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Norwegian School of Economics

Bergen, Fall 2016

The Global Saving Glut in the light of demographic developments

A numerical simulation of the developments in China and the US

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Master thesis, MSc in Economics

NORWEGIAN SCHOOL OF ECONOMICS

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Abstract

The objective of this thesis is to predict how demographic developments will affect the *Global Saving Glut*. The thesis examines how the changes in the age structure in China and the US are affecting their respective aggregate savings rates.

Ben Bernanke was the first economist to mention the term *Global Saving Glut*, which describes an economy where desired saving exceeds desired investment. He states that the increase in the global supply of savings was one of the main reasons behind the low global real interest rates.

This thesis will use an *Overlapping Generation Model* with seven generations overlapping in the time period from 2010 to 2060. By including numerous generations, this will provide an improved analysis and understanding of the demographic patterns and developments in both countries. In the US, the model will include the effect of the aging of the baby boomers, while in China the model will capture the long run effects of the family planning policies.

From our analysis, we see an increasing number of elderly per worker in both China and the US. In line with the *Life-Cycle Hypothesis*, our results, therefore, project a decrease in both countries' savings rates since more people are in the dissaving stages of their life-cycle. Also, with fewer workers per elderly, taxes will need to increase to keep the two nations' pension systems in their current forms. In order to dampen the effects of the increase in the old-age dependency ratios, a solution can also be to increase the retirement age.

Since China and the US are the two largest economies in the world, the developments in their savings rate will have large implications for the global economy and the global real interest rate. A large reduction in aggregate saving, and thereby in their current account balances, will lower the global supply of saving. As a result, these developments might increase the low global real interest rates we have been seeing over a longer period of time.

Preface

This thesis was written as a part of our Master of Science (MSc) degree in Economics at the Norwegian School of Economics (NHH), fall 2016.

Many countries worldwide, and then especially advanced economies, are currently facing an increasingly older population, and fewer workers per elderly. This thesis analyzes how these demographic developments might affect the world's two largest economies, China and the US, and their savings rate. Further on, we look into and discuss whether the projected changes might lead to a decrease in the global saving glut. We are truly grateful for finding such an engaging and current topic for our research.

Even though the process has been challenging at times, it has been an educational and exciting process that has given us a broader insight into more advanced macroeconomic issues and methods.

Finally, we wish to thank our supervisor Øystein Thøgersen, for help, support, and inspiration. It has been a true pleasure to work with you.

Bergen, December 2016

Marianne Håland and Malin Karlberg Pettersen

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1. Introduction

From 1985 to 2015 the global long-term real interest rate has dropped from over 4 percent to around 0.5 percent, see Figure 1.1 (King and Low (2014) & Finansdepartementet (2015)). There are various reasons for the decrease in the interest rates, one of the most recent ones being the financial crisis in 2008. The recession that followed lead central banks worldwide to lower their policy rate. In addition, people became more risk averse which affected their saving and investment patterns.

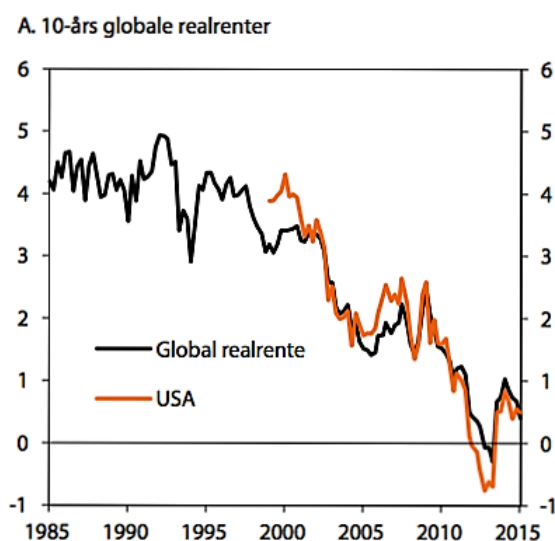


Figure 1.1 – The 10-year global real interest rate in percent (1985-2015). Source: King and Low (2014) & Finansdepartementet (2015).

Still today most central banks have kept their policy rates at very low levels, and in Sweden their key repo rate is even -0.50 percent (Riksbanken (2016)). Through the monetary transmission mechanisms, a low policy rate stimulates aggregate demand and increases capacity utilization, which in turn also increases the inflation rate. This will lead to an increase in the expectations of higher inflation in the future, which, at least in theory, should increase the long-term real interest rate. However, inflation levels are still well below inflation targets in most western

countries ¹, and is, therefore, a reason for why most central banks are prolonging the rise of their policy rate. As a result, this might be an explanation for the persistent long-term real interest rate.

However, the low long-term real interest rates are not just a consequence of central banks' monetary policy and cyclical changes, but also due to more long-run structural factors leading to a savings surplus globally. In order to equalize the supply and demand for capital, i.e. investment must equal saving globally, the global real interest rate is pressured down in order to make investments more desirable and lower the saving incentive.

1.1 The Global Saving Glut

Looking more into structural factors, we will focus on the mechanisms determining a country's level of savings and investment, as one of the main reasons for today's low long-term real interest rates. One of the first economists to mention the global imbalance between desired saving and planned investment was Ben S. Bernanke, the former Chairman of the Federal Reserve. It was in a speech in March 2005 that Bernanke introduced the term *The Global Saving Glut*. In his speech, he stated that the increase in the global supply of savings was one of the main reason for the increase in the US' current account deficit, as well as the low long-term real interest rates (Bernanke (2005)).

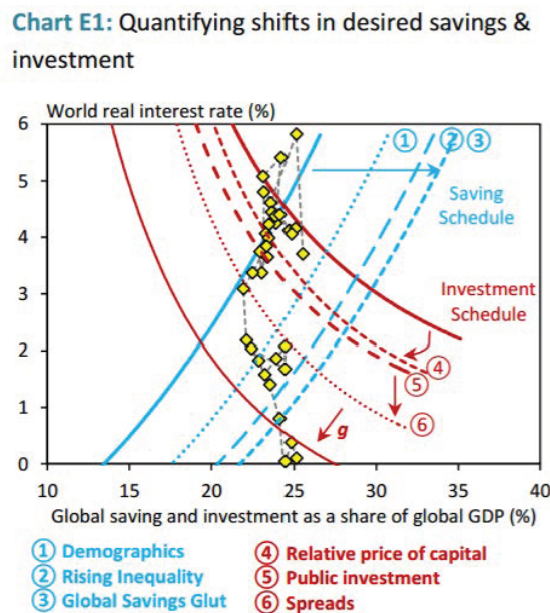
One of his perspectives on this topic was that an increase in the global savings rate, especially by Asian emerging-market countries, had led to a global saving glut, which in turn is putting a downward pressure on the real interest rates. Further on, Bernanke stated that developing and emerging-market countries have now become large net lenders to industrialized countries, instead of having large capital flows coming into their countries. This, in turn, affects the current account deficits of countries such as the US, who is now a net borrower of financial capital (Bernanke (2005)).

Rachel and Smith (2015) mention six reasons for shifts in preferences for saving and investment

¹One exception is Norway, where the inflation rate (KPI-JAE) in August 2016 was at 3.3 percent. According to Norges Bank (2016), the high inflation rate is temporary and held up by a weak exchange rate. By the end of the forecast period, Q4 2019, it is expected that the inflation rate will be below the inflation target at 2.5 percent.

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in their article regarding the global real interest rate. These are demographic changes, higher inequality, emerging-markets' saving glut, falling relative price of capital, a decline in public investments, and an increase in spreads between risk-free and actual interest rates. These factors are shown in figure 1.2 below. The graph illustrates the relationship between saving (the blue line), investment (the red line) and the world real interest rate. An excess of supply of savings will put downward pressure on the real interest rate in order to reach a new equilibrium between global saving and investment. A lower real interest rate will make investments relatively cheaper, and will therefore possibly incentives an increase in investments in order to create an equilibrium between the volume of saving and investment (Rachel and Smith (2015)).



Source: Authors' calculations.

Figure 1.2 – Different factors that affect global saving and investment, and how these affect the world real interest rate. Source: Rachel and Smith (2015).

1.2 Demographics and the life-cycle hypothesis

Our main focus will be on demographic developments and patterns as one of the main drivers behind the global saving glut. We will here define demographics as the age structure within a country. As we saw from figure 1.2, Rachel and Smith (2015) suggest that an increase in the

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proportion of people that is of working age will shift the saving schedule to the right and lower the global real interest rate (all else held constant).

To explain the saving pattern due to demographic changes, we will build on versions of the life-cycle hypothesis (LCH) by Franco Modigliani. This hypothesis proposes that saving is a way to obtain the preferred consumption path over an individual's life-cycle ², illustrated in figure 1.3. The LCH assumes that people prefer to smooth their consumption during their finite lifetime. Before entering the labor market, individuals have no income and should, therefore, borrow money. As they start working, they are able to pay back what they borrowed, as well as maintain their consumption profile. During this working time-frame, they should also accumulate savings, which they can later consume when they retire. Put in other words, individuals tend to save or dissave during different stages in their life in order to smooth their consumption (Doppelhofer (2009)). How much individuals prefer to save while they are working will also depend on the characteristics of a country's pension system. A generous pension system will reduce the incentive and necessity to save a large share of income while working. If a country's inhabitants receive pension benefits, they will not be as dependent on their saving, and can thereby obtain a smooth consumption profile without saving as much. In contrary, if individuals are faced with a non-existent or poor pension system, they would need to save more during their working period in order to maintain a smooth consumption path after they retire. As the distribution of people within different age groups varies a lot across different countries, this will, in turn, affect the aggregate national saving across countries. Thus, the demographic structure could be an important variable to determine a country's national savings rates.

²LCH: $y_1 + \frac{y_2}{1+r} + b_0(1+r) = c_1 + \frac{c_2}{1+r} + \frac{b_2}{1+r}$ where y is output, c is consumption, b is bequest and r is interest rate (Doppelhofer (2009)).

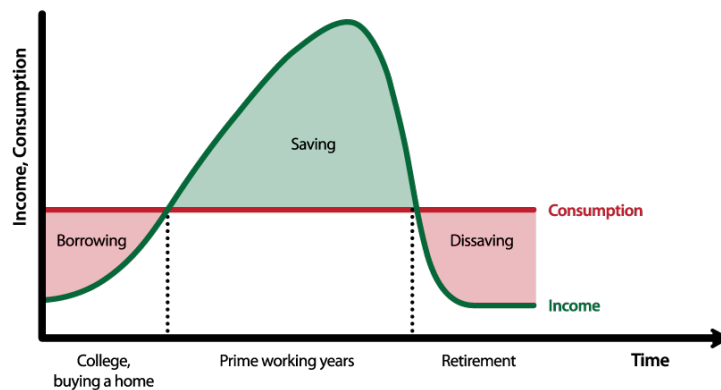


Figure 1.3 – A figure of Modigliani’s life-cycle hypothesis (LCH). Consumption is relatively smooth throughout the individual’s lifetime, while income varies according to life stages. Source: Doppelhofer (2009).

This thesis will exclusively zoom in on the demographical structure in the US and China. Both countries are experiencing a change towards fewer workers per elderly, along with an increasing life expectancy. The two countries have very different pension systems, which might have an effect on individuals’ saving- and consumption patterns. While the US has a relatively generous pension system, the Chinese are more dependent on their own savings and their family since the Chinese pension system is generally less generous and almost absent in the rural areas. This is reflected in what we see, that the Chinese national savings rate is higher than that of the US³. In addition, with fewer workers per elderly, pension systems are no longer as generous since there are fewer people able to pay taxes. Along with an increased life expectancy, more people in both countries will need to save more while working in order to be able to have a smooth consumption path throughout their life-cycle.

1.3 Research questions

The low global long-term real interest rates can be explained by a global saving glut. There are global financial imbalances due to the fact that there are several countries worldwide with high savings rates, and others with large current account deficits. We will focus on China, a country

³In 2015 the gross national savings rate was around 17.5 percent of GDP in the US, while China’s national savings rate was roughly 47 percent of GDP (Macrobond).

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with an exceptionally high savings rate, and the US, which has a huge deficit. The aim of our thesis will be to consider how the global saving glut is related to the age structure in these two countries. This has motivated the following research questions:

Research question 1:

How is the demographic structure affecting the saving patterns in China and the US?

Research question 2:

What are the possible outlooks for the two nations' demographic developments, and how will these affect the level of the global saving glut?

1.4 Structure of this thesis

The following chapter will look at the large heterogeneity among countries regarding their financial situation. Further on, we will zoom in on China and the US, and their saving and demographic developments. Chapter 4 introduces Modigliani's life-cycle hypothesis, while chapters 5 and 6 present the overlapping generation model and an extended version of this. This gives us a foundation to make numerical simulations of the developments we are seeing in both China and the US in chapter 7. Finally, in chapter 8 we make our final concluding remarks and have a brief discussion about the implications of our model.

2. Global saving

The global saving glut implies that many countries worldwide have high savings rates and that there has been an increasing global supply of saving. As a result, the interest rate has decreased in order to incentives the demand for capital. This is due to the fact that the world as a whole can be looked upon as a closed economy, which means that the global supply of saving needs to be equal to the global investment. This increase in the supply of saving can especially be explained by the high economic growth in China and India, whom today account for more than one-third of the world's savings (OECD (2015)).

On a world basis, savings rates differ significantly between countries. Figure 2.1 and 2.2 show how much countries worldwide saved, in percent of GDP, in respectively 1990 and 2014. From the maps, we can see that for example, China had a high savings rate in both time periods and that it increased significantly from roughly 38.5 to 48.7 percent of the nation's GDP. The US and other industrialized countries, on the other hand, have had a decrease in their savings rate between 1990 and 2014. In the US their gross savings rate went from 18.8 percent of the nation's GDP in 1990, to 17.6 percent in 2014. In addition, by comparing the two maps we see that gross savings rates seem to be higher in developing and emerging market countries than in developed countries (World Bank).

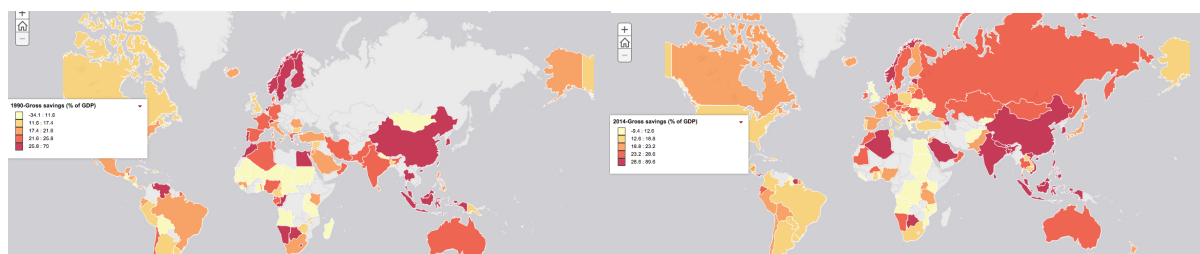


Figure 2.1 – Gross Saving, in percent of GDP, in 1990 for different countries worldwide. Source: World Bank.

Figure 2.2 – Gross Saving, in percent of GDP, in 2014 for different countries worldwide. Source: World Bank.

The worldwide investment rates show the same trends as the savings rates. Figure 2.3 and

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2.4 illustrate the investment rates for various countries in 1990 and 2014. The investment rates differ quite a lot among countries and between the two time periods. From the maps, we can see that China has had a high investment rate in both years. In 1990 the country had an investment rate equal to 35.9 percent of their GDP, and this increased to 46.2 percent in 2014. Increases in national investment rates from 1990 to 2014 have mainly been in emerging markets and developing countries. In more advanced economies the overall investment rate has gone down. In the US the investment rate decreased from 21.5 percent in 1990, to 19.9 percent of GDP in 2014 (World Bank).

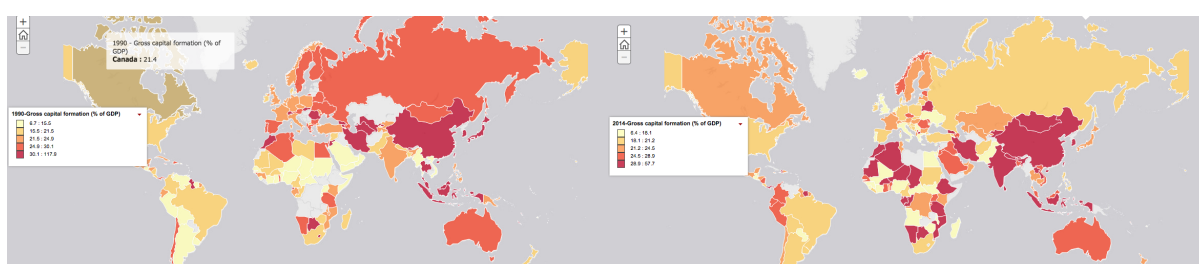


Figure 2.3 – Gross Capital Formation, in percent of GDP, in 1990 for different countries worldwide. Source: World Bank.

Figure 2.4 – Gross Capital Formation, in percent of GDP, in 2014 for different countries worldwide. Source: World Bank.

In addition, the current account balances differ a lot between countries worldwide. Countries with relatively high savings rates compared to the nation's investment rate will have a current account surplus, while countries with a higher investment than savings rate will, as a result, have a current account deficit. From figure 2.5 we see the current account balance, as a percentage of GDP, for China, the US, Japan, Mexico, and the Euro Area. It shows a clear heterogeneity in current account balances between the countries, where the US and Mexico both have current account deficits, while the others have current account surpluses. However, we see that after the financial crisis the spread between the countries has decreased. Today the different current account balances have an interval between roughly 2.5 and -2.5 percent of GDP. Especially for Japan and China, this can be a result of declining national savings rates.

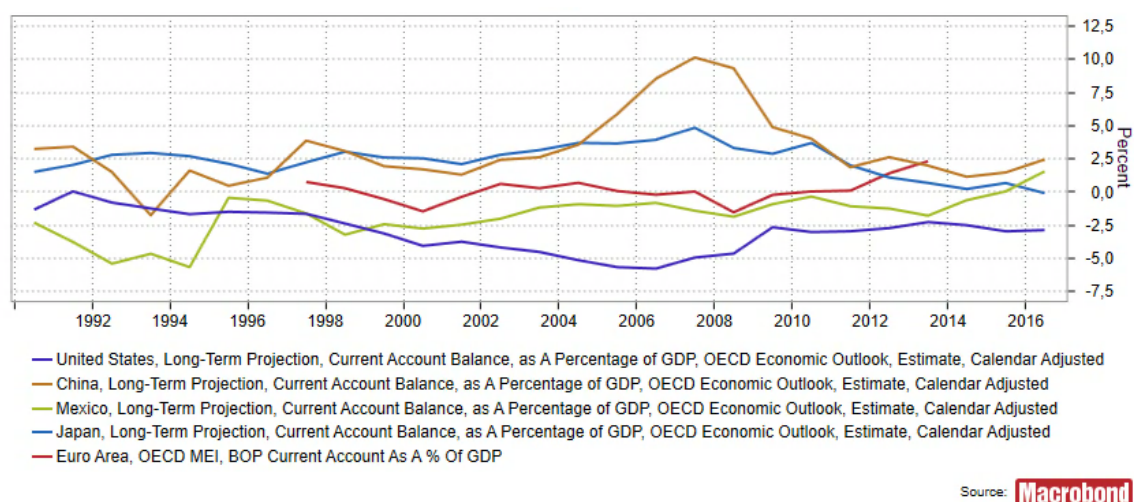


Figure 2.5 – The current account balance, as a percentage of GDP, for China, the US, Japan, Mexico and the Euro Area (1990-2016).

This chapter will further on look deeper into the saving pattern in four different countries: The US, China, Japan, and Mexico. Before we go into this, we need to clarify the definition of saving. National saving can be divided into two parts, private and public saving. Private saving is savings made by households and private businesses, and equals personal savings plus after-tax corporate profits minus dividends. Public saving is on the other hand savings made by the government (Mankiw (2012)).

2.1 The US

From 1991 and up to today there has been a significant gap between the US' national saving and investment rate, as a percentage of the nation's GDP, see figure 2.6. During this time period, the investment rate has been consistently higher than the nation's savings rate. For 2016 the forecast is that the gross capital formation rate, as a percentage of GDP, will be just over 21 percent, while the gross national savings rate will be 18.4 percent. Compared to many other countries, especially emerging markets, these rates are very low (IMF (2014)). The projection up to 2060 is that the savings rate will be lower than the investment until 2056. From 2056 and at least up to 2060 the nation's savings rate is projected to exceed the country's investment rate. In other words, we can expect to see a current account surplus in the country after 2056.

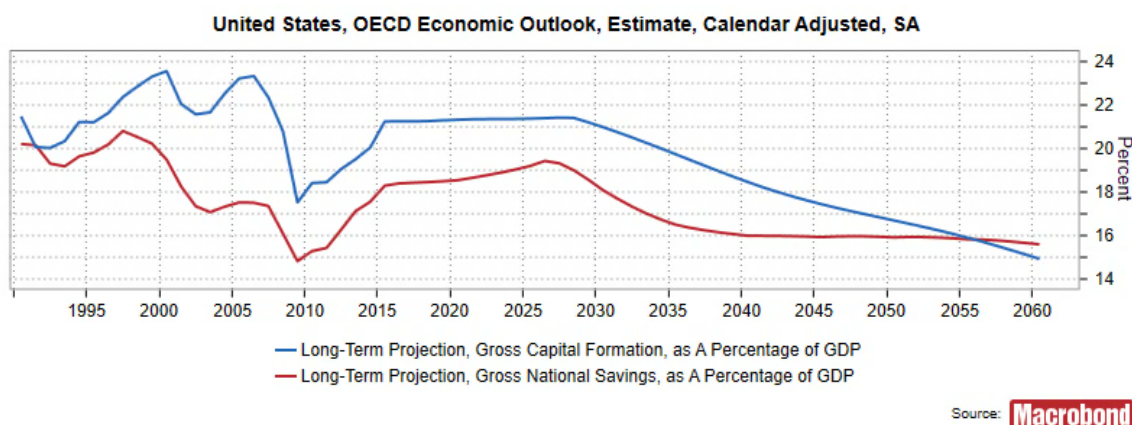


Figure 2.6 – The relationship between US’ long-term gross capital formation and national saving, as percentage of GDP (1990–2060).

In 2015, the US import rate was 15.4 percent of GDP, while their export rate was 12.6 percent of GDP. This means that the country had a negative trade balance of 2.8 percent of GDP. In total, the nation had a current account ¹ deficit for 2015 at 2.58 percent of their GDP (World Bank). A current account deficit implies that the US is a net financial borrower, and the deficit leads to a decrease in the nation’s net foreign assets. To cover the deficit the US is dependent on borrowing assets from abroad. In fact, a lot of China’s excess savings are used to finance the US’ current account deficit (Bernanke et al. (2011)).

Figure 2.7 shows the total level of gross private and government saving in trillion USD. It illustrates that private saving has had a relatively steady increase during the last decades. Private saving has exceeded government saving over the whole period, and this gap has also increased over the years. In fact, in 2015 the US’ public saving was at almost minus 0.5 trillion USD, while private saving was over 3.5 trillion USD. One can especially notice that after the financial crisis, the gross private saving increased, while the government saving decreased and has since then been negative. The increase in private saving could be a result of a precautionary saving motive ², while the government at the same time increased its spending, and thereby reduced savings, in order to stimulate the American economy.

¹Current account=(X-M)+NY+NCT, where X is export, M is import, NY is net income from abroad, and NCT is net current transfers (Investopedia).

²“Precautionary saving is additional saving that results from the knowledge that the future is uncertain” (Carroll and Kimball (2006)).

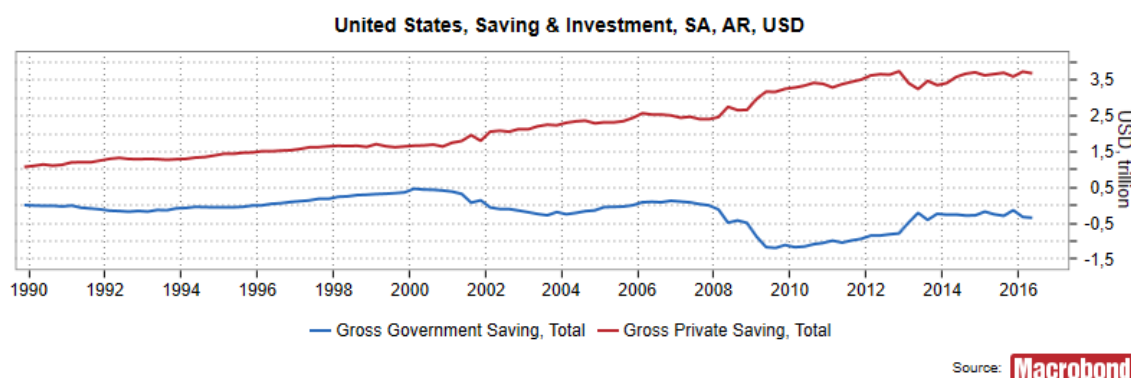


Figure 2.7 – Gross private and government saving in USD (1990-2016).

In the years leading up to the financial crisis, the household savings rate was very low, at around 3 percent of disposable income, see figure 2.8. At the same time, the investment in housing was high due to low interest rates and low restrictions for taking up loans. The result was an increasing debt ratio and decreasing household savings rate. As the housing prices increased, the phenomenon "wealth effect" occurred as people thought they were richer than they actually were, and thus did not feel the same need to save. After the recession and the drop in the house prices, the savings rate has increased. As a result of reduced expectations among individuals about the future economic growth, people became more risk averse, which probably lead to increased precautionary saving. Together with an increase in the unemployment rate, the future economic situation became even more uncertain for many Americans. However, even though the private savings rate has increased over the last years, it is still low compared to many other countries, such as Canada, Australia and Austria (Barghini and Pasquali (2015)).

The US' household savings rate, as a percentage of disposable income, was in 2015 over 5 percent, see figure 2.8. The highest level was in 2012 when the savings rate was over 7.5 percent of disposable income. The forecast for 2016 is roughly 5.1 percent, while it is supposed to drop in 2017 to around 4.5 percent (OECD (2016a)). In other words, we observe that after a sharp increase in the private savings rate following the aftermath of the financial crisis, this is expected to decrease in the years to come.

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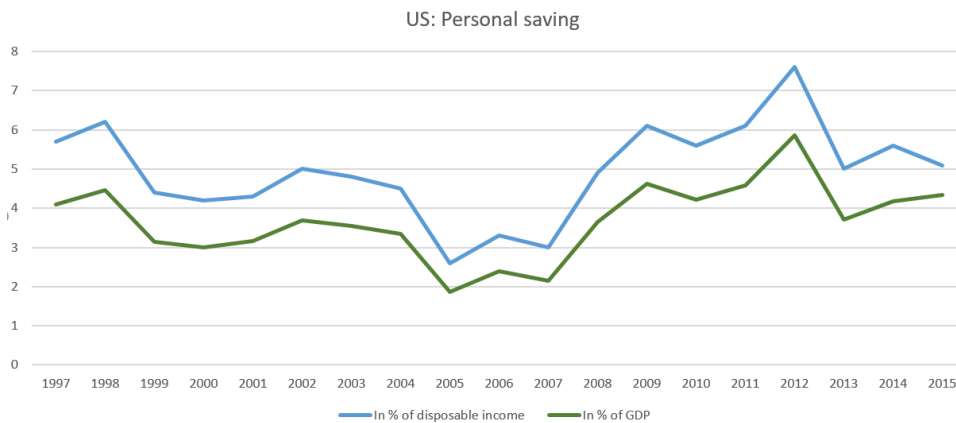


Figure 2.8 – Household savings rate in the US, as a percentage of disposable income and GDP (1997-2015). Source: Federal Reserve Bank of St Louis (2015).

In 2015 the personal consumption rate was around 68 percent of GDP, which equals around 12.2 trillion USD (Federal Reserve Bank of St Louis (2015)). In comparison, figure 2.8 shows that the personal savings rate is just over 4 percent of GDP. This highlights that Americans are consuming a lot more of their income instead of saving it for future consumption. In figure 2.9 below, the relationship between personal saving and consumption, as a percentage of GDP, is illustrated. It clearly displays the disparity between the amount Americans have consumed and saved each year since 1997 and up to 2015.

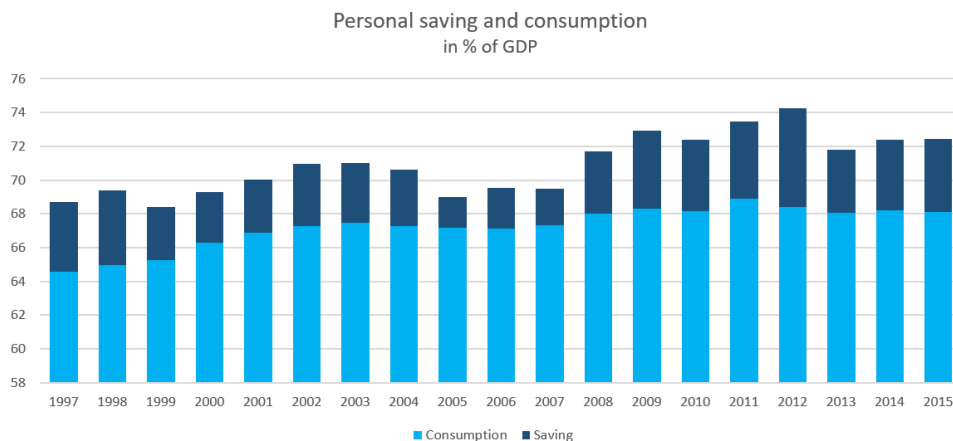


Figure 2.9 – Personal saving and consumption, as a percentage of GDP (1997-2015). Source: Federal Reserve Bank of St Louis (2015).

2.2 China

The developments and projections for China's saving and investment rates from 1990 to 2060 are shown in figure 2.10. The red line represents China's gross national savings rate, while the blue line illustrates the country's gross capital formation rate, both as percentages of the nation's GDP. From around 1994 we can clearly see that the national savings rate has been higher than the nation's investment rate. At the peak level around 2009, the savings rate was around 53 percent, while the investment rate was just over 48 percent. Last year, in 2015, the national savings rate in China was reduced to 47.6 percent, while the gross capital formation rate was at 46.1 percent. Following, among other things, a stronger focus on consumption-based growth, the projection up to 2060 is a decrease in both the national saving and investment rate. The savings rate is estimated to fall to a staggering 36 percent of GDP by 2060, after its peak between 2008-2010. In 2057 we see that the investment rate will exceed the savings rate, and thereby possibly lead to a current account deficit.

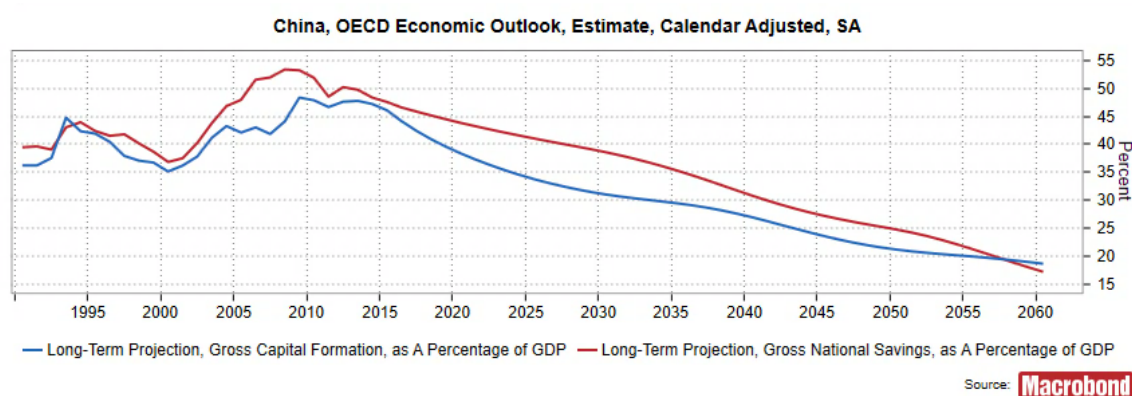


Figure 2.10 – The relationship between China's long-term gross capital formation and gross national savings rates, as a percentage of GDP (1990–2060).

China's current account balance, as a percentage of its GDP, has been continuously positive for the last 20 years. In 2015 it was just over 3 percent, while the highest percentage number was in 2007 when their current account surplus was over 10 percent of its GDP. Last year China exported goods for a total value of roughly 225 billion USD, while the value of imports was about 175 billion USD (World Bank (2015)). In other words, a large reason for the country's current account surplus is due to their high export revenues.

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The gross saving (excluding households), as a percentage of GDP, increased significantly from the year 2000 to 2007. The savings rate reached a peak in 2007 with a rate at around 32 percent of GDP, shown by the blue line in figure 2.11. This line represents both public saving and private businesses' saving. One explanation for the development in the public savings rate was an increase in the public income in this time period. From 1999 to 2007 the Chinese government increased taxes on income and production, and collected social security fees. All these factors resulted in an increase in the income for the government. As income exceeded consumption, this led to an increase in public saving (Yang et al. (2011)).

In 2010 the gross savings rate ("Other") started to decrease, and in 2015 it was at 20 percent of GDP, see figure 2.11. This was a fall equal to 12 percent compared to the level 8 years earlier. Weaker global demand reduced export revenues, and thereby the public income. In addition, the government expenditure is expected to increase following the plan to strengthen the social safety net and increase household consumption. As a result, the decrease in income and increase in public expenditures can explain a lot of the trend we are seeing with a decreasing national savings rate.

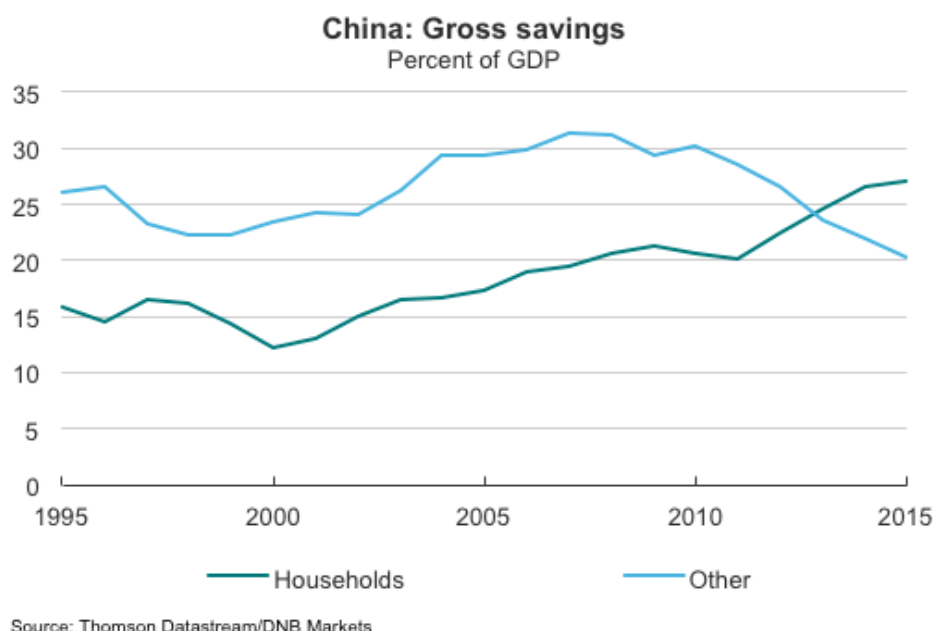


Figure 2.11 – Gross saving as a percent of GDP.

China's savings rate has however not always been high, especially not private saving. From 1955 to 1977 the household savings rate in China had an average of around 5 percent of dispos-

able income. Over the last decades, the savings rate has increased rapidly, which coincided with the nation's demographic transition, then especially the introduction of the one-child policy by Mao in 1980. Fewer children per household meant that Chinese households could save more of their income. In addition, a poor pension system and fewer children to depend on meant that people had to save more in order to maintain a certain consumption level after retirement (Curtis et al. (2015a)). As a result, the household savings rate has more than doubled since the beginning of the year 2000, as illustrated in figure 2.12. This is also the trend when we look at household savings as a percent of GDP. In 2015 households saved around 27 percent of GDP, compared to approximately 16 percent in 1995 (DNB Markets).

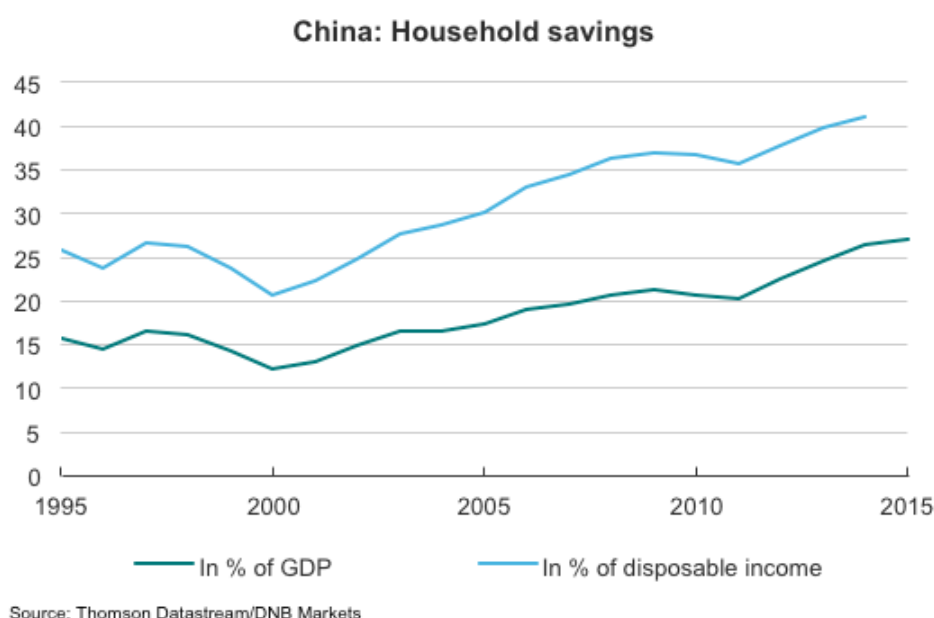


Figure 2.12 – Households saving as a percent of disposable income and GDP.

According to the International Monetary Fund (2016a) we are now seeing a change in the household savings rate in China. The rate is expected to fall in the years to come, see figure 2.13. The change is especially due to the rapid aging of the population, along with pro-consumption reforms. A planned strengthening of the social safety net, especially by higher government spending on health care, is expected to reduce precautionary saving motives, and thereby further reduce the household savings rate. In effect, the household savings rate is expected to fall from almost 25 percent of GDP in 2015 to 20.5 percent in 2021. With the recent lift of the one-child policy, this could further on reduce the savings rate, depending on the effect

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on the fertility rate. If the fertility rate increases, individuals might not need to save as much since they can depend on one more child when they grow older, in addition to increased spending due to one more child in the household. In the longer term, an increase in the fertility rate might signify a slower decrease in the number of workers per elderly (International Monetary Fund (2016a)).

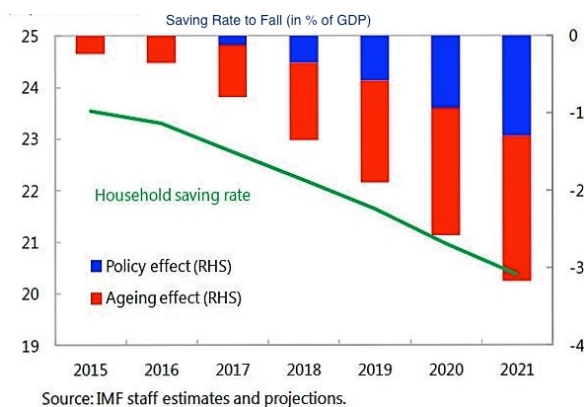


Figure 2.13 – The expected fall in the Chinese household savings rate (2015-2021), due to aging and changes in policy. Source: International Monetary Fund (2016a).

Household consumption, as a percentage of GDP, has decreased slightly during the last 20 years, see figure 2.14. The figure illustrates the relationship between household consumption and saving, as a percentage of GDP. We can see that the composition of saving and consumption has changed during this time period, with a slow decrease in consumption and an increase in net saving (DNB Markets). This development helps explain the increase in the personal savings rate.

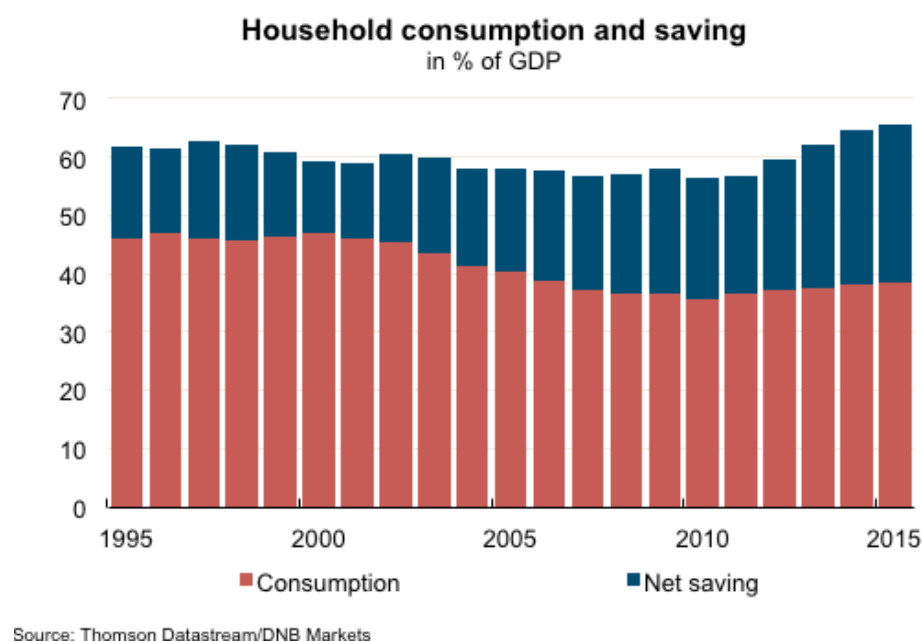


Figure 2.14 – Household consumption and net saving as percentage of GDP.

However, the total Chinese consumption expenditure level has increased a lot over the last decades. Since 2000 the consumption level has increased by over 229 percent, or from 1.322 trillion USD (in constant 2010 USD) to 4.345 trillion in 2015 (World Bank). The high aggregate consumption level in China the last decade might be explained by a stimulus package of 585 billion USD that The State Council unveiled in 2008 in order to reduce the impact of the financial crisis (Economics (2016)). This increased public expenditure might further help explain the decrease in the gross national savings rate from 2010.

2.3 Japan

Figure 2.15 illustrates that Japan had a higher savings rate than investment rate, as a percentage of GDP, from 1990 to around 2015. In 2015 the gross national savings rate was at 21.6 percent of the nation's GDP, while the gross capital formation rate was at 21.4 percent. For 2016 the savings rate is projected to be around the same level, while the investment rate is predicted to exceed 22 percent of GDP. The forecast up to 2030 is that the investment rate will continue to increase to around 25 percent, while the savings rate will decline to just over 20 percent. After this, we see that the investment rate will start to decline while the savings rate will remain

CHAPTER 2. GLOBAL SAVING

relatively stable. From 2045 to 2060, the projection shows that the savings rate will exceed the investment rate. It is also worth noticing that both the investment and savings rate have declined significantly since a peak around 1990 when both rates, as a percentage of GDP, exceeded 32 percent.

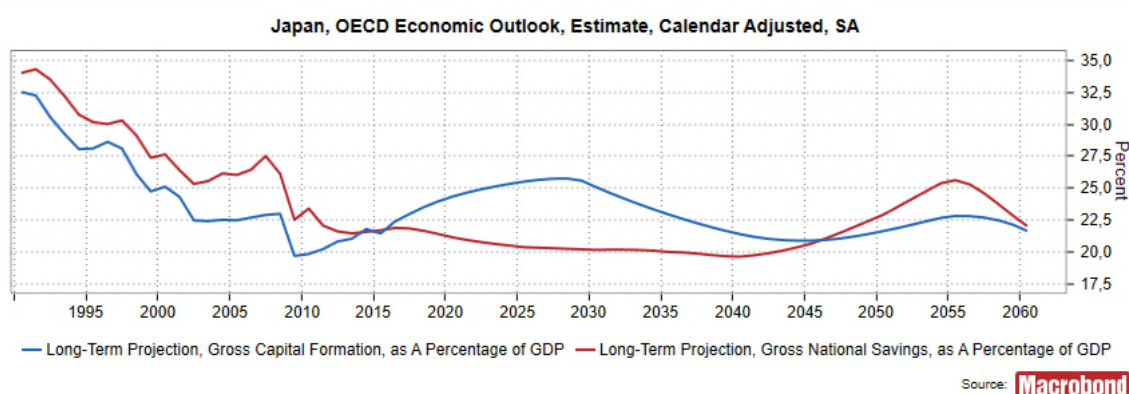


Figure 2.15 – The relationship between Japan’s long-term gross capital formation and gross national savings rate, as a percentage of GDP (1990-2060).

Japan’s current account surplus has fluctuated between approximately 0.8 and 4.8 percent of its GDP during the last two decades. At its highest level in 2007, the current account surplus was 4.86 percent of GDP, and the trade surplus was 1 trillion JPY. From 2014 to 2015 the current account surplus increased significantly with over 2.5 percentage points. The trade balance, however, was negative from 2011 and up to 2015, with the lowest value in 2014 at minus 2 trillion JPY. In 2015, the trade balance was at approximately zero, while the current account surplus rose to 3.29 percent of the nation’s GDP (World Bank). In other words, earnings from investments abroad helped Japan from delivering a current account deficit.

Japan has a huge gross general government debt. By the end of 2015, this amounted to roughly 248 percent of the nation’s GDP. In comparison, the US had a government debt equal to 125.8 percent of GDP. In fact, Japan’s debt-to-GDP ratio is over twice the OECD-wide average, and by far the highest in the developed world (Horioka et al. (2014)). An important reason behind the large public debt is the country’s demographic developments. The population has been, and is still, aging quickly. This age effect has increased public expenditure for health care and pension benefits. Further on, a reason for why the high debt level has been sustainable is that around 90 percent of the debt is held by its residents, largely due to home bias and a large

amount of private saving (International Monetary Fund (2016b)). In other words, domestic savers absorb most of the government debt. Thus, compared to many other countries with high debt levels, Japan does not have to rely on foreign investors.

From figure 2.16, we see that the gross national savings rate, as a percentage of the nation's GDP, was around 21 percent in 2015 and the gross private savings rate was at 25 percent. In other words, the public savings rate dragged down the national savings rate, meaning that the gross public savings rate has been negative. Up to around 2000, the situation was, however, opposite, but after the financial crisis, the public savings rate decreased. What is also worth noticing from the graph is that the private savings rate increased sharply after the financial crisis, but after 2011 the gross private savings rate has decreased significantly. From a peak of around 28 percent in 2011, the private savings rate is expected to fall to around 21 percent in 2030. From 2034, the projection shows that gross national saving will exceed gross private saving.

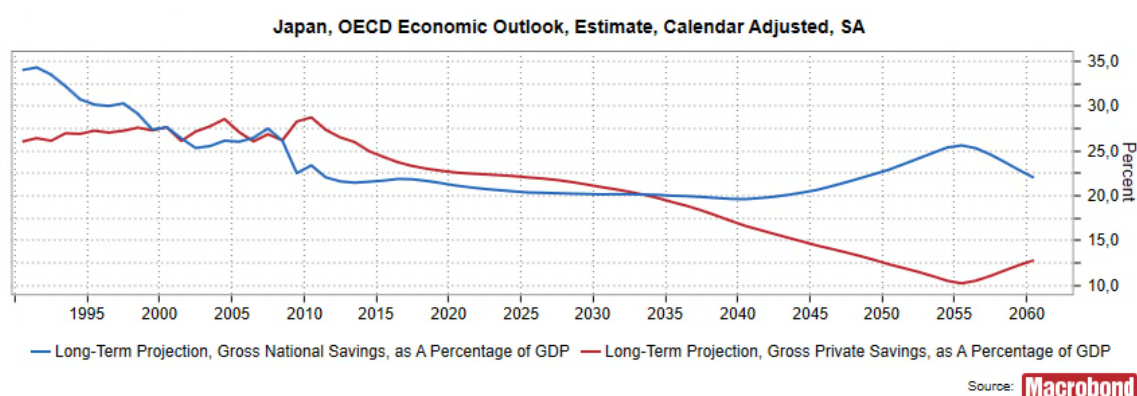


Figure 2.16 – Gross national and private saving as a percentage of GDP (1990-2030).

As mentioned above, there is a large heterogeneity within the country when it comes to the public and private saving pattern. While the public savings rate is very low, this is corrected for by high private saving. The predicted trend for the future is a decrease in the household savings rate. This can especially be explained by the increasing number of retirees in the country. With 28 percent of the population in the age group above 63 years, Japan has the oldest population in the world. As a larger part of the population got older, the aggregate household's savings rate started to decline from its peaks in the 1970s and 1980s at approximately 23 percent of disposable income. The largest decline happened after 2000 when the population aged quickly,

and in 2012, Japanese households saved less than 5 percent of their disposable income (Curtis et al. (2015b)).

2.4 Mexico

Mexico’s gross capital formation and national savings rate, as a percentage of the nation’s GDP, have followed each other relatively closely from 1995 and up to 2016. From 1997 and up to 2015 the country has had a higher investment rate than savings rate. In 2015 both rates were roughly 20 percent of GDP, as shown in figure 2.17. However, this trend is predicted to change after 2016 when the savings rate is expected to start exceeding the investment rate. This is due to a sharp fall in the investment rate, to 12.5 percent in 2025. In comparison, the national savings rate is projected to modestly decline to roughly 20 percent in 2025. However, after 2039 the nation’s capital formation rate is projected to exceed its national savings rate. In other words, from 2016 to roughly 2039 we can expect to see a current account surplus, but after this and at least until 2060 we can expect that the country will again experience a current account deficit.

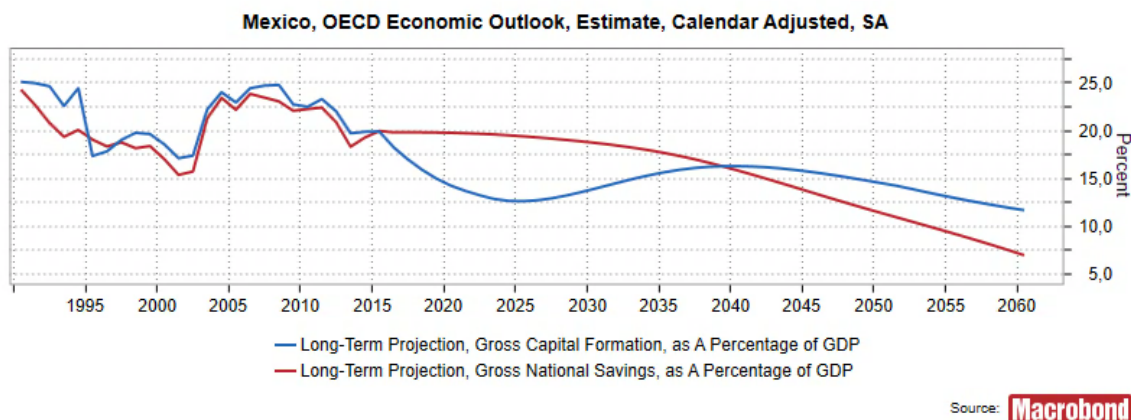


Figure 2.17 – The relationship between Mexico’s long-term gross capital formation and national saving, as a percentage of GDP (1990-2060).

Mexico has had a current account deficit since 1988. It reached the bottom at 5.64 percent of the nation’s GDP in 1994. The deficit then started to decrease, and from 1995 and up to today, the current account deficit has fluctuated around 1 to 3 percent of GDP. In comparison, the nation’s trade balance has remained around zero during the last twenty years. However,

the total export and import value has increased greatly from around 5 billion USD to approximately 35 billion USD during the same time period. In 2015 the current account deficit was at 2.83 percent (Macrobond). This deficit mainly reflects the difference between the national saving and investment rate, since the trade balance has been roughly around zero (Ghosh and Ramakrishnan (2012)).

A possible explanation for the decline in the savings rate since 2008 might be that Mexico experienced a decline in export revenues after the financial crisis. The US is a large export country for Mexico, and as the financial crisis hit the American economy, this affected the Mexican economy as well (Sidaoui et al. (2010)). Also, the net household saving, as a percentage of net disposable income, has decreased continuously from 8.1 percent in 2008 to 5.4 percent in 2013, see figure 2.18. This is presumably an effect of the financial crisis as the export sector is a big part of the Mexican economy, and thus a lot of people work within this sector.

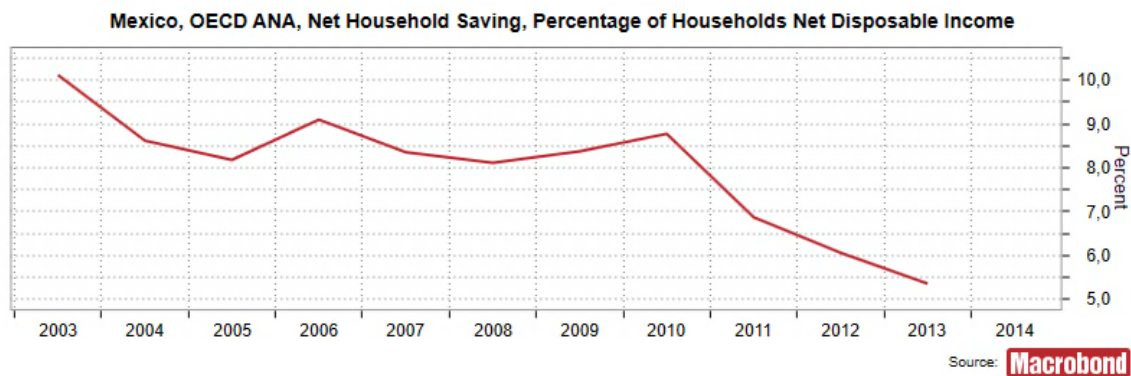


Figure 2.18 – Mexico’s net household saving, as a percentage of net disposable income (2003-2013).

Regarding the aggregated saving for Mexico, this is estimated to increase up to 2025, which is mainly due to the entry of a large number of skilled workers into the workforce. More people of working age and with a higher level of education will increase income, and thereby household savings rates. The share of the working-age population will reach a peak in 2025, and the following decrease will lead to a decrease in the nation’s aggregated saving (The World Bank (2013)). This demographic change implies that Mexico will experience that a larger share of their population will be above retirement age in the decades to come. Mexico is, therefore, lagging behind in the demographic development of an older population compared to many developed countries, and might therefore not experience the same immediate decline in their national savings rate as the US, China, and Japan.

2.5 Summary of chapter 2

From looking deeper into the development of the saving patterns in the US, China, Japan, and Mexico, we can see a common trend of a projected decline in their national savings rate. For Japan, their national savings rate has declined significantly over the last decade, especially due to the aging of their population. China stands out with a remarkable high savings rate over the last decades, but this is also projected to fall due to planned strengthening of social safety net and pro-consumption reforms. In addition, as a result of their family planning policies their population is aging quickly, which will possibly further reduce their private savings rate. In comparison, Mexico has a younger population and is therefore not facing the same demographic challenges. The long-term forecast for Mexico is however that their national savings rate will decline.

Both China and Japan have today current account surpluses, while the US and Mexico are experiencing deficits. However, the forecast up to 2030 is that Mexico will experience a current account surplus, while Japan will possibly experience a deficit as their population keeps aging. Further ahead, at the end of the 2050s, China might experience a current account deficit, while the US may have a current account surplus. Japan, however, will again experience a surplus after 2046, and Mexico a current account deficit yet again around 2039.

3. Saving and demographic developments

Further on, the thesis will zoom in on the US and China, and look deeper into the two countries' saving and demographic developments.

OECD has made projections for various countries regarding changes in their national savings rates, as a percentage of GDP, for the period from 2016 to 2030, see figure 3.1. The three different bars in the figure identify the most important contributors to changes in the total savings rate ¹. The bar for China shows that the total savings rate will decline with roughly 9 percent of their GDP during this time period. Two of the contributors for this negative development are the extension of the social welfare system, along with an increasing old-age dependency ratio ². An increasing old-age dependency signifies that a larger share of the population does not earn an income, and thus rather consume of the savings they accumulated while they were in the workforce. The improvement in the social safety net, especially public health provision, might further reduce national saving. The bar for the US shows that changes in their total savings rate will be close to non-existent. An important reason is that an increase in public saving will exceed the decrease in saving following an increase in their old-age dependency ratio (OECD (2015)).

¹However, the bars do not sum up to the "Total" because there are smaller contributors from other factors that are not explicitly included.

² $Old-Age\ Dependency\ Ratio = \frac{(number\ of\ people\ aged\ 65\ and\ above)}{(number\ of\ people\ aged\ 15-64)} \cdot 100$

CHAPTER 3. SAVING AND DEMOGRAPHIC DEVELOPMENTS

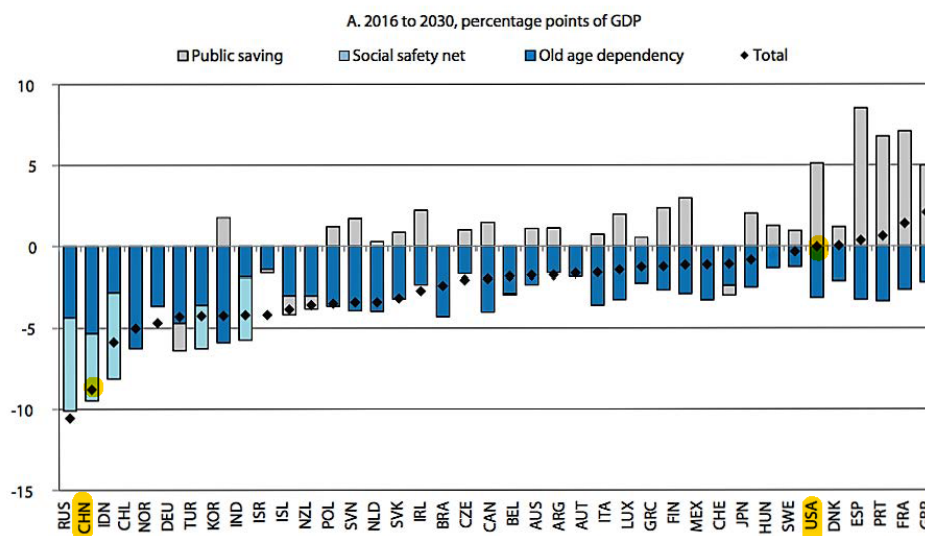


Figure 3.1 – Changes in total savings rate (2016-2030). Source: OECD (2015).

From the projections in figure 3.1, we can see that increasing old-age dependency ratios will have a negative effect on all the included countries' total savings rate (OECD (2015)). Figure 3.2 displays a graph for old-age dependency ratios for various countries for 2010 and 2050. Among the observations is that all the included countries and the world in total will experience an increased old-age dependency ratio from 2010 to 2050. Looking closer at the US and China we see that in 2010 the old-age dependency ratio was higher in the US compared to China, and also the world average. However, the forecast for 2050 shows that China will have an older population than both the US and the average in the world. From 2010 to 2050, China will according to the forecast go from having a share of people above 65 years at 11.6 percent of its labor force, to 38.8 percent (The Economist (2009)). In other words, a change in the population dynamic in both countries can have a negative effect on the national savings rates, and thereby possibly reduce the global saving glut.

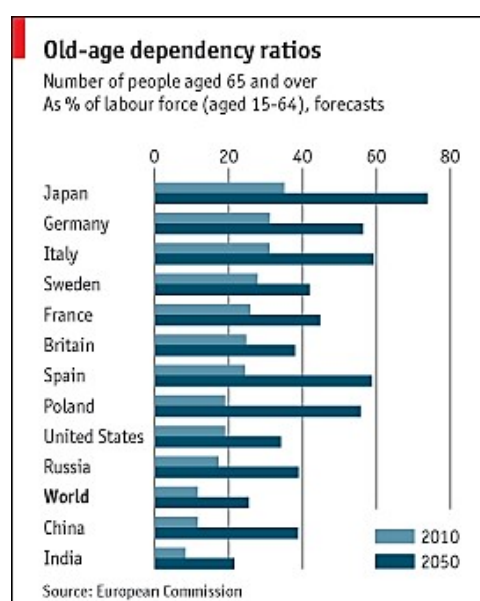


Figure 3.2 – Old-age dependency ratios for various countries in 2010 and 2050. Source: The Economist (2009).

3.1 The US

Today the US' population grows with roughly 0.7 percent per year. However, this annual growth rate is much lower than it was in the 1960s. The largest decline took place in the time period from 1960 to 1969 when the annual population growth went from 1.7 percent to 0.97 percent. After a small peak in the 1970s, the annual growth rate remained quite stable to the end of the 1980s, before a new peak in 1992 at 1.3 percent. From 1992 the annual growth has kept declining to today's level (Shrestha and Heisler (2011)).

The population growth is closely related to the fertility rate and longevity. The fertility rate has been declining over the last decades, while at the same time the longevity has increased. The fertility rate in the US dropped from 3.4 births per woman in the 1950s to 1.8 in the 1970s. From the beginning of the 1990s, it started to rise until 2009 when it peaked at 2.1. After this, the fertility rate has again decreased and is today at 1.88 births per women (Curtis et al. (2015a)). Compared to many western countries the fertility rate in the US is relatively high, but compared to the rest of the world it is lower³ (World Bank).

³In the European Union the fertility rate is 1.6 children per women, and in the world the rate is 2.45 children per women (World Bank).

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The US had a very high population growth in the 1950s due to a baby boom after World War II. After this period the fertility rate declined, and as a result also the annual population growth. The growth rate increased again as the baby boom generation's children were born during the 1970s. This baby boom generation is highly affecting the demographic pattern and changes in the US. In 2015 the old-age dependency ratio was at 22.3 percent, and the percentage of the population aged 65 years and above is predicted to keep increasing along with a low fertility rate (World Bank).

Figure 3.3 and 3.4 display the age pyramid for 2016, and a forecast for 2030. The pyramid in figure 3.3 clearly illustrates the baby boom generation in the age group around 50-60 years. This generation's children is shown in the next large "bulk" in the pyramid, the age groups for those in their 20s and 30s. If we look at the predictions for 2030, the fertility rate has decreased, and we can see a trend of an aging population. An additional reason for this trend is that the mortality risk has decreased along with an increase in life expectancy (Shrestha and Heisler (2011)). This is illustrated by an upward shift of the age group bars, and thereby a larger weight on the top of the pyramid. However, the shifts from 2016 to 2030 are rather smooth. From the pyramids, we see that the main difference is that in 2030, a larger proportion of the population is above retirement age.

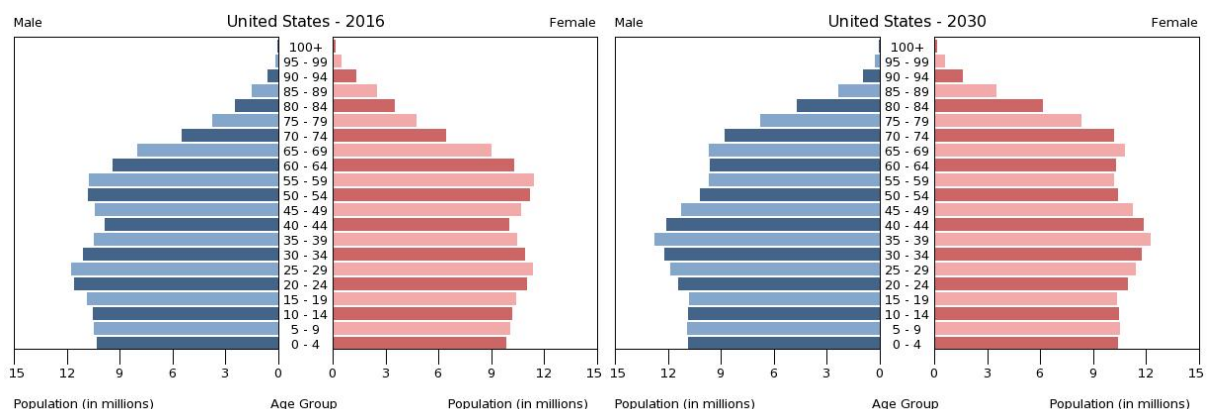


Figure 3.3 – Population pyramid graph for the US in 2016. Source: United States Census Bureau.

Figure 3.4 – Population pyramid graph for the US in 2030. Source: United States Census Bureau.

The changes in the demographic pattern will possibly affect the national saving and investment rate significantly. As a higher fraction of the population grows older, this reduces the number

of workers. It follows that the aggregate production level will also decrease ⁴, and thereby both public and aggregate private income. How much individuals prefer to save while they are working also depends on the pension system in the respective country. As there are fewer people in the workforce to pay taxes to social welfare, this might signify that both taxes and public expenditures have to increase in order to take care of an increasingly aging population.

The US has a "Pay-As-You-Go" (PAYGO) pension system, where the taxes paid by the working population will have to finance the pension benefits for the elderly at all times. If there is an increase in the total tax base from an increase in the workforce and/or in the productivity, this will lead to a fall in the necessary tax rate needed to finance the pension benefits. However, with the tendency of an increase in the old-age dependency ratio, one way to finance this is to increase the tax rate paid by workers. This is true if an increase in the productivity does not outweigh this tendency (OECD (2015)). In other words, without an increase in tax base, productivity and/or public expenditures, the current social welfare system cannot be expected to stay as generous.

The increasing old-age dependency ratio might lead to uncertainty when it comes to future social welfare systems, such as pension benefits. Due to uncertainty about the future, this might encourage precautionary saving, which will affect the saving pattern. According to the life-cycle hypothesis, the present value of lifetime income equals the present value of lifetime consumption. This implies that people would need to save more of their income while working in order to maintain a smooth consumption path during their whole lifetime. In light of the LCH, the result will be a change in the saving pattern, with an increase in the household savings rate by people in the workforce.

The individuals in the workforce are the ones who save a part of their income, and those who are retired consume of their accumulated wealth instead of actually saving. With a smaller proportion of the population in employment relatively to the number of retirees, this will affect the gross national savings rate negatively. This differs from what we discussed above, as we are now talking about the total amount of national savings. While the savings rate for people of working age will possibly increase, we can see that for the nation as a whole the savings rate will decrease. From figure 3.5 we can see the projections up to 2060 for the US' old-age

⁴Given a constant productivity level.

dependency ratio, along with the nation’s expected gross national savings rate as a percentage of GDP. Along with an increasing old-age dependency ratio, we can also see a slowly decreasing gross national savings rate. This can be a result of both a larger proportion of the population not saving, but rather dissaving, and increased public expenditures for health care and pension benefits, which leads to lower public saving.

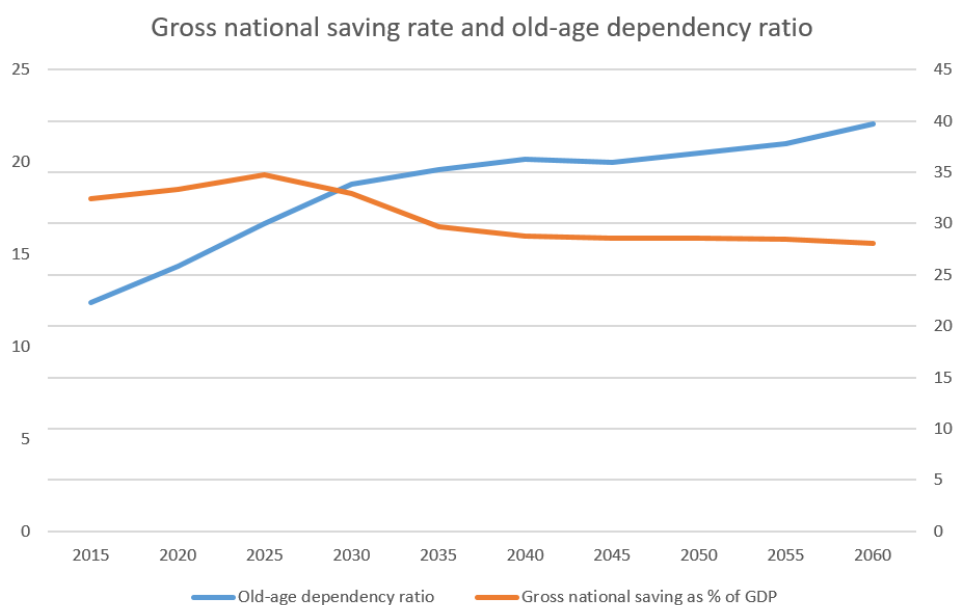


Figure 3.5 – The relationship between an increasing old-age dependency ratio and a decreasing gross national savings rate, as percentage of GDP (2015-2060). Source: Knoema and Macrobond (2016).

3.2 China

The long-term projections of the real interest rate and savings rates are especially sensitive to the development in a high saving country like China ⁵. The rapid change in the aging of their population will most likely lead to an increase in the real interest rate due to a projected decrease in the national savings rate (OECD (2015)). Since 1980 and up to 2010 the old-age dependency ratio in China decreased significantly, while it has since then started to increase (World Bank).

The fertility rate in China has decreased over the last decades, and the largest fall took place

⁵China and India account for more than one-third of the global saving (OECD (2015)).

between 1950 and 1975, following family planning policies. In this time period, the fertility rate dropped from 6.1 children per women to 2.9. After the 1970s it kept falling, but from 1990 to 2009 the rate has been stable at around 1.8 children per woman. Today it is on an even lower level, at 1.66 (Curtis et al. (2011)). How the fertility rate will evolve in the years to come can be affected by the removal of the one-child policy last year.

The projected developments in the demographic structure for 2016 and 2030 in China are illustrated by respectively figure 3.6 and 3.7. We can see a clear decrease in the proportion of young people from 2016 to 2030. In 2030 there will be a much smaller share of the population within the age group 20-30. The majority of the population will be around 50-60 years, which is around the time when an average Chinese retire. A larger weight on top of the pyramid in 2030 signifies an increasing old-age dependency ratio. We can also see an increased life expectancy in the population, illustrated by longer bars at the top of the pyramid.

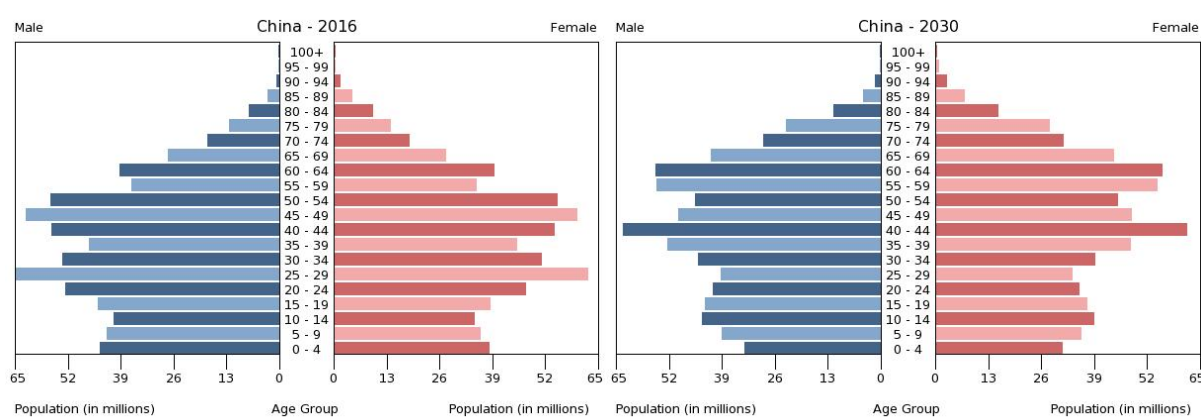


Figure 3.6 – Population pyramid graph for China in 2016. Source: United States Census Bureau.

Figure 3.7 – Population pyramid graph for China in 2030. Source: United States Census Bureau.

There is a nation-wide basic pension system outlined by the Chinese government, and this consists of three pillars. The first pillar is based on the National Social Security Fund (NSSF) and contains an individual account as well as a PAYGO system, which are totally financed by the employees. Pillar 2 is based on voluntary contribution either from the employers or a mix between the employees and the company. This is a supplementary pension system. Finally, pillar 3 is a complementary private savings account which contains only private saving (Salditt et al. (2007)).

Around half of China's population live in rural areas, and the majority here is not covered by a

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pension system. In urban areas, more people have access to a pension system, but this covers mostly those who work in the government, SOEs, and large, private companies. The lack of a good pension system for a large majority of the population signifies that 70 percent of the elderly are dependent on financial help from their family. This problem has been called the 4:2:1 problem, which means that a couple has responsibility for four parents, as well as one child. In order to reduce this burden, the government encouraged people to privately save more (Hesketh et al. (2005)).

Modigliani and Cao (2004) state in their article that due to Chinese cultural tradition, a child is an effective substitute for life-cycle saving. The logic behind this is that in China, the younger members of the family are supposed to care for the elderly, while the elderly in return leave bequests for their children. Along with the rapid decrease in the fertility rate, the savings rate also increased, which could be explained as a substitute for fewer children that could take care of the elderly. In other words, the working part of the population saves both for themselves as well as for leaving bequests for their children. This can be looked at as a way to pay back their children for taking care of them. This can, therefore, be a reason for why we have seen such a high savings rate in China.

The Chinese government aims to make the pension system more generous. In February 2014, the State Council announced plans to connect rural and urban pension systems into one pool. New reforms in 2015 and 2016 include that basic investment funds will invest in stocks, a decrease in businesses' social insurance contribution rates, and a plan to delay the retirement age (China Policy (2016)). This might result in a decrease in the personal savings rate, following an increase in the present value of future income from improved pension benefits.

Figure 3.8, shows how the old-age dependency ratio is predicted to increase up to 2060. The ratio is predicted to go from around 10 percent to over 60 percent in 2060. At the same time the gross national savings rate, as a percentage of GDP, is expected to decrease from a level at around 47 percent to approximately 22 percent in 2060. As mentioned, the young part of the population is becoming a smaller share of the total population, relatively to the number of elderly. This is resulting in fewer people saving, and as a result, the national savings rate is forecasted to decrease. However, if the fertility rate increases as a result of the removal of the one-child policy, the old-age dependency ratio in the longer-term will probably not be as high

as predicted.

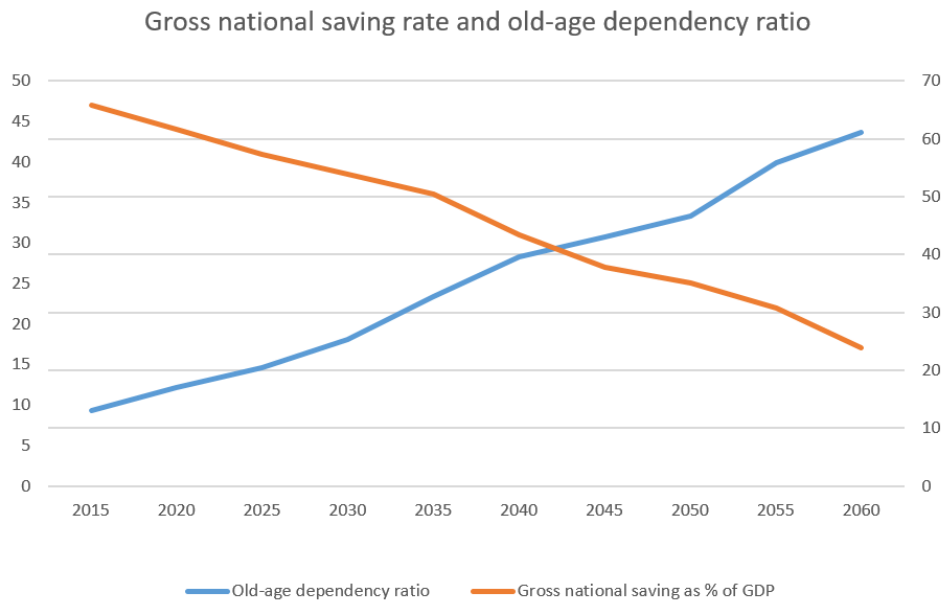


Figure 3.8 – The relationship between an increasing old-age dependency ratio and decreasing gross national savings rate as percentage of GDP (2015-2060). Source: Knoema and Macrobond.

3.3 Summary of chapter 3

A deeper insight into the saving and demographic pattern in China and the US showed that the US today has a higher old-age dependency ratio and a lower household savings rate than China. However, as a result of family planning policies in the 1970s, China is now experiencing a rapidly aging population. Estimates show that in 2050 China's population will be relatively older than the American population. Following this, we also see a trend towards a sharper decline in China's national savings rate.

The US has a relatively more generous pension system than China, especially due to the fact that it covers a larger proportion of their population. In China, there are large differences, where the rural population has almost non-existent pension benefits. In light of the LCH theory, this can be an explanation as to why the household savings rate has been so high in China compared to the US, as well as other advanced economies. Further on, a potential strengthening of the pension system in China could lead to a reduction in private saving. In the US we also see a

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trend towards an aging population and decreasing national savings rate, but neither of these two seems to be decreasing as rapidly as those of China.

4. Life-cycle hypothesis

The life-cycle hypothesis (LCH) by Franco Modigliani explains individuals' saving and consumption decisions over the course of their lifetime. We will use this model in order to look more into individuals' saving and consumption patterns.

4.1 Basic model

LCH suggests that saving is a way to obtain the preferred consumption path over individuals' life-cycles. If we consider a model where individuals live for three periods, the intertemporal budget constraint can be expressed by equation 4.1. We are here assuming well-functioning credit markets so that individuals can borrow and save in order to smooth their consumption path over their life-cycle

$$w_1(1 - \tau) + \frac{w_2(1 - \tau)}{1 + r} + \frac{R}{(1 + r)^2} + b_0(1 + r) = c_1 + \frac{c_2}{1 + r} + \frac{c_3}{(1 + r)^2} + \frac{b_3}{(1 + r)^2} \quad (4.1)$$

Here w is labor income, τ tax rate paid on income, R the pension benefit¹, c consumption, b_0 initial wealth and b_3 bequests left for future generations. From equation 4.1 we see that the present value of lifetime income and initial wealth equals the present value of lifetime spending.

Further on, individuals have different preferences for consumption in the three different time periods. Individuals wish to maximize their utility for all three time periods, see equation below

$$\text{Max} \quad u(c_1) + \frac{1}{1 + \rho} u(c_2) + \frac{1}{(1 + \rho)^2} u(c_3) \quad (4.2)$$

This lifetime utility function is strictly concave, with $u' > 0$ and $u'' < 0$, so that the marginal utility is positive but diminishing. The subjective discount factor $\frac{1}{(1 + \rho)}$ measures each individ-

¹We are here assuming that pensioners do not pay any taxes on their pension benefit.

CHAPTER 4. LIFE-CYCLE HYPOTHESIS

ual's degree of impatience, and we assume that the rate of time preferences $\rho > 0$. Consumers wish to maximize their utility function, subject to the intertemporal budget constraint expressed in equation 4.1. This maximization problem can be solved by the Lagrange method

$$L = u(c_1) + \frac{1}{1+\rho}u(c_2) + \frac{1}{(1+\rho)^2}u(c_3) - \lambda \left[c_1 + \frac{1}{1+r}c_2 + \frac{1}{(1+r)^2}c_3 + \frac{1}{(1+r)^2}b_3 - b_0(1+r) - w_1(1-\tau) - \frac{1}{1+r}w_2(1-\tau) - \frac{1}{(1+r)^2}R \right] \quad (4.3)$$

The first-order conditions for the maximization problem for c_1 , c_2 and c_3 are

$$\frac{\partial L}{\partial C_1} = u'(c_1) - \lambda = 0 \quad (4.4)$$

$$\frac{\partial L}{\partial C_2} = \frac{1}{1+\rho}u'(c_2) - \lambda \frac{1}{1+r} = 0 \quad (4.5)$$

$$\frac{\partial L}{\partial C_3} = \frac{1}{(1+\rho)^2}u'(c_3) - \lambda \frac{1}{(1+r)^2} = 0 \quad (4.6)$$

If we combine these equations, we get an extended Euler equation, which is expressed in 4.7. The Euler equation illustrates that the marginal rate of substitution between consuming today or in any of the two following time periods must be equal to the marginal rate of transformation

$$u'(c_1) = \frac{1+r}{1+\rho}u'(c_2) = \frac{(1+r)^2}{(1+\rho)^2}u'(c_3) \quad (4.7)$$

If we assume that $r = \rho$, then $u'(c_1) = u'(c_2) = u'(c_3)$, which in turn implies that $c_1 = c_2 = c_3 = C$. Moreover, if $r > \rho$, the consumption path would be increasing, and vice versa. In other words, as long as $r = \rho$, the model predicts that individuals will have a perfectly flat consumption path over their life-cycle. We can thereby re-write the intertemporal budget constraint from 4.1

$$\sum_{t=1}^3 \frac{1}{(1+r)^{t-1}}C = w_1(1-\tau) + \frac{1}{1+r}w_2(1-\tau) + \frac{1}{(1+r)^2}R + b_0(1+r) - \frac{1}{(1+r)^2}b_3 \quad (4.8)$$

Using the formula for a finite geometric series: $1 + a + a^2 + \dots + a^T = \frac{(a-1)}{a^T-1}$ when $a \neq 1$, we obtain

$$C \left[\frac{\left(\frac{1}{1+r}\right)^T - 1}{\left(\frac{1}{1+r}\right) - 1} \right] = w_1(1 - \tau) + \frac{1}{1+r} w_2(1 - \tau) + \frac{1}{(1+r)^2} R + b_0(1+r) - \frac{1}{(1+r)^2} b_3 \quad (4.9)$$

$$C = \left(\frac{r^2 + 2r + 1}{r^2 + 3r + 3} \right) \left[w_1(1 - \tau) + \frac{1}{1+r} w_2(1 - \tau) + \frac{1}{(1+r)^2} R + b_0(1+r) - \frac{1}{(1+r)^2} b_3 \right] \quad (4.10)$$

Consumption can, therefore, be determined as an annuity value that is consumed in each of the three times periods. Intuitively, we see that if the interest rates $r = 0$, individuals will consume one-third of the present value of their income in each of the three time periods.

From equation 4.10 we see than an increase in the tax rate, everything else held equal, will reduce lifetime income, and thus reduce the consumption. A decrease in tax rate, on the other hand, will increase consumption. Looking at the retirement benefit, an increase in R , everything else held equal, leads to an increase in consumption. The opposite is true if the pension benefit decreases, or if there is no pension benefit. This will lead to a decrease in the consumption path, possibly because individuals will need to save more in order to finance their retirement.

An important implication of the model is that consumption responds relatively little to temporary changes in income, but proportionally to permanent changes. In addition, the marginal propensity to consume out of current income depends on age (Doppelhofer (2009)). In other words, when talking about the aggregate national saving level, the demographic pattern will possibly have an important effect on a nation's saving pattern. If a country has a large proportion of its population in the saving stage of life, this will contribute to an increase in aggregate private saving. Reverse, with an increasing old-age dependency ratio more people will be in their dissaving stage of life, and thereby push the aggregate saving level down.

We can make a numerical example in order to illustrate equation 4.10. We will first look at a country, for example, the US with a well-functioning pension system before looking at a country with a poor or non-existent pension system, such as China.

$$\left\{ \begin{array}{lll} w_1(1 - \tau) = 30 & w_2(1 - \tau) = 100 & R=40 \\ r=0.10 & b_0 = 5 & b_3 = 10 \end{array} \right\}$$

From calculating the numbers above into equation 4.10, we find that the optimal consumption path is a consumption equal to roughly 55.27 per year (can look at this as in thousand USD). Further on, we can then solve for the amount of saving in the different time periods ².

$$\left\{ \begin{array}{l} s_1 = 30 - 55.27 + 5 \cdot 1.10 \approx -19.77 \\ s_2 = 100 - 55.27 + (-19.77) \cdot 1.10 \approx 22.97 \\ s_3 = 40 - 55.27 - 10 + 22.97 \cdot 1.10 = 0 \end{array} \right\}$$

From the example, we see that the individual has a hump-shaped income profile over her life-cycle and that she has a negative saving in the first time period, while $s_2 > 0$. It follows by the endogenous saving profile that the individual pays back the loan she took up in the first time period, at a rate of 10 percent. In the last period, the individual is using her accumulated wealth. Without the use of savings from period 2, the individual would have a negative wealth of 25 273 USD. In other words, in order to keep a smooth consumption path the individual takes use of the well-functioning credit market and both borrows and saves in order to have a consumption of roughly 55 270 USD annually over her life-cycle. This relationship is illustrated in figure 4.1, where the green area shows how much individuals save while working, while the pink areas represent when the young borrows money and the older generation dissaves after retiring.

²Here $s_1 = w_1 - c + b_0(1 + r)$, $s_2 = w_2 - c + s_1(1 + r)$ and $b_3^* = R - c - b_3 + s_2(1 + r)$

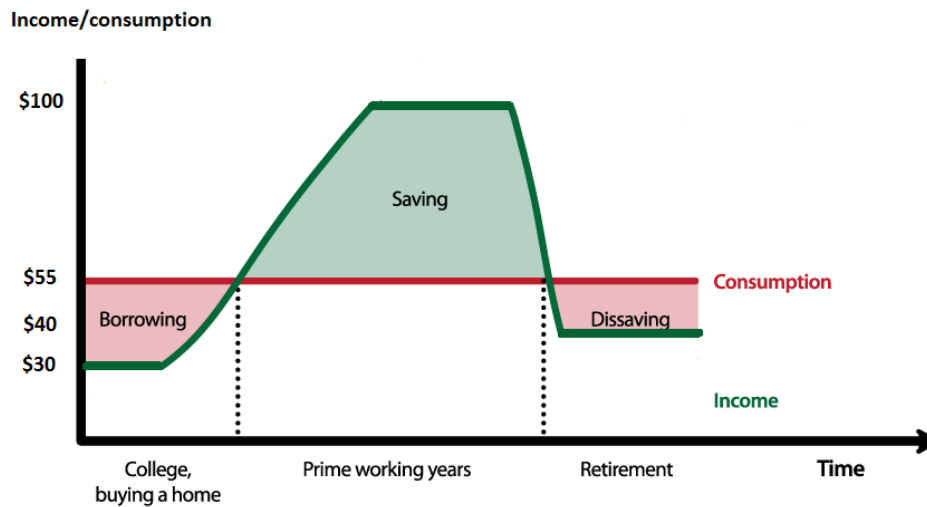


Figure 4.1 – The life-cycle income profile and consumption path for individuals with pension benefits.

In China, a large share of the population is not covered by a formal pension system. It is, therefore, interesting to look at what effect this can have on both the consumption path and the saving pattern for the average Chinese. If we use the same number as in the example above, but set $R = 0$, we get that the annual consumption is roughly 43 180 USD. This gives us the following solutions for s_1 , s_2 and s_3 .

$$\left\{ \begin{array}{l} s_1 = 30 - 43.18 + 5 \cdot 1.10 \approx -7.69 \\ s_2 = 100 - 43.188 + (-7.69) \cdot 1.10 \approx 48.35 \\ s_3 = 0 - 43.18 - 10 + 48.35 \cdot 1.10 = 0 \end{array} \right\}$$

From the example above we see that individuals without pensions benefits have a lower consumption path, due to a lower present value of lifetime income. As a result, the amount borrowed is less than one-fourth of the amount if one expects to receive pension benefits. Further on, this leads to higher saving when the individual is working. These results are illustrated in figure 4.2 below. We see that individuals now have no income after retiring, and thereby saves more while working so that they can maintain a smooth consumption path over their life-cycle.

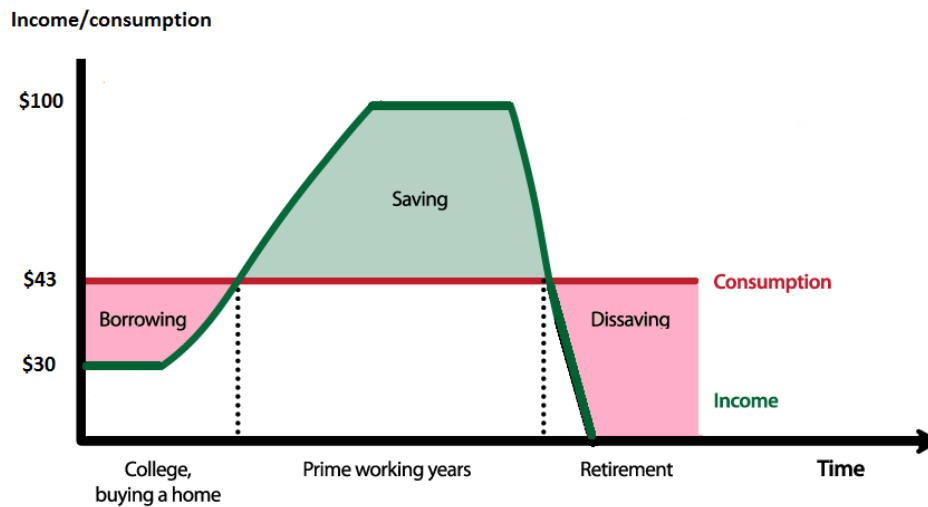


Figure 4.2 – The life-cycle income profile and consumption path for individuals without pension benefits.

These results can help explain the differences we are seeing between China and the US. Due to a lack of a generous social safety net in China, the population is dependent on their own savings in order to maintain the consumption path. However, it is important to notice that wages in the US and China are far from equal, but the example does illustrate that a less generous pension system increases saving. In our example, Chinese would save over double the amount as the Americans in order to take care of themselves after they retire.

In order to take zoom in on the effect of a pension system on saving decisions, we will further on use a two-period model. For two periods the individual will have a present lifetime income equal to: $w_1(1 - \tau) + \frac{1}{(1+r)}R$.

We can consider a pension system where workers will pay a social security tax rate (τ) of their labor income (w) while working, and later receive a pension benefit equal to R . We here assume that the government's only costs are associated with pension payments so that the taxes paid in by the workers only go to cover these. N_t is the size of the young and working population, while N_{t-1} is the old and retired part of the population. We therefore get the relationship $N_t = (1 + n)N_{t-1}$, and that the population grows with the constant rate of n . Further on, we assume that wages increase from one time period to the next with a constant productivity rate λ . As a result $w_t = (1 + \lambda)w_{t-1}$.

We assume that individuals' pension benefit are determined by a certain compensation rate θ

out of the wage they had before they retired w_{t-1} . Assuming a PAYGO system, these payments need to equal the financial contribution from the workers, i.e.: $w_t\tau N_t = w_{t-1}\theta N_{t-1}$. If we solve the equation above we get the relationship: $\theta = (1+n)(1+\lambda)\tau$. By choosing a certain compensation rate for the pensioners, this also determines what the tax rate needs to be in order to have the young workers pay for the old generation.

Equation 4.11 shows that lifetime income (b_t) is determined by the tax rate, the productivity growth, the population growth and the real interest rate. The only variables the government can decide is the tax rate or the compensation rate since all the other variables are assumed to be constant and exogenous.

$$b_t = (1 - \tau)w_t + \frac{(1 + n + \lambda + n\lambda)\tau w_t}{1 + r} \quad (4.11)$$

If we set $g = n + \lambda + n\lambda$ we can rearrange the equation above

$$b_t = (1 - \tau)w_t + \frac{(1 + g)\tau w_t}{1 + r} \quad (4.12)$$

Further on we can re-write this to make it easier to see the implication of changes in r and g in the lifetime income b_t

$$b_t = w_t \left[1 - \tau \frac{r - g}{1 + r} \right] \quad (4.13)$$

Here g can also be understood as the implicit return on the PAYGO-system. Comparing with the case of no pension system ($\tau = \theta = 0$), which implies $b_t = w_t$, we observe that $r = g$. This signifies that the PAYGO system will not alter the net lifetime income of the average person. In the scenario where r is higher than g , i.e the case of a dynamic efficiency, this signifies that b_t will be lower with a PAYGO system. In this case, it is better for individuals to save by themselves and receive return r . In other words, the only way the PAYGO system will benefit the population is if $r < g$, so that the implicit return is higher than the market's actual return.

Compared to the situation in the US, Chinese are therefore more reliant on their savings. The absence of a PAYGO system can thereby explain the high aggregated saving level we are seeing in China. With a PAYGO system, paying taxes can be looked at as a mean to force the

population into saving for their retirement. Chinese, however, need to save by themselves in order to maintain their consumption path.

4.2 Uncertainty

When individuals face uncertainty regarding future income and consumption, this might affect their saving pattern. By assuming a *Constant Absolute Risk Aversion* (CARA) utility function we can derive an illuminating saving equation, which captures an individual's optimal saving level that varies in response to uncertainty in the income level. This depends on the interest rate r , the uncertainty in the economy given by σ^2 , and the individual's preference for risk aversion θ .

The consumption in period one and two is

$$C_1 = y - s \quad (4.14)$$

$$C_2 = y + \varepsilon + (1 + r)s, \quad \varepsilon \sim N(0, \sigma^2) \quad (4.15)$$

The CARA utility function is given by

$$U(C_t) = -\frac{1}{\theta} e^{-\theta C_t} \quad (4.16)$$

We can then maximize the utility function with respect to saving in order to find the optimal saving level

$$\text{Max} -\frac{1}{\theta} e^{-\theta(y-s)} + \frac{1}{1+\rho} E\left[-\frac{1}{\theta} e^{-\theta(y+(1+r)s+\varepsilon)}\right] \quad (4.17)$$

If we assume that $r = \rho$ and $X \sim N(E(x), \sigma_x^2)$, the first order condition is thereby

$$\frac{\partial U}{\partial s} = -\frac{1}{\theta}(-\theta)e^{-\theta c_1} + \frac{1}{1+\rho} E\left[-\frac{1}{\theta}(-\theta)(1+r)e^{-\theta c_2}\right] = 0 \quad (4.18)$$

$$e^{-\theta c_1} = E\left[e^{-\theta c_2}\right] \quad (4.19)$$

Since $E[e^x] = e^{E(x)+0.5\sigma_x^2}$, we can solve for the equation above

$$\begin{aligned} e^{-\theta c_1} &= e^{-\theta[y+(1+r)s]+0.5\theta^2\sigma^2} \\ -\theta c_1 &= -\theta[y+(1+r)s]+0.5\theta^2\sigma^2 \\ y-s &= y+(1+r)s-0.5\theta\sigma^2 \end{aligned}$$

The optimal saving level is then

$$S = \frac{1}{2(2+r)}\theta\sigma^2 \quad (4.20)$$

This illustrates a *Precautionary saving* motive where higher income uncertainty σ^2 leads to increased saving³. If a large share of a nation's population is uncertain about their future income, this might explain a high aggregate saving level. An increase in the interest rate r will decrease the saving, since savings will be more worth in the future. Individuals will therefore not need to save as much in order to have the same level of savings, and thereby consumption, in the next period.

As mentioned previously in the thesis, precautionary saving can, therefore, help explain the high aggregate saving in China, due to high uncertainty about future income. This might induce saving, also in order to leave a bequest for their children. With a stronger social safety net in the US, this could indicate that the Americans are less uncertain about their future, and thus does not have such a high precautionary saving motive.

4.3 Increased life expectancy

How much individuals will save in order to keep a smooth consumption path also depends on their life expectancy. Life expectancy has increased during the last decades (World Health Organization (2016)), along with a higher old-age dependency ratio. For a given retirement age, increased longevity implies that individuals will need to save more in their working period in order to provide for a longer retirement period.

³Since $u'''(\bullet)$ is positive, $u'(\bullet)$ is a convex function of consumption. This implies that a marginal reduction in c_t increases the expected utility. As a result of a positive third derivative and uncertainty regarding future income, current consumption decreases and thereby raises saving (Romer (2012)).

CHAPTER 4. LIFE-CYCLE HYPOTHESIS

Torben M. Andersen (2005) proposes a two-period model, in order to capture the effect of increased life expectancy on saving and consumption. The length of the second period, when individuals are old, is denoted β_t ⁴. Following Andersen (2005), we assume that total consumption as old is c_{2t} , and the total utility from consumption in the second period is $\beta_t u(\frac{c_{2t}}{\beta_t})$, where $\frac{c_{2t}}{\beta_t}$ is the consumption stream in period 2.

Further on, individuals can work a certain fraction α_t ⁵ of their period as old. This yields an income in the second period equal to $\alpha_t y$.

We will treat β_t and α_t as exogenous and see how an increase in both longevity and in years working in the second period will affect saving, by maximizing the utility function

$$\text{Max } u(c_{1t}) + \frac{1}{1+\rho} \left[\beta_t u\left(\frac{c_{2t}}{\beta_t}\right) \right] \quad (4.21)$$

The utility function is given by: $u(c_t) = \ln(c_t)$

$$\text{Max } \ln(y - s) + \frac{1}{1+\rho} \beta_t \left[\ln(\alpha_t y + (1+r)s) - \ln \beta_t \right] \quad (4.22)$$

$$\frac{\partial U}{\partial s} = \frac{1}{y-s} + \frac{\beta_t}{1+\rho} \left(\frac{1}{\alpha_t y + (1+r)s} (1+r) \right) = 0 \quad (4.23)$$

We will continue to assume that $r = \rho$

$$\frac{1}{y-s} = \frac{\beta_t}{\alpha_t y + (1+r)s}$$

$$\alpha_t y + (1+r)s = \beta_t (y-s)$$

Optimal saving is therefore

$$S = \frac{(\beta_t - \alpha_t)}{((1+r) + \beta_t)} Y \quad (4.24)$$

⁴ $\beta_t \leq 1$

⁵ $\alpha_t \leq \beta_t$

To find the consumption in the first period of life, we can insert 4.24 into the consumption function: $C_{1t} = Y - S$, so that we get

$$C_{1t} = \frac{(1 - \beta_t - \alpha_t)}{((1 + r) + \beta_t)} Y \quad (4.25)$$

From this equation, we see that if longevity increases, the consumption in period one as a fraction of income will decrease. This is coherent from what we saw in 4.24, where saving will increase with increased life expectancy (all else held constant).

An increase in the life expectancy does not necessarily have an impact on saving if the working period as old is prolonged. A longer time in the workforce can, therefore, counteract the effect of increased longevity. To see the direct effect on saving of an increase in β_t and/or α_t , we will exemplify with numbers. We will first look at the effects of an increase in β_t , everything else held equal. If we start off by $\beta_t=0.6$, $\alpha_t = 0.3$, $r = 0.02$ and $Y = 100$, this results in an optimal saving equal to 18.5 (we can think of this as in thousand US dollars). Notice that, as with precautionary saving, an increase in the real interest rate will decrease the saving level, all else held constant.

An increase in life-expectancy, $\beta_t=0.8$, will lead to a new optimal saving level, equal to 27 500 USD. Thus, increased life expectancy, everything else held equal, will encourage a higher saving. This implies that if people know that they will live longer, they will save more in order to keep a smooth consumption path over their life-cycle.

An increasing life expectancy can be very expensive for the society if there is a generous social welfare system since aggregate pension payments will increase. One obvious way to solve this might be to increase the retirement age, so that α_t also increases. This implies that the retirement period will shorten since this time period is equal to $\beta_t - \alpha_t$.

If all else is held constant, and β_t is again 0.6, an increase in the retirement age, $\alpha_t = 0.4$, leads to an optimal saving of 12 350 USD. This implies that if people could work longer, they would earn money for a longer period of time, and thus do not need to save as much. In addition, an increase in the retirement age will slow down the increase in the old-age dependency ratio, and thereby more people of working age would be able to support the elderly.

5. Overlapping Generation model

We will further look more into the intertemporal choices of saving and investment by using the *Overlapping Generation Model* (OLG).

The OLG model we are going to use in this thesis is a version that Persson (1985) developed based on Diamond's (1965) OLG model. The model is used to look into what drives the saving pattern and focuses on the life-cycle behavior of individuals and their saving behavior as a function of their age (de la Croix and Michel (2002)).

The baseline in the OLG model is that time is discrete and runs to infinity. Further on, the model is based on that people live for two time periods, and that at each point in time there are two generations alive and overlapping. There is therefore always one young and one old generation living together at the same time. At each time t , the size of the young and old population is given by N_t and N_{t-1} respectively. The population grows with the constant growth rate n , and thereby $N_t = (1 + n)N_{t-1}$.

The model captures that each generation goes through different stages of life. Individuals work in the first time period, while in the next period they retire. The consumption and saving behavior for individuals within each generation is determined by the life-cycle hypothesis (Groth (2011); Thøgersen, Ø. (1995)). We will here presume that the old generation can receive pension benefits.

Further on, we will keep the real interest rate exogenous and constant. In addition, we will also keep wages and pension benefits constant, so that they over time only increase with labor productivity and economic growth.

5.1 Population

In the traditional OLG model, the population growth n is assumed to be constant. However, by zooming in on the demographic developments in both the US and China, we are going to allow $n_t \neq n$. As a result, the growth in the population can vary both from year to year, and between the two countries.

By allowing for different growth rates, the population in nation i at a point in time $t + 1$ can be expressed as

$$N_{t+1,i} = (1 + n_t)N_{t,i} \quad (5.1)$$

5.2 Consumers

In period t the young generation consumes $c_{1,t}$, while the old generation consumes $c_{2,t+1}$. The preferences of individuals will determine their amount of consumption in period t and $t + 1$. This will maximize an intertemporal utility function, as the one shown below

$$U(c_{1,t}, c_{2,t+1}) = u(c_{1,t}) + \frac{1}{1 + \rho} u(c_{2,t+1}) \quad (5.2)$$

During the first time period of a person's life, individuals are young and in the workforce. Each individual offers one unit of labor inelastically to the wage w_t . The consumption level for a worker is given below in equation 5.3. From this we see that an individual's consumption in period 1 is determined by their labor income w_t , minus the tax rate τ they have to pay while working, and the saving S they choose to accumulate during this time period.

$$C_{1,t} = (1 - \tau_t)w_t - S_t \quad (5.3)$$

In the second period, the young generation from the first period is retired. In this period the individual's consumption is decided by the savings they accumulated while working to the

CHAPTER 5. OVERLAPPING GENERATION MODEL

constant interest rate r , and the pension benefits R . If there is a poor or non-existent national pension system, an individual should save more in order to have a certain level of consumption. In equation 5.4 we are not assuming a bequest motive, and individuals are therefore consuming all that is left of savings from period 1 along with their pension benefit.

$$C_{2,t+1} = (1 + r)S_t + R_{t+1} \quad (5.4)$$

We continue to assume that $r = \rho$, which results in a flat consumption path over the life-cycle, $c_{1,t} = c_{2,t+1} = C$ ¹. The equation for the optimal consumption over the two periods is therefore given by 5.5. We can see that if $r = 0$ individuals will divide their lifetime income equally between the two periods they live in.

$$C = \left(\frac{1+r}{2+r} \right) \left[(1-\tau)w_t + \frac{1}{1+r}R_{t+1} \right] \quad (5.5)$$

Given that consumption is equal in the two time periods, we can find the optimal saving by setting the two consumption functions equal to each other, see below

$$(1-\tau)w_t - s_t = (1+r)s_t + R_{t+1} \quad (5.6)$$

By solving 5.6 with respect to s , we find the optimal saving

$$S = \frac{1}{2+r} \left((1-\tau)w_t - R_{t+1} \right) \quad (5.7)$$

From equation 5.7 we see that an increase in wage, all else held constant, will increase saving. On the other hand, if retirement benefits, the tax rate or the real interest rate increase, this will reduce saving. Since China has a less generous pension system than the US, equation 5.7 can, therefore, be one explanation for why Chinese have a higher savings rate than Americans.

¹The flat consumption path is a result of maximizing the utility function with respect to an individual's intertemporal budget constraint, given by $c_1 + \frac{1}{1+r}c_2 = (1-\tau)w_1 + \frac{1}{1+r}R$

An individual's private wealth at a point in time t is represented by equation 5.8, and is given by a possible initial wealth and the return earned on these. The private wealth at the beginning of period $t + 1$, ω_{t+1} , is the accumulated savings from last period to the interest rate r

$$\omega_t = (1 + r)B_0 \quad (5.8)$$

$$\omega_{t+1} = (1 + r)s_t \quad (5.9)$$

Aggregate private wealth at the beginning of period $t + 1$ depends on the accumulated saving from period t and the size of the working population, N_t

$$\Omega_{t+1}^p = N_t S_t \quad (5.10)$$

Per capita, private wealth is then given by

$$\omega_{t+1}^p = \frac{N_t S_t}{N_{t+1}} = \frac{S_t}{1 + n_t} \quad (5.11)$$

By inputting 5.7 into the equation above we get

$$\omega_{t+1}^p = \frac{1}{(1 + n_t)(2 + r)} \left[(1 - \tau)w - R_{t+1} \right] \quad (5.12)$$

Equation 5.12 illustrates that private wealth increases with savings, but is reduced if n_t increases. In other words, an increasing old-age dependency ratio will, in theory, lead to a higher private wealth (all else held constant).

5.3 Production

On the production side, firms use capital and labor² in order to produce goods that can be consumed, invested or traded internationally. We also assume that the market is perfectly com-

²We will here not include technology or depreciation.

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petitive. The neoclassical production function is given by: $Y_t = F(K_t, L_t)$. Production per capita can be expressed as: $y_t = f(k_t)$, since $y_t = \frac{Y_t}{N_t}$ and $k_t = \frac{K_t}{N_t}$.

The workers L_t receive wage w_t , and the return of capital is r_t . The profit maximization problem for the firms is, therefore

$$\text{Max}[F(K_t, L_t) - r_t K_t - w_t L_t] \quad (5.13)$$

We find the optimal solution by derivating equation 5.13 with respect to labor and capital.

The investment for a period t is implicitly given by setting the marginal product of capital equal to its cost

$$f_k(k_t) = r_t \quad (5.14)$$

The capital stock in $t + 1$ is determined by the amount of capital invested in period t and the current capital stock. This is due to the "time to build" assumption ³.

Given constant returns to scale, gross wage can be expressed as

$$w_t = f(k_t) - k_t f_k(k_t) \quad (5.15)$$

Since the real interest rate is constant, we can find a constant capital, k , from 5.14. This further on decides a constant gross wage, w , given by 5.15. As the population N_t grows with n_t , this implies that capital K_t also will grow with n_t , and thus investment will grow with the same rate.

5.4 PAYGO

In order to finance public expenditures, such as social welfare benefits to the old generation (R_t), the government collects taxes from the working population.

³ $I^d = K_{t+1} - (1 - \delta)K_t$, since we have assumed $\delta = 0$, the investment function can be expressed as $I^d = K_{t+1} - K_t$ (Doppelhofer (2009))

In our model, we assume that the only public expenditures are pension payments so that all tax income goes to the PAYGO system. In other words, all the collected taxes are used to finance the pension benefits. Public wealth Ω_t^G is, therefore, zero on both an aggregate and per capita level. This means that

$$\tau_t w N_t = R N_{t-1} \quad (5.16)$$

As mentioned in chapter 4, individuals receive pension benefits equal to a compensation rate θ of their gross wage: $R = \theta w$. We can thereby rewrite the equation above

$$\tau_t w N_t = \theta w N_{t-1} \quad (5.17)$$

$$\tau_t (1 + n_t) = \theta \quad (5.18)$$

We see that τ and θ are linked together and that an increase in n_t will increase the compensation rate. On the other hand, if n_t decreases, the compensation rate will decrease, and thus the pension system is less generous. n_t can, therefore, be looked at as the implicit return on the PAYGO system.

Further on, we can input equation 5.17 into the optimal saving function 5.7

$$S_t = \frac{1}{2+r} \left[(1 - \tau_t)w - \tau_t(1 + n_t)w \right] \quad (5.19)$$

$$= \frac{1}{2+r} \left[w - w\tau_t - \tau_t(1 + n_t)w \right] \quad (5.20)$$

$$= \frac{1}{2+r} w \left[1 - (2 + n_t)\tau_t \right] \quad (5.21)$$

From 5.21 we see that an increase in the tax rate will decrease the optimal saving. This effect is also reinforced if n_t increases. For a given PAYGO system, if n_t decreases, and by that, the population is aging, this will again increase saving.

5.5 National wealth and current account balance

Following the assumption that all tax income is used to finance the PAYGO system, the public wealth is zero. This implies that the national wealth is only given by aggregate private wealth

$$\Omega_t^n = \Omega_t^g + \Omega_t^p = \Omega_t^p \quad (5.22)$$

The same implies for national wealth per capita

$$\omega_t^n = \omega_t^g + \omega_t^p = \omega_t^p \quad (5.23)$$

National wealth can also be given by the real capital accumulation and foreign debt per capita, a

$$\omega_t^n = k + a_t \quad (5.24)$$

Changes in ω_t^n , and thereby ω_t^p , further on leads to changes in a_t as the capital accumulation is constant, see equation 5.14.

In a closed economy, a country will not have a current account surplus or deficit. It follows that the demand for capital must equal the supply of private and public capital.

However, with international capital mobility, it is possible for a country to operate with a current account surplus or deficit. Foreign debt equals public wealth and savings minus the sum of the total capital formation. Per capita the foreign debt at the beginning of period $t+1$ can, therefore, be expressed by equation 5.25 ⁴

$$a_{t+1} = \omega_{t+1}^g + \frac{S_t}{1 + n_t} - k \quad (5.25)$$

⁴The current account balance can also be explained as a measure of the difference between a country's national saving and domestic investment: $S_t - I_t$.

A country's current account balance per capita q_t for a period t can thereby be expressed by equation 5.26. We see from 5.25 that a decreasing n_t , all else held constant, will increase the current account balance

$$q_t = a_{t+1} - a_t \tag{5.26}$$

5.6 Steady state

A steady state is characterized by constant values for w , r , τ , and the same apply for consumption and wealth. If we in a steady state look away from growth in technology, the capital accumulation is equal to: $k_{t+1} = k_t = k$. In steady state, all aggregated variables will, therefore, grow with rate n_t . At the same time, all variables per capita will be constant.

6. Extension of the OLG model

Further on, we will extend the OLG model to include seven generations, from now on called cohorts (a). The first cohort consists of people between 15 and 25 years (<25), while the next cohorts increase with a ten-year interval, which makes the next cohort those in the age of 25 to 34 years and so on. By including more cohorts we can gain a better understanding of the demographic patterns and developments, both within a country and between different countries. The time frame for our model is 2010 to 2060. The reason for this choice is to catch the demographic effect of an aging baby boom generation in the US, and the family planning policy in China. Further on, we can look at how these different demographic developments affect saving patterns both now and in the years to come.

China and the US will first be looked at as two small open economies where the rest of the world is considered as a residual. This means that prices are given and that the current account deficit and surplus will be absorbed by the rest of world which creates a global equilibrium.

6.1 Demographics

The size of a nation's population above working age for period t in country i is given by 6.1. Here individuals will start working at $a = 1$, retire in $a = a_R$ and die in $a = a_D$.

$$N_{t,i} = \sum_{a=1}^{a_D} N_{t,a,i} \quad (6.1)$$

Further on, we can divide the population into effective workers, $L_{t,i}$, and pensioners, $Z_{t,i}$. The growth in the population from period t to $t + 1$ can be expressed by the different growth rates for each cohort, $\gamma_{t,a,i}$, see below

$$N_{t+1,a+1,i} = (1 + \gamma_{t,a,i})N_{t,a,i} \quad (6.2)$$

6.2 Consumers

Individuals maximize their utility of consumption throughout their life-cycle, see equation below

$$\text{Max } U_{t,a,i} = \sum_{t=1}^T \frac{1}{(1+\rho)^{t-1}} u(c_{t,a,i}) \quad (6.3)$$

Where ρ is an individual's impatience level, and $c_{t,a}$ the consumption for the different cohorts for different time periods.

Further on, we will assume that the utility function is isoelastic

$$u(c) = \frac{c^{1-\theta}}{1-\theta} \quad (6.4)$$

Here θ is the coefficient for the relative risk aversion, and $\theta > 0$. The marginal utility in this function is $u'(c) = c^{-\theta}$. As a result, we can rewrite equation 6.3 to the equation below

$$\text{Max } U_{t,a,i} = \frac{1}{1-\theta} \sum_{t=1}^T \left[\frac{1}{(1+\rho)^{t-1}} (C_{t,a,i})^{1-\theta} \right] \quad (6.5)$$

Going further, we will include the possibility of initial wealth and bequests motives, as this can help explain saving patterns, especially in China. Given an initial wealth of b_0 and a bequest at time T of b_T , the intertemporal budget restriction is given by equation 6.6. It expresses that the present value of lifetime consumption and bequests has to equal the present value of lifetime labor income, pension benefits, and initial wealth.

$$\sum_{t=1}^T \frac{1}{(1+r)^{t-1}} c_{t,a,i} + \frac{b_T}{(1+r)^{T-1}} = \sum_{t=1}^{a_R-1} \frac{1}{(1+r)^{t-1}} ((1-\tau)w_{t,a,i}) + \sum_{t=a_R}^T \frac{1}{(1+r)^{t-1}} R_{t,a,i} + b_0(1+r) \quad (6.6)$$

The intertemporal consumption maximization problem can be solved by the Lagrange method, shown in 6.7

$$L = \frac{1}{1-\theta} \sum_{t=1}^T \left[\frac{1}{(1+\rho)^{t-1}} (C_{t,a,i})^{1-\theta} \right] - \lambda \left[\sum_{t=1}^T \frac{1}{(1+r)^{t-1}} c_{t,a,i} + \frac{b_T}{(1+r)^{T-1}} - \sum_{t=1}^{a_R-1} \frac{1}{(1+r)^{t-1}} ((1-\tau)w_{t,a,i}) - \sum_{t=a_R}^T \frac{1}{(1+r)^{t-1}} R_{t,a,i} - b_0(1+r) \right] \quad (6.7)$$

By deriving 6.7, with respect to both $c_{t,a,i}$ and $c_{t+1,a+1,i}$, and setting these two solutions equal to each other, we get the Euler equation

$$\left[\frac{c_{t+1,a+1,i}}{c_{t,a,i}} \right]^\theta = \frac{1+r}{1+\rho} \quad (6.8)$$

The Euler equation illustrates that the marginal rate of substitution between consuming today or consuming tomorrow must be equal to the marginal rate of transformation. This depends on the individual's time preference and the level of relative risk aversion (Doppelhofer (2009)).

Equation 6.8 can also be expressed as

$$c_{t,a,i} = c_{t+1,a+1,i} \left(\frac{1+r}{1+\rho} \right)^{\frac{1}{\theta}} \quad (6.9)$$

From 6.9 we see that the growth rate of consumption is determined by the difference between the real interest rate and the time preference, as well as θ . The intertemporal elasticity of substitution of consumption between time periods is measured by $1/\theta$. The intertemporal elasticity of substitution decides the strength of the response of consumption today and tomorrow. A higher θ reflects a stronger incentive to smooth consumption over time, and a more "curvature" utility function (Groth (2011)).

Further on, we will again assume that $r = \rho$. This leads to $c_{t,a,i} = c_{t+1,a+1,i} = \dots = C$, which signifies perfect consumption smoothing. In order to find the optimal consumption in each period we use the formula for a finite geometric series: $1 + a + a^2 + \dots + a^T = \frac{a^{T+1}-1}{a-1}$ for when $a \neq 1$

$$C \left[\frac{\left(\frac{1}{1+r}\right)^T - 1}{\left(\frac{1}{1+r}\right) - 1} \right] = \sum_{a=1}^{a_R-1} \frac{1}{(1+r)^{t-1}} (1-\tau)w_{t,a,i} + \sum_{a_R}^{a_D} \frac{1}{(1+r)^{t-1}} R_{t,a,i} \quad (6.10)$$

The saving profile for workers, $s_{t,a,i}$, is given by 6.11. It expresses how much individuals in each cohort save of their net income after consumption in period t

$$s_{t,a,i} = (1 - \tau)w_{t,a,i} - c_{t,a,i} \quad (6.11)$$

The private wealth at the beginning of period $t + 1$ for a representative individual in cohort a is given by the savings accumulated in the previous period and the return made on these

$$\omega_{t+1,a+1,i} = (1 + r)s_{t,a,i} \quad (6.12)$$

For the youngest cohort, their private wealth will, therefore, be zero if we do not assume any bequest motive. However, if we do assume a bequest motive, private wealth at the beginning of the next period for the second cohort will be equal to initial wealth and the return made on this.

One generation's total wealth at the beginning of period $t + 1$ can, as a result, be expressed as

$$\Omega_{t+1,a+1,i}^P = N_{t,a,i}\omega_{t+1,a+1,i} \quad (6.13)$$

The total private wealth for a nation at the beginning of period $t + 1$ is, therefore

$$\Omega_{t+1,i}^P = \sum_{a=1}^{a_D} \Omega_{t+1,a+1,i}^P \quad (6.14)$$

6.3 Pension system

From our model it is individuals in period $a \in [a_R, a_D]$ who receive pension benefits. In the PAYGO system, the taxes from the working population need to finance the pension benefits at each point in time, see below

$$\tau_t \sum_{a=1}^{a_R-1} w_{t,a} L_{t,a} = \sum_{a=a_R}^{a_D} R_t Z_{t,a} \quad (6.15)$$

CHAPTER 6. EXTENSION OF THE OLG MODEL

The basic calculations for the PAYGO system are based on the average of the effective gross income an individual has earned over his or her working period. This is illustrated below, where ϑ is the number of periods an individual works

$$\bar{w} = \sum_{a=1}^{a_R-1} \frac{w_{t,a}}{\vartheta} \quad (6.16)$$

The pension benefit R_t that is paid out each year after retirement a_R is determined by the compensation rate θ and the average gross income \bar{w}

$$R_t = \theta \bar{w} \quad (6.17)$$

In the US, the average compensation rate is 45 percent of gross average labor income (OECD).

A large part of the population in China live in rural areas where there are no or very poor pension systems. China does have a PAYGO system, mainly in urban areas, but it is not as generous as in the US. Based on Curtis et al. (2015a), the compensation rate is set to 25 percent. The 25 percent is meant to reflect an average of those participating in the pension system and those who are not.

The government in China is aiming at strengthening the nation's social safety net, and thereby also improving the pension benefits for all Chinese. Since this is not yet fulfilled, or not on a large scale, we will therefore not focus on this any further, but rather think of this as an important future research topic.

7. Further Discussion

This chapter looks at real data for the US and China and discusses what both the current and projected situations are for the two nations' demographic pattern, saving profile, aggregate saving, and private wealth. We discuss whether real data for the US and China illustrates a LCH saving profile. Further on, we take a look at how increased life expectancy might change individuals' saving behavior. We have also looked closer at how an increasing old-age dependency ratio might affect the PAYGO system. All of these topics take into consideration the demographic developments we are seeing in the time period from 2010 to 2060.

We are first going to look at China and the US separately where they are modeled as open economies, and subject to an exogenous, constant real interest rate ¹. Thus, we deliberately zoom in on the demographic effect on saving, and how this varies between these two countries. Towards the end of this chapter, we will qualitatively comment on the global capital market equilibrium and the potential interest rate responses.

In the calibration of our numerical simulation model (as presented in previous chapters) we have used micro data from the Chinese Household Survey done in 2002 by the Chinese Academy of Social Sciences (CASS) in order to find the average Chinese disposable income for each cohort (Liane (2011)). For the US, we have used data from the Bureau of Labor Statistics, and their Consumer Expenditure Survey from 2015 ².

¹We presume that the real interest rate is 3.8 percent, which is a weighted average between the FED's interest rate and the average return on S&P 500 over the last ten years.

²For both countries we have presumed that labor income increases with labor productivity and economic growth over our time frame. Labor productivity is presumed constant, but differs between the two countries, and is calculated as an average over the last twenty years.

7.1 Demographic developments

As discussed earlier in the thesis, both the US and China are facing large demographic changes in the decades to come. Both countries' populations are aging quickly, and with that seeing an increasing old-age dependency ratio. In order to illustrate this, we have looked at the projections for the development of both countries' population from 2010 to 2060. The age structure in each country, and the net growth rate for each cohort, is embedded in $N_{t+1,a+1,i}$.

In order to zoom in on the developments of the different age cohorts in both countries, we have taken the number of people in each cohort in each year as a share of the total population over 15³ in 2010. Thereby we can easier compare the development in each cohort over our time period.

Figure 7.1 shows the projected demographic developments in the US. It illustrates how the different age cohorts, as shares of the total population, change over this time period. From the figure, we see the largest change in the oldest cohort. In 2010, 9 percent of the population was over 75 years, while in 2060 this share is expected to increase to 16 percent. Over the five decades, it is the two oldest cohorts that are expected to increase the most. This is consistent with the projected increasing old-age dependency ratio in the country, especially following the aging of the baby boomers. However, we still see an increase in all the included cohorts. The total population over 15 is expected to grow by 39 percent from 2010 to 2060. In comparison, the population almost doubled from 1960 to 2010 (OECD (2016b)).

³The reason for why we have chosen to look at the population from age 15 and up is because the working population is set to be between 15 and 65 years from the old-age dependency ratio calculation.

CHAPTER 7. FURTHER DISCUSSION

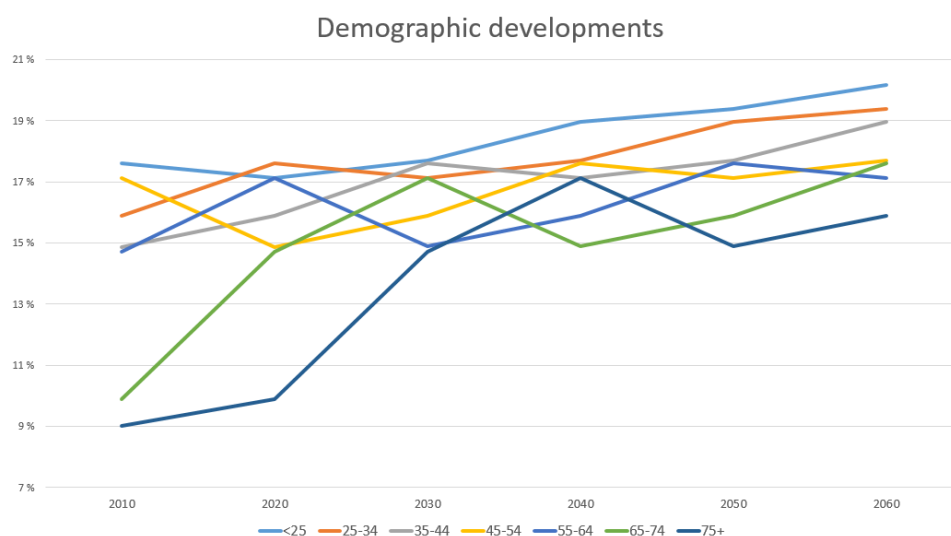


Figure 7.1 – The development in the different cohorts’ share of the total population over 15 in the US (2010-2060). Source: OECD (2016b).

Figure 7.2 illustrates the demographic developments in China. From this figure, we see that the youngest cohort in China is projected to decrease significantly, from over 36 percent in 2010 to around 25 percent in 2060. At the same time, the share of elderly is increasing. The oldest cohort will increase the most around 2020, and will from 2010 to 2050 go from 3 percent to 12 percent of the total population. This can be explained by the aftermath of the family planning policies. The youngest cohort will however still continue to be the largest share of the population in 2060, but the gap between the size of the youngest and the oldest cohort will continuously decrease (OECD (2016b)).

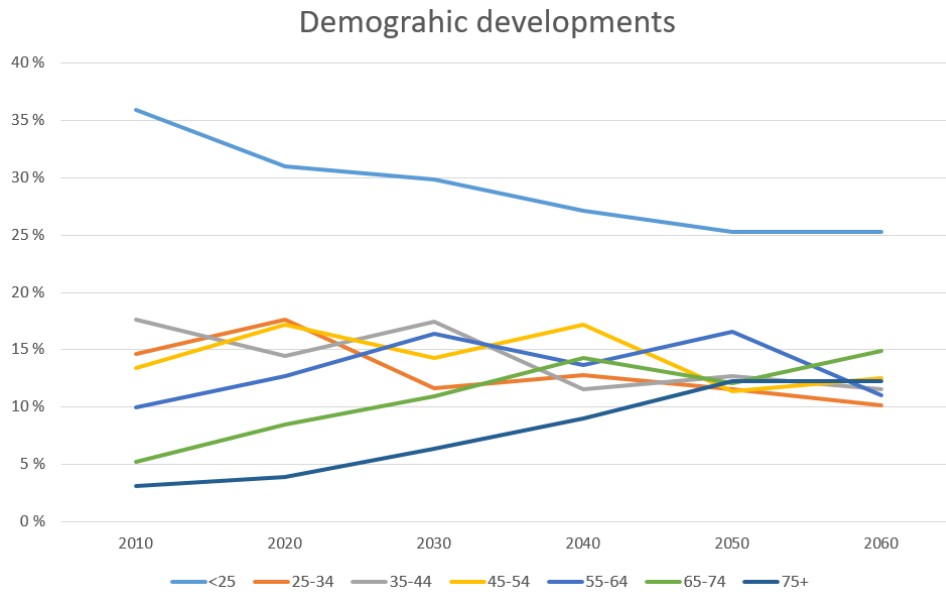


Figure 7.2 – The development in the different cohorts’ share of the total population over 15 in China (2010-2060). Source: OECD (2016b).

In order to compare the demographic developments in China and the US, we have looked at the projected old-age dependency ratio for both countries. From figure 7.3 we see that up to 2030 the US will have an increasing old-age dependency ratio, but after this, it will be relatively flat. China’s population, on the other hand, is growing older each year and surpasses the US’ old-age dependency ratio in 2040. In 2060, China’s population over 65 will be almost half the size of the working age population (OECD (2016b)).

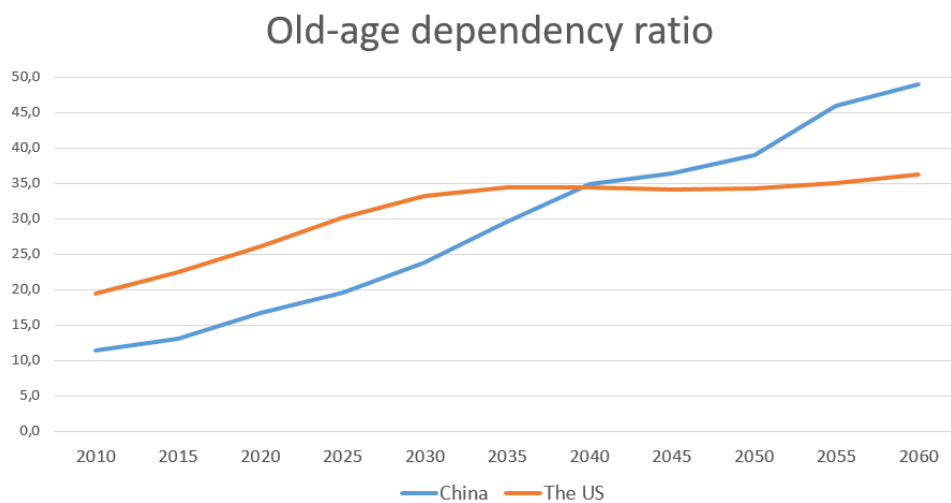


Figure 7.3 – The development in the two countries’ old-age dependency ratio (2010-2060). Source: OECD (2016b).

7.2 Saving profile

In light of the life-cycle hypothesis, we would expect to see an inverted U-shaped saving profile for both the population in China and the US. The youngest cohort should borrow money, while the cohorts in the workforce should accumulate savings while working. Thereafter the oldest cohorts should dissave after retiring. To investigate if the saving profile in China and the US corresponds to the LCH, we have found the optimal flat consumption path for each generation. We have therefore assumed that individuals have perfect foresight, and thereby know their lifetime income. In order to find the saving profile for individuals we used real data for their income, and then plotted saving against the different cohorts. Thus, wages are exogenous for all time periods, and since the compensation rate is given, this implies that also pension benefits are exogenous. In addition, since we assume a PAYGO system and no public debt, the tax rate will change during this time period in order to keep the same compensation rate for all generations. In other words, the tax rate will be endogenous in our model and vary between years.

As mentioned earlier, Chinese leave behind bequests to future generations. We can thereby not expect the same inverted U-shaped saving profile unless we include a bequest motive. We have, therefore, in our numerical simulation model, assumed that Chinese leave behind 30 percent of their lifetime income. We have also included that individuals receive an initial wealth, which is equal to the previous generation's bequest and the return earned on these ⁴. In the case of the US we have chosen to leave out a bequest motive, and thereby assumed that they consume all of their lifetime income during their life-cycle.

From figure 7.4 we see the saving profile over a life-cycle for an average American in generation N_t . We have calculated the optimal flat consumption path over the life-cycle based on the given wages and interest rate, and assumed that the two oldest cohorts receive a pension benefit equal to 45 percent of the gross average wage earned over their working period. From the figure, we see that the saving profile follows the life-cycle hypothesis relatively well. However, we notice that the youngest cohort does not dissave, but rather saves during their first period in the workforce. The two oldest cohorts are on the other hand dissaving, and thereby consuming

⁴ $\sum_{t=1}^T \frac{1}{(1+r)^{t-1}} C + \frac{1}{(1+r)^{T-1} B} = \sum_{t=1}^{a_R-1} \frac{1}{(1+r)^{t-1}} ((1-\tau)w_{t,a,i}) + \sum_{a_R}^T \frac{1}{(1+r)^{t-1}} R_{t,a,i} + B_{t-1}(1+r)$

of their accumulated wealth. A possible explanation for why the youngest cohort is saving is because of changes in the tax rate throughout the life-cycle of an individual in generation N_t . Due to an increasing old-age dependency ratio, the tax rate in 2010 is lower compared to the other years. Even though the youngest cohort's gross labor income is relatively low compared to the others cohorts, the net wage is not as low due to a much higher tax rate in the following years ⁵.

Since the tax rate differs between years, we will also find some differences between the saving profiles for the respective generations within our model. Figure 7.4 is on the other hand still representative, in the sense that both these and the other saving profiles mentioned will have an inverted U-shape.

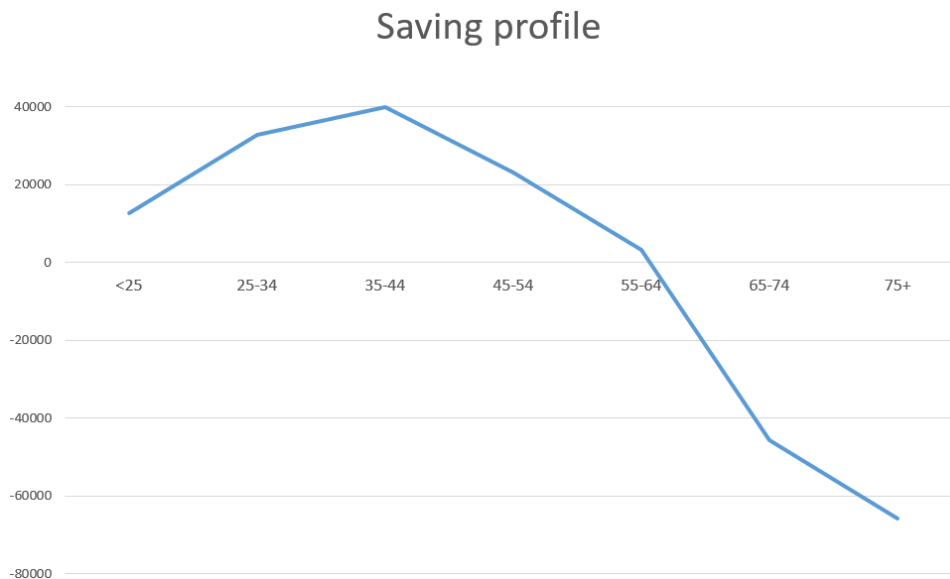


Figure 7.4 – Saving profile for an individual in generation N_t .

Figure 7.5 illustrates the saving profile for an average Chinese in generation N_t . This saving profile shows that individuals save money until they reach retirement age. We have here assumed that all individuals leave the workforce when they reach 55 years, and thereby work for one period less than the average American. This implies that the four youngest cohorts are in the workforce, while the three oldest are retired. After they retire, they receive a pension benefit equal to 25 percent of the average gross wage while working, as well as family trans-

⁵Later in this chapter we will see that the tax rate will need to increase from 10.60 percent in 2010, to 16.36 percent in 2030.

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fers. This contribution from the family is estimated to be 8 percent of average income (Curtis et al. (2015a)). We have included a bequest motive so at the end of a life-cycle the individual leaves behind a bequest for the next generation. This also implies that individuals are born with an initial wealth. The inheritance is a reason behind the high saving in the beginning of the life-cycle, as well as the large drop in saving at the end. It is important to underline that this is the saving profile for the total population and that there are large differences between the urban and rural population.

The tax rates are increasing in order to keep the PAYGO system in its current form. This implies that the disposable income is relatively lower in 2060, and will thereby also affect how an individual will save during her life-cycle. These increases in the tax rate are discussed more in detail in section 7.6 later in this chapter. On the other hand, by keeping the tax rate exogenous, and thereby the compensation rate endogenous, this would result in a lower pension benefit. A lower pension benefit will affect the saving profile for an individual differently than what we are seeing in figure 7.5, since we will most likely see a higher saving in the middle and more dissaving towards the end.

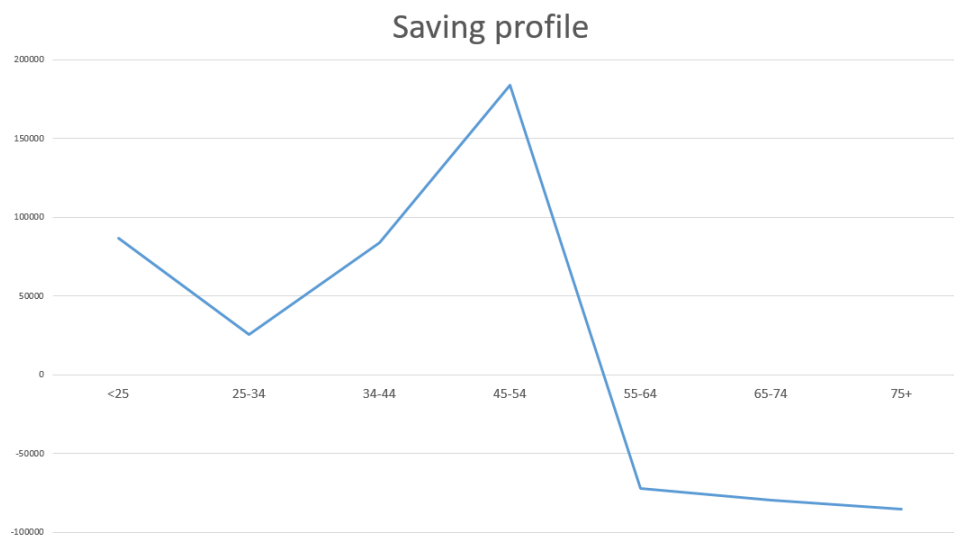


Figure 7.5 – Saving profile for an individual in generation N_t .

As pointed out, there are large differences between rural and urban areas. The rural population tends to work longer than the urban workers. Labor income is, therefore, a larger source of rural elderly's income for a longer period of time than for urban elderly. In fact, the average working life is about ten years longer for the rural population (Liane (2011)). For rural elderly, pension

benefits are even less generous than for urban retirees. They are therefore highly dependent on support from their family (OECD (2010)). This would result in a different saving profile than the one shown above. As they depend more on support from their family, this would imply a higher saving while working in order to leave behind bequests.

7.3 Aggregate consumption

Since wages and the real interest rate are exogenous and given, and individuals have a flat consumption path, we can simulate how the demographic developments will affect the aggregate consumption level in the two countries over our time period.

From figures 7.6 and 7.7 we see the development in aggregate consumption in the US and in China as a percentage of GDP. We see that the consumption level in both countries is steadily increasing over our time period, however, aggregate consumption as a percentage of GDP seems to be flattening out for the US. Since wages increase with labor productivity, consumption paths are flat for each generation, and that the overall population is increasing, this is also what one might expect to observe.

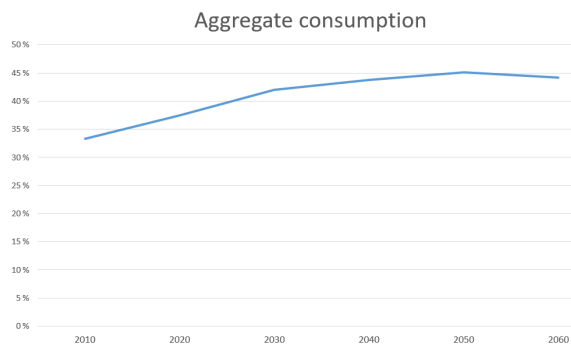


Figure 7.6 – Aggregate consumption in the US, as percentage of GDP, from 2010 to 2060.

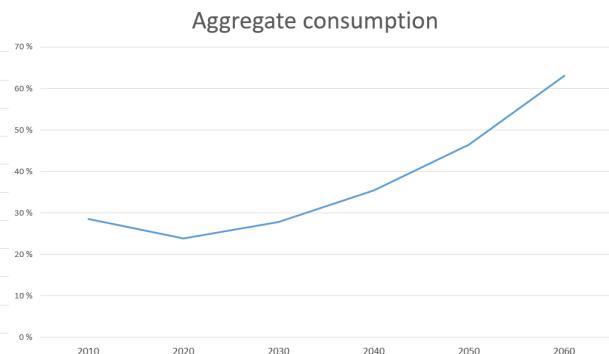


Figure 7.7 – Aggregate consumption in China, as percentage of GDP, from 2010 to 2060.

7.4 Aggregate saving

In order to look at the effect demographic developments might have on the US' and China's household saving, we have aggregated private saving with the size of each generation up to

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2060. Notice that we are here zooming in on the demographic effects, and have kept the other parameters, except for the tax rate, constant.

Figure 7.8 illustrates the development in aggregate saving in the US as a percentage of GDP. We see that aggregate saving is predicted to decrease for the whole time period. It is expected to fall sharply until 2040, and then more slowly up to 2060. One explanation for this decrease is the aging of the baby boomers. From the saving profile shown earlier, we saw that an average American dissaves in the two last cohorts. In other words, we would expect that the aggregate savings rate falls as the old-age dependency ratio increases. Since the old-age dependency ratio is expected to stabilize itself around 2040, we could also expect the savings rate to decrease with a slower rate up to 2060. In addition, the change in the tax rate might be another explanation for the slope of the line. The tax rate increases the most between 2010 and 2030 and is in the following years relatively stable. Saving will, as a result, fall the most in the first 20 years.

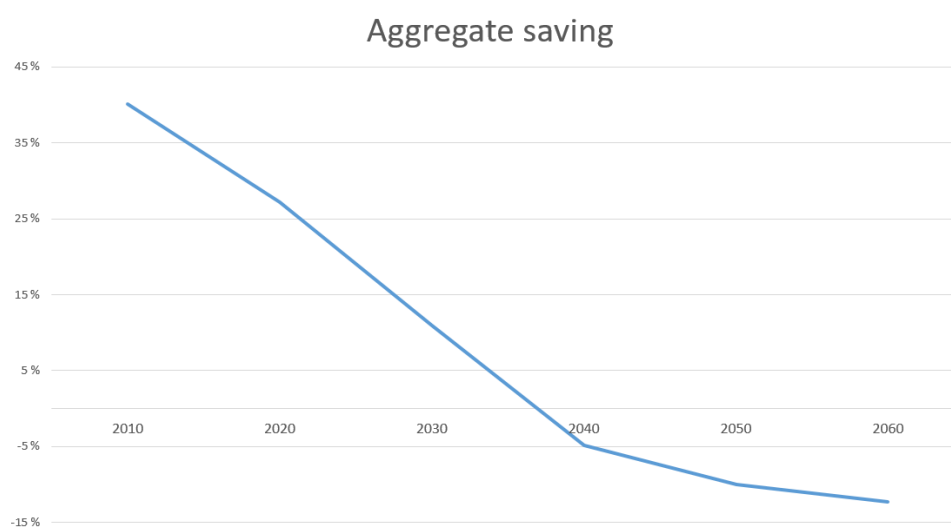


Figure 7.8 – Aggregate saving in the US, as percentage of GDP, from 2010 to 2060.

Figure 7.9 displays aggregate saving as a percentage of GDP in China. The figure illustrates a significant drop in the aggregate savings rate from 2010 to 2020, and from 2050 to 2060. This is at the same time as we are seeing a sharp increase in the old-age dependency ratio. Along the same lines, the youngest cohorts are the ones who are saving the most, and as they are decreasing as a share of the total population, this will further on lower aggregate saving. As pointed out earlier, the tax rate will increase, and individuals will experience a relatively lower net income in the future, which will amplify the decrease in aggregate saving.

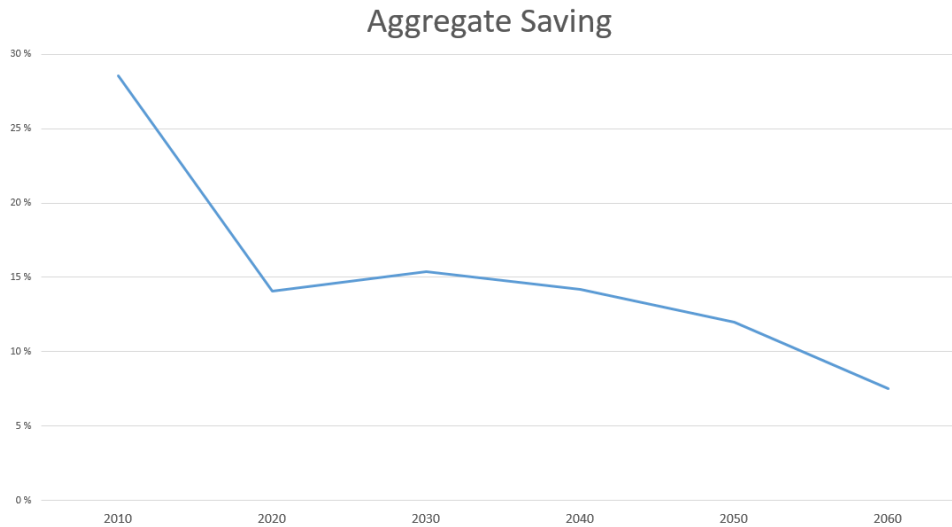


Figure 7.9 – Aggregate saving in China, as percentage of GDP from 2010 to 2060.

7.5 Aggregate private wealth

Further on, we wish to look at private wealth, and how the aggregate level changes with the demographic developments. Through our numerical simulation model we have therefore found the private wealth for each generation and for each year ⁶. Since aggregate wealth is a function of savings from the previous time period, we have had to make some assumption regarding savings accumulated in 2000 for the six oldest generations. We have here assumed that their saving follows the same trend as the one for generation N_t .

From figure 7.10 we see aggregate private wealth as a percentage of GDP in the US. The figure shows that aggregate private wealth will increase from 2010 to 2020, and then start to decrease sharply up to 2060. Notice, however, as we previously mentioned, that we have taken some assumption regarding private wealth in 2010 that might affect the trend we are seeing from 2010 to 2020. From 2020 to 2060 we clearly see that aggregate private wealth follows the trend in aggregate saving. Further on, a decreasing aggregate private wealth will reduce the country's financial wealth, since national wealth in our model equals private wealth and capital is constant.

⁶We found private wealth at the beginning of the next period by using the following equation: $\omega_{t+1,a+1,i} = (1+r)s_{t,a,i}$. For Chinese we have also included a bequest motive, so for those in the youngest cohort their private wealth will equal: $\omega_{t+1,a+1+i,i} = (1+r)B_{t-1}$.

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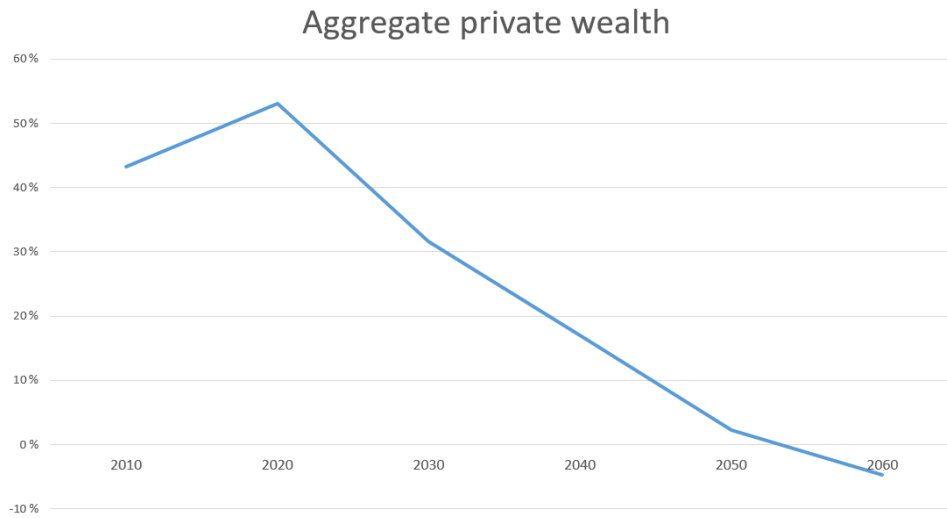


Figure 7.10 – Aggregate private wealth in the US, as a percentage of GDP (2010-2060).

Figure 7.11 displays aggregate private wealth in China as a percentage of GDP. The figure illustrates that private wealth decreases during the whole time period. Looking at figure 7.11 together with figure 7.3, we see that the largest increase in old-age dependency ratio can explain the rapid decline in aggregate private wealth, especially between 2010 and 2030. As private wealth is accumulated savings from the previous period including the returns made on these, private wealth is lagging one time period to aggregate saving.

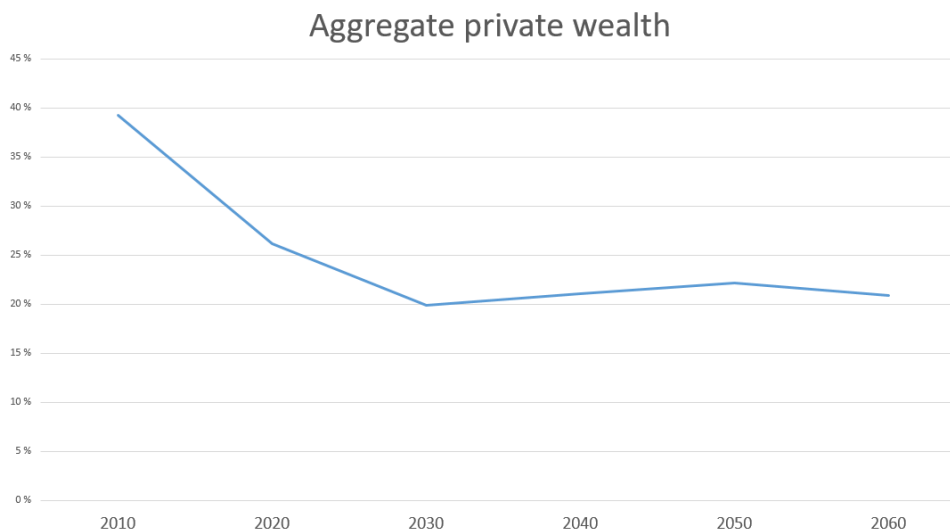


Figure 7.11 – Aggregate private wealth in China, as a percentage of GDP (2010-2060).

7.6 A closer look at PAYGO

In our thesis, we have assumed that the taxes paid by the working population in both the US and China are only used to in order to finance the pension benefits for the retirees in the same year. With fewer workers per retiree, the tax rate will need to increase in order for the tax income to equal the pension payments ⁷. In the next sections, we have highlighted how the tax rate will need to change. Notice that these simulations are used in order to calculate the optimal consumption paths for each generation in both countries, as presented earlier.

7.6.1 PAYGO in the US

As mentioned previously, we have assumed that the pension benefit in the US is equal to 45 percent of an individual's average gross labor income. From table 7.1 we see the results of the different tax rates that are needed in order to keep the PAYGO system at the same level. We clearly see that there is a relationship between the high increase in the old-age dependency ratio from 2010 to 2030 and the increase in the tax rates for the same period. As with the old-age dependency ratio in the US, the tax rates from 2040 to 2060 are also expected to be around the same level. In other words, as the baby boomers retire, the tax rate will need to increase for the working population in order for there to be an equilibrium between the tax income and pension payments. If not, the compensation rate will need to decrease.

Years	2010	2020	2030	2040	2050	2060
	10.60%	13.49%	16.36%	15.22%	15.98%	16.98%

Table 7.1 – The new tax rates needed in order to keep the pension system at the same level.

⁷In order to find the tax rate needed to keep the PAYGO system in equilibrium, we use the equation: $\tau_t \left(\sum_{a=1}^{a_R-1} w_{t,a} L_{t,a} \right) = \theta \left(\sum_{a_R}^{a_D} w_{t,a_R-1} Z_{t,a} \right)$. Since the two populations, wages and compensation rates are given, we can solve for the respective τ_t .

7.6.2 PAYGO in China

Table 7.2 shows that the tax rate in China will need to increase in order to finance the pension expenditures. The compensation rate for the pension benefit is as mentioned 25 percent of the retirees' income they earned while they were in the workforce. Even though there are very large differences in the pension systems for urban and rural areas, this table illustrates the necessary tax rises for China as a whole. The dramatic increase in the tax rate illustrates the rapidly increase in the number of elderly per worker.

Years	2010	2020	2030	2040	2050	2060
	16.93%	22.10%	28.12%	31.74%	33.62%	32.66%

Table 7.2 – The new tax rates needed in order to keep the pension system at the same level.

7.6.3 Consequences

A higher tax rate will in both countries signify a lower disposable income. Further on, a lower lifetime income also signifies a lower flat consumption path. Aggregate consumption will thereby decrease and as a result, saving will also decrease. For those who are already pensioners, their situation will not change, since we assume that they do not pay taxes on their pension benefits. However, the people in the workforce will experience a decrease in their net income, and thereby consumption and saving. If the tax rate is kept at the same level, the compensation rate will need to decrease in order for there to be an equilibrium. Pensioners will, therefore, be worse off, especially since they have already paid a certain tax during their working period to receive a certain pension benefit.

With an increasingly older population, one can also imagine that other government expenditures will increase due to higher health costs, and a lower tax income. In other words, if one also includes these expenditures the tax rate might, in fact, have to increase even more.

7.7 Life expectancy

One possible solution to avoid the increasing tax rate is to increase the retirement age. As people would work longer, this could reduce the old-age dependency ratio and thereby maintain the PAYGO system in its current form. In addition, people would not need to save as much as they could live off their labor income for a longer time period.

From chapter 4, we found an expression for the optimal saving level when life expectancy is increasing. In table 7.3 below we have created different scenarios for how the savings rate will change if either or both the life expectancy (β_t) and retirement age (α_t) increase. This will give us a theoretical picture of how individuals with perfect foresight will possibly react to changes in their life expectancy and/or retirement age.

The scenario is based on real data for the US, where life expectancy is roughly 79 at birth, the retirement age is 65 and that the average disposable income is 60 448 USD. Further on, we have said that the length of the period after 65 years is 35 years, so that people can in theory live and work till they are 100. If $\alpha = 0$ and $\beta = 0.4$, this means that an individual is retiring at 65, and expected to live till she is 79. In this case, the optimal savings rate would be 28 percent of her disposable income.

$\alpha_t \backslash \beta_t$	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	Retirement age
0	16%	22%	28%	33%	37%	40%	44%	46%	49%	65
0.1	8%	15%	21%	26%	31%	35%	38%	41%	44%	68.5
0.2	0%	7%	14%	20%	24%	29%	33%	36%	39%	72
0.3	0	0%	7%	13%	18%	23%	27%	31%	34%	75.5
Longevity	72	75.5	79	82.5	86	89.5	93	96.5	100	-

Table 7.3 – The savings rate as a percentage of disposable income in different scenarios where the life expectancy and/or retirement age is changing, everything else held constant.

If we imagine the scenario that β_t increases from 0.4 to 0.6, the life expectancy at birth goes from 79 to 86 years. If α_t is still 0, this would result in an increase in the savings rate from 28

percent to 37 percent. However, if α_t increases together with the life expectancy, say that it is set to 0.2 so that retirement age is now 72 years, the savings rate would actually decrease to 24 percent. A higher lifetime income due to a longer period in the workforce will thereby increase the optimal consumption and reduce the need for saving. What is also worth noticing is that if an individual knows how long she is going to live and choose to work until her death, she will not need to save anything.

An increase in retirement age in China might affect the incentives for saving for both the old and young cohorts. The old cohorts may not feel the same need for leaving a bequest for the next generation since they can provide for themselves for a longer period of time, and the young cohorts would not need to provide for their parents in the same magnitude. This is especially the case in urban areas, where elderly are more reliant on their pension benefit. For rural people, a higher pension age will not have a large impact since they mainly work on family smallholdings. However, a rise in the retirement age could, all in all, lead to a further decrease in the total savings rate in China, everything else held constant.

In other words, theoretically, it seems relatively simple to solve the problem with an increasing old-age dependency ratio. If the retirement age increases, pension benefits could remain at the same level, and people would not have to save as much. Unfortunately, a lot of people do not wish to work for a longer period of time, or are not able to work more due to poor health.

7.8 Qualitative discussion

From our numerical simulation model we have found that aggregate saving, and thereby aggregate private wealth, is projected to decrease in both the US and China, see figures 7.10 and 7.11. This will further on have implication on the two countries' current account balances. In our model, national wealth equals private wealth and capital is held constant. As a result, changes in private wealth will lead to changes in foreign debt, and thereby a country's current account balance⁸. With both countries facing decreasing private wealth, we can further draw the conclusion that their current account balances are deteriorating.

⁸Foreign debt per capita is as shown in chapter 5, as $\omega_t^n = k + a_t$, which further leads to a current account balance per capita equal to: $q_t = a_{t+1} - a_t$

In Chapter 3 we looked at projections regarding the outlook for both the US' and China's national savings and capital formation rates up to 2060. Both showed a trend of decreasing savings and investment rates for this time period. In China the capital formation rate is even projected to be higher than the savings rate by 2057, see figure 2.10. This will, in turn, affect the current account balance, and possibly lead to a current account deficit in China. In contrast, even though both rates are also projected to decrease in the US, from 2056 the country's savings rate is projected to exceed the country's capital formation rate. In other words, we can expect to see a current account surplus in the US at the end of our time period, see figure 2.6.

To sum up, our numerical simulation model shows a decline in aggregate private wealth in both China and the US. This is also the projection made for China, but it is however not what is expected to happen in the US. The private savings rate in the US is in fact supposed to decline, but the US' national savings rate is predicted to increase, see figure 7.12. In other words, the public savings rate is predicted to increase, which in turn will reduce their current account deficit, and possibly lead to a current account surplus after 2056.

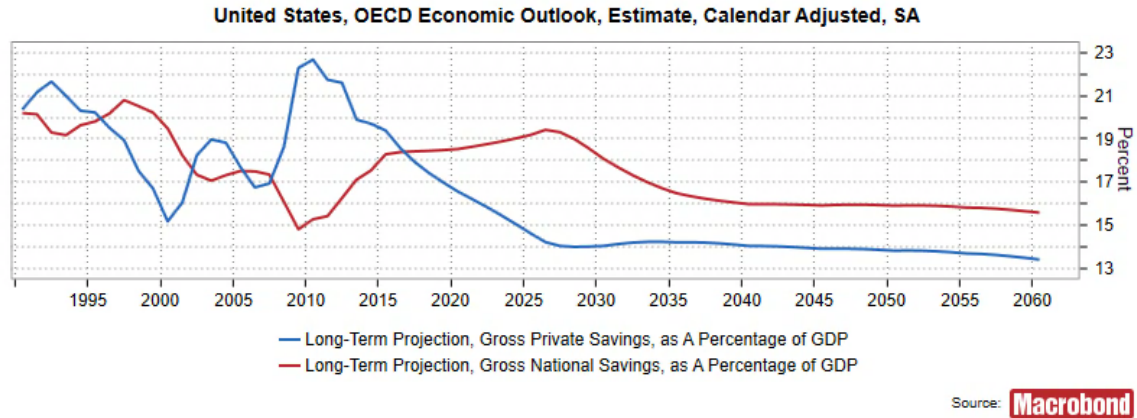


Figure 7.12 – The forecast for the US' private and national savings rate, as a percentage of GDP (1990-2060).

China and the US are the world's two largest economies and have thereby huge impacts on the global economy. We can, therefore, discuss what might happen in the global capital market from the trends we are seeing in the US and China. As discussed, the old-age dependency ratio implies a lower national saving. On a world basis, this could lead to a negative shift in the supply of saving and reduce the global saving glut, see figure 1.2. Since the world as a whole can be characterized as a closed economy, this reduction in aggregate saving will, in theory, increase the global real interest rate, all else held constant.

CHAPTER 7. FURTHER DISCUSSION

The prediction from OECD (2015) also shows that we can expect a higher real interest rate in the future. This projection is very sensitive to what will happen in a big saving country such as China, who is now experiencing a continuously aging population. Following our discussion, we can, therefore, see a possible increase in the global interest rates as a result of a lower global saving glut.

My conclusion was that a global excess of desired saving over desired investment, emanating in large part from China and other Asian emerging market economies and oil producers like Saudi Arabia, was a major reason for low global interest rates. – Ben Bernanke (2015).

8. Conclusion

The aim of this thesis is to analyze the demographic developments in China and the US from 2010 to 2060, and how these will affect their saving. Further on, it discusses to what extent these changes will affect the global supply of saving, and thereby the global saving glut.

Through an overlapping generation model, the analysis showed that from 2010 to 2060 both countries will experience a significant decline in their aggregate household savings rates. These results are coherent with the life-cycle hypothesis, as a larger share of the two populations will in the decades to come be in the dissaving stages of their life-cycle. This can be explained as an outcome of an increase in both countries' old-age dependency ratios, where China's population over 65 in 2060 will be almost half the size of its workforce.

An increasing old-age dependency will further pressure the nations' pension systems since there are fewer workers per elderly. The analysis highlights that the tax rate will need to increase in both countries in order to finance the PAYGO system in its current form. In China, the tax rate will even have to almost double in order to keep the compensation rate constant. The necessary increase in the tax rate in the US is more modest, especially due to a slower increase in their old-age dependency ratio after 2030. One possible solution to reduce the effects of a rapidly aging population is to increase the retirement age. It has been shown how an increase in retirement age might reduce saving, which is highly relevant seeing that longevity is increasing.

The decreasing aggregate private wealth will in both countries affect their current account balances. For China, this implies that they will experience a decrease from the persistently high current account surplus they have maintained the last 20 years. In fact, the long-term projections show that the country will experience a current account deficit in 2057. For the US, the projected outlooks is a current account surplus after 2056. As China and the US are the two biggest economies in the world, these transitions will have large impacts on the global capital market equilibrium.

As Ben Bernanke mentioned, China is a large reason for the high supply of saving in the global economy, and thereby an explanation behind the global saving glut. Thus, as the aggregate saving in China is projected to decrease, this might reduce the global saving glut. As a result, in order to create a new equilibrium between lower saving and desired investment, the global real interest rate might increase.

8.1 Further research and limitations

Finding reliable data for China, especially on a micro level, is a large implication and limitation to this thesis. The newest data we could find on a cohort level for labor income was from 2002. It is especially hard to find data available for the rural population. Further on, another limitation is that the thesis is aiming at making projections up to 2060. Several assumptions have therefore been necessary to make, for example, predictions regarding the two countries' demographic developments.

When we analyzed the demographic developments in China and the US, we have not included migration or mortality. In today's global world it can be interesting to look into the effect of migration, and if it could decrease the two countries' old-age dependency ratios, and thereby delay the sharp decrease in saving. In addition, future research could include public debt and expenditures aside from pension payments, since this will most likely affect the results on the countries' current account balances. Older populations will most probably lead to higher public expenditures regarding health care, and lower tax incomes. Therefore, the countries' current account balances might worsen.

The limitations of our model will presumably give us results that are in another magnitude than what we may see in other projections, and in the decades to come. We will, however, still argue that our findings are central in the light of how the demographic developments will reduce the aggregate saving in both China and the US, and as a result possibly reduce the global saving glut and increase the global real interest rates.

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A. Appendix 1

A.1 Data sources

The table below displays from which online data sources we found the data used in this thesis.

Data	Source
US income	Bureau of Labour Statistics
China income	Chinese Academy of Social Sciences
China consumption and saving	DNB Markets
GDP numbers	Knoema.com
Population historical and projections	stats.oecd.org
US national saving and capital formation rate	Macrobond
China national saving and capital formation rate	Macrobond
Japan national saving and capital formation rate	Macrobond
Mexico national saving and capital formation rate	Macrobond
Maps of worldwide saving and capital formation rates	data.worldbank.org
Population pyramids	United States Census Bureau
Labor productivity	The Conference Board
S&P 500	FRED, St. Louis Fed. Economic Research