



Department of Economics  
Lund University

# The Economic Growth Consequences of Population Aging in Sweden

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Author: Annika Eriksson  
Supervisor: Pontus Hansson

## Abstract

Population aging, early retirements and postponed labor entry may have profound effects on the economic growth in Sweden during the forthcoming decades. This study examines the economic growth consequences that may occur in the future if not preventive measures soon are considered. An extended and modified version of the well known Solow model has been used to analyze these effects. The results indicate that the government tax rate will have risen to 103 % in year 2050, due to this population aging scenario. Implicitly, substantial changes need to be pursued by the Swedish government in order to cope with this aging challenge. The model is based upon theoretical grounds and it is not tested with actual data, therefore all the comprehensive outcomes are only applicable in the illustrated model.

*Key words:* Population aging, Economic growth, Longevity, Health care, Labor

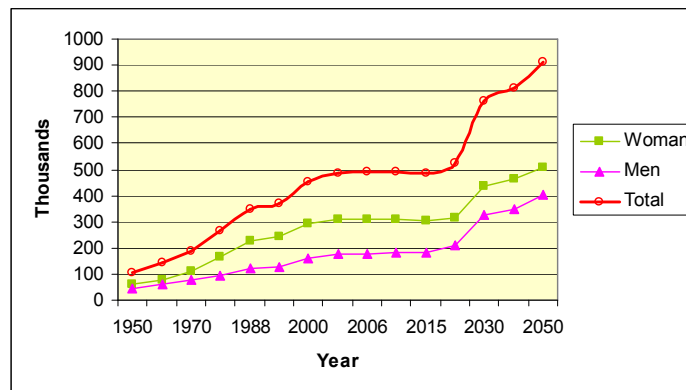
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# 1. Introduction

The fraction of the aging population in Sweden is expected to continue to rise at a relatively rapid rate over the coming decades. The percentage of the population that is aged 65 years and older is at present approximately 17 % and by the year 2020, it is estimated that one in five Swedes will be over the age of 65. A large portion of the developed countries, such as Finland, Germany, Italy and Japan is facing a similar demographic change (OECD 2006a). The amount of the elderly population in Sweden is not only growing, but their life expectancy is also rising. It is currently equal to 83 years for a woman, and 79 years for a man. These levels are expected to increase to 86 and respectively 84 years in the year 2050 (Statistics Sweden 2006b). This demographic change is likely to generate increased strain on the Swedish governments health care spending. The recent forecasts are estimating that this strain will levitate the decades after year 2016. Between the years 2020 to 2030 individuals aged 80 and over, will rapidly increase by roughly 55 percent, since the 1940's baby-boom generation enters this era. In year 2040 it is estimated that eight percent of the total population will be aged 80 or older (Statistics Sweden 2006:2).

Graph 1: Population in age group 80 < (1950 - 2050)



Source: Statistics Sweden (2006:2)

Moreover, the present low fertility rates may also affect the population growth rate in Sweden. This could imply that these characteristics of population aging, rising life expectancy and

declining fertility will result in the total amount of the working population continues to decline over time, hence there will only be a reduced labor force to support a large, aging population.

Postponed labor entry is another aspect that may influence the economic growth rate in Sweden. It is becoming increasingly common that young people do not enter the labor market until they reach the age of 27, compared to the end of the 1980's when the labor entry age was 21, thus it has declined with 6 years over the last 15 years (Arbetsmarknadsstyrelsen 2006:2). Instead of entering the labor market directly after high school at age the of 19, the younger people continue either to pursue a higher level of education, such as university, or take time off to travel and broaden their experiences. This implies that the younger generation is dependent on government support during a longer life time, hence the Swedish government will receive less tax income from this generation, as long as they continue to postpone entering the labor market.

The issue regarding early retirement pension funds has been in the spotlight during the fall. Thus, it can be seen that there is an increase in the long-term trend of early retirements. The retirement age in Sweden today is 65 years, but there are approximately 539,000 people in early retirement pensions (Försäkringskassan 2005:5). The average retirement age for both sexes is 60.3 years (Riksförsäkringsverket 2004:11). Furthermore, in a recent report by Försäkringskassan (2006), they shed light on the younger generation's part in early retirement's funds. Compared with 10 years ago, the amount of newly awarded grants for early retirement funds for individuals aged 20 to 29, have risen from 12,300 individuals in the year 1997, to the present 22,800. Early absence due to sickness may have effects both on an individual level and on the national level, since it is most likely that these young individuals will be having a hard time entering the labor market later on, hence contributing to the economic growth.

All of these developments are likely to lead to decline in the labor force growth, and hence a slowdown in the country's economic growth. Moreover it can affect our living standards in the long run. Therefore all of these developments need to be reversed in the near future, otherwise Sweden will face severe social and economic challenges.

## 1.1 Research Question and Purpose

The purpose of the thesis is to examine how the current developments concerning population aging, early retirements and postponed labor entry can affect the future economic growth in Sweden. Hence, further create a realistic forecast from the results. A comprehensive conclusion concerning the effects these important characteristics in a demographic transition may have is not yet fully acknowledged within science. Therefore I have chosen to examine these facts and its effects more carefully. The primary question that will be addressed in this thesis is:

*How will the developments regarding population aging, early retirements and postponed labor entry affect the economic growth in Sweden during the forthcoming decades?*

## 1.2 Methodology

To answer my research question, I will construct an extended and modified version of the well known economic growth model created by Robert Solow. Additionally, the population aging challenge and the consequences of each selected parameter will be enhanced and discussed in the thesis. Further, I will add data for all of the chosen parameters and from there start with my simulations. By implementing different simulations it will then be possible to further make a prediction of how the economic growth could develop in Sweden during the forthcoming decades with these aging parameters. By interpreting the results of my simulations it will then be possible to determine the parameters that are of great importance for answering my research question, thus create a forecast. This forecast will be a foundation to further estimate whether new reforms are needed to be initiated to maintain a sustainable economic growth.

## 1.3 Delimitations

Viewed from a macroeconomic perspective there are several parameters that are of great importance when estimating the future economic growth in Sweden. I reason that changes in parameters such as economic policies, environmental policy aspects and individuals utility maximization are also of great importance when estimating the country's economic growth path. However, since the purpose of this thesis is to estimate the economic growth consequences of

population aging in Sweden, these parameters will not interact and have any influence on my final outcome.

## 1.4 Disposition

In the forthcoming section, the theoretical model will be illustrated and its subsection contains a short outline of previous research in the area of demographic transition viewed from an economic perspective. Further, the third section will illustrate the modifications and extensions of the chosen theoretical model. Section four will explain and enhance some important demographic expressions that are of importance for understanding further reading in the thesis. It is followed by an outline of Sweden's past, present and projected demographic situation. Thus, the following subsection contains a short outline of the dependency ratio and the health care expenditures in Sweden. Moreover, in the subsequent section five, the simulations are illustrated and explained. In the final section, a discussion of my results is presented and also a comprehensive conclusion of my work.

## 2. The Theoretical Model

By using economic models and adding or changing economic parameters we can estimate how one change in a parameter will affect the others in the model and then make estimates about the future. The model that will be used in this report is illustrated in the Neoclassical Growth Theory, established by Robert Solow in 1956.

### 2.1 The Solow Model

The Solow model illustrates in a long run perspective, how a country's growth rate approaches its steady state level of the economy. The steady state is the level where all the parameters in the model are in equilibrium. The basic building blocks of the Solow model are built upon a production equation and a capital accumulation equation. This production function is denoted as a Cobb-Douglas function and it exhibits constant returns to scale. The basic inputs in this production function are determined by capital,  $K$  and labor,  $L$ . The capital letter  $Y$  denotes the output (GDP), thus GDP per capita is denoted with  $y$ .

$$Y = F(K, L) = K^\alpha L^{1-\alpha} \quad (2.1)$$

The second key equation, capital accumulation is determined by the amount of savings, investments and depreciation. Moreover, population growth ( $n$ ) is also included as a contributing factor in the model.

$$\dot{K} = s(1 - \tau)Y - (n + \delta)k \quad (2.2)$$

Additionally the model considers how far a country is from its steady state, hence a country that is far below its steady state will grow at a faster rate than, a country which is close to the steady state (Jones 2002).

Furthermore, to allow for long run growth in the GDP per capita, Solow added an exogenous term, technology into the production function (Jones 2002). Thus, Solow found that this



technology parameter could explain the continuous growth of economies. The distinguishing feature of this model is that countries in the steady state are growing along a balanced growth path, compared to the original Solow model (without the technology parameter) where countries do not grow at all in the steady state.

In a research paper by Paul Romer in the 1990's he presented a theory known as the New Growth Theory. In Solow's model, technology was assumed to be exogenous, hence it did not explain what caused technology to improve over time. Romer changed this exogenous assumption so that the technology term should be considered endogenous, determined by forces within the model. Research and development are determined to be the forces behind the technological progression. Further along in Romer's model, the growth in human capital is determined by average years of schooling, education quality, the overall productivity, the amount of a country's human capital and also by the technology level in the world (Jones 2002).

## 2.2 Previous Research

Since the 1990's several researches have been made in the area of demographic transition, and how they may affect the economic growth for developed countries. However, the important facts that are highlighted in the thesis concerning the economic growth consequences of population aging in Sweden have not yet been fully acknowledged within research previously.

A conclusion concerning whether population aging has a negative or a positive effect is not yet fully established within science. Futagami and Nakajima (2001) have written a research paper that examines how a country's economic growth is affected by an aging population. They used a continuous time, life cycle savings model in combination with endogenous growth. They argue that an increased retirement age would result in a lower savings rate, thus contribute to a growth slowdown. Nonetheless they concluded that an aging population is not certainly a negative factor for economic growth.

Heinrich and Weil (2006) have conducted research on how a country's population age structure interacts with fertility and economic dependency. They developed a continuous time generation's

model and divided the population into three groups (young, working age and old) thus, these three groups overlapped each other. Their model investigated how a change in fertility would affect the consumption burden at different stages in life. The authors conclude that a large fraction of a working age population's income will be redistributed to the elderly generation, if a specific country has a high level of old-age dependency. The working age individuals would respond by lowering fertility. Moreover, their results suggest that the positive consumption effect due to a low fertility will turn, to a negative scale instead over time. Viewed in a long run perspective, the authors conclude that this would lead to further reductions in fertility, implying a decline in the future consumption level. This research is of interest since the old-age dependency ratio in Sweden is expected to exceed the youth's dependency ratio around year 2035 (Statistics Sweden 2006:2). This is further explained in section 4.3.

Furthermore Bloom, Canning and Sevilla (2004) have studied the different effects behind a rising life expectancy. They concluded that a better health implies labor productivity improvements, thus increased longevity may have a positive effect on the economic growth rate. Their model suggests that a one-year improvement in a population's life expectancy would raise output by four percent.

### 3. Model Extensions and Modifications

The purpose of the thesis is to create a realistic description of how the economic growth path could develop during the forthcoming decades. Therefore I have extended and modified the Neoclassical Growth model by Solow with additional parameters. These intended parameters are the labor force, longevity, health care expenditures and labor input. I reason that these chosen parameters are of importance when making an estimation and evaluation of the economic growth in Sweden.

#### 3.1 The Extended and Modified Model

The production function: 
$$Y = K^\alpha p^\alpha (AhL)^{1-\alpha} \quad (3.1)$$

Where Y is GDP, A is technology, K is capital, h is human capital and L is labor and finally the parameter p measures the total labor input. This parameter is estimated with the following expression:

$$p = w * \mu \quad (3.2)$$

Where w is working hours per day,  $\mu$  is number of working days per year, thus this parameter is measured per individual. The subscript parameter  $\alpha$  is an exogenous parameter, thus it determines how large the output fraction will depend on the different production factors.

The capital accumulation function is specified as:

$$\dot{K} = s(1 - \tau)Y - \delta K \quad (3.3)$$

s is savings,  $\delta$  is the depreciation rate and  $\tau$  is the government tax rate, denoted with this specified equation<sup>1</sup>:

$$\tau = \left[ \frac{\theta\lambda}{Y} + \frac{\varphi - L}{\varphi} \right] \quad (3.4)$$

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<sup>1</sup>  $\tau = \frac{T}{Y} = \frac{\theta\lambda + [(\theta - L/\theta)]Y}{Y} = \frac{\theta\lambda}{Y} + \frac{\varphi - L}{\varphi}$

The tax function is further explained in section 3.2.5

where,  $\theta$  is the total number of newborn individuals that are presumed to reach an age of 80 or older. It is denoted as:

$$\theta = \pi * \varphi \quad (3.5)$$

$\pi$  is the percentage of the total population which is aged 80 and older, and  $\varphi$  is the total population (both of these parameters are based on forecasts from Statistics Sweden). Further back to the tax equation (3.4) and its remaining parameters. The parameter  $\lambda$  is health care expenditures for individuals aged 80 and older. It is denoted as:

$$\lambda = \theta * \Omega \quad (3.6)$$

$\Omega$  is the average health care expenditures for elderly individuals. The last parameters in the tax equation (3.4) are  $Y$  which is the total GDP level and  $L$  is the total labor force. On account of the projected demographic change in Sweden during the upcoming decades, the government tax equation is constructed in a way that it includes longevity changes, health care expenses for elderly inhabitants and labor force changes, additionally the total GDP level is also included. Nevertheless, the Swedish government may need to pursue a goal of collecting a larger amount of taxes, in order to maintain a stable economic growth during the forthcoming decades.

Quality improvement in labor is represented by the term, human capital. It is denoted with the following expression:

$$h = e^{\psi u} \quad (3.7)$$

where,  $\psi$  describes the education quality and  $u$  is average years of schooling.

Both the parameters, output per worker ( $g_y$ ) and capital per worker ( $g_k$ ) grows at a constant rate, stated as a balanced growth path, similar as in the Solow model with technology. The steady state growth rate is driven exogenously by the growth of the technological progress<sup>2</sup>:

$$g_y = g_k = g \quad (3.8)$$

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<sup>2</sup> See Appendix 1, for details of this expression

The steady state level is estimated by the following expression<sup>3</sup>:

$$y^* = \left[ \frac{s \left( 1 - \left[ \frac{\theta \lambda}{Y} + \frac{\varphi - L}{\varphi} \right] \right)}{\delta + g + n} \right]^{\frac{\alpha}{1-\alpha}} \times \left( \frac{e^{yu} L}{\varphi} \right) \times p \quad (3.9)$$

From this expression it can be seen that the income level will rise with each individuals additional labor input contribution in terms of labor hours, and evidently when the fraction of the labor force is growing. The income level will increase as well with an improved level of human capital. In this expression, the aging population will have a negative impact on the country's economic growth. The income level will decrease when a newborn child's probability of becoming aged 80 and older rises. Additionally, a rise in the elderly health care expenditures will lower each individual's income level.

This expression exhibits two contradicting effects. Suppose that the average number of years of schooling increases, this will contribute to a higher level of human capital. However the contradicting effect is that the fraction of the available labor force will decline, since the younger generation additionally extends, the already postponed labor market entry.

## 3.2 The Extended and Modified Parameters

The following sections contain a general discussion of the model's extended parameters. Additionally, each parameters consequence for the Swedish economic growth and the country's total GDP level is also discussed.

### 3.2.1 The Labor Force

The labor force is defined as individuals, aged between 20 - 64 years that are working either part-time or full-time. The non-working population is defined as children, students, individuals on a

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<sup>3</sup> See Appendix 1, for details of this calculation.

disability pensions and old-age pensions. The long-term trend of early retirements has also been a key contributor to the hazardous fact of a declining labor force participation in Sweden. One reason for the early labor market exit could be that it is harder for older workers to keep their jobs, since they are being replaced by the younger working age population, which contributes with more innovative and recent knowledge than the older work force. Viewed from an employer's side, a reason for not employing an older worker may be due to the perception of assuming that it is harder for an older worker to adapt to new technology and changes within the company (OECD 2006b). In the beginning of year 2006 the Swedish telecom company Ericsson, offered their "middle aged" employees incentives to leave the company and, thus make room for the younger generation to enter the telecom labor market. According to Ericsson, employees aged between 35 and 50 were defined as "middle aged" employees. The Ericsson board of directors motivated this strategic decision with a statement that declared that this age structure change would direct the corporation into a better competing position in the world market (Borås Tidning 2006).

If the elderly generation is getting larger than the available work force, then there might be need for a change in the work force pattern. A possible scenario might be that the working aged generation today will be forced to work until they reach the age of 70, thus this could boost the labor force participation rate in Sweden, and this would further contribute to the economic development.

Immigration is often discussed whether it contributes to the economic growth for developed countries. In a research article by Fehr, Jokisch and Kotlikoff (2004) they made estimations in three regions, the US, Japan and EU if immigration would alleviate the stress of the rising old dependency ratios in these countries. The authors argue that a significant enlargement of low skilled immigrants will not contribute so much, since it would lead to reductions in the real wages. The immigrants also need to be provided with the same social insurance benefits as the native population, although they discuss that an expansion of high skilled immigrants would be a positive contributor for the developed countries.

### 3.2.2 Longevity

Increased longevity may have impacts on the economic growth in Sweden, since population aging raises the demand for public health care. Life expectancy at birth is projected to rise from the present, 83 years for a woman respectively 79 years for a man, to 86 years for a woman, correspondingly 84 years for a man in year 2050 (Statistics Sweden 2006b). Increased longevity may cause strain on the country's public finances. It is most likely that Sweden will have a need for a larger cohort of working inhabitants in order to cope with this challenge, in combination with increased taxes or by cuts in the social government benefits.

Yakita (2001) considered the effects the fertility rate has on population aging, and further how this affects the economic growth rate for a country. He concludes that increased longevity will lead to a decline in fertility rates, thus increase the demand for retirement savings, which can be used for future consumption later on when the individual enters the retirement age era.

Science as regards how increased longevity affects growth determinants such as savings, time spent on education and fertility is illustrated in an article by Zhang and Zhang (2005). Their empirical studies reveal that increased life expectancy leads to incentives to reduce fertility, although incentives to raise the human capital, savings and the growth rate. Additionally the authors argues that in developed countries with already high life expectancy levels, these countries will not experience any large economic impacts in the coming future. As the authors results illustrates the positive economic growth effects improved life expectancy has.

Health improvements are one of the reasons behind the rising longevity in Sweden, hence this further affects the labor market exit age. Increased longevity unaccompanied, gives incentives for higher savings rates among the younger generations (Yakita 2001). However, health improvements may have effects that postpones the early labor market exit age, thus postpone the retirement entry age (Bloom 2003).

### 3.2.3 Health Care

The population aging consequences viewed from a health care perspective is of importance since the number of elderly individuals is anticipated to rise in Sweden within the near future. This may give incentives for an enlarged and an endeavored economic burden.

Earlier, most signs pointed towards that the elderly population in Sweden is getting larger due to quality improvements in the health care treatment, but there is a hazard that this scenario will turn the other way around in the future. Recently Meinow (2006) presented a report concerning this issue. In the past decades it has been harder for retired individuals to move to “old age institutions”, hence the outcome of this is that a larger fraction of frail individuals are still living at home and have medical needs, as well as needs for home help services. Today the signs have started to change direction towards that the elderly population’s health has been deteriorating. If these signs turn out to be correct it could imply that health care expenditures in Sweden may boost to an even higher level. The Swedish government might face bigger impacts than what is currently anticipated for the future.

### 3.2.4 Labor Input

Labor input is an important contributor for a country’s economic growth. The common postponed labor entry among the Swedes may have an influence on the country’s GDP per capita. Today a young individual is likely to enter the labor market at the age of 27 (Arbetsmarknadsstyrelsen 2006:2). An individual who is not participating in the labor force does not contribute considerably in terms of working hours to facilitate the challenge that the aging population will convey. It is most likely that this continuously postponed labor market entry will have consequences on the economic growth, in the foreseeable future. Moreover, most individuals in available work force in Sweden hold a full-time work position. However, average hours of work are currently low in Sweden. A “standard” working week contains 30.6 hours per individual measured in terms of both sexes (Statistics Sweden 2006c).



To grasp these crucial implications, a needful change in the amount of each individual's labor input may be of great importance. I have chosen to further extend the link between contributed working hours as well as the amount of working days per year. Therefore I decided to construct a parameter which is denoted,  $p$ . This parameter measures how much labor input one individual will be contributing with.

### 3.2.5 Government Taxes

The government tax rate is constructed in a way that it contains parameters such as the available work force, the total GDP level, longevity and health care expenses for very old inhabitants. I reason that if these parameters are changed simultaneously, they could have a significant long-run effect on the economic growth.

The logic behind this tax equation is based on the assumption that the income redistribution is in benefit for the working fraction of the total population. Hence, they obtain the total capital stock, this implies that they will receive all the available income. As a result, the non-working population does not receive any income for presumable work, which further can be spent on consumption. Nevertheless in order to cope with this situation above, the Swedish government will need to collect taxes from the working fraction of the population. This additional income will be redistributed to the non-productive individuals in terms of a subsidy, which can be spent on consumption. Moreover by continuing assuming that the total population holds an equal consumption level, then the government's income in terms of taxes must be part of a share of the total GDP, which must be equally large as the non-productive individuals.

## 4. Demography and Health Care Expenditures in Sweden

Since this thesis consists of numerous demographic terms, I reason it is easier for the reader to follow the statements and results, which will be presented later on, if I describe the demographic terms in more detail. Further along, this section contains facts concerning Sweden's past, present and projected demographic situation, the dependency ratio and also details about the country's health care expenditures.

### 4.1 Demographic Expressions

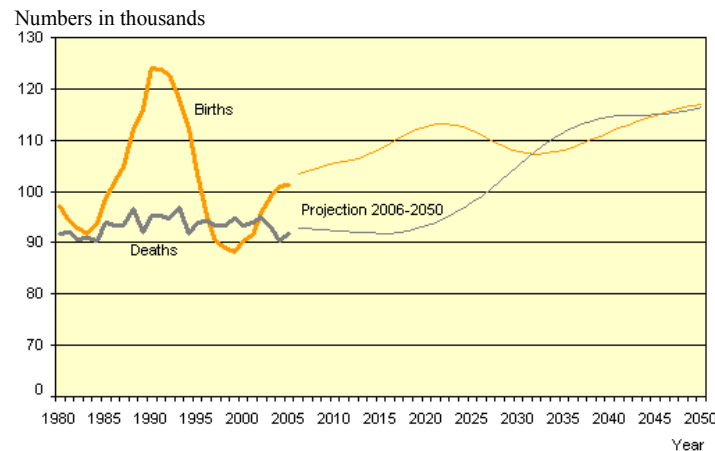
Life expectancy at birth is defined as the average number of years that a newborn child can expect to live, if the individual is subjected during all his life to the current morality conditions. Fertility is measured by an indicator expressed as the total fertility rate (TFR). It is defined as the average number of children that a woman would give birth to during her reproductive lifetime period adjusting to the age-specific fertility rates of a given year (Weil 2004). The number of deceased over the total population in a certain time frame determines the mortality rate in a country. The combined measure to estimate the effects of fertility and mortality in determining population growth is illustrated by the net rate of reproduction (NRR). It is defined as the average number of daughters that each woman who is born is expected to give birth to, assuming she passed through her lifetime conforming to the fertility and mortality rates of a given year. If the net rate of reproduction is 1, this implies that a country's population is constant. On the other hand if the NRR is 2, this indicates that the total population would double every generation (Weil 2004).

### 4.2 Sweden's Past, Present and Projected Demographic Situation

The Swedish population has since the beginning of the 1900's increased from 5.1 Million to the present, 9 Million inhabitants in year 2005 (Statistics Sweden 2005a). Since the 1920's Sweden has experienced two noticeable baby-boom eras, which gave the total fertility rate a boost to 2.5

in the 1940's, hence the second baby-boom era occurred in the 1990's, where the total fertility rate increased from 1.66 in the 1980's to a rate of 2 in the year 1990. Around year 2020 this generation will have effects on the available labor force. Depending on how large the immigration surplus will develop, the working age fraction is expected to continue to increase until 2045 with the exception of a sharp decrease in year 2030 (Statistics Sweden 2006:2). There has been an obvious decrease in the total fertility rate since the 1940's (except for the two visible baby-boom eras previously described), the fertility rate has declined to a current level of 1.77. As indicated by Statistics Sweden the TFR is projected to slightly increase over the coming years, and then level out to a constant rate of 1.85 from year 2015 until year 2050 (Statistics Sweden Databases 2006). Once the previously described baby-boom generations approach their retirement age and Sweden still is facing a low fraction of young people who are entering the labor market, implicitly there will not be enough individuals to replace the huge number of retirements.

Graph 2: Births and deaths 1980-2005 and projection 2006-2050

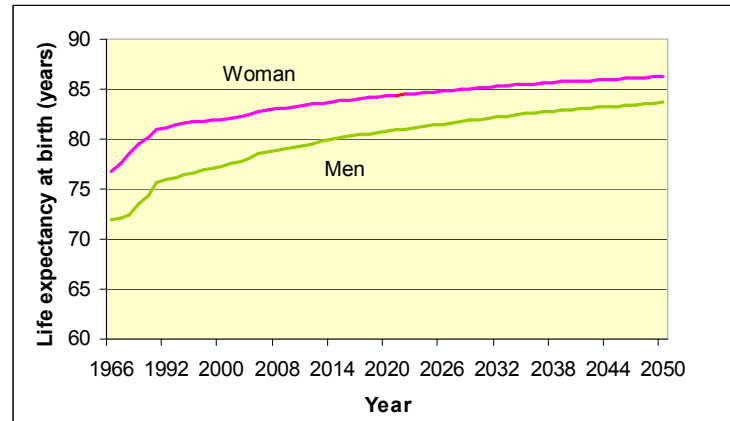


Source: Statistics Sweden (2006:2)

The mortality rates in Sweden have slightly decreased since the beginning of the 1900's century. This reduction can be explained by the quality improvements in the medical treatment and the standards of living. These two alterations concerning, fertility and mortality have had positive effects on the life expectancy at birth. It has alleviated from 57 years for a woman, respectively 54 years for a man in year 1905, to the present 83 years for a woman, correspondingly 79 years for a man in year 2005 (Statistics Sweden Databases 2006). Nevertheless, these levels are expected to reach to 86 years correspondingly 84 years in year 2050 (Statistics Sweden 2006b).

Japan is the only country which has higher life expectancy rates than Sweden currently is subjected to.

Graph 3: Past and predicted life expectancy at birth, (1966 - 2050).



Source: Statistics Sweden Databases (2006)

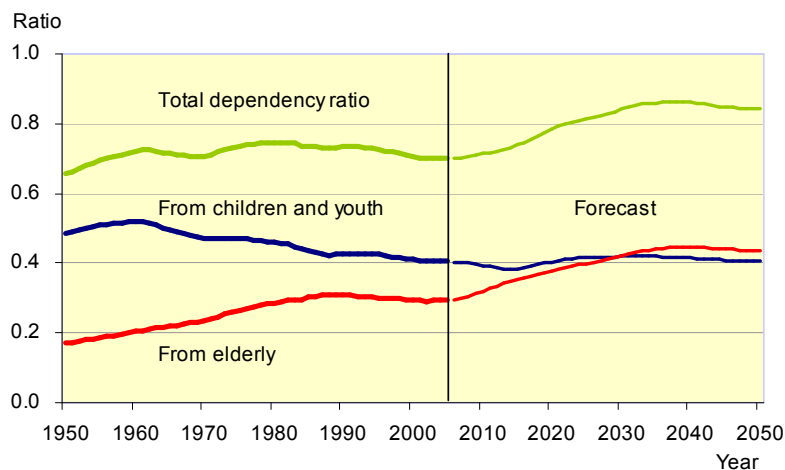
The population forecasts by Statistics Sweden (2006b) are estimating an enlargement in the Swedish population to 10.5 Million in year 2050. Since fertility rates will continue to be low, this population increase will be a consequence of future projections that are estimating a larger immigration than migration.

A country's population is often viewed as a population pyramid, with the younger and larger generation in the bottom and the smaller elderly generation in the top. However, by looking at data from year 1850 and the future predictions until year 2050, the Swedish population pyramid will change significantly over a time period of 200 years. In the beginning of the 1950's the pyramid started to take the form of a cube instead of a pyramid, hence this evolution is still continuing. The latest forecasts are estimating that the Swedish population will have a cube-like shape in year 2050 (Statistics Sweden 2005b). The net rate of reproduction for Sweden is today approximately 0.83 and according to a forecast by United Nations (2005) it is expected to increase with a modest amount, and stay at a constant rate of 0.89 from the year 2015 until year 2050.

### 4.3 Dependency Ratio

The dependency ratio is one of the indicators used to describe the effect the working population has on the amount of an older population. This measure can estimate how large the economic burden will turn out to be on the labor force participants<sup>4</sup>. As seen in the graph below the old age dependency ratio will almost have doubled in year 2050, compared to year 1990. The total amount of elderly inhabitants in Sweden that will be in need of government support will exceed the younger generations need, around year 2035. In the 1950's the dependency ratio for younger individuals was significantly higher compared to the elderly. The total dependency ratio will rise from the present 0.70 to 0.84 in year 2050. Nevertheless, this outcome implies that each working age individual needs to support 0.84 individuals by the year 2050 (Statistics Sweden 2006:2). Increased pressure on the public health care expenditure in the forthcoming decades is likely to occur as a consequence of population aging, hence health spending per capita is higher for older inhabitants.

Graph 4: Dependency ratio, 1950 - 2005 and projection 2006 - 2050



Source: Statistics Sweden (2006:2)

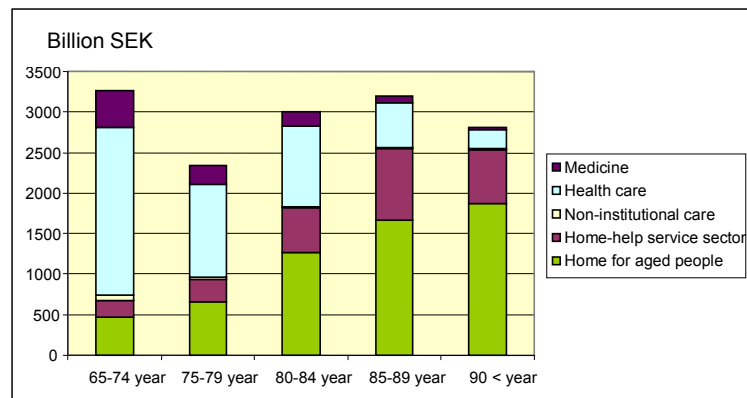
### 4.4 Health Care Expenditures

Increased economic strain may be an inescapable outcome for Sweden in the coming decades, due to the significant boost of elderly individuals. Statens Kommuner och Landsting (SKL) has estimated that their health cost expenses for men will double from the age of 60 to 75, hence a

<sup>4</sup> Defined as working aged individuals between 20 to 64 years.

similar effect can be seen among the woman. Moreover, seen from the demographic transitions viewpoint this population aging effect will increase the economic strain on the Swedish Country Council by roughly 0.70 percent per year. In combination, the cost enhancements in medicine, medical-technical development and with government reforms, the economic strain will end up in a yearly increase of 1.7 percent, over the coming years (Wikstrand, M. 2006).

Graph 5: Total health care spending for retired individuals during year 2003



Source: Socialstyrelsen (2006)

The graph above illustrates the total health care spending for retired individuals in the Skåne region during year 2003, though costs per individual are highest among individuals aged 90 and over. Nonetheless this health care spending is seven times higher for individuals aged 90 and over, than for individuals aged 65 - 74 years (Socialstyrelsen 2006). Special home's for elderly inhabitants is the largest expense for individuals aged above 90 years. This provocation may imply that there is a need for further reform changes, to be able to cope with this aging challenge.

## 5. Population Aging Simulations

The undertaken model used for the simulations in this thesis is the economic growth model by Robert Solow. It has been extended and modified with additional parameters, which were explained more in detail in the third section. The purpose of constructing these simulations is to illustrate how a demographic change viewed by considering the aging population, early retirements and postponed labor entry may have consequences on the economic growth in Sweden. By changing the described parameters in the modified model in the third section, hence it is possible to determine the parameters which are of great importance for estimating the economic growth path and its future development in Sweden.

### 5.1 Base Values<sup>5</sup>

Insofar I have explained all the parameters that are involved in this growth projection and now I will present the chosen base values. It may be difficult to acquire data for some of the parameters previously described in section three, however it is common to select a value between 0 and 1 for these parameters, where 0.5 then is the most neutral base value in this case. Since it has been difficult to acquire an appropriate base value for the Omega parameter ( $\Omega$ ), which measures the average health care expenditures for one elderly individual, I have chosen to use this neutral base value. Note that this only pertains to the Omega parameter ( $\Omega$ ).

The value for the technology growth rate ( $g$ ), is obtained by calculating the long-term growth rate in the Swedish GDP, here it is calculated to be 2.2 % between the years 1950 - 2005. Year 2005 has been set as the base year for this simulation, data for the labor force ( $L$ ), the total population ( $\varphi$ ), the capital stock ( $K$ ) and the GDP ( $Y$ ) have been obtained from Statistics Sweden Databases (2006). The total amount of newborn individuals that are presumed to reach an age of 80 or older ( $\theta$ ) is also obtained from Statistics Sweden Databases (2006). This is based on their forecast of how large the fraction of the total population that will be aged 80 and older during the

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<sup>5</sup> See appendix 2, for all the values defined in a table.

coming decades. Thetas ( $\theta$ ) base value is set to 487,620. The pi ( $\pi$ ) parameter measures the percent of the population that is aged 80 and older, its base value is set to 0.054. The base value for the health care spending ( $\lambda$ ) parameter is set to 244,000, since this parameter depends on the  $\theta$  value and also on the average health care spending per elderly individual ( $\Omega$ ). The base value of Omega has been set to 0.5, since it was difficult to acquire an appropriate value for this parameter. The parameter total labor input ( $p$ ) is set to 1.38 since it is affected by an individual's average daily working hours. From Statistics Sweden Databases (2006) I acquired data over the average daily working hours per individual ( $w$ ), it is estimated to be 6.12 hours per day, and the number of working days per year is (exclusive public holidays and five weeks of vacation) estimated to be 226. The depreciation rate,  $\delta$  is set to 0.05, which is the most common value used by economists. The savings rate ( $s$ ) is set to 0.205 and this data is obtained from the Penn World Table (2006). Moreover, the parameter education quality ( $\psi$ ), in the human capital function is set to 0.1. This parameter illustrates that for every additional year of schooling an individual will raise its output with 10 % (Jones 2002). The human capital functions also consist of the parameter ( $u$ ), which represents average years of schooling. For this parameter I have assumed a base value of 13. Alpha ( $\alpha$ ) is set to 1/3 in this projection, since it is difficult to estimate an exact number for this parameter I have used the most common value among economists for this parameter (Jones 2002).

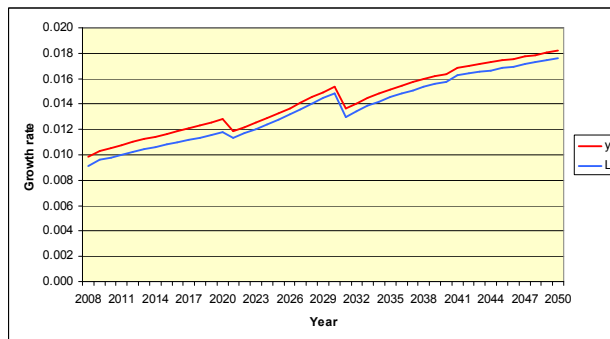
### 5.1.1 Changes in the Labor Force

To estimate whether population aging will affect the economic growth in Sweden, I have conducted a scenario that involves changes in the amount of the available labor force. I have used forecasted data from Statistics Sweden (2006:3) concerning how the labor force is estimated to change over the upcoming decades. The available labor force base value is set to 4,328,000 according to this forecasted data. Starting from year 2005 and until year 2020, this value is estimated to exhibit a yearly increase of 12,300 individuals per year. Between the years 2020 and 2030 this value is estimated to increase with only 6,000 individuals per year. Since Statistics Sweden only had forecasted data over the available labor force until year 2030, I made the simple assumption that the available work force will be growing at a constant rate of 6,000 individuals until year 2050.

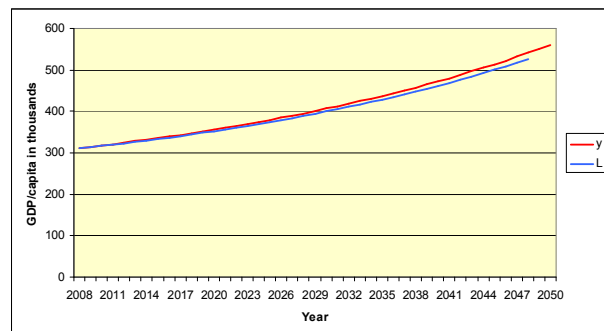


Between the years 2006 and 2020, the available labor force is changed from its base value to a yearly increase of 8,000 individuals (instead of 12,300 individuals per year). This is based on the assumption that within this time frame a large amount of elderly will start leaving the labor market. Yet, in year 2020 this assumption is changed to a yearly increase of 5,000 individuals (instead of 6,000 individuals per year), since the large baby-boom generation enters this decade. Nevertheless, in year 2030 the available labor force is once again changed to a yearly increase of 4,500 individuals, based on the assumption that the elderly population will continue to be a large part of the total population in Sweden. This scenario has considered the huge effects the previously described baby-boom generations (explained in section 4.2) may have on the Swedish income level in the future.

**Graph 6:** GDP growth rate (y) indicated by forecasts from Statistics Sweden and the GDP growth rate consideration taken with respect to labor force (L) changes.



**Graph 7:** The GDP/capita's (y) development indicated by forecasts from Statistics Sweden and the GDP/capita's development consideration taken with respect to labor force (L) changes.



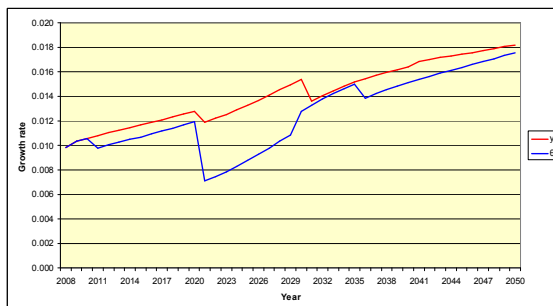
The first sharp decline in graph 6 above illustrates the first baby-boom generations complete withdraw from the labor market. The following positive trend illustrates the second baby-boom generations entry to the labor market. Over the forthcoming years Sweden will experience a huge alteration in the available work force, as the fraction of the elderly workers will abandon the labor market and retire, thus fertility rates are also projected to be low in the future. In the end, the changes will depend on how large the immigration will turn out to be, though these numbers are difficult to project. Nonetheless, the average annual growth rate will drop from 1.5 % to 1.4 % in year 2050. Graph 7 illustrates the development in the Swedish GDP per capita over the coming decades. These results reveal that the GDP per capita in year 2050 would be reduced

from 571,000 SEK to 555,000 SEK. This outcome implies a yearly reduced income of 16,000 SEK for the average Swede in year 2050. This scenario illustrates how the Swedish economic growth could develop during the coming decades with the undertaken labor force changes.

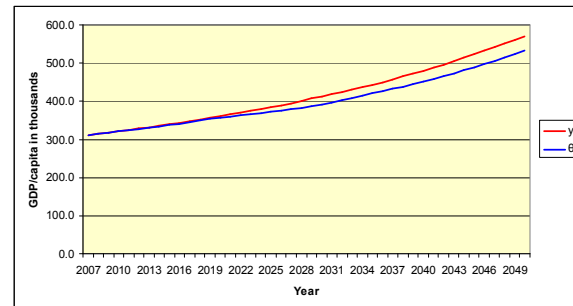
### 5.1.2 Changes in Longevity

This scenario is estimated by changing the base values acquired from the Statistics Sweden Databases (2006) of elderly individuals aged 80 and older. Initially I changed this parameter from its base value 0.054 to 0.07 from year 2010, based on the assumption that individuals aged 80 and older will start increasing from this year and forward. In year 2020 this value is once again changed since it is projected that Sweden most likely will experience a huge alteration of the amount of elderly individuals. The value is changed from its base value of 0.058 to 0.11. Hence, in year 2030 and for the next 20 years, this value is changed once again from its base value of 0.084 to 0.1.

**Graph 8:** GDP growth rate ( $y$ ) indicated by forecasts from Statistics Sweden and the GDP growth rate consideration taken with respect to longevity ( $\theta$ ) changes.



**Graph 9:** The GDP/capita's ( $y$ ) development indicated by forecasts from Statistics Sweden and the GDP/capita's development consideration taken with respect to longevity ( $\theta$ ) changes.

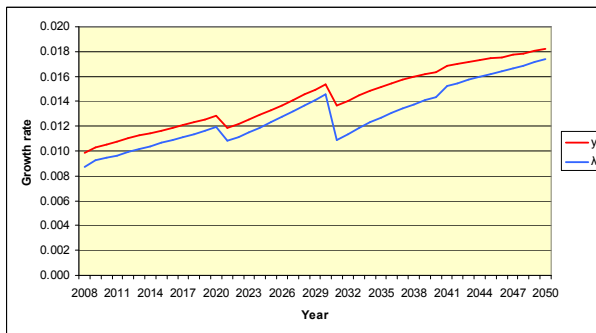


This scenario illustrates how a longevity change might affect the country's economic growth in the forthcoming decades. The annual growth rate will decline from a level of 1.5 % to 1.3 % in year 2050 with this aging probability parameter. Graph 9 indicates a reduction of the GDP per capita from 571,000 SEK to 532,000 SEK. This outcome implies a yearly reduced income of 39,000 SEK for the average Swede in year 2050 with the undertaken longevity alterations.

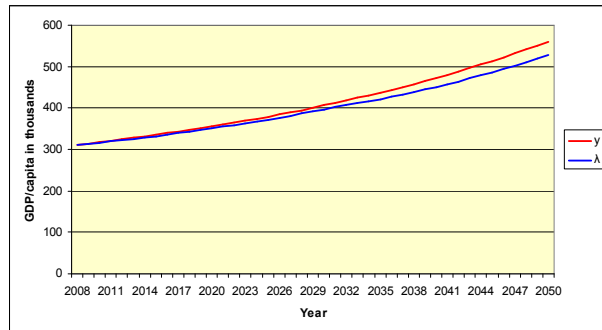
### 5.1.3 Changes in the Health Care Expenses for an Elderly Individual

This scenario will estimate whether the aging population may have any effect on the GDP per capita in Sweden, seen from a health care expenditure viewpoint. Initially I changed the  $(\theta)$  parameter to the similar base values as described in the previous section, thus I also changed the health care expenditures from 0.5 to 0.9. This conveys that the health care expenditure ( $\lambda$ ) parameter will change from its base value of 244,000 to 439,000. Health care spending per individual is significantly higher for individuals aged 80 and older, since they most likely have a larger need for special made homes and an increased need of home help services.

**Graph 9:** GDP growth rate ( $y$ ) indicated by forecasts from Statistics Sweden and the GDP growth rate consideration taken with respect to health care expenditure ( $\lambda$ ) changes.



**Graph 10:** The GDP/capita's ( $y$ ) development indicated by forecasts from Statistics Sweden and the GDP/capita's development consideration taken with respect to health care expenditure ( $\lambda$ ) changes.

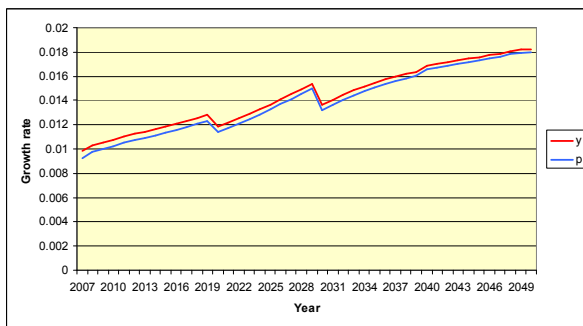


The first sharp edge in graph 9 above illustrates the scenario of the first baby-boom generations approach to ages above 80 years. Graph 10 illustrates how large the GDP per capita reduction will be in year 2050, when increased health care expenses have been taken into consideration. Thus, the GDP per capita will be reduced from a level of 571,000 SEK to 538,000 SEK. This outcome implies a yearly reduced income of 33,000 SEK for the average Swede in year 2050. Furthermore, the annual growth rate will decline from a level of 1.5 % to 1.4 % in year 2050 with these undertaken health care expenditure changes.

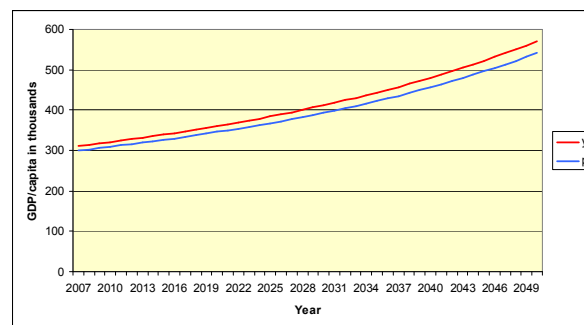
### 5.1.4 Changes in Labor Input

In this scenario I want to illustrate how a decline in an individuals labor hours will implicitly lead to a decrease in the country’s economic growth. Initially I presume the assumption that Sweden will experience an alternation from a large cohort of full-time workers and a small cohort of part-time workers to the contrary. Hence, the base value of the parameter working hours per day ( $w$ ) is changed from 6.12 to 5.5 hours per day with this assumption.

**Graph 11:** GDP growth rate ( $y$ ) indicated by forecasts from Statistics Sweden and the GDP growth rate consideration taken with respect to labor input changes ( $w$ ).



**Graph 12:** The GDP/capita’s ( $y$ ) development indicated by forecasts from Statistics Sweden and the GDP/capita’s development consideration taken with respect to labor input changes ( $w$ ).

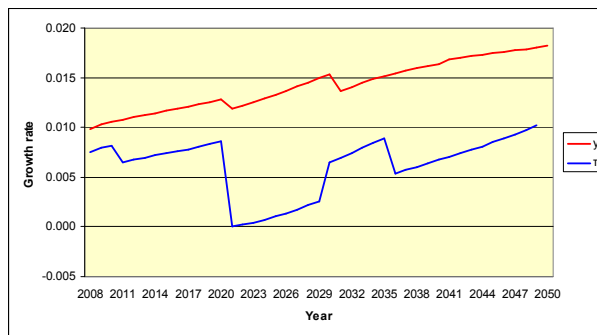


Graph 12 illustrates how large the GDP per capita reduction will be in year 2050, when a reduced amount of labor input have been taken into consideration. Thus, the GDP per capita will be reduced from a level of 571,000 SEK to 542,000 SEK in year 2050. This outcome implies that the average Swede would loose 29,000 SEK of its yearly income with this scenario. The annual growth rate will decline from a level of 1.5 % to 1.45 % in year 2050 with these undertaken labor input changes.

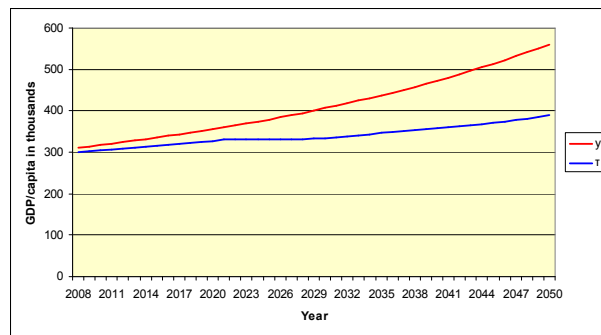
### 5.1.5 Simultaneous Changes

Insofar I have made changes in one parameter at a time, since I wanted to illustrate how each parameter unaccompanied would affect the country's economic growth. In this scenario I have performed all of the four parameter changes simultaneously, since all the parameters have previously shown that they unaccompanied may have considerable long run effects on the economic growth. When I conducted all the changes simultaneously the tax rate is changed from its base value of 0.56 to 0.6. In year 2050, the tax rate has changed from its base value of 0.65 to 1.03. Implicitly, its crucial consequences can be understood. An average Swede would pay 103 % of its available income in government taxes.

**Graph 13:** GDP growth rate ( $y$ ) indicated by forecasts from Statistics Sweden and the GDP growth rate consideration taken with respect to tax rate ( $\tau$ ) changes.



**Graph 14:** The GDP/capita's ( $y$ ) development indicated by forecasts from Statistics Sweden and the GDP/capita's development consideration taken with respect to tax rate ( $\tau$ ) changes.



This tax parameter may perhaps have huge consequences for the country's future income level. The annual growth rate will decline to a level of 0.7 %. Additionally, in graph 14 the huge consequence can be seen, the GDP per capita would drop to a level of 393,000 SEK in year 2050 (The base value for the annual growth rate was 1.5 % and the GDP per capita was 571,000 SEK). The outcome of this scenario is that the average Swede would experience a yearly reduced income of 178,000 SEK in year 2050.

This specified tax equation illustrates from a population aging perspective, the economic challenges Sweden might be facing in the coming decades. In the long run, it is most likely that the average Swede will experience an adjustment from today's standards of living.

## 6. Discussion and Conclusion

This purpose of the thesis was to estimate and evaluate the economic growth consequences Sweden might face, due to the profound effects of population aging, early retirements and postponed labor entry during the forthcoming decades. This thesis is based upon theoretical grounds and it is not tested with actual data. Therefore, all the comprehensive conclusions are only applicable in the illustrated model.

The interpretation of the results indicates that all of the illustrative modifications in each parameter of the model will have profound effects on the economic growth. This model illustrates a rather surreal scenario, since my projections predicts the outcome that the tax rate will have risen to 103 % in year 2050, due to the aging population. Although, this outcome can be seen as a sign to the Swedish government to pursue crucial changes in the foreseeable future, in order to cope with the large demographic transition.

Increased labor force participation in combination with increased working hours per week has legible been indicated by the results to be an essential and important part. The Swedish government needs to enhance the cohort of working inhabitants in order to maintain a sustainable economic growth. A possible scenario can be that the working fraction of the population might experience longer working days, and also enter the labor market earlier than they are currently. Besides this scenario, the Swedish government may also need to increase the retirement age to 70 years instead of 65 years, in order to obtain supplementary tax incomes, in combination with reduced social government benefits, to be able to support this estimated large cohort of elderly individuals.

This thesis outcome also highlights the importance of the elderly workers contribution to the economic growth. Sweden needs to reverse the trend of replacing the older workers too early, since they are part of the key to cope with the large aging population.

The result of the thesis illustrates the comprehensive impact the aging population may have in the foreseeable future, if the Swedish government does not consider necessary preventive measures. Considerable improvements need to be pursued in order to manage the aging challenge.

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## Appendix 1: The Extended and Modified Model's Steady State Solution

Production function:

$$Y = K^\alpha p^\alpha (AhL)^{1-\alpha} \quad (\text{A.1})$$

where,

$$h = e^{\eta u} \quad (\text{A.2})$$

Capital accumulation:

$$\dot{K} = s(1-\tau)Y - \delta K \quad (\text{A.3})$$

where,

$$\tau = \left[ \frac{\theta \lambda}{Y} + \frac{\varphi - L}{\varphi} \right] \quad (\text{A.4})$$

To obtain the growth rate in  $\dot{K}$ , divide (A.3) with K:

$$g_k = \frac{\dot{K}}{K} = s(1-\tau) \frac{Y}{K} - \delta \quad (\text{A.5})$$

This expression above implies that when  $g_k$  is constant in the steady state,  $y$  and  $k$  will be growing at the same rate:

$$g_y = g_k \quad (\text{A.6})$$

Assume that the technology growth rate,  $A$  grows at a constant rate:

$$g = \frac{\dot{A}}{A} \quad (\text{A.7})$$

To obtain the GDP per capita, divide the production function with the total population,  $\varphi$ :

$$y = kp^\alpha (Ah)^{1-\alpha} \left( \frac{L}{\varphi} \right)^{1-\alpha} \quad (\text{A.8})$$

To obtain the growth rate in  $y$ , take logs of equation (A.8) and derivatives with respect to time:

$$\frac{d \ln Y}{dt} = \alpha \frac{d \ln K}{dt} + \alpha \frac{d \ln p}{dt} + (1-\alpha) \frac{d \ln A}{dt} + (1-\alpha) \frac{d \ln h}{dt} + (1-\alpha) \frac{d \ln L}{dt} \quad (\text{A.9})$$

$$\Rightarrow g_Y = \alpha g_k + \alpha \times 0 + (1 - \alpha)g + (1 - \alpha) \times 0 + (1 - \alpha) \times 0 \quad (\text{A.10})$$

As observed in the steady state the growth rate in the capital stock equals the growth rate in the GDP per capita, hence the growth rate in y will become:

$$g_Y = \alpha g_k + (1 - \alpha)g \quad (\text{A.11})$$

$$\Rightarrow g_Y = g_k = g \quad (\text{A.12})$$

The parameter  $\tilde{k}$  represents the ratio of capital per worker to technology:

$$\tilde{k} = \frac{k}{A} \quad (\text{A.13})$$

The parameter  $\tilde{y}$  represents the ratio of output to technology:

$$\tilde{y} = \frac{y}{A} \quad (\text{A.14})$$

Rewriting the production function:

$$\tilde{y} = \tilde{k}^\alpha \tilde{p}^\alpha \left( \frac{hL}{\varphi} \right)^{1-\alpha} \quad (\text{A.15})$$

To obtain a solution for  $\tilde{k}$ , we first start with solving for  $\dot{\tilde{k}}$ , by taking derivatives with respect to time:

$$\dot{\tilde{k}} = \tilde{k} \left( s(1 - \tau) \frac{\tilde{y}}{\tilde{k}} - \delta - g - n \right) \quad (\text{A.16})$$

$\dot{\tilde{k}} = 0$  in the steady state, thus  $\tilde{k}$  steady-state solution will become:

$$\tilde{k} = \left[ \frac{s(1 - \tau)}{\delta + g + n} \times \left( \frac{hL}{\varphi} \right)^{1-\alpha} \times p^\alpha \right]^{\frac{1}{1-\alpha}} \quad (\text{A.17})$$

Substitute  $\tilde{k}$  into the production equation (A.8):

$$\tilde{y} = \left[ \frac{s(1 - \tau) \left( \frac{hL}{\varphi} \right)^{1-\alpha} p^\alpha}{\delta + g + n} \right]^{\frac{\alpha}{1-\alpha}} \times \left( \frac{hL}{\varphi} \right)^{1-\alpha} \times p^\alpha \quad (\text{A.18})$$

By simplifying this expression,  $\tilde{y}$  will become:

$$\tilde{y} = \left[ \frac{s(1-\tau)}{\delta + g + n} \right]^{\frac{\alpha}{1-\alpha}} \times \left( \frac{hL}{\varphi} \right) \times p \quad (\text{A.19})$$

Finally by replacing the parameter  $h$ , with the term in (A.2) and the parameter  $\tau$ , with the term in (A.4), we will obtain the steady state expression for the GDP per capita:

$$y^* = \left[ \frac{s(1 - \left[ \frac{\theta\lambda}{Y} + \frac{\varphi - L}{\varphi} \right])}{\delta + g + n} \right]^{\frac{\alpha}{1-\alpha}} \times \left( \frac{e^{\nu u} L}{\varphi} \right) \times p \quad (\text{A.20})$$

## Appendix 2: Base Values

### Values obtained from Statistics Sweden, base year 2005:

GDP per capita ( $y$ )	276,000
Working population ( $L$ )	4328,000
Total population ( $\varphi$ )	9030,000
Technology growth rate ( $g$ )	0.022
Percent of population aged 80 and older ( $\pi$ )	0.054
Working hours per day ( $w$ )	6.12
Total amount of newborn individuals assumed: aged 80 < ( $\theta$ )	487,620

### Values obtained from the Penn World Table:

Savings ( $s$ )	0.205
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### Chosen values:

Depreciation ( $\delta$ )	0.05
Health care expenditures ( $\lambda$ )	244,000
Education quality ( $\psi$ )	0.1
Years of schooling ( $u$ )	13
Alpha ( $\alpha$ )	0.333
Working days per year ( $\mu$ )	226
Health care expenditures per individual ( $\Omega$ )	0.5