rep. of Korea	1999	2017	2026
Singapore	1999	2018	2026
PRC	2000	2025	2035
Japan	1970	1994	2005
US	1942	2013	2029
UK	1929	1975	2026
Germany	1932	1971	2008
France	1964	1990	2019
Canada	1945	2010	2024

PRC = People's Republic of China, UK = United Kingdom, US = United States.

Note: Taipei, China's ratio in 2020 is 15.1%.

Source: Huang, Lin, and Lee (2019); United Nations (2019); National Development Council (2020); authors' compilation.

Economists have observed Taipei, China's rapid aging for a long time. Angus Deaton, the 2015 Nobel Prize winner in Economics, noticed that it is relevant to life cycle saving because of its rapid transition over the last several decades from high to low population growth (Deaton and Paxson 1994) and then initiated a long-run program to track the causes and consequences (Deaton and Paxson 1997, 2000). Note that the decline of the population will produce some advantages, for example improved quality of life and alleviated environmental pressure in densely populated areas like Taipei, China. Besides, the so-called "senior industries" could achieve an opportunity for economic transformation, for instance remote home health care services, remote medical services, medical equipment, pharmaceuticals, mobility aids, health-preserving food, cosmetics, and toiletries products. There is an expectation that business opportunities in the senior industry for Taipei, China will reach \$150 billion in 2025 (Tsai 2008). However, it has to deal with the economic impact by itself, which explains why the economy's population conundrum will haunt it for years to come. Increasing education and job opportunities for women, together with changing family values, have led to the prevalence of late marriage and delayed childbearing, causing an aging society.

Of course, we should not neglect ideas beyond economics. For instance, sociologists prefer to discuss the issue based on social welfare and long-term care. The imbalanced age distribution makes the island increasingly reliant on foreign labor and brides to fill the gap in labor shortage and elderly care, respectively. However, these are not without costs. The opportunity to have a grandparent and grandchild living under the same roof becomes more frequent as life expectancy extends. Grandparenting also creates tensions within the family (Tsai 2008). The elderly will become clients of physical and mental health services, long-term care services, personal social services, and the public pension system, which in turn puts pressure on the national health insurance system, residential care institutions, and the public pension system covering various income-related social insurance schemes (Lin 2010).

The authorities are, of course, fully aware of the causes and consequences of an aging society. However, this does not mean that the government has sufficient time and tools to stop the worsening trend. This paper introduces the current situation, the official strategies, and evaluations from the empirical literature. It discusses policies on retirement, pension systems, health care, human capital accumulation, capital flows, and financial markets that target the aged population, with accompanying policy suggestions.

As a state of the field based on the literature, this paper contributes to evaluating the impact of aging on economic growth and volatility using relevant data and then concludes with the government's policies that are relevant to the prospective aging problem. The structure of the paper is therefore as follows. Section 2 describes the impact of aging on economic growth. Section 3 introduces simulated results for the impact of aging on other macroeconomic and financial situations, using a model by Gertler (1999) as a foundation. Section 4 concludes with the relevant policies and provides a perspective on the aging problem.

## **2. IMPACT ON ECONOMIC GROWTH**

In economics, the first issue is, of course, the impact of an aging society on economic growth. Numerous studies have explored the impact of population aging on productivity and economic development. It makes sense to predict a negative relationship between an aging workforce and economic growth (e.g., Bloom et al. 2010 for the case of Asia; Maestas et al. 2016 for the United States; Aiyar et al. 2016 for Europe). However, some research has found that aging workers may not cause a decline in productivity (e.g.,



Burtless 2013; Börsch-Supan and Weiss 2016) and that it may depend on other factors, such as the relative value of the death and birth rates (Prettner 2013) and foreign labor immigration. A few studies have stressed the potential of immigration to prevent population decline, to maintain the support ratio, and to slow population aging (e.g., Felbermayr et al. 2010; Boubtane et al. 2016; Borjas 2019), but they have not covered problems related to social welfare and public order.

Due to the different economy structures, it is necessary to conduct a case study on the impact of population aging and human resource aging specifically in Taipei, China. However, data limitations and a rapid aging rate make statistical estimation difficult. Huang, Lin, and Lee (2019) used quarterly data from 1981 to 2017 to examine the impact of Taipei, China's aging society on its economic growth rate, utilizing the old-age dependency ratio (*OADR*, %), the population aged 65 years and above divided by the population aged 15–64 years, the aging workforce (*AgeWorker*, %), the ratio of workers aged 55–64 years to the total workforce, and the national average real GDP per worker (*WGDP*) as proxies for the population, workforce aging, and economic productivity, respectively. Note that Taipei, China has been implementing welfare and care policies targeting the elderly since the launch of the Senior Citizens Welfare Act in 1980.

The number of workers serving in elderly long-term care, nursing, and caring institutions divided by the total nursing staff (*ElderCare*, %) can act as a proxy for healthcare policies in an aging society. Hence, the model includes the interaction terms  $ElderCare \times OADR$  and  $ElderCare \times AgeWorker$  to observe the mitigating effect of policies related to an aging population and workforce. The ratio of foreign workers with residency (*ForWorker*, %) can capture the foreign personnel effect on economic development, and the model includes its interaction terms  $ForWorker \times OADR$  and  $ForWorker \times AgeWorker$  to observe the similar mitigating effect of the foreign labor policy. The ratio of the workforce to college or higher educational attainment (*WHEDU*, %) is a traditional variable explaining income growth, but it is possible to use its interaction terms  $WHEDU \times OADR$  and  $WHEDU \times AgeWorker$  to determine whether investment in human capital can mitigate the negative effect of aging.

We control for other determinants related to aging and economic growth so that we can focus mainly on the effect of the important variables and their interaction terms. The controlled variables include the youth dependency ratio (*YADR*, %), the ratio of employed population to working-age (15–64 years) population (*Employ*, %), the ratio of gross investment to GDP (*Invest*), and the *WGDP* of the previous year.

The unit root tests including augmented Dickey–Fuller (ADF), Phillips–Perron (PP), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) use the above variables in the level and first-order difference forms, respectively. Most variables are non-stationary at level but become stationary after their transformation into difference forms. Therefore, the first-order differential for the natural logarithm makes the empirical results that Table 3 shows.

Table 3 is a recompilation of that of Huang, Lin, and Lee (2019) but updates the explanations as follows. First, most of the controlled variables concerning traditional economic theory in Columns (1), (2), and (3) are statistically significant with the expected signs. Second, the old-age dependency ratio ( $OADR_t$ ) has a significantly negative effect, but the significantly positive coefficient for the interaction term  $ElderCare \times OADR$  highlights that expanding long-term care for the elderly can significantly mitigate the negative impact of a high old-age dependency ratio. Besides, the aging workforce ( $AgeWorker_t$ ) is positively significant, meaning that senior workers do not handicap but rather support economic development. That is, the rapid increase in  $OADR_t$  creates a social burden while we still consider  $AgeWorker_t$  to improve productivity. To mitigate the

burden resulting from  $OADR_t$ , the government has implemented related health and elderly care policies, which  $ElderCare_t$  represents.

Third, although we cannot find any evidence to support the benefits of the ratio of foreign workers with residency ( $ForWorker_t$ ), its interaction term with  $OADR_t$  is significantly positive. That is, introducing immigration and a foreign labor force can partially deal with the concerns of population aging.

**Table 3: Impact of Aging on Income Growth (1981Q1–2017Q4) from Huang et al. (2019)**

Variable	(1)	(2)	(3)
<i>c</i>	0.21 (0.56)	0.20 (1.52)	0.23 (1.04)
$WGDP_{t-1}$	-0.43** (-2.34)	-0.23* (-1.80)	-0.27** (-2.21)
$Invest_t$	1.07** (2.09)	0.88* (1.88)	1.14 (1.55)
$Employ_t$	-1.39* (-1.80)	-1.01** (-2.25)	-1.21* (-1.78)
$OADR_t$	-3.67** (-2.12)	-3.01** (-2.79)	-2.88* (-1.74)
$YADR_t$	-0.85 (-1.05)	-0.15 (-1.31)	-1.21* (-1.78)
$AgeWorker_t$	1.05* (1.68)	1.27** (2.46)	0.95* (1.95)
$ElderCare_t$		0.48 (1.25)	0.58 (0.89)
$OADR_t \times ElderCare_t$		1.12** (2.40)	0.80* (1.67)
$AgeWorker_t \times ElderCare_t$		0.10 (0.86)	-0.73 (-1.03)
$WHEDU_t$	1.53** (2.34)	1.33** (2.38)	0.82* (1.94)
$OADR_t \times WHEDU_t$		0.29 (1.20)	
$AgeWorker_t \times WHEDU_t$		0.57 (0.27)	
$ForWorker_t$	0.44 (0.58)	0.45 (1.63)	1.00 (1.05)
$OADR_t \times ForWorker_t$			1.26** (2.20)
$AgeWorker_t \times ForWorker_t$			0.92 (1.00)
Obs.	148	148	148
Adjusted $R^2$	0.46	0.52	0.64

Note: The dependent variable is the first-order differential for the natural logarithm of the real GDP per worker ( $WGDP_t$ ). The same applies to all the other independent variables. We control for the year dummy. \*\*\*, \*\*, and \* indicate significance at the 1%, 5%, and 10% levels (two-sided), respectively. The *t*-values are in the parentheses.

Source: Huang, Lin, and Lee (2019); Directorate-General of Budget, Accounting and Statistics; Ministry of Health and Welfare; Authors' compilation.

From the above initial assessment, we can infer, for the case of Taipei, China, that an aging workforce ( $AgeWorker_t$ ) is not bad for economic growth. The old-age dependency ratio ( $OADR_t$ ) has a significantly negative effect on economic development, but appropriate policies for foreign labor immigration and elderly long-term care can mitigate it. Besides, higher education attainment still works to support economic growth in the long run.

Many issues concerning an aging society and long-run development need exploration. Economic growth typically assumes that people's discovery of new ideas drives either a constant or a growing population. It is necessary to investigate what happens to economic growth in the higher-income economies, where the fertility rates are already below their replacement rates (Jones 2020). Besides, Glover and Short (2020) observed that, in the US, the share of income that workers receive (labor's share) has declined concurrently with the aging demographics. They hypothesized that an aging workforce has contributed to the decline in labor's share because employers of older workers may have substantial monopsony power due to the decline in labor market dynamism that accompanies age. This manifests as a rising wedge between a worker's salary and the marginal product over his (her) life. The decline in labor's share in the US and globally has raised concerns regarding the distribution of income and its impact on income and wealth inequality. It implies that Taipei, China, with a flexible labor market like that of the US, should consider not only economic growth but also the problem of income distribution.

### 3. IMPACT ON ECONOMIC AND FINANCIAL STABILITY

Life cycle theory predicts that an aging society will cause a current account deficit and capital inflow because of the existence of a large old population that has a relatively low saving rate. Many papers have confirmed that demographic changes indeed influence the international capital flow, but few studies have discussed the responses of net foreign assets to technology shocks in a small open economy facing population aging.

Gertler (1999) introduced two states of the human life cycle: work and retirement. Each individual is born as a worker facing a random transition probability from work to retirement and then to death. Using an appropriate parameter setting yields a realistic average length for each state. The main property of Gertler's model is that an individual changes his or her consumption behavior and considers different discount rates that vary with the life state. In other words, the worker and the retiree face different preferences and budget constraints. As Gertler suggested, this model is easily extendable to a small open economy by adding the net foreign asset position to the market-clearing condition. This implies that the economy can borrow from or lend abroad at international interest rates.

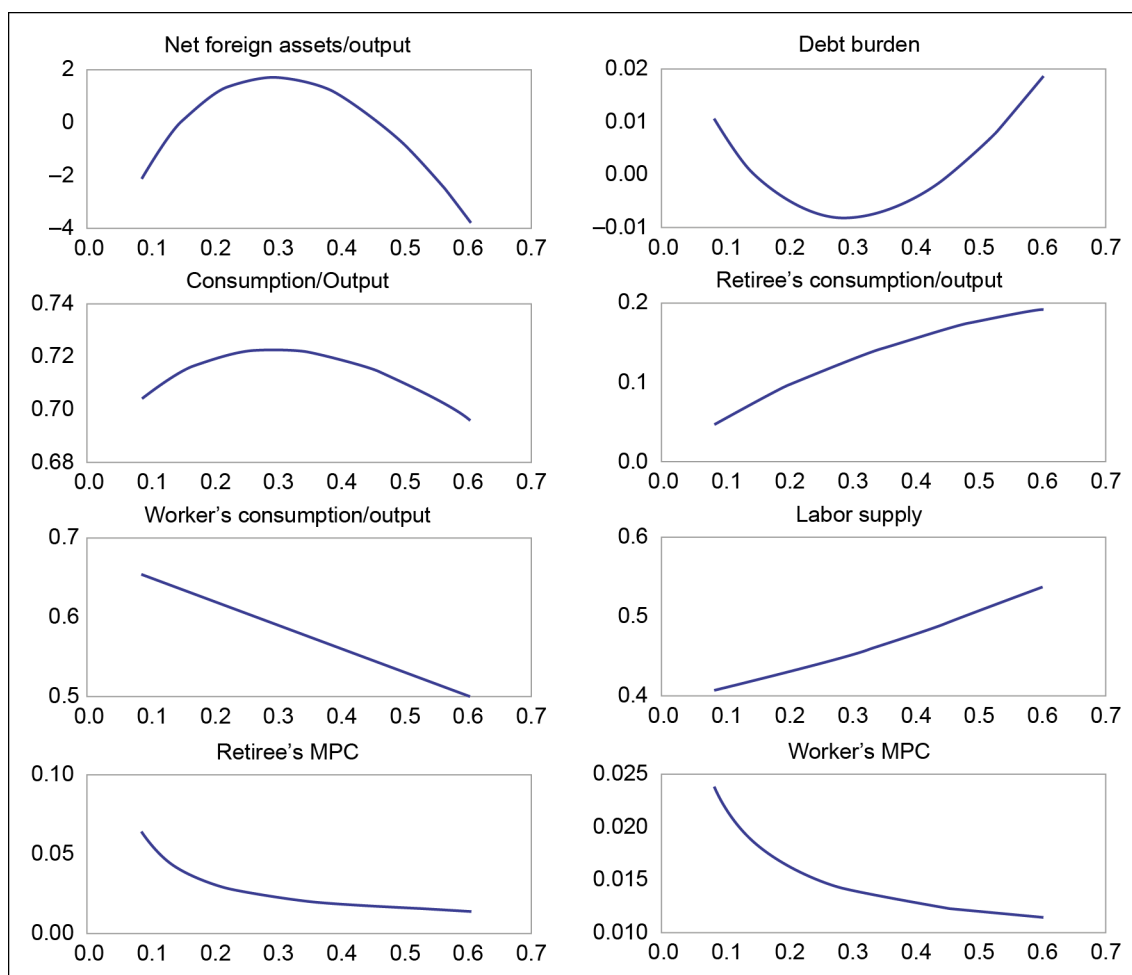
Tseng (2010) and Yeh (2010) extended Gertler's (1999) tractable overlapping generation model. We add a stochastic technology shock and assume that agents can borrow from or lend abroad. The economy is a small open economy, so the domestic interest rate equals the international interest rate. The two kinds of agents in the model are households and firms, and we can distinguish workers and retirees by their marginal propensity to consume ( $MPC$ ).

The Appendix shows the details of the modeling and calibration for Taipei, China, which we base on Tseng (2010) and Yeh (2010). Our model consists of 20 equations, including 19 endogenous variables and one exogenous technology shock. It is necessary to detrend all the quantity variables because the growth rates of both the labor-augmenting technology and the population are deterministic. We can solve the parameters of the

prototype model with quarterly frequency. For simplicity, here we present the important implications concerning the impact of aging on financial situations. The Appendix contains the mathematical derivations.

Three parameters can represent demographics: the population growth rate, the probability of surviving, and the probability of remaining in the workforce. A decrease in the birth rate and an increase in longevity are two resources that cause population aging. In this model, a decline in the population growth rate represents a decrease in the birth rate. An increase in the survival rate represents an increase in life expectancy. Both rising survival rates and falling population growth rates increase the old-age dependency ratio. Various combinations of parameters can yield the same old-age dependency ratio. Besides, these two resources may affect macroeconomic variables differently. In the following paragraphs, we show how a declining population growth rate and an increasing survival rate influence the long-run values of macroeconomic variables.

**Figure 2: Long-Run Effect of Increasing Longevity**



Note: The horizontal axis is the old-age dependency ratio.  
 Source: Tseng (2010); Yeh (2010).

Figure 2 varies the survival rate from 0.9765 to 0.9943, meaning that the retirement life expectancy varies from 10 years to 40 years. Meanwhile, the old-age dependency ratio varies from 21.77% to 69.47%. The horizontal axis represents the old-age dependency ratio. As we can see, the rising survival rate increases the net foreign assets at first and then augments the holding of international debt. The net foreign asset position is negative when the old-age dependency ratio is high. Meanwhile, the debt burden increases. This result seems a little strange because traditional life cycle theory suggests that increasing old-age dependency would bring about capital inflows, decreasing the net foreign assets. In other words, the life cycle theory is valid only in the latter part of the simulation.

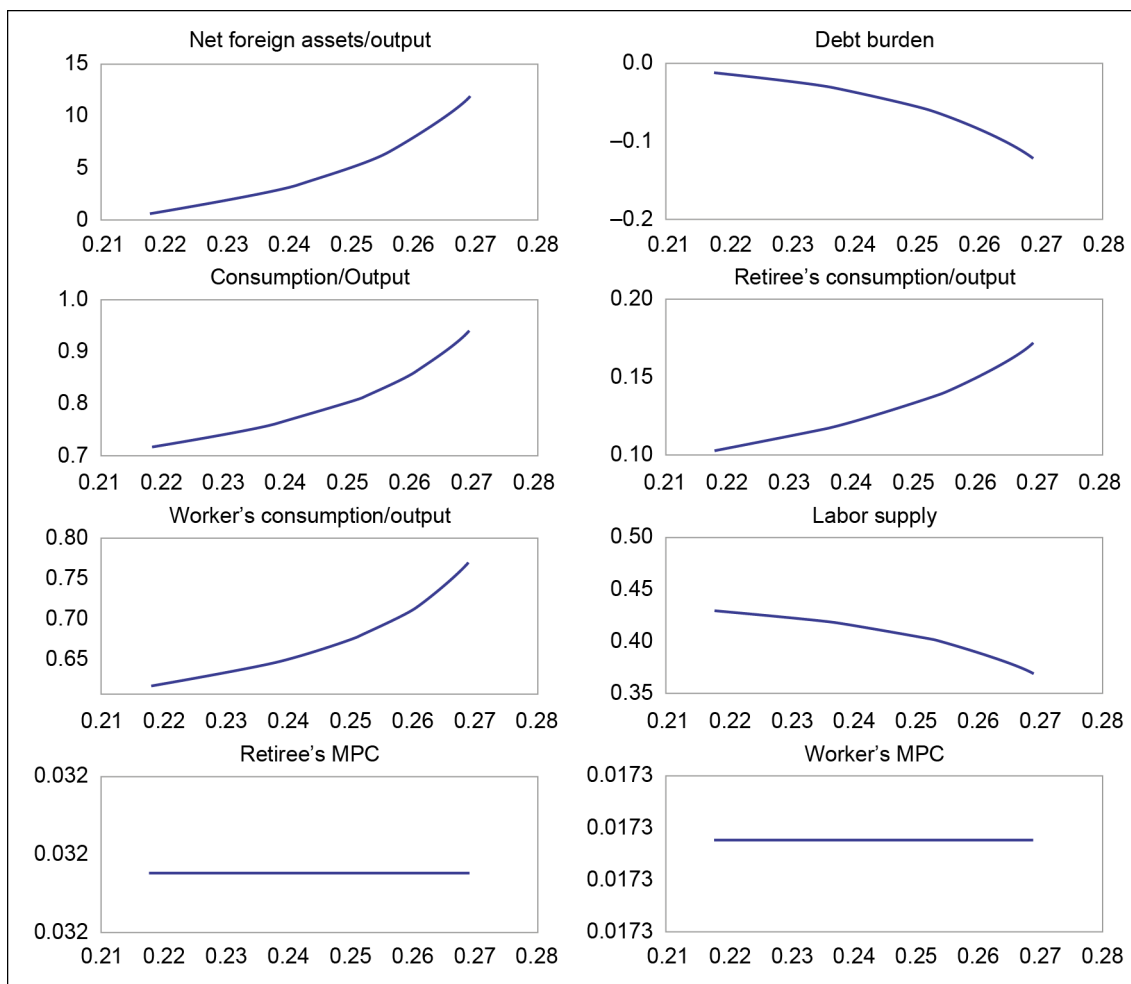
However, this would not appear to be a strange phenomenon if we understood the entire story. Workers increase their savings when they have a longer life expectancy. In the simulation, workers' savings are sufficient to compensate for the consumption of retirees at first. Although the old-age dependency ratio increases, the net foreign assets rise. As the number of older people grows, workers' savings will not be sufficient to compensate for retirees' consumption. Therefore, the net foreign assets start to decline and even become negative in the simulation. Besides, an increase in longevity lowers workers' *MPC* and retirees' *MPC*. This implies that individuals try to save more and consume less with a longer life expectancy.

Figure 3 assumes that the population growth rate changes from 0.01 to  $-0.01$  and shows the long-run effect of a falling population growth rate. The horizontal axis of Figure 3 represents the old-age dependency ratio. The long-run effect of a falling population growth rate is quite different from the long-run effect of increasing longevity. Although both falling population growth rates and increasing survival rates can increase the old-age dependency ratio, their effects on net foreign assets differ. The net foreign assets will increase when the population growth rate falls. This implies that a decrease in population growth causes capital outflow because the smaller population reduces the long-run growth rate of the domestic economy. In this situation, there is an incentive to hold foreign assets for domestic agents. Unlike an increase in longevity, a decrease in population growth brings about capital outflow. Besides, decreasing fertility does not affect the *MPC*.

From the above discussion, we know that an aging population may either increase or decrease the net foreign assets, depending on the size of the old-age population and the population growth rate. Both aging factors can increase the old-age dependency ratio, but the effects differ. It is not possible to simulate the old-age dependency ratio reasonably by changing just one of the population structure parameters. Calibrating population projection data is a reasonable way to choose population structure parameters.

In the subsequent analysis of dynamic properties, we choose demographic assumptions to match the population projections. We take the year 2010 as the younger economy and the year 2025 as the older economy. The reason for choosing 2025 as the older economy is the expectation that Taipei, China's population will become a super-aged society in the years 2025–2026 (20.7%), as we mentioned above.

**Figure 3: Long-Run Effect of Decreasing Fertility**



Note: The horizontal axis is the old-age dependency ratio.

Source: Tseng (2010); Yeh (2010).

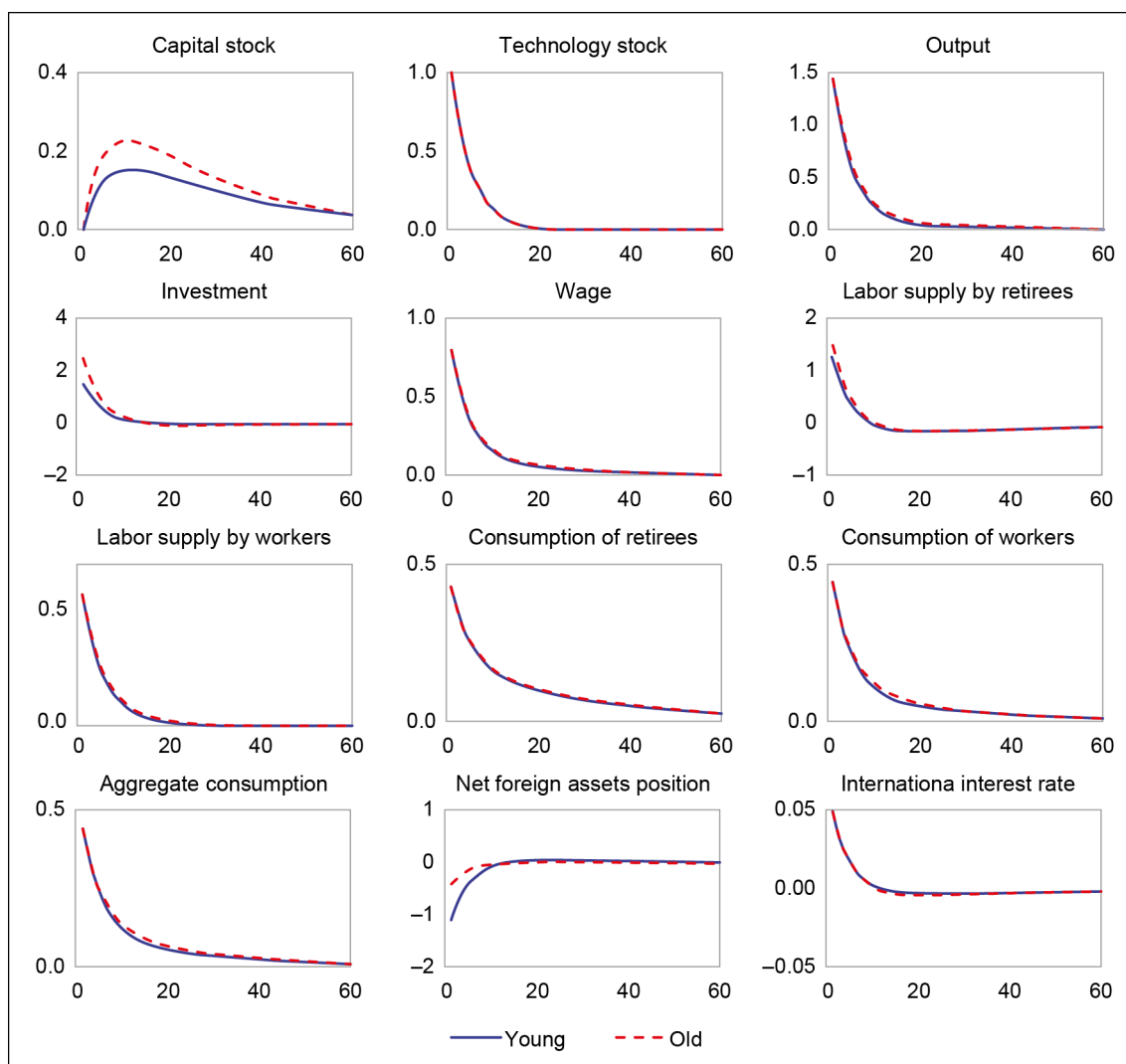
The life expectancy at birth in 2010 is 79 years, so we calibrate a 14-year retirement life. Meanwhile, the population growth rate in 2010 corresponds to 0.03%. The old-age dependency ratio that the model implies is 25% in the younger economy. The older economy closely matches the population projection of Taipei, China. Comparing 2010 and 2025, the projections show that the population growth rate will decrease to -0.4% while life expectancy will increase by 3 years. In the older economy, the old-age dependency ratio that the model implies is 33%, close to the old-age dependency ratio of 31% that it projected for the population in 2025.

Figure 4 shows the demographic structures of the younger and older economies that we calibrate using the population projections of Taipei, China. It shows the impulse response to the positive technology shock in the younger and older economies. The solid line represents the younger economy, while the dashed line represents the older economy. It is no accident that the output, consumption, and investment respond positively to a positive technology shock. The labor supply also responds positively to the shock because it increases the wage levels.

Meanwhile, the net foreign asset position responds negatively to a positive technology shock because the domestic economy increases its imports when a domestic positive technology shock occurs. The increase in imports causes a current account deficit and brings about capital inflow, thus increasing the domestic international debt.

Most variables, except investment, capital stock, and net foreign assets, respond similarly under alternative demographic structures. The responses of investment and capital stock are larger in the older economy because mainly retirees depend more on the returns from non-human wealth. With a longer life expectancy, individuals would invest more and accumulate more capital stock in preparation for retirement. Unlike investment and capital stock, the response of net foreign assets is smaller in the older economy mainly because, logically, a longer life expectancy encourages saving behavior. Individuals prefer to increase their consumption less than in the younger economy when they face a positive technology shock, so the increase in foreign debt is relatively small in the older economy.

**Figure 4: Responses to a Technology Shock under Alternative Demographic Structures**



Note: The horizontal axis is on a quarterly basis.

Source: Tseng (2010).

In sum, the demographic structure indeed affects the net foreign asset position in the long run. An increase in longevity first enhances and then erodes the net foreign assets. This finding supports the traditional life cycle theory that an aging society attracts capital inflow. The demographic structure also changes the size of the response to technology shocks. High old-age dependency ratios cause investments to respond strongly to technology shocks because individuals prefer to save more for retirement in aging societies. However, the correlations among the macroeconomic variables show that the demographic structure only slightly affects the transmission mechanism of technological shocks. This implies that the aging of the population has a minor influence on the dynamics of the macroeconomic variables.

Research has not explored many issues concerning an aging society and macroeconomic stability. For instance, housing prices would affect fertility, early life child health, and then the speed of aging (e.g., Daysal et al. 2020). It is important to monitor the trend of East Asian housing prices since the QE in 2009 and the COVID-19 shock.

#### **4. CONCLUSION AND POLICY RECOMMENDATIONS**

From the empirical study and simulations of Taipei, China's economic growth and volatility, we can conclude that the situation is not as bad as we expected. An aging workforce is not detrimental to economic growth, and the old-age dependency ratio has a significantly negative effect on economic development, but appropriate policies for foreign labor immigration and elderly long-term care can mitigate it. Higher education attainment still works to support economic growth in the long run. Besides, an increase in longevity first enhances and then erodes net foreign assets, and high old-age dependency ratios cause investments to respond strongly to technology shocks because individuals prefer to save more for retirement in aging societies. However, population aging has a minor influence on the dynamics of the macroeconomic variables.

While numerous developed and developing economies are facing the challenge of an aging population, Taipei, China is aging at a faster rate than other advanced and emerging economies. The above empirical results still provide some policy implications to improve healthcare and increase the supply of the eldercare workforce and foreign personnel, contributing to countering the negative impact of an aging population on national economic growth. It is necessary to implement policies to improve elderly long-term care and relax restrictions on the foreign workforce appropriately. Social welfare support must also become an important aspect of the social security framework. The government must adjust economic development strategies to the reality of a falling birth rate and an increasingly elderly population. In response to its aging human resources, it should allocate resources to help labor-intensive and low-skilled industries transform into more innovation-oriented and knowledge-intensive ones.

According to the evidence above, Taipei, China's Government has imposed four main policies as follows (National Development Council 2018). The first is, of course, to raise the birth rate to enhance the childbearing and child-rearing environment. It has approved a "2018–2022 program" to respond to the low birthrate, aiming for a fertility rate of 1.4 in 2030.

Second, the government should attempt to raise labor productivity by catering to future industry needs, promoting economic development, and upgrading and transforming the industrial structure. It has promoted some new policies, such as the so-called "5+2 Industrial Innovation Plan," the Industrial Innovation and Transformation Fund, the Act for the Recruitment and Employment of Foreign Professionals, and the New Economic Immigration Bill, which is currently in the planning stage.



Third, the government must create a friendly society for older people. Given the speed of population aging, creating a society that is welcoming to older people is a task to undertake without delay. The Ministry of Labor drafted the Act for Employment of Middle-Aged and Older People to help them secure employment.

Last but not least, the government must implement the “Long-Term Care Plan 2.0” with the support of industrial, financial, land use, social, medical care, retirement, housing, pluralistic social development, and other relevant policies to match the demographic change. Note that, in 2008, the government implemented the first generation of the Ten-Year Long-Term Care Plan, and, since 2015, the Ministry of Health and Welfare (MOHW) has promoted the National Ten-Year Long-Term Care Plan 2.0. It initiated the second generation of the plan for Long-Term Care 2.0 to establish a system to help low-income elderly and disabled people in need. The objectives of the policy are to combine public and private resources at all levels and integrate resources for medical care, long-term care, and preventive healthcare to perfect community care systems and mechanisms and create qualitative, affordable, and accessible long-term care services.

The Ministry of Health and Welfare (2019) is responsible for the Long-Term Care Plan 2.0. In addition to extending the target groups and services, the launch of benefit and payment systems encourages people to provide long-term care (LTC) services, enhance service functions, and assist more people in need. The MOHW care management system found a 70.9% increase over the previous year in first-time applicants for LTC services from January to November 2018, rising from 71,777 to 180,660.

The Long-Term Care Plan 2.0 has four major features, beginning with providing resources. To promote a comprehensive community-based care service, the government established the so-called “ABC scheme”: 472A (Integrated Community Service Center), 2,922B (Long-Term Care Service Institution), and 1,603C (Grocery Store of Care Service). Though just established at the end of November 2018, the number reached 3,827 in 2019, which was ahead of the Long-Term Care Plan 2.0’s schedule. The government has approved the construction of health, welfare, and long-term care facilities under the Forward-Looking Infrastructure Project for 568 cases, representing nearly NT\$2.47, with an approval rate of 92.3%.

The MOHW promotes dementia care services and set up a Support Center for People with Dementia and their Families in 2017. It also announced the details of the [Taipei,China] Dementia Plan 2.0 in June 2018, with the establishment of 350 such support centers and 73 integrated dementia care centers by the end of November 2018. Some 184 hospitals participated in the intensive plan for LTC discharge-friendly hospitals. To streamline the discharge planning services and connect health care with LTC services, it launched a pilot plan for diversified rehabilitation services in August 2018. This helps people with the activities of daily living, reducing the cost of care and family caregiver burdens to promote localized healthy aging. In 2019, 11 cities initiated a Family Caregivers Support Innovation Plan and all 22 cities promoted it.

The Long-Term Care Plan 2.0 is also notable for significantly improving home caregiving staff’s working conditions by raising salaries and encouraging job retention. According to a nationwide survey on the monthly salary of home care workers in August 2018, 44.29% receive over NT\$35,000; another 35.63% receive between NT\$32,000 and NT\$35,000. (Note the exchange rate \$1.00 = about NT\$1.30).

The MOHW has launched a pilot plan in collaboration with the Ministry of Labor to expand respite care services for families with foreign caregivers. Since 1 December 2018, two kinds of families have been able to apply for respite care services and related benefits if the foreign caregiver is temporarily unable to provide care services: one is families

employing foreign home caregivers to take care of individuals who meet the requirement for the disability levels of 7–8 according to the LTC Management Centers' assessment and are living alone (only living with their foreign caregivers), and the other is those whose primary caregiver is over 70 years old. This pilot plan benefited 8,610 families in 2019.

A new telephone hotline (No. 1966) has offered assistance to those seeking to access LTC services since 24 November 2017. By the end of November 2018, the total number of incoming calls was 125,464, averaging 338 calls daily. This hotline has built a Customer Relationship Management System since 2019 to upgrade the traffic progression and manage customer data to share information about public resources in a better way.

Needless to say, research has not yet explored many issues related to an aging society, macroeconomic development, and stability. The government still needs to deal with population aging as a matter of national security concern, be alert to new developments, and take the necessary precautions.

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## APPENDIX: MODELING AND CALIBRATION

The derivations of this Appendix are from Tseng (2010) and Yeh (2010), who based their work on that of Gertler (1999). As in Gertler's (1999) life cycle model, the population is a composite of workers and retirees. Individuals have an infinite life expectancy and two sequential states during their lifetime, namely work and retirement. Each individual is born as a worker and faces the constant probability of remaining in the workforce in the next period.  $\omega$  denotes the probability of remaining in the workforce in the next period, while  $1 - \omega$  is the probability of becoming a retiree in the next period.  $1 / (1 - \omega)$  denotes the length of the working period.

### A1. Households

When an individual becomes a retiree, we assume that he or she survives in the current period but faces a constant probability of staying alive in the next period.  $\gamma$  denotes the probability of surviving in the next period. Similarly,  $1 - \gamma$  represents the probability of death in the next period and  $1 / (1 - \gamma)$  is the average length of retirement.

We use  $N_t$  as the number of workers in period  $t$  and assume that  $(1 - \omega + n) N_t$  new workers are born in each period. This implies that the law of motion for workers is

$$N_{t+1} = (1 - \omega + n)N_t + \omega N_t = (1 + n)N_t$$

Thus, the workforce growth rate is  $1 + n$ . Further, we can show the law of motion for retirees as

$$N_{t+1}^r = (1 - \omega)N_t + \gamma N_t^r$$

$$\frac{N_{t+1}^r}{N_t^r} = (1 - \omega)\frac{N_t}{N_t^r} + \gamma\frac{N_t^r}{N_t^r}$$

We assume that the demographic structure is constant. The stationary population structure implies that workers and retirees have the same rate of population growth. We can represent the ratio of retirees to workers as

$$\frac{N^r}{N} = \frac{1 - \omega}{1 + n - \gamma} = \Gamma$$

where  $\Gamma$  is the old-age dependency ratio. This ratio increases with the survival rate and the retirement rate and decreases with the rate of population growth.

In this model, we can distinguish workers and retirees by their marginal propensity to consume (MPC). The MPC varies with the life cycle state because the effective discount rate of workers differs from that of retirees. In the following, we will show that workers consider a higher effective discount rate than retirees. The difference in discount rates would make the MPC vary with life states. In general, the MPC of retirees is higher than that of workers because workers have a higher effective discount rate. The reason for workers having a higher effective discount rate is that they might retire in the future, so their expected future wage is lower. A high effective discount reduces the value of the discounted stream of wage incomes, decreasing consumption and increasing savings. Therefore, this model captures workers' life cycle behavior of saving for retirement.

### A1.1 Workers and Retirees

We express the preference of our agents as follows:

$$V_t^z = \left\{ [(C_t^z)^v (1 - L_t^z)^{1-v}]^\rho + \beta^z E_t (V_{t+1}^z | z)^\frac{\rho}{\kappa} \right\}^\frac{1}{\rho}$$

$$\begin{cases} \beta^w = \beta \\ \beta^r = \beta\gamma \end{cases}$$

$$E_t \{ V_{t+1} | z \} = \begin{cases} \omega V_{t+1}^w + (1 - \omega) V_{t+1}^r & \text{if } z = w \\ V_{t+1}^r & \text{if } z = r \end{cases}$$

where  $z$  represents different cohorts. The superscript  $r$  stands for retirees, while the superscript  $w$  stands for workers. Individuals have one unit of time per period. They can spend their time on work or leisure. Note that retirees form part of the labor force in our model. However, we assume that the productivity of retirees is less than that of workers. Let  $C_t$  denote consumption and  $\beta$  denote a subjective discount factor. The discount factor of retirees differs from that of workers because retirees face the probability of death. On the other hand, retirees' discount rate is greater than workers' discount rate. The parameter  $\rho$  refers to intertemporal substitution. The parameter  $\kappa$  relates to risk aversion.  $E_t \{ V_t | z \}$  is the conditional expectation of the value function for the next period and depends on the current life state.

To keep the model tractable, we assume that there is no aggregate risk. Nevertheless, the lifetime of individuals is idiosyncratic. Workers face the uncertainty of wage loss caused by retirement. Retirees face uncertainty about their time of death. These uncertainties make derivation and aggregation difficult. We need more assumptions to mitigate the uncertainty and keep the model simple. For instance,  $\kappa = 1$  and retirees earn  $R_t^f / \gamma$  from their non-human assets to compensate fully for the risk of death.

### A1.2 Decision of the Representative Retiree

The representative retiree maximizes the following recursive utility function:

$$\max_{\{A_{t+1}^{rjk}, L_t^{rjk}\}} V_t^{rjk} = \left\{ [(C_t^{rjk})^v (1 - L_t^{rjk})^{1-v}]^\rho + \beta\gamma E_t (V_{t+1}^{rjk})^\rho \right\}^\frac{1}{\rho}$$

subject to

$$A_{t+1}^{rjk} = \frac{R_t^f}{\gamma} A_t^{rjk} + W_t \vartheta L_t^{rjk} - C_t^{rjk}$$

The superscript  $jk$  represents the retiree who was born at  $j$  and retired at  $k$ .  $W_t$  denotes the real wage.  $A_t^f$  is the non-human wealth that the retiree holds.  $R_t^f$  is the gross international interest rate.  $\vartheta$  is the relative productivity of the retiree to that of the worker, capturing the productivity decline when the individual retired. One can obtain the labor supply and consumption Euler equation from the first-order conditions:

$$E_t C_{t+1}^{rjk} = \left[ \beta E_t R_{t+1}^f \left( \frac{W_t}{E_t W_{t+1}} \right)^{\rho(1-\nu)} \right]^{\frac{1}{1-\rho}} C_t^{rjk}$$

By combining the first-order conditions with the budget constraint, we can show the consumption equation as follows:

$$C_t^{rjk} = \varepsilon_t \theta_t \left[ \frac{R_t^f}{\gamma} A_t^{rjk} + H_t^{rjk} \right]$$

where  $\varepsilon\theta$  is the retiree's marginal propensity to consume out of wealth (MPC),  $\theta$  is the worker's MPC, and  $\varepsilon$  is the ratio of the retiree's MPC to the worker's MPC. Thus, consumption is the product of MPC and wealth.  $H_t$  is human wealth. Human wealth derives from the discounted stream of wage incomes:

$$H_t^{rjk} = \frac{\sum_{q=0}^{\infty} W_{t+q} \vartheta L_{t+q}^{rjk}}{\prod_{z=1}^q R_{t+z}^f / \gamma}$$

$$H_t^{rjk} = W_t \vartheta L_t^{rjk} + \frac{\gamma}{E_t R_{t+1}^f} E_t H_{t+1}^{rjk}$$

We obtain the dynamic equation of the retiree's MPC after deduction:

$$\varepsilon_t \theta_t = 1 - \frac{\varepsilon_t \theta_t}{E_t \varepsilon_{t+1} \theta_{t+1}} \gamma \left( E_t R_{t+1}^f \right)^{\frac{\rho}{1-\rho}} \beta^{\frac{1}{1-\rho}} \left( \frac{W_t}{E_t W_{t+1}} \right)^{\frac{\rho(1-\nu)}{1-\rho}} \quad (1)$$

### A1.3 Decision of the Representative Worker

The representative worker maximizes the following recursive utility function:

$$\max_{\{A_{t+1}^{wj}, L_t^{wj}\}} V_t^{wj} = \left\{ [(C_t^{wj})^\nu (1 - L_t^{wj})^{1-\nu}]^\rho + \beta E_t [\omega V_{t+1}^{wj} + (1 - \omega) V_{t+1}^{rj}]^\rho \right\}^{\frac{1}{\rho}}$$

subject to

$$A_{t+1}^{wj} = R_t^f A_t^{wj} + W_t L_t^{wj} - C_t^{wj}$$

The superscript  $j$  represents the worker who was born at  $j$ .  $A^w$  is the non-human wealth that the worker holds. Similarly, we derive the labor supply and consumption Euler equation from the first-order conditions:

$$\begin{aligned} & \omega E_t C_{t+1}^{wj} + (1 - \omega) (\varepsilon_{t+1})^{-\frac{1}{\rho}} E_t C_{t+1}^{rj} \left( \frac{1}{\vartheta} \right)^{1-v} \\ &= \left[ \beta E_t R_{t+1}^f \quad \omega + (1 - \omega) (E_t \varepsilon_{t+1})^{-\frac{1-\rho}{\rho}} \left( \frac{1}{\vartheta} \right)^{1-v} \right] \left( \frac{E_t W_{t+1}}{W_t} \right)^{(v-1)\rho} \frac{1}{\rho-1} C_t^{wj} \end{aligned}$$

By combining the first-order conditions with the budget constraint, we can show the consumption equation as follows:

$$C_t^{wj} = \theta_t \left[ R_t^f A_t^{wj} + H_t^{wj} \right]$$

where  $\theta$  is the worker's MPC and  $H^w$  is the human wealth of the worker. Human wealth derives from the discounted stream of wage income:

$$H_t^{wj} = W_t L_t^{wj} + \omega \frac{E_t H_{t+1}^{wj}}{E_t R_{t+1}^f \Omega_{t+1}} + (1 - \omega) (E_t \varepsilon_{t+1})^{\frac{\rho-1}{\rho}} \left( \frac{1}{\vartheta} \right)^{1-v} \frac{E_t H_{t+1}^{rj(t+1)}}{E_t R_{t+1}^f \Omega_{t+1}}$$

where  $H^{rj(t+1)}$  is the value of human wealth for the individual who worked in period  $t$  and retired in the next period.

$\Omega_t$  can be shown as

$$\Omega_t = \omega + (1 - \omega) (\varepsilon_t)^{-\frac{(1-\rho)}{\rho}} \left( \frac{1}{\vartheta} \right)^{1-v} \quad (2)$$

$\Omega_t$  augments the interest rate for the worker and distorts the worker's decision rule.  $\Omega_t > 1$  since the ratio of the retiree's MPC to the worker's MPC is greater than 1,  $\varepsilon_t > 1$ . Therefore, the worker's discount rate is higher than the infinite horizon model's discount rate.  $\Omega_t$  arises from life cycle behavior and captures the attitude of the worker who faces the potential probability of retirement. For instance, if the relative productivity of the retiree in terms of the worker is falling,  $\Omega_t$  would increase, depressing the worker's current consumption. This implies that the worker would save more for retirement.

Finally, the worker's decision rule also yields the dynamic equation of the worker's MPC:

$$\theta_t = 1 - \left( E_t R_{t+1}^f \Omega_{t+1} \right)^{\frac{\rho}{1-\rho}} \beta^{\frac{1}{1-\rho}} \left( \frac{E_t W_{t+1}}{W_t} \right)^{\frac{(v-1)\rho}{1-\rho}} \frac{\theta_t}{E_t \theta_{t+1}} \quad (3)$$

#### A1.4 Aggregation

To obtain the aggregate function, we define the law of motion of non-human assets that retirees hold:

$$A_{t+1}^r = R_t^f A_t^r + W_t \vartheta L_t^r - C_t^r + (1 - \omega) \left[ R_t^f A_t^w + W_t L_t^w - C_t^w \right]$$



where the first term is the assets that retirees have accumulated at time  $t$  and the second term is the assets that the workers who worked at time  $t$  and retired in the next period hold.

We define  $\lambda$  as the ratio of retirees' assets to the society's assets:

$$\lambda_t = \frac{A_t^r}{A_t}$$

where the non-human asset  $A_t$  is the sum of the capital stock and net foreign assets:

$$A_t = K_t + F_t \tag{4}$$

The assets that workers hold at time  $t + 1$  is

$$A_{t+1}^w = \left[ R_t^f A_t^w + W_t L_t^w - C_t^w \right] \omega$$

We can simplify the law of motion of the assets that retirees hold:

$$\lambda_{t+1} A_{t+1} = \omega \left[ (1 - \varepsilon_t \theta_t) \left( R_t^f \lambda_t A_t + H_t^r \right) + W_t \vartheta L_t^r - H_t^r \right] + (1 - \omega) A_{t+1} \tag{5}$$

Next, multiplying the individual's labor supply by the population of each life state yields the aggregate labor supply function and aggregate human wealth:

$$L_t = L_t^w + \vartheta L_t^r \tag{6}$$

$$L_t^r = \Gamma N_t - \frac{1 - v}{v} \frac{C_t^r}{\vartheta W_t} \tag{7}$$

$$L_t^w = N_t - \frac{1 - v}{v} \frac{C_t^w}{W_t} \tag{8}$$

$$\begin{aligned} H_t^r &= \frac{\sum_{q=0}^{\infty} W_{t+q} \vartheta L_{t+q}^{rjk} N_{t+q}}{\prod_{z=1}^q (1+n) R_{t+z}^f / \gamma} \\ &= W_t \vartheta L_t^{rjk} N_t + \frac{\gamma}{(1+n) R_{t+1}^f} \frac{\sum_{q=0}^{\infty} W_{t+q+1} \vartheta L_{t+q+1}^{rjk} N_{t+q+1}}{\prod_{z=1}^q (1+n) R_{t+1+z}^f / \gamma} \end{aligned}$$

$$H_t^r = W_t \vartheta L_t^r + \frac{\gamma}{(1+n) E_t R_{t+1}^f} E_t H_{t+1}^r \tag{9}$$

$$\begin{aligned} H_t^w &= W_t L_t^w + \omega \frac{E_t H_{t+1}^w}{(1+n) E_t R_{t+1}^f \Omega_{t+1}} \\ &\quad + (1 - \omega) (E_t \varepsilon_{t+1})^{\frac{\rho-1}{\rho}} \left( \frac{1}{\vartheta} \right)^{1-v} \frac{E_t H_{t+1}^r}{(1+n) E_t R_{t+1}^f \Omega_{t+1}} \end{aligned} \tag{10}$$

Note that the population growth rate  $1 + n$  increases the discount rate of aggregate human wealth because increasing the population reduces the share of wages that the current generation earns. The term  $1 + n$  ensures that we can separate the income streams of the current generation from those of the future generation.

Finally, eliminating the superscript  $jk$  from individual consumption, one obtains the aggregate consumption:

$$C_t = C_t^r + C_t^w \quad (11)$$

$$C_t^r = \varepsilon_t \theta_t \left[ R_t^f \lambda_t A_t + H_t^r \right] \quad (12)$$

$$C_t^w = \theta_t \left[ R_t^f (1 - \lambda_t) A_t + H_t^w \right] \quad (13)$$

## A2. Firms

We assume that firms are perfectly competitive. Firms employ labor  $L_t$  and capital  $K_t$  to produce output  $Y_t$ . The production function follows the Cobb–Douglas form:

$$Y_t = Z_t (X_t L_t)^{1-\alpha} K_t^\alpha \quad (14)$$

where  $Z_t$  is the exogenous total factor productivity and follows an AR(1) process.  $X_{t+1} = (1 + x) X_t$  is the labor-augmenting technical progress. Firms choose the optimal inputs to maximize their profit. Note that the firm holds all the capital stock. The depreciation of capital stock is the only cost of holding capital.

$$\max_{\{L_t, K_{t+1}\}} \mathfrak{R}_t = \sum_{s=0}^{\infty} \left( R_t^f \right)^{-s} \Pi_{t+s}$$

$$\Pi_t = Y_t - W_t L_t - I_t$$

$$I_t = K_{t+1} - (1 - \delta) K_t \quad (15)$$

where  $I_t$  and  $\delta$  are an investment and the depreciation rate, respectively. The firm's optimal problem implies the following wage equation and the interest rate equation:

$$W_t = (1 - \alpha) \frac{Y_t}{L_t} \quad (16)$$

$$R_t^f = \alpha \frac{Y_t}{K_t} + (1 - \delta) \quad (17)$$

## A3. Market Clearing and the World Interest Rate

This is a small open-economy model. Agents can lend to or borrow from abroad at international interest rates. The market-clearing condition equals the national income identity of an open economy:

$$Y_t = C_t + I_t + TB_t$$

where  $TB_t$  is the trade balance. To include net foreign assets in the market-clearing condition, we define net foreign assets (NFA) as the payment that the country receives from foreign countries in exchange for domestic goods. We can represent the evolution of net foreign assets as the sum of the compound interest and trade balance in the previous period:

$$F_{t+1} = R_t^f F_t + TB_t$$

We rewrite the market-clearing condition as

$$K_{t+1} + F_{t+1} = Y_t - C_t + (1 - \delta)K_t + R_t^f F_t \quad (18)$$

where  $F_t$  is the net foreign asset position.  $F < 0$  implies the net holdings of international debt and  $F > 0$  the net holdings of international bonds.

We have enough equations to generate the steady-state value by assuming that the domestic interest rate equals the international interest rate, which we obtain exogenously. However, one more equation is necessary to describe the dynamics of net foreign assets when their level deviates from the steady state. We use the debt-elastic interest rate approach to complete the model. We assume that the international gross interest rate is an increasing function of the country's detrended international debt:

$$R_t^f = R^* - \varphi \left( \frac{F_t}{X_t N_t} - f \right) \quad (19)$$

where  $R^f$  is the constant world interest rate,  $\varphi > 0$  is the risk premium parameter, and  $f$  is the steady-state value of the detrended net foreign asset position.

#### A4. General Equilibrium and Steady-State Values

Here, we discuss the steady-state property under alternative demographic structures. The model consists of 20 equations. There are 19 endogenous variables from equations (1)–(19) and one exogenous shock,  $Z_t$ . All the quantity variables require detrending because the growth rates of both the labor-augmenting technology and the population are deterministic. We detrend  $Y$ ,  $K$ ,  $C$ ,  $F$ ,  $H$ , and  $A$  using  $XN$ ,  $W$  by  $X$ , and  $L$  by  $N$ . We denote detrended variables with lower-case letters.

Table A1 describes the parameters of the prototype model. We solve the model with quarterly frequency, so we display all the parameters in quarterly terms. Note that we modify the survival rate and the probability of remaining as a worker to generate a realistic length for each life state. We assume that the working age is 15–64 years and the retirement life expectancy is 10 years. Therefore,  $\omega$  and  $\gamma$  can equal  $1.023^{-0.25}$  and  $1.1^{-0.25}$ , which generate an old-age dependency ratio of 21.77%. We base other parameters on Gertler (1999), except for the risk premium, which follows the small open-economy model.

Sims's optimization program `csolve.m` can solve for the steady-state values. Table A1 also lists the steady-state values of the prototype model.

$tb / y$  is the ratio of the trade balance to the output, which we can show as

$$\frac{tb}{y} = \frac{-(R^* - 1 - x - n) f}{y} = \frac{-f}{y / (R^* - 1 - x - n)}$$

This ratio measures the burden of a foreign debt on the economy. The higher the ratio, the greater the likelihood that the debt is unsustainable. We can use  $tb / y$  to check the foreign debt burden under alternative demographic structures.

**Table A1: Values of the Parameters and Steady-State Values of the Prototype Model**

Parameter	Value	Definition
$\sigma$	0.25	Intertemporal elasticity of substitution
$\varphi$	0.01	Risk premium parameter associated with the debt position
$\beta$	$1.04^{-0.25}$	Subjective discount factor
$\omega$	$1.023^{-0.25}$	Probability of remaining as a worker
$\alpha$	1/3	Capital share, while $1 - \alpha$ is the labor share
$\delta$	$1.1^{0.25-1}$	Capital depreciation rate
$\rho$	-3	$(\sigma - 1) / \sigma$
$\nu$	0.4	Utility weight on consumption
$\vartheta$	0.6	Labor productivity of retirees
$\gamma$	$1.1^{-0.25}$	Probability of remaining as a retiree
$x$	$1.01^{0.25-1}$	Labor-augmenting technology growth rate
$n$	$1.01^{0.25-1}$	Population growth rate
$\Gamma$	0.2177	Old-age dependency ratio $\Gamma = (1 - \omega) / (1 + n - \gamma)$
$R^*$	$1.04^{0.25}$	World interest rate
$c / y$	0.718	Share of consumption in output
$k / y$	9.813	Share of capital in output
$f / y$	0.859	Share of net foreign assets in output
$tb / y$	-0.004	Share of trade balance in output
$\lambda$	0.139	Share of assets held by retirees
$\Omega$	1.012	Weighting term on workers' discount rate
$\theta$	0.017	Marginal propensity to consume out of wealth (workers)
$\varepsilon\theta$	0.032	Marginal propensity to consume out of wealth (retirees)
$l^w$	0.401	Participation rate of workers
$l^r$	0.052	Participation rate of retirees

Source: Tseng (2010); Yeh (2010).