Stockholm School of Economics
Department of Economics
5350 Master's Thesis in Economics
Academic Year 2014-2015

Life, Death, and Taxes: The Evolution of Household Saving in Sweden

Mark Conrad (40611) and Katharina Huhn (40533)

Abstract. Sweden, from the late 1990s to the present day, has seen a pronounced and prolonged increase in its household saving rate. This change seems opposite to what most common theoretical saving models would predict. Our study aims to investigate what caused Sweden's diversion from its past and expected saving behaviour. To solve the Swedish household saving conundrum we investigate Nordic economic data empirically using OLS and GLS econometric models. We proceed into modeling the Swedish economy with a recursive stochastic life cycle model. The results indicate that income, wealth, and bequest tax levels alongside age-demographic changes can partially explain Sweden's increase in household saving.

Keywords: Household Saving, Saving Determinants, Income Tax, Inheritance Tax, Sweden

JEL classification: E21, H24, H31

Supervisor:	Johanna Wallenius
Date submitted:	May 14th, 2015
Date examined:	May 22nd, 2015
Discussants:	Mårten Ambjörnsson, Mathias Magnusson
Examiner:	Kelly Ragan

Acknowledgements

We would like to acknowledge and express our heartfelt gratitude to our supervisor Johanna Wallenius for her guidance and our valuable discussions.

Our special thanks to many of our colleagues from the Economics Master Class of 2015 for their ideas and support.

Finally, we would like to thank our beloved families, and in particular our parents.

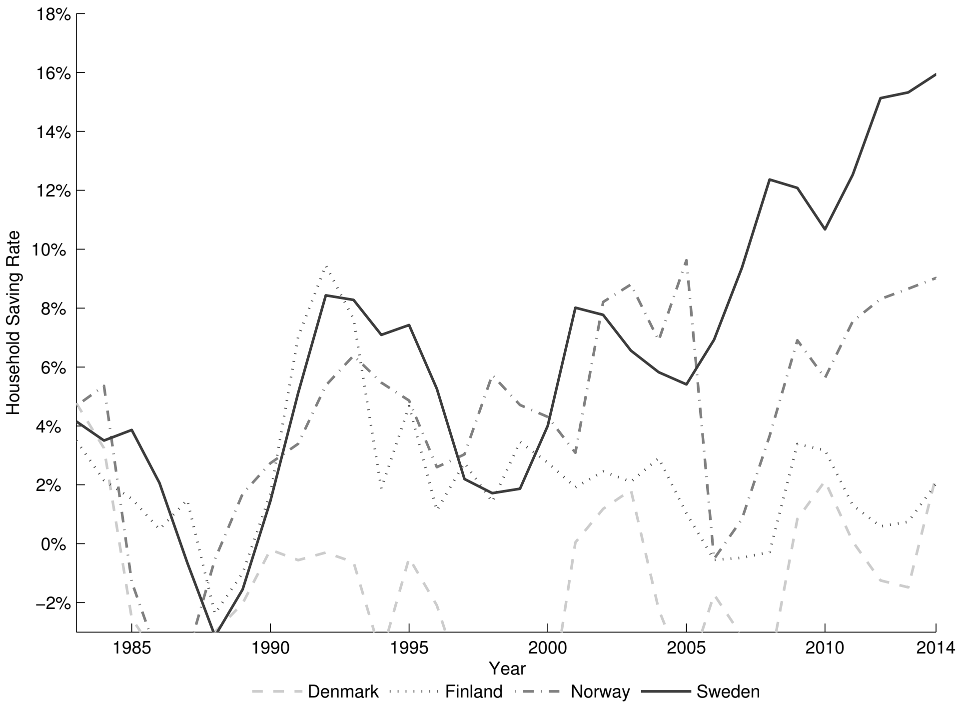
Contents

List of Figures

List of Tables

1 Introduction

Figure 1.1: Household Saving Rate



Notes: The figure shows the household net saving rate, expressed as a percentage of disposable income, for Denmark, Finland, Norway and Sweden from 1983 until 2014. Source: OECD.

Sweden, from the late 1990s to the present day, has seen a pronounced and prolonged increase in its household saving rate. As Figure 1.1 visually evidences, the country has diverged from its past saving behavior and has moved out of line with its Nordic brethren, with the majority of this divergence occurring during the past ten years.

At the same time Sweden appears custom built for low saving, and indeed that has been the modus operandi for the majority of time the statistic has been kept. The country subscribes to the "Nordic Model", with a strong social safety net and property rights, public pension plans, low barriers to free trade, high union participation, as well as high public spending financed by some of the highest tax burdens in the world (Andersen et al., 2007). These social insurances are traditionally considered to be causal factors in a low saving rate.

The other large Nordics (Denmark, Finland and Norway) share cultural, linguistic, demographic, and political traditions with Sweden, yet they do not show this increase in household saving. Their traditions and ties can lead to economic data appearing like a fugue, repetitions on a theme. Thus, a question becomes apparent. What changed in Sweden to have caused the deviation and make household saving appear to move in the opposite direction of what the most common theoretical saving models would predict?

The paper proceeds as follows. Section two outlines the current state of knowledge about household saving behavior. The number of factors stated to affect the household saving/disposable income balance is quite large, and we focus as much as possible on factors which seem most relevant in the context of Swedish household saving. After this literature review, we formulate our research questions and discuss limitations.

In section three we run a series of regressions on saving data, with the intention of giving evidence to what might be causing the deviation of Sweden. Econometric analysis on data from Sweden and its neighbors falls short in finding a silver bullet to slay the Swedish saving conundrum. A reduced model gives evidence towards a hypothesis that the saving behavior in Sweden could be caused by structural changes in tax policy.

Following this, we build two model economies in section four, with the ability to vary income, wealth and bequest tax levels as well as match the demographic evolution of Sweden. This model economy revolves around a representative household maximizing utility through time.

Section five summarizes results from the models introduced in section four, culminating in the presentation of a model which matches Swedish tax policy. Section six concludes.

2 Review of Saving Literature

2.1 Why Household Saving Matters

There are three measurements of saving easily available to the inquisitive researcher interested in comparing saving behavior between countries. These are household saving, corporate saving, and government saving. When referring to all of these together, the term *national* saving is commonly used, and when referring to just household and corporate saving one speaks of *private* saving. Our investigation hinges on *household* saving, which is the percentage of disposable income the non-corporate private sector does not consume.

Though the three have distinct functions in economics, they all serve as channels for turning income into wealth. And, in the perspective of an economist modeling a nation's economy, a high national savings rate is often associated with a high economic growth rate. This stems from a series of economic models built upon capital accumulation as a driver for growth. Romer and Lucas predicted that saving leads to permanently higher growth rates, whereas Solow argued for a short term bump. Regardless, the accumulation of capital by corporate and household saving is a necessary ingredient for a functioning economy.

2.2 Motives for Household Saving

Economic modeling and literature has moved past the idea of a household saving rate as an externally determined parameter. In the basis of every model is the consideration that a household will have to spend money at a time when they will not be earning it. Thus, wealth must be accumulated from income to prevent penury. This avoidance of complete destitution is a broad stroke motive for household saving, and two separate schools of thought have arisen to describe how the savings rate changes through time.

In a Nobel Prize winning dissection of saving data, Modigliani (1966) built up the Life Cycle hypothesis around the idea that individuals aim to smooth consumption over their lifetime. A consumer has a certain income over the entirety of their life, and they are using that permanent income to make their choice in consumption. His result states that with this as the primary aim, saving rate would run pro cyclically with the economy. That means if the economy is growing fast, so shall the saving rate, and vice versa in a slowing economy. Agents spend more money on consumption relative to their lower incomes, and thus save less during recessions. Hence, business cycle fluctuations are dampened as consumption to GDP increases, which boosts demand, while consequently the household saving rate decreases. When the economy is on an upturn, on the other side, individuals save higher fractions of their temporarily increased incomes.

In Modigliani's model the consumer is a perfect maximizer. While revolutionary when published, this theory did not do an adequate job of accurately describing saving behavior when compared to aggregate saving data. The easiest complaint is that the elderly do not dissave as quickly as anticipated, and empirical testing shows that individual saving behavior does not appear to run pro-cyclically (see, for example, (Adema and Pozzi, 2012)), as would be anticipated by Modigliani (1966). Consumption is too smooth and too correlated with lagged income for the Permanent Income Hypothesis to reign supreme.

Thus, saving behavior needed motivations other than "avoid poverty by smoothing consumption through your life cycle." A second strand of literature allows for precautionary saving motives. The available data on household saving showed consumption as more smooth and more responsive to income change than expected by the Life Cycle Model. Pioneered by the work of Carroll et al. (1992) and Deaton (1991), the Buffer-Stock model has emerged as the workhorse to describe consumption and savings decisions. The Buffer-Stock model shares the basic premise of the Permanent Income models, but allows for 'precautionary savings' to be a part of an individual's decision making process.

Precautionary savings is risk-aversion in action, with households unwilling to dissave if they have a belief that the economic climate in the future will be worse than it is currently. Further manipulation of the Buffer-Stock model has created a place for impatience and credit constraints (Adema and Pozzi 2012, Carroll et al. 2012). Unlike the Life Cycle hypothesis of consumption, it suggests counter cyclical saving behavior. As income decreases during downturns and unemployment uncertainty increases, individuals save a larger fraction of their incomes. The mechanism is reversed during economic upturns. Business cycle fluctuations are amplified through changes in household saving as recessions decrease the consumption to GDP ratio and therefore lower demand.

Whether saving rates are pro or counter cyclical has differing implications for growth. A pro cyclical saving rate will mean that capital accumulation falls during recessions. As wealth decreases there will be negative long-run effects on economic growth. Counter cyclical saving implies long-run economic growth as capital accumulation, hence wealth, increases during economic downturns.

The importance of understanding household saving and its underlying determinants links back to its implications for the economic environment as a whole and policy maker's options as they try to affect this economic environment. In the case of the Life Cycle hypothesis, fiscal policy is an effective tool in counteracting business cycle fluctuations and in particular to smooth the effects of a recession. Fiscal policy under the precautionary saving assumption is less effective in fighting recessions. However, public policy affects household saving through national saving as well as tax and social welfare. Thus, when changing social welfare or tax systems, the impact on household saving must be taken into account.

2.2.1 The Buffer Stock Model

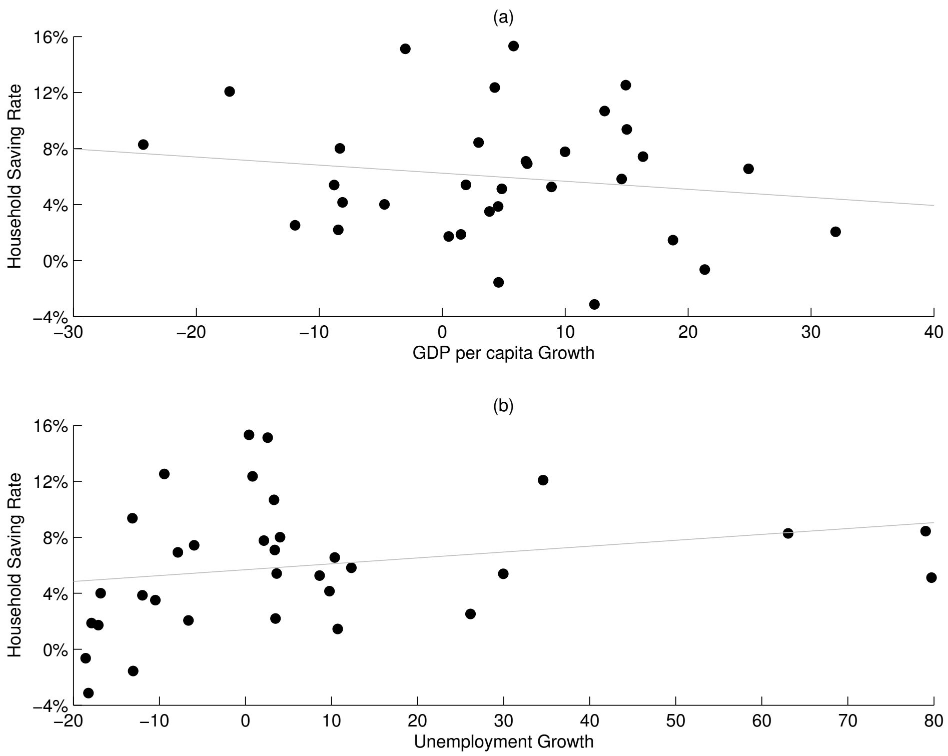
The Buffer Stock model of saving allows for and expects a number of saving behaviors which appear in the Swedish data. Saving runs counter cyclically, with higher savings occurring in periods of economic contraction measured by GPD per capita growth (see Figure 2.1 (a)) and uncertainty as measured by for example unemployment rate jumps ((see Figure 2.1 (b)).

The aggregate saving behavior of Swedes suggests that the Buffer Stock can offer intuition into what drives Swedish saving behavior. As such, we move forward by describing this model of saving, pulling heavily from the work of Carroll (1992, 1996, 2012) and Deaton (1991), among many others.

The Buffer Stock framework arises from the same skeleton as the PILCH, that of a consumer choosing their current period of consumption to maximize a utility function over their entire lifetime. In the PILCH, consumers choose to save for the purpose of having wealth to consume in retirement. They have some idea of what their lifetime income will be, and act accordingly.

In the Buffer Stock model, consumers have two attributes which complicate their saving/consuming decision. These consumers are still dynamic optimizers, but they are both impatient and prudent. They are impatient because they would borrow against future income to consume in the current period if they could, and they are prudent because they act with a precautionary saving motive. This precautionary saving is the heart of

FIGURE 2.1: Swedish Household Saving versus Growth in GDP per capita and Unemployment



Notes: Subplot (a) shows the household net saving rate, expressed as a percentage of disposable income, versus GPD per capita growth in Sweden between 1981 until 2014. The fitted line shows a negative association between the two variables. Subplot (b) shows the household net saving rate plotted against unemployment growth in Sweden for the same time span. High unemployment growth appears to be associated with higher household saving, as the fitted line suggests.

the Buffer Stock model, and what differentiates it from the PILCH. Saving is not merely a way to consume later in life, but an insurance against the chance that income drops severely later in life. Consumers hold assets to shield themselves from unpredictable flux in income.

The impatience and prudence motives are continually acting in opposition, with the desire to save for calamity opposed by the desire to consume today. The result of this opposition is a "target-wealth-ratio." When current wealth is below target wealth, the consumer will save more, as precaution and prudence dominate impatience. If current wealth is higher than target wealth, impatience dominates prudence and more of disposable income is consumed.

In most specifications of the Buffer Stock model, consumer behavior is defined by three factors. First, in line with the PILCH, current wealth and potential lifetime wealth determine a large portion of how one can save and consume. The maximization problem an agent faces is choosing consumption in one period with an idea of what lifetime wealth will be. Thus, changes in wealth have a significant effect on one period saving decisions. Future wealth, however, is not always available to be spent in the present. Thus, the looseness of credit has a central effect on the spend/save decision. And finally, the degree of apprehension a consumer has for the future is the primary driver of precautionary saving. These three channels are referred to as the wealth effects, credit effects, and precautionary effects of saving.

What must be noted is that one event can affect saving rates via more than one channel. A financial crisis, for instance, can have a primary effect of plummeting current wealth while simultaneously tightening the availability of credit. Similarly, a decrease in unemployment risk can drive down precautionary savings while simultaneously loosening access to credit.

The heart of the Buffer Stock model is a target wealth ratio in the face of income uncertainty. The model considers individuals as risk averse, and thus requiring a bit of a financial cushion to fall upon in the face of unexpected disasters. The Buffer Stock framework offers intuition into what drives Swedish saving behavior, though it leaves much to be desired in a modeling framework. The modeling work of Carroll and others relies on restrictive assumptions of unemployment, requiring a complete lack of insurance. This is too restrictive for the Swedish economy and its substantial unemployment insurance and strong pension system.

2.3 Individual Inputs in a Household Saving Function

In addition to the overarching saving model debate begun with Modigliani, a subset of saving literature has sought to identify how economic variables or policy decisions affect saving. In this section, we review these motives and consider whether they would seem to be involved in Sweden's current saving deviation.

Two motives have already been discussed at length: precautionary savings and income smoothing, the primary drivers of the Buffer Stock and Permanent Income models. Callen and Thimann (1997) identify an additional two "primary" motives for saving: financing of large expenditures and the goal of giving bequests after death. Together, these four primary variables suggest a host of secondary inputs to a saving decision, which we discuss in turn below.

2.3.1 Growth

As household saving strongly depends on disposable income, one of its primary determinants should be economic growth. Household saving has implications for growth in both the short and long term. We would expect a positive effect of growth on household saving. A growing economy will allow for increases in wages and subsequently increases in GDP per capita, hence household saving. Attanasio et al. (2000) discuss human capital and productivity growth. Productivity growth implies that the saving of the young exceed the dissaving of the old due to a growth in productivity over time. However, if the borrowing of the young is large, strong productivity growth can lead to a negative correlation between household saving and growth rates.

In Sweden, GDP per capita growth has not had a significant deviation from its low saving rate period. GDP per capita had its largest fluctuations around the mid-90s and mid-2000s financial crises. The saving behavior observed at that point in time holds steady with the countercyclical movements discussed above.

2.3.2 Inflation and the Real Interest Rate

An increase in inflation is expected to decrease saving. Inflation implies the erosion of an agent's purchasing power, with a dollar saved today buying less in the future than it would currently. As inflation causes the value of money to change constantly, saving for future expenditures or retirement becomes akin to shooting at a moving target. As a result agents are expected to invest into less volatile capital stock or consume more today rather than tomorrow.

That dollar saved, however, can appreciate due to interest. The real interest rate has a somewhat ambiguous effect as income and substitution effects move into opposite directions. A fall in interest rates illustrates these effects. The substitution effect causes individuals to consume more instead of saving. The income effect causes a decline in income as interest payments decline. Individuals may thus see a need to increase saving to maintain returns from income at a certain level. Empirical analysis has often shown a small positive but insignificant effect on saving, though it is difficult to specify the relevant interest rate. Ideally one would like to include the after tax real interest rate in any analysis of household saving. Empirical analysis has also shown that interest rate elasticity is relatively low for aggregate domestic saving (Callen and Thimann, 1997).

In Sweden, inflation has been steady and consistent from the mid-90s onward. The real interest rate has seen a slight downward trend from the 1980s onward, remaining extremely low in recent years.

2.3.3 Financial Deregulation and Terms of Trade

As Callen and Thimann (1997) argue, a well-developed financial system allows for investment and thus for higher returns on capital, which would increase household saving. Access to credit is enhanced and liquidity constraints are eased (Bayoumi, 1993). Access to credit is especially linked to the motive of saving for large financial expenditures. If households have easy access to credit, they no longer need to save as much. They can now take loans to finance their education or a credit to purchase, for example, a house. When individuals are able to borrow more easily from banks, household saving will decrease.

An improvement in terms of trade causes expenditure on consumption goods to decrease, as imports will put pressure on prices. Having to expend less disposable income on consumption will consequently allow for higher household saving. As mentioned above, low interest rates could cause households to save less. With the possibility of investing both domestically and abroad, individuals will be able to invest in those markets where returns to their capital are the highest. The incentive for saving should likely be higher in an open economy than in a closed one.

Sweden is consistently ranked as one of the most financially open countries in the world. Neither access to capital nor cross-border regulations would suggest the increase in saving Sweden has experienced.

2.3.4 Income Equality

Savers can be divided into different groups: those that are liquidity constrained, those that accumulate vast sums and those in between. Household saving is dependent on the distribution of household income between the extremes. A large share of aggregate household saving comes from high-income households. In an unequal society high-income households will be able to save a lion share of their earnings leading to a higher aggregate level of saving (Edwards, 1996) than in an equal economy where more households save, but to a lesser extent.

As measured by the GINI coefficient, Sweden is one of the most equal countries in the world while simultaneously being one of the most wealthy. This would suggest that Swedes would save a large amount of their disposable income. However, Sweden has long been both rich and equal. It would not appear that becoming more equal and richer has caused this saving behavior.

2.3.5 Social Security and Welfare System

Social security and welfare systems are closely linked to the precautionary saving motive and play a central part in household saving, as the main purpose in most industrialised countries is to maintain household income. Benefit payments generally depend on the contributional history of an individual or some average of past earning that will determine the size of the benefit. These payments are government provided insurance in case of income losses through unemployment or large unexpected expenditures, such as a health emergency. As saving is largely driven by the motive to cover for potential losses of income, social security and welfare systems drastically decrease the incentive for household saving. When unemployment risk is high, but unemployment benefits are secure, households need less precautionary savings than under a regime with no unemployment insurance.

Both gross and net governmental (gross transfers less social security contributions) transfers to households influence aggregate household saving. Changes in the social security and welfare systems will therefore have a significant effect on household saving (see for example Skinner 1988). Gross transfers are important as they measure how generous the social security system is. This in turn affects the incentive to save. If education, public housing and health care are subsidised or sponsored by the government, household saving will be lower as individuals do not have to cover large expenditures in these areas. Callen and Thimann (1997) argue that the effect of the social security system on household saving depends to a large extent on the value, length, availability and certainty of the benefit payments. The higher the replacement ratio, that is the proportion of previous earnings that individuals are entitled to, the lower the saving ratio. The same holds true for the amount of time that individuals are entitled to benefit payments and the certainty of their availability. A well functioning pension system will reduce the need to accumulate large amounts of private assets for retirement. Thus, it will usually lower the aggregate household saving due to the wealth effect (Feldstein 1980, Koskela and Viren 1983). If the prospect of a public pension causes individuals to retire prematurely or its existence makes them more aware of that they have to save for their pension, social security arrangements may actually boost savings as argued by Kopits and Gotur (1980).

Net transfers concern the financing of the social security system and affect aggregate household saving through distributional channels (Callen and Thimann, 1997). That is whether contributions constitute a fixed proportion of income or are deducted progressively as a tax. Whereas the former usually starts already at low-income levels and is capped at high-income levels, the latter more often exempts low-income groups and is not capped at high-income groups. In general contribution financing shifts the burden to low-income groups compared to tax financing. Low-income groups save comparatively little and tax contributions increase with income, which may lead to generally lower levels of aggregate household saving (Callen and Thimann, 1997).

In the data period studied, Sweden has engaged in a full shift of its pension model[1] to a pay-as-you-go model with a notional defined scheme. This rollout happened slowly over the course of the 1990s and 2000s, and has been criticised by some as shifting all risk over to the individual (Scherman, 2003). If this is the case, then a precautionary saver would increase their household saving to cover for the risk that their pension is too low to support them in the future.

2.3.6 Demographics

The population structure has an impact on household saving as a large working age population and low proportion of children relative to the total population will lead to higher savings. The age dependency ratio measures the pressure on the productive population. It is the ratio of people typically not in the workforce (younger than 15 or older than 64) to those typically in the workforce (those aged 15-64). As the workforce constitutes that part of the population that is saving, a large proportion of working individuals compared to the not active population will yield higher household savings. A high age dependency ratio will result in lower aggregate household saving as young people and people in retirement dissave. This is closely linked to the second observation about population structure: a low proportion of children will yield higher aggregate household saving.

Sweden's dependency ratio has increased in recent years, which would suggest a decrease in saving. Dependency ratio focuses on the role played by those who earn the least, and thus are a net drag on saving. However, one could also consider the ratio of those who earn and save the most, which would be positively correlated with saving rate. This would occur in a phenomenon such as the baby boomers in the US, where a dense distribution of individual wrecks havoc on a number of economic situations, including pension systems.

[1]Today's pension system is based on individuals' lifetime contributions, where each year's pension entitlements (*pensionsrätter*) are the basis for future pension benefits. Prior to its reform, the Swedish pension system was build on so called pension credits (*pensionspoäng*) that an individual would collect during their 15 best years of earning. Whereas the prior ATP-system (*allmän tilläggspension*) was based on price levels, today's pension entitlements and pension benefits are based on income levels. The reformed pension system takes into account that the population's lifespan is increasing by basing pension benefits on the expected lifespan of each age cohort. Compared to the previous pension system it is therefore better constructed to manage future socioeconomic and demographic developments as for example a higher dependency ratio. To secure long-term financial stability in the pension system, the system is complemented by a balancing mechanism (*automatisk balansering* or *bromsen*) to eliminate the risk of permanent deficits.

2.3.7 Housing Market

The Swedish housing market is characterised by high house prices due to a strong increase in disposable income and a growing population on the demand side, and constraints on construction of new housing on the supply side. In fact, the increase in house prices surpasses that of disposable income. Whereas the disposable income growth has allowed households to accumulate saving buffers, this increase has also fueled an increase in indebtedness via home ownership (Directorate-General for Economic and Financial Affairs, 2015). A decrease in housing prices would consequently lead to an increase in household indebtedness. In order to avoid such unfavorable situation households will start spending less on consumption and save more to be able to repay their loans.

Yet, there are no signs that housing prices would decrease in the near future, especially not in urban areas. The underlying drivers of the house prices are low interest rates and high mortgage tax reductions in Sweden. Furthermore, the low levels of inflation that Sweden is facing today are directly translated into decreasing mortgage loan rates which encourage households to take even higher loans while their monthly payments stay at the same level or become potentially smaller. Sweden's favorable credit conditions are magnified by the availability of amortisation-free mortgage loans (Riksbank, 2005). According to the IMF, the actual repayment period could amount to more than 140 years (Directorate-General for Economic and Financial Affairs, 2015), that is for loans that are not amortised or have variable interest rates.

From a historical perspective, deregulation of the mortgage market was a major theme during the 80s to enable households to invest into property. Then, in 2010, Sweden enacted a mortgage cap. The expected effect of such regulation would naturally be that household saving would increase as larger down payments are required upon purchase of real estate.

2.3.8 Tax

Tax changes lifetime wealth and is therefore an important determinant of saving. Whether income or consumption is taxed has a significant impact on the returns of saving. A tax on consumption or expenditures will not change the price of current or future consumption as it equally affects both. Thus, it does not change saving either. This is equally true for an income tax where capital income is exempt from taxation. In most countries capital income is not exempt from taxation and therefore the price of current to future consumption decreases (Callen and Thimann, 1997). Hence it becomes more expensive to consume in the future and saving will decrease. Taxes on both income, from which savings is generated, and capital returns, the returns from saving, are effectively taxing saving twice and thus leads to a distortion of the intertemporal resource decision. A tax can also be levied on wealth itself, rather than capital gains.

The big bulk of income taxes are paid by the working population, whereas other taxes are more evenly distributed across age and income groups. Whether income taxes are progressive or regressive plays an important role for household saving. Usually income taxes are progressive so that high income households are taxed more. Regressive income taxation would imply the opposite. As high income households are normally those households that save most, a progressive tax would thus lead to lower household savings.

A plethora of other taxes can affect saving behavior in addition to the capital (wealth) and income taxes above. In particular, the tax on bequests could be extremely important. Most literature regard the retired population as a strong driver of dissaving, with the idea that they aim to spend their saving while they are alive. It is reasonable to expect that this in not necessarily the case, and that humans receive altruistic utility from leaving an inheritance to their progeny. If this is true, then this warm glow utility would be lessened by a tax on bequests, causing the utility maximizing pensioner to consume more and save less.

All three of the taxes discussed above could have significant effects on Swedish saving behavior. First, Sweden has significantly lessened its income tax burden over the course of the last thirty years. More importantly, Sweden has completely removed taxes on both wealth[2] and bequests[3]. Both of these changes would have positive effects on the household saving rate. In addition, these changes occur at precisely the time that Sweden had its largest jump in savings rate that would not be applicable to a counter-cyclical motive. In addition, Sweden's marginal income tax rate has been reduced, another potential candidate for the cause of increased saving.

[2]The wealth tax amounted to 1.5 percent of wealth bigger than 1.5 M SEK for singles and 3 M SEK for married couples. Until its abolishment in 2007 by the Alliansen government, billions Swedish Crowns left the country every year to be placed abroad if not the Swedes themselves left to avoid paying taxes on their capital income.

[3]Sweden abolished its inheritance tax on January 1st 2005. Previously, the inheritance tax amounted up to 30 percent of the inherited property's value. Especially family enterprises were hit hard and often forced to liquidate assets of their business to pay the inheritance tax when implementing a generational transition of the company. Above and beyond the tax yielded little return for the government but required a lot of administration.

2.4 Specification of our Detailed Research Focus

2.4.1 Research Question

As evidenced by the previous section, economic literature has tracked how a number of institutional, demographic, and socioeconomic factors should impact the household saving rate. A look at Swedish data reveals that these factors appear to have affected household saving in the predicted manner over the last few decades. Periods of uncertainty, such as Sweden's financial crisis in the early 1990s and the global recessions in the early and mid 2000s, caused a tightening in credit and increase in unemployment risk, both positively correlated with household saving.

There has, however, been a diversion. Sweden's saving pattern for the past 10 years started moving out of line with its own past behavior. Since 2005 Sweden has become one of the most penurious countries in the developed world as measured by household saving. Whereas before Sweden consistently ranked in the bottom of the OECD in terms of household savings rate. With savings taken as a whole over the decade of the 1980s, the four countries with the least saving were Finland, Denmark, Norway, and in last, Sweden. The first half of the 1990s were no different, even given the financial crisis among Sweden's banks. (Callen and Thimann, 1997).

Given the similarities between Sweden and neighboring economies all built around the Nordic Model, one would expect its neighbors to have experienced a similar movement in saving behavior. That is not the case. Denmark and Finland remain at the bottom of the saving rate heap, and though Norway has increased its saving slightly, it remains near the OECD average.

It is thus necessary to take a more profound look at what drives Swedish household saving. Our research question reads as follows: *What has caused the deviation of Swedish household saving behavior over the past decade?*

Saving is the building block of capital formation, itself the building block of economic growth. Without a firm groundwork of saving knowledge to stand upon, policy makers are limited in their ability to respond to economic fluctuations, and to predict economic outcomes of current policies.

2.4.2 Validity and Reliability

On a more general note we would like to consider the reliability and validity of our study. Reliability depends upon the consistency of our measures, and in an effort to make our results reliable and repeatable we spell out our procedures in great detail.

Validity is concerned with the integrity of our results. To address the internal validity of our study we proceed with our analysis in two steps. From the work of Modigliani onwards, a large number of individual factors have been investigated in regard for their effect on saving. In the spirit of this literature, we examine the saving behavior of Sweden, Denmark, Finland and Norway empirically, and check the relationship between these variables and household saving. We use both OLS and GLS to test different econometric models. From this exercise, we identify the idiosyncratic characteristics of Sweden, which we then can use to adapt a recursive stochastic life cycle model to more accurately reflect saving behavior observed over the past 15 years.

Internal validity also concerns whether statistical inferences about causal effects are valid. In our econometric analysis we do not claim to find causal relationships between the variables in question. It is rather an indicator for which variables are significantly correlated with household saving in Sweden and shall be taken into consideration when modeling a Swedish economy.

A threat to internal validity could be sample sizes and missing data. Sweden and its neighbors have annual household saving data available from 1980, as well as data involving a number of the potential saving factors from the mid 1990s at the earliest. Because of the dearth of important data, any conclusions from our econometric work must be taken with a grain of salt, lest we tempt the fates of small sample sizes.

External validity evaluates whether results can be generalised beyond the specific context. Note, that our study is solely focused on explaining the recent change in Swedish household saving behaviour, and does not claim to find general patterns that are necessarily valid beyond the Swedish context. We do use several sensitivity checks to test the validity of our results concerning the Swedish model economy. Our models are built upon wage, bequest, and pension processes parameterized from Swedish data, and should not be taken outside this context.

3 Econometric Analysis of Saving Behavior

3.1 Data

The above section detailed a number of possible causal relationships between measurable variables and household saving. We collected data on these variables and specified a range of regressions to see how well established theory matches the numbers. With the aim of illuminating which factors are driving Sweden's current saving behavior, we start by using an unbalanced panel of four countries (Denmark, Finland, Norway and Sweden) between 1980 and 2013. As earliest household saving data was available from 1980 on an annual basis, we match our independent variables accordingly.[4] In order to increase the number of observations and hence increase validity of our regression results we include Sweden's immediate neighbors in our panel analysis.

To start we employ an Ordinary Least Squares (OLS) model to test the effect of the previously identified determinants on household saving. We do this in a stepwise manner, where we include different groups of variables to see their individual effects, before running a regression including all variables. Whereas this cross-check will offer a brief overview of the correlation between household saving and several saving determinants, a basic linear regression model will fail to account for heteroscedasticity and autocorrelation between observations. In other words, we expect the variance of household saving to vary for different values of the independent variables that we include throughout our specifications. By controlling for autocorrelation, we adjust for correlation of the same variable at different points in time. In a next step we use a General Least Squares (GLS) model to try and eliminate these possible sources of inefficiency. We suspect that serial correlation is still not eliminated with GLS, which leads us to test a Feasible Generalised Least Square (FGLS) model. This model allows for AR(1) autocorrelation within panels. These models are augmented with both fixed effect and random effect specifications.

[4]See Appendix A for summary statistics and a full list of variables together with their definitions and data sources.

3.2 Basic OLS Model

To empirically test how the different saving determinants affect household saving we start out with an OLS model of the form

$$y_{it} = \alpha + x_{it}\beta + \varepsilon_{it} \tag{3.1}$$

where $i = 1, ..., m$ is the number of units (or countries), and $t = 1, ..., T_i$ is the number of observations per country. Our dependent variable *household saving* is denoted by y_{it}, α is the constant and β measures the coefficients of our independent variables x_{it}. The error term is specified as ε_{it}.

Regression (1) in Table 3.1 shows evidence of countercyclical behavior. An increase in *unemployment rate* should cause households to be less certain of consistent future income, thus they would raise their wealth target to insure against poverty. Likewise a decrease in unemployment rate should lead to better expectations of future income and decrease current period saving. We also see the expected positive coefficient of *unemployment rate growth* on household saving.

GDP per capita growth is our proxy for household income. We choose not to use disposable income growth in any of our regressions, as disposable income is used in the calculation of household saving and would bias our regressions results. An alternative method of calculating household saving as percentage of GDP and including disposable income in our regression model proved incompatible with the OECD and World Bank data sets we utilized. Regardless of the data used, theory would suggest a negative relationship between income growth and household saving rate. Our level variable for *GDP per capita* enters with a positive and statistically significant coefficient, whereas *GDP per capita growth* enters negatively and significantly.

We test another group of indicators in regression (2). *Gross national savings* have been found to have a negative and significant effect on *household saving*. This implies that higher saving in the public sector is offset by lower saving in the household sector (Callen and Thimann, 1997). Even though our results from (2) support this assumption, the variable enters insignificantly. *Inflation* enters insignificantly but positively, which is counter intuitive and opposite to what theory would predict. The *real interest rate* enters with the right sign but is insignificant as well. As was discussed in the previous chapter, Sweden and its neighbors have been consistently ranked as some of the most financially open countries in the world and show consistent index values over the observed time period. It is therefore not surprising that our index for *capital account openness* (Chinn and Ito, 2006) enters insignificantly.

TABLE 3.1: OLS Model of Household Saving Determinants

VARIABLES	(1) Household Saving	(2) Household Saving	(3) Household Saving	(4) Household Saving	(5) Household Saving	(6) Household Saving	(7) Household Saving
GDP per capita	5.54e-05***					-7.94e-05***	-8.49e-05***
	(1.67e-05)					(2.60e-05)	(2.42e-05)
Unemployment Rate	0.209**					0.0699	
	(0.0873)					(0.0867)	
GPD per capita Growth	-0.0621***					-0.0313**	-0.0331**
	(0.0181)					(0.0151)	(0.0150)
Unemployment Growth	0.0477***					0.0304***	0.0301***
	(0.0117)					(0.00835)	(0.00829)
Gross National Savings		-0.0153				-0.120*	-0.140**
		(0.0845)				(0.0676)	(0.0666)
Inflation		0.143				0.386***	0.360***
		(0.148)				(0.105)	(0.0958)
Capital Account Openness		1.738					
		(2.690)					
Real Interest Rate		-0.0900					
		(0.141)					
Age Dependency Ratio			0.560***			0.0217	
			(0.102)			(0.0915)	
Price-to-Income Ratio				-0.113***		-0.287***	-0.295***
				(0.0338)		(0.0420)	(0.0400)
Price-to-Rent Ratio				-0.119		-0.0913**	-0.0979**
				(0.0739)		(0.0430)	(0.0389)
Real House Prices				0.168**		0.356***	0.371***
				(0.0784)		(0.0728)	(0.0691)
Mortgage Cap				0.587		2.955***	3.046***
				(1.662)		(0.962)	(0.841)
Tax on Personal Income					-0.326***	-0.545***	-0.561***
					(0.0575)	(0.0760)	(0.0679)
Wealth Tax					1.718**	4.053***	4.145***
					(0.703)	(0.865)	(0.839)
Inheritance Tax					-8.740***	-6.091***	-6.097***
					(1.442)	(1.330)	(1.332)
Constant	-0.220	1.500	-26.41***	9.694***	14.94***	23.23***	25.93***
	(0.851)	(4.255)	(5.301)	(2.387)	(1.290)	(6.624)	(1.992)
Observations	135	103	135	135	135	135	135
R-squared	0.185	0.026	0.144	0.093	0.489	0.782	0.781

Note:The dependent variable is household saving with annual observations between 1980 and 2013 for Denmark, Finland, Norway and Sweden. The independent variables cover the same time period and countries. All regressions are estimated in STATA using the regression command: regress saving [*indepvars*], r. Robust standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

In (3) we regress the *age dependency ratio* on *household saving* as a measure for demographic development. The relevance of the *age dependency ratio* is quick to be seen. The population can be considered as being made up of workers and non-workers. Workers have income, which can be spent or saved. Non-workers do not have this choice, and must dissave to consume. They can either dissave via their own previous savings, by borrowing from their future earnings, or living under the roof of a worker, who thus saves less to compensate for the extra mouth to feed, house, and clothes. The *age dependency ratio* simply measures the portion of a nation which is too young or too old to work. Theory would suggest that an increase in dependency ratio would lead to a decrease in *household saving* (Modigliani, 1966). Including the *age dependency ratio* in (3) yields results inconstistent with theory.

In (4) we include the four measures *price-to-income ratio*, *price-to-rent ratio*, *real house prices* and *mortgage cap* to describe the housing market. The *price-to-income ratio* measures affordability, whereas the *price-to-rent ratio* measures the profitability of owning a house. While only the former appears statistically significant in our specification, both enter negatively, suggesting that a decrease in affordability and profitability affect household saving positively. *Real house prices* enter as statistically significant. We find that an increase in *real house prices* brings about an increase in household saving, which is consistent with theory. We include a dummy variable for *mortgage cap*, which was introduced in Sweden in late 2010. Its effect is positive but insignificant in this specification.

In an attempt to analyse a number of structural changes in Sweden, including a removal of taxes on wealth and inheritance, we include a variable for *income tax* as well as two dummy variables for the abolition of *wealth tax* and *inheritance tax* respectively in (5).[5] If these tax changes have significant effects on a modeled economy, it could partially explain the uniqueness of Sweden via a structural break.

Not surprisingly, an increase in *tax on personal income* lowers household saving and enters significantly. *Wealth tax* is significant with a positive coefficient. Opposed to what we would expect this implies that an abolition of a wealth tax has a negative effect on household saving. *Inheritance tax* on the other hand behaves as predicted by theory and has a large negative coefficient that is highly significant at the one percent level.

Specifications (1)-(5) have some significant flaws, not the least of which is a significant amount of omitted variable bias. We therefore run a rich specification in (6) and a more parsimonious version in (7). *GDP per capita* and *GDP per capita growth* now both enter negatively and significantly. Of our unemployment variables only *unemployment growth* enters with a positive and significant coefficient. *Gross national saving* becomes

[5] Denmark abolished its wealth tax in 1995 and Finland in 2006. Norway has had no inheritance tax as of 2014, which does not enter the regression as data is only included until 2013.

statistically significant in both (6) and (7). The *age dependency*, though with a negative coefficient, is insignificant. Both the variables for the housing market as well as those for different taxes, point to the same direction and with similar levels of significance as previously.

This first model offered only a brief overview of the correlation between *household saving* and several saving determinants. One criticism of this basic linear regression model is that we suspect that our errors have unequal variances (heteroscedasticity) and are correlated (autocorrelation). In a next step we use fixed effect and random effect models to refine our knowledge.

3.3 Panel Data Analysis: Fixed and Random Effects

3.3.1 Fixed Effects Model

A fixed effects model is built to analyze the impact of variables that vary over time. This specification is most interesting when dealing with multiple entities which have individual characteristics that might influence our predictor variable. Fixed effects require these characteristics to be time-invariant and unique to the individual, and thus not correlated to another individual's characteristics.

For our specifications, the individuals are the countries we analyze. The assumptions boil down to some characteristic of the country being both unique to that country and biasing to the predictor variables. For instance, if one country had a particular cultural view on spending behavior with regard to inflation, and this view remained consistent throughout time, a fixed effect model would prevent that from biasing results. This potential of systematic differences between the Nordic countries is the best argument for a country fixed effect model. These differences can account for a number of factors that cannot be explicitly modeled with our available data, including expectations within a populace.

We choose to expand our analysis beyond an entity fixed effects model to include a time and entity fixed effects model. The time fixed effects model carries similar assumptions, with the control for time effects catching whenever unexpected variation or special events may affect the outcome variable.

Our argument for using the time and entity fixed effect model is as follows. We are studying the behavior of a country specific variable over a long period of time. Each country can be assumed to have a unique structure around saving and the variables which affect saving, including laws, regulation, and beliefs about the country and its structure. This motivates the entity fixed effects. Despite these differences, each country is positioned similarly within the global economy. As small and open economies, these countries are subject to a significant amount of fluctuation on a year to year basis which should affect each country equally in a given year. A time fixed effect model will attempt to control for business cycle affects of our model.

The time and entity fixed effect model has the following form:

$$y_{it} = \beta_0 + \beta_1 x_{1,it} + ... + \beta_k x_{k,it} + \gamma_2 E_2 + ... + \gamma_n E_n + \delta_2 T_2 + ... + \delta_t T_t + \varepsilon_{it} \qquad (3.2)$$

where $i = 1, ..., m$ is the number of countries, and $t = 1, ..., T_i$ is the number of observations per country. Our dependent variable *household saving* is denoted by y_{it} with i as country and y as time, the independent variables are $x_{k,it}$, β_k is the coefficient for the independent variables, ε_{it} is the error term, E_n is the entity n dummy with n-1 included and γ_n as its coefficient, and finally T_t serving as the year dummy with coefficient δ_t.

The results of our fixed effects specifications are shown in Table 3.2. Four specifications are shown, with two containing entity fixed effects and two containing both time and entity fixed effects. The results are generally in line with theory and with the OLS model. Two primary differences are that *age dependency ratio* takes the expected negative sign, and that most variables are significant at lower levels than in the OLS specification. This is clearest in our variables which attempt to account for countercyclical saving behavior, which would be expected if the time specific effects are due to world economic fluctuations. The fixed effect of the world economy would have a different effect in each year upon the independent variables looking at change in GDP and unemployment.

A key factor of this specification is that the time-invariant effects of the fixed effect model cannot be investigated as a cause of the dependent variable, *household saving*. This is sensible given the scope of our paper, which is to attempt to identify what has caused the change in Swedish saving behavior through time. If these characteristics such as culture have not changed in the period being studied, they cannot be the target of our investigation.

A key assumption of the fixed model is that the differences in entities influence only the independent variables, and not the dependent. However, this assumption could be violated in our specification. In small open economies such as the Nordics, it seems quite likely that global economic behavior could cause differences in saving behavior, or that countries' particular characteristics could include opinions on saving and spending.

Table 3.2: Fixed Effects Model

VARIABLES	(1) Household Saving	(2) Household Saving	(3) Household Saving	(4) Household Saving
GDP per capita	-0.000153**	-2.86e-06	-7.99e-05	-2.59e-05
	(3.47e-05)	(9.07e-05)	(7.46e-05)	(2.75e-05)
Unemployment Rate	0.398**	0.456	0.530*	0.638
	(0.0737)	(0.213)	(0.216)	(0.288)
GPD per capita Growth	-0.0242	0.000342		
	(0.0109)	(0.0581)		
Unemployment Growth	0.0249**	0.0303**	0.0302*	0.0357***
	(0.00782)	(0.00675)	(0.0119)	(0.00595)
Gross National Savings	-0.112	-0.183		
	(0.0665)	(0.160)		
Inflation	0.586**	0.242	0.619*	0.210
	(0.114)	(0.195)	(0.246)	(0.269)
Age Dependency Ratio	-0.384	-0.00188		
	(0.210)	(0.405)		
Price-to-Income Ratio	-0.324*	-0.368**	-0.234	-0.384***
	(0.119)	(0.0756)	(0.156)	(0.0610)
Price-to-Rent Ratio	-0.151*	-0.149**	-0.130**	-0.165*
	(0.0551)	(0.0406)	(0.0264)	(0.0595)
Real House Prices	0.505**	0.594**	0.353	0.651***
	(0.155)	(0.106)	(0.175)	(0.0987)
Mortgage Cap	3.078**	2.432**	1.571	1.816**
	(0.789)	(0.502)	(0.971)	(0.322)
Tax on Personal Income	-0.382	-0.237**		
	(0.324)	(0.0708)		
Wealth Tax	3.091	1.424		
	(1.597)	(0.911)		
Inheritance Tax	-2.947*	-6.099**	-4.067*	-5.276**
	(1.175)	(1.856)	(1.475)	(1.468)
Observations	135	135	135	135
R-squared	0.686	0.816	0.579	0.806
Number of country	4	4	4	4
Time Effects	NO	YES	NO	YES

Note: The dependent variable is household saving for the years 1980-2013 from Denmark, Finland, Norway and Sweden. The independent variables cover the same time period and countries. All regressions are estimated in STATA using a fixed effects within regression model and the regression command: xtreg saving [*indepvars*], fe vce(cluster country). Regressions (2) and (4) control for time fixed effects. Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

3.3.2 GLS Random Effects Model

Because of our concerns with the assumptions behind a fixed effects model, we considered moving forward with a random effects model. A random effects model assumes that the entity's error term is not correlated with the predictors which allows for time-invariant variables to play a role as explanatory variables.

To decide whether a random effects or fixed effects was more appropriate, we ran a Hausman test. The Hausman test has the null hypothesis that the preferred model is random effects, testing whether unique errors are correlated with the regressors. In the null hypothesis, they are not. The results of this test were conclusive, suggesting that we could not reject the null hypothesis and that we should move forward with the random effects model which is more efficient.

The GLS random effects (RE) model is of the form

$$y_{it} = \alpha + x_{it}\beta + v_{it} + \varepsilon_{it}. \tag{3.3}$$

The term v_{it} refers to the between-entity error and the ε_{it} refers to within-entity error. Unlike the fixed effects model, the variation across entities is assumed to be random and uncorrelated with the independent variables.

Table 3.3: GLS Random Effects Model

VARIABLES	(1) Household Saving	(2) Household Saving
GDP per capita	-7.94e-05*	-8.49e-05**
	(4.21e-05)	(4.13e-05)
Unemployment Rate	0.0699	
	(0.0822)	
GPD per capita Growth	-0.0313***	-0.0331***
	(0.0102)	(0.00814)
Unemployment Growth	0.0304***	0.0301***
	(0.00784)	(0.00780)
Gross National Savings	-0.120**	-0.140***
	(0.0531)	(0.0482)
Inflation	0.386***	0.360**
	(0.149)	(0.151)
Age Dependency Ratio	0.0217	
	(0.110)	
Price-to-Income Ratio	-0.287**	-0.295***
	(0.117)	(0.114)
Price-to-Rent Ratio	-0.0913***	-0.0979***
	(0.0308)	(0.0295)
Real House Prices	0.356***	0.371***
	(0.138)	(0.141)
Mortgage Cap	2.955***	3.046***
	(0.911)	(0.945)
Tax on Personal Income	-0.545***	-0.561***
	(0.110)	(0.119)
Wealth Tax	4.053**	4.145***
	(1.594)	(1.573)
Inheritance Tax	-6.091***	-6.097***
	(1.789)	(1.717)
Constant	23.23***	25.93***
	(7.704)	(2.923)
Observations	135	135
Number of countries	4	4

Note: The dependent variable is household saving for the years 1980-2013 from Denmark, Finland, Norway and Sweden. The independent variables cover the same time period and countries. All regressions are estimated using a GLS random effects model and the regression command: xtreg saving [*indepvars*], vce(cluster country). Clustered standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

Table 3.3 (1)-(2) represents regression results where we strip down the model to include only statistically significant variables. Table 3.1 (6) and table 3.3 (1) are regressions with the same range of variables included in the specification. We note that the coefficients are exactly the same, while standard errors are larger in the GLS model. A more parsimonious take on the GLS RE model in (2) does not show any significant changes in levels, signs or significance levels compared to our OLS specification.[6] The significant which was lost in the FE model generally returns in this specification.

To sum up, households save more when they are more likely to become unemployed, less when they believe fortunes will improve, and these results are evident in all specifications. They increase saving as house prices increase and decrease their buffer stock when affordability and profitability of house ownership increases. Moreover we found that a mortgage cap has a positive effect on households' saving. With no inheritance tax in place, households accumulate more assets, while they save less when tax on personal income increases. This implies that while the core tenants of precautionary savings are evident some portions of saving theory do not align with the Swedish economy. What is perhaps most surprising is that a wealth tax would have a positive effect on household saving according to our model.

This result still leaves us with no satisfactory answer as to why Sweden has deviated from its previous saving behavior. It has however given us a good indication of several factors that matter in determining Swedish household saving. In a next step we can use this knowledge to start modeling a Swedish economy and test the effects of variable changes in a more sterile environment. Although modeling is less precise than a perfect econometric model, it can provide keen insight to how certain factors would affect the Swedish economy. Given the dearth of detailed saving data in the Nordics, a Sweden specific model is the best method to answer our research question.

[6]See Appendix B for an alternative specification using a cross-sectional time series FGLS regression model that allows for autocorrelation between panels.

4 Recursive Stochastic Life Cycle Model

In this section we present two life cycle models to simulate Swedish saving and consumption behavior. The first model is as parsimonious as possible, containing only a consumption/saving decision over an adult life from age 25-80 with taxes upon wealth and wage income. From this simple model we extend to a variable length of life, with utility garnered from bequests as well from consumption. The extended model takes steps to more accurately represent Swedish behavior, including parameterizing wages, survival rate, and pensions to reflect those found in Sweden. The inclusion of two models allows for a number of comparisons in how these parameters change saving behavior with the addition of bequest utility.

4.1 Basic Setup

In our basic setup, individuals derive utility from consumption which depends on both income and assets. They solve the following finite horizon optimization problem for $t = 1, 2, ..., T$, where $t = 1$ corresponds to age 25, the beginning of economically independent life, and $T = 55$ corresponds to age 80, the absolute end of life.

$$max \quad \mathbb{E}\left[\sum_{t=1}^{T} \beta^{t-1} u(c_t)\right] \tag{4.1}$$

subject to

$$c_t + a_{t+1} = (1+r)(1-\tau_a)a_t + (1-\tau_w)w_t(z_t) \tag{4.2}$$

$$a_{t+1} \geq 0 \tag{4.3}$$

$$a_1 \quad given \tag{4.4}$$

Expected utility from consumption in period t is denoted by $u(\bullet)$ and is dependent on consumption in period t, c_t, and the discount rate, $\beta > 0$.

Consumption and saving are subject to a periodic budget constraint (4.2). It states that an individual's assets in period t+1, a_{t+1}, depend on consumption, c_t, capital from the previous period (assets), a_t, and noncapital income (wage), w_t, in period t. Assets in the current period, a_t, are dependent on the exogenously determined interest rate, r, and the tax on capital income (wealth tax), τ_w. The wage, w_t, depends on the wage income tax, τ_i, an exogenous time varying income shock z and age. As seen above τ_i is applied only to wage income, and not to capital gains. The income shock takes on two values $z = [z^1, z^2] = [1, 2]$ with associated probabilities

$$P = \begin{bmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{bmatrix} = \begin{bmatrix} 0.8 & 0.2 \\ 0.2 & 0.8 \end{bmatrix}. \tag{4.5}$$

Thus, if an individual is employed in period t, $z_t = z^1$, the probability that they are employed in the next period, $z_{t+1} = z^1$, is equal to 80 percent, $p_{11} = 0.8$, and that they are unemployed, $z_{t+1} = z^2$, is equal to 20 percent, $p_{12} = 0.2$. Similarly if an individual is unemployed in period t, $z_t = z^2$, the probability of employment in the next period, $z_{t+1} = z^1$, is equal to 20 percent, $p_{21} = 0.2$, and the probability of unemployment, $z_{t+1} = z^2$, is equal to 80 percent, $p_{22} = 0.8$. The values in our transition matrix, P, are chosen in a way so that the probability of an individual staying in the current state of nature are higher than that of them moving to the other state.

From period 40 onward, the individual is retired and receives a pension benefit. Furthermore we rule out borrowing in our economy (4.3) and take an initial asset holding for our representative household as given (4.4).

4.1.1 Solving the Individual Problem

The choice of consumption and saving in each period depends on assets of that period and the previous realisations of the income shock. Since future realisations of income are unknown, an individual is unable to choose a complete consumption or saving path. Future consumption and saving decisions in a given period are represented by a decision tree as they depend on all past realisations of the income shock. We have $c_t(z_1, z_2, ..., z_t)$ and $a_{t+1}(z_1, z_2, ..., z_t)$.

Given an initial stock of assets a_1 and guaranteed employment in period 1, $z_1 = z^1$, the optimal consumption and saving decisions in the first period can be written as $c_1(z_1)$ and $a_2(z_1)$. For the following period the income shock can leave an individual either employed or cause them to fall into unemployment according to our transition probabilities, $[p_{11}, p_{12}]$, from (4.5). Depending on which shock occurs in period 2, the individual will choose some level of consumption $c_2(z_1, z_2)$ and saving $a_3(z_1, z_2)$. An individual's consumption and saving in period 3 will depend on one of four possibilities given whether they were employed or unemployed in the previous period and the income shock of this period. As the number of periods increases, the number of possible consumption and saving paths increases as well.

Hence, the value of expected utility is a function of two state variables[7], the amount of assets that are available in the period and the realisation of the income shock. This problem can be written recursively. We get the value function for a household with a Markov chain stochastic process as

$$V(a_t, z_t) = \max_{c_t} \quad [u(c) + \beta E_t V(a_{t+1}, z_{t+1})|z_t] \tag{4.6}$$

Where $|z_t$ means that the expectations are taken conditional on the realisation of z_t.

The value function calculates the expected lifetime utility given current saving, income shock and optimal decisions in the future. The solution to a stochastic recursive problem like that in equation (4.6) finds a function that returns values for consumption, the control variable[8], that maximise the value function over the domain of the state variables. The solution function can be called a decision rule and written as

$$c_t = H(a_t, z_t). \tag{4.7}$$

The decision rule gives the optimising choice of consumption in every period as a function of the available assets and the realisation of the income shock. The idea behind this transformation of the problem is the optimality principle. If an optimal decision is to be taken from next period on given inherited assets and the income shock, then all the individual has to take into consideration is to make the optimal decision this period given assets and the income shock.

The first practical problem presents itself in the value function being defined over a continuum of savings, which we overcome by creating a discrete state space for all possible savings. We have a minimum a from equation (4.3), and create a maximum that will never be binding. With this we create a grid of elements to optimize over in regards to consumption. Linear interpolation is utilized for estimates of a' that do not appear on our grid. As a review, the linear interpolant between two known points is the straight line between those points. In the case of our asset grid, an asset value not falling upon a grid

[7]State variables are variables whose value is determined by the individual's actions in the past.

[8]Control variables are defined as variables whose value the individual chooses in that period with the goal of maximising their utility.

point will be dealt with as a weighted average of the two grid points it falls between. This allows us to approximate our value function $f(x)$ as the linear interpretation polynomial $p(x)$, where

$$p(x) = f(x_0) + \frac{f(x_1) - f(x_0)}{x_1 - x_0}(x - x_0) \tag{4.8}$$

After solving the individual problem recursively, we simulate life cycle consumption and saving paths. This is done by utilizing a random number generator against the Markov chain probabilities to simulate employment history and thus income shocks. Given all employment states z, and initial endowment a_1, we can use the decision rule function determined recursively to solve for first period consumption, which then allows us to know next period assets, and the process is repeated until end of life. In each specification, we calculate 1000 life cycle saving paths, and average consumption and saving decisions across simulations to get a scope of the representative household's actions across a life cycle. We seed our random generator to allow for the most accurate comparisons between specifications.

4.2 Dynamic Programming of the Basic Model in Matlab

Our value function is solved numerically in Matlab, making heavy use of the built-in function *fmin* to determine optimal consumption given the current state. Utility is calculated assuming a standard constant-relative-risk-aversion function:

$$u(c) = \begin{cases} \frac{c^{1-\sigma}}{1-\sigma}, & \text{if } \sigma > 0, \sigma \neq 1 \\ log(c), & \text{if } \sigma = 1 \end{cases} \tag{4.9}$$

where σ is the risk aversion parameter. Unless otherwise stated, this parameter is set equal to 2.

The income shock process in this basic model is defined as above, a two state Markov Chain. This process determines income for the first 40 periods of life, with the last 20 periods having a guaranteed pension benefit. Our model has an employed individual receiving an income of 2, unemployed receiving 1, and the pension benefit of 0.5 roughly matching in proportional terms the minimum Swedish pension and unemployment insurance, which will be discussed at length in the extension of this basic model.

Our code begins by creating an asset grid from our minimum assets imposed by the borrowing constrain to an arbitrary upper bound, choosing 50 gridpoints distributed logarithmically by the command logspace. We follow by creating three dimensional arrays for Value, Consumption Policy, and Saving Policy. The latter two give the correct consumption and saving choice for each location in the asset/income/age matrix, and the value vector stores the utility garnered from these paths.

We create this value function by backwards shooting from time period 55. In this specification, with no utility from bequests, all assets are consumed in the terminal period and converted into utility. We then progress backwards to period 54, where the function *fmin* is utilized to choose the correct consumption in that period, given that all remaining assets will be consumed in period 55, after they have garnered interest and been subject to a wealth tax. This process is repeated until a optimal path is created for every combination of age, employment status, and current assets.

The simulation process in the basic model is quite simple, beginning with the creation of a matrix of random number draws. One draw is created for every period for every simulation, and that draw is used in conjunction with the P matrix of employment probabilities and previous period employment status to simulate a lifetime employment and income stream. The Consumption and Saving Policy function are then utilized to simulate a lifetime asset accumulation and consumption pattern.

4.3 Extending the Basic Model

The above model is able to give a reasonable simulation of how a representative household will act in the face of some unemployment uncertainty. With this model, we are able to see how tax changes among income and wealth change behavior in a neutral world. As a baseline for how taxes affect consumption and saving decisions, this model serves quite well. However, we aim to provide insight on a particular economy, Sweden, and thus we extend our model in three ways to better simulate modern Sweden. Our extended model includes a utility function for bequests, a Sweden specific income process, and a pension system roughly tracking with the fixed Swedish pension.

4.3.1 Including Bequests

In the basic model, a life was very strictly defined. A consumer appears into existence at age 25, retires at 65, and dies at 80. The only pleasure this simulation can gain is by consuming from age 25 to 80. Because this individual is certain about when he/she will die, utility is maximized by consuming all assets in the last period. This is unrealistic in two ways: first, excluding some tragic and morbid circumstances, an individual does not know his/her precise date of death as soon as he/she is born. Secondly, most individuals chose to leave some assets for their progeny, even in circumstances where they know their remaining lifespan with some accuracy. With this in mind, we extend our model to include both survival probabilities and utility from leaving assets unconsumed.

In this extended model, the potential lifespan is from 25-100, but with a caveat. As in the basic model, retirement occurs at age 65. In every period thereafter, there is a probability that the consumer dies, in which case assets are given away as bequests. If an agent survives to age 100, they end their life after consuming in that period and remaining assets are given as bequests. In an appendix, a number of motives behind bequests and the correct formation of a bequest utility function are discussed. Unless otherwise noted, the bequest utility function is linear of the form:

$$u_b(x) = wx \tag{4.10}$$

Where x is the bequest given and w is a scalar, set to 1.25 unless otherwise noted. The survival probabilities are build from Swedish data taken from the Human Mortality Database.

4.3.2 New Income Process

Income in the basic model can take three values: 1 if an individual is unemployed, 2 if employed, and 0.5 if retired. The extended process allows for significantly more variation. Rather than create a Markov chain driven employment/unemployment simulation, this income process allows for aggregate data to be interpreted at a household level. First, average income for Sweden is found, and normalized at 1. For a next step, we take average earning for each year of life (earnings at 25, at 26, etc.) and normalize this data off of the national average. For example, if average national income is 10000/month, and the average 28-year old earns 8000, the normalized average income for period 4 (corresponding to age 28) is 0.8.

These age-driven normalized average earnings drive the majority of the working age income process. In each period of life, an individual receives the average income for their age, adjusted by a shock term. To further imitate Sweden, this shock process is built to mimic Swedish income data. The shock is an autoregressive process of degree one, with shock z in period $j+1$ described by $z_{j+1} = \rho z_j + \varepsilon_{j+1}$. ε is normally distributed about zero with a variance of σ_ε^2. The ρ term is estimated from Swedish data and set to 0.89, with σ_ε^2 set to 0.02. Income w in the period j is calculated as $w_j = e^{z_j} h_j$, with h_j being normalized average income for period j.

4.3.3 Pension Process

The modern Swedish pension system consists of three parts: a guaranteed minimum pension, an income based pension focused on lifetime earnings, and a premium pension. Our basic model includes only a basic guaranteed pension of 0.5 in every retired period, our extension allows for an income based pension to come into play. Pension accrual occurs throughout the working life, and is dependent on accrual rate ϕ and wage w_j, which is itself a function of income shock z_j. Pension benefit is dependent on both the minimum national pension and pension accrual. The minimum pension b_min is again built from Swedish data, with a normalized value of 0.2. To state explicitly, pension accrual P and benefit B are defined as

$$P(p, z, j) = p + \phi w_j(z_j) \tag{4.11}$$

$$B = p + max(0, b_{min} - 0.5p) \tag{4.12}$$

This pension process is used for all extended model simulations. This has the unfortunate side effect of preventing our model from uncovering any change in Swedish saving behavior due to the change in pension system throughout the 1990s.

These three extensions allow for a much more nuanced exploration into the determinants of the Swedish saving phenomenon. In particular, they allow us to quantify how a nation like Sweden would save under different combinations of wealth and bequest taxes. Our econometric analysis hinted that the changes in bequest and wealth taxation coincided with the increase in saving behavior, and this model allows that to be tested.

4.3.4 Solving the Model

In our specification, the household's problem can be solved starting from the last period. After period T the individual is guaranteed to have died, so there is no next period to take into account. Given current wealth and pension knowledge, defined as $B(x, \overline{w}, t)$, the problem is solved recursively as follows:

$$V_j(a, z) = \max u(c) + \beta S_t \mathbb{E} V_{j+1}(a', \varepsilon') + (1 - S_j) u_b(a'(1 - \tau_b)) \tag{4.13}$$

subject to

$$c + a' = (1 + r)a + w(\varepsilon) + B(x, \overline{w}, t) \tag{4.14}$$

$$B(x, \overline{w}, t) = x\overline{w} \quad \text{if} \quad t > 40 \tag{4.15}$$

$$a' \geq 0 \tag{4.16}$$

The second term in the right side of (4.13) is the expected remaining lifetime utility in the next period, discounted by both a subjective discount factor and the survival probability. The next term is the probability of leaving a bequest multiplied by the value of that bequest including taxes.

This problem is solved recursively, though the bequest motive complicates things slightly by not having the borrowing constrain be binding as long as some bequest motive exists. The first practical problem presents itself in the value function being defined over a continuum of savings, which we overcome by creating a discrete state space for all possible savings. We have a minimum a from equation (4.16), and create a maximum that will never be binding. With this we create a grid of elements to optimize over in regards to consumption. We must also create a grid of all possible pension accruals, as this is an additional state variable. Lastly, we must have all combinations of assets and accruals with all possible values of the wage shock, our third state variable. Functions from the CompEcon toolbox for Matlab are utilized for interpolation and for computing the coefficients of the value function (Miranda and Fackler, 2002).

After solving the individual problem recursively, we simulate life cycle consumption and saving paths. This is done in a similar manner to the basic model, with the lone difference being that instead of probabilities for the employment chain, this simulation takes draws of the normal distribution to replicate the income shock.

The next section contrasts the results of these simulations under a number of different specifications, and discusses how they compare to recorded Swedish saving behavior from 1980-2014.

5 Results of Modeling

In this section we present the results of our modeling endeavours. We first describe how we manipulate our simulated representative data to calculate a saving rate, followed by a presentation of results for a variety of specifications from both our simple and extended models. When relevant the results of the extended model are compared to the results of the simple model. We next discuss our best fitting simulation, a version of our extended model in which tax changes follow those of Sweden from 1980-2014. The chapter ends with the conclusion of our results, that the high saving rate in Sweden can be attributed to tax changes, demographic development, and counter-cyclical saving behavior. Sensitivity testing for all structural variables is included in appendix D.

5.1 Calculation of Saving Rate Through Time

The aim of this paper is to uncover new information pertaining to the evolution of the household saving rate in Sweden. Both models we have presented, however, do not explicitly calculate the household saving rate. Thus, some data manipulation is required to compare our simulations to the last few decades in Sweden.

First, recall the results of our models. Both the simple and extended model create simulations of 1000 households, each of which faces a unique and random set of shocks to their income throughout time. Our simulations terminate with the record of the income, assets, and consumption of each individual in each period. As we are not interested in the actions of a given individual, but rather equilibrium behavior under the given parameters, we average the above matrices across the 1000 simulations for each time period. Instead of a 75x1000x2 matrix of assets, we have a 75x1x2 matrix of mean assets and mean consumption in a given time period.

With this information, we can calculate the average saving rate of an individual throughout their life. This is simply the sum of their total saving over their lifetime divided by total disposable income. This saving rate is a poor estimation of the household saving rate for the entire country for a number of reasons. First, because the simple model has no bequest motive, all income is either eventually consumed or taxed away. In the simple model, this calculation of saving would be identically zero in every specification. Second, as implied with the survival rates in the extended model, assuming every individual dies at the same maximum age is unrealistic. Third, the number of individuals of each age in a nation is affected by a wide range of factors outside of simple period-to-period survival rates. The wax and wane of birth rates and death rates cause continuous fluctuations in age distribution. This is touched upon in sections 2 and 3, as the dependency ratio is mentioned as a potential causal factor in Sweden's saving behavior.

Our model allows for a more thorough demographic simulation than a simple dependency ratio calculation. Given the distribution of a population from ages 25 to 100 (or 25 to 80 in the case of our simple model), we can calculate a total saving rate by using our simulated action for each year of life. As above, the total saving rate in year y, TSR_y, is the amount saved by the population in year y, TAS_y, divided by the disposable income of the population in year y, DI_y. From our "average individual" calculations, we have the average amount saved, consumed, and earned by the average individual of age i. With this, we can calculate the average saving rate of an age i individual, SR_i. This saving rate by age, together with disposable income by age and a distribution of ages in the population, AW_i, allows for an accurate total saving rate to be calculated. Income includes both wage income, which is taxed, and capital income, which is not.

$$TSR_y = \frac{TAS_y}{DI_y} \tag{5.1}$$

$$= \frac{\sum_{i=t}^{T} DI_i SR_i AW_i}{\sum_{i=t}^{T} DI_i AW_i} \tag{5.2}$$

From the Statistics Sweden (Statistiska centralbyrån) website, we queried the number of individuals within Sweden of each age for every year from 1980 to present. Population age is denoted by PA_i^t. From this we took the sum of all individuals age 25 to 80 for our simple model, and 25 to 100 for the extended. Age wedge, AW_i, for each year y is calculated as follows:

$$AW_i^y = \frac{PA_i^y}{\sum_{i=t}^{T} PA_i^y} \tag{5.3}$$

With the Swedish age distribution data, we can calculate simulated saving behavior which is easily comparable to the recorded data.

To reiterate: in each set of 1000 simulations with a given parameterization, we record the average income and consumption of each age. We pair this with age distribution data to create a saving rate for each year from 1980 to 2013.

5.2 Judging the Simple Model

Our simple model was built with the aim of being as parsimonious as possible. The model can vary in interest rate, r, wealth tax, τ_w, income tax, τ_i, parameter of risk aversion σ, unemployment Markov probabilities, and in discount parameter β. The model was solved for a variety of parameterizations of each variable. In the most paired down specification, the tax variables are set to zero with interest rate set to 4 percent, β to 0.96, σ to 2, and the Markov chain following the probabilities presented in section 4. In this base specification, the household saving rate varies between a low 6.26 in 1987 and 8.39 in 2003.

Throughout this results section, we compare model specifications on how well they match empirical evidence in Sweden. Our primary method of comparison is the coefficient of determination, listed as R^2. Because of the roughness of this measure, we also note where the models seem to consistently over and under predict saving. In addition, with the extended model we calculate the size of simulated bequests and compare this to size of an average Swedish bequest. Simulated bequests are calculated via average assets at each year of life and the survival probabilities discussed in section 4.

Our simple model without taxes does not simulate Swedish savings with a high degree of accuracy. When paired with the Swedish saving series, the R^2 value was 0.005. The saving value was generally overestimated in the 1980s, and underestimated in the 2000s. However, we are able to increase the accuracy of the simple model by adding in tax values which mimic those in Sweden.

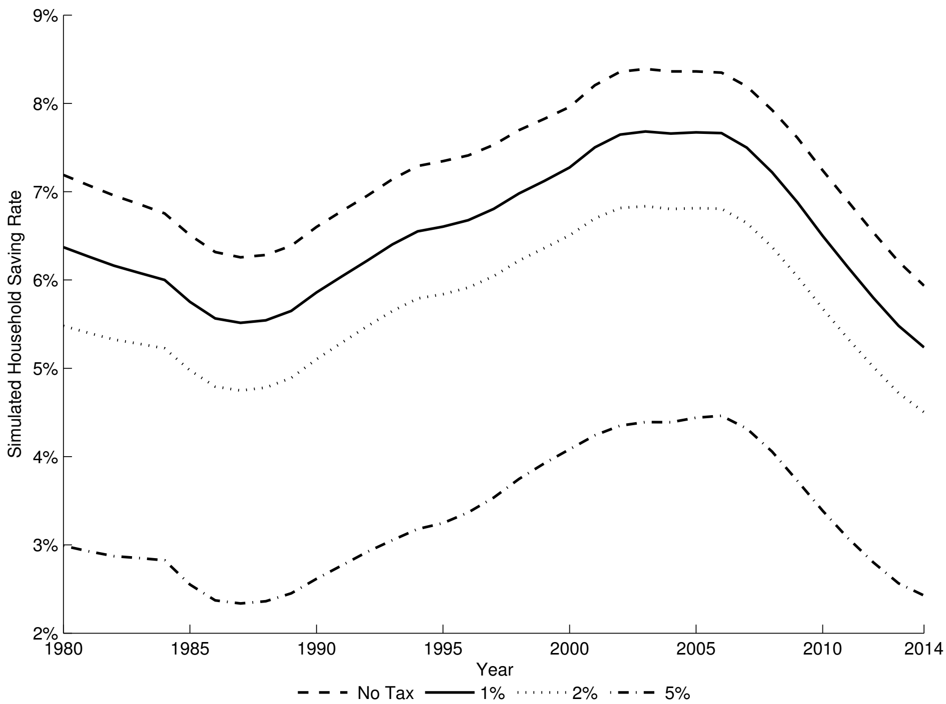
5.2.1 Wealth Tax Variations

The removal of the wealth tax by the Swedish Parliament was raised as a potential causal factor for increased household saving in our motivating econometric work. However, our results showed an ambiguous effect. In theory, a wealth tax is a disincentive to saving: saving x kronor leads to $(1 - \tau_w) * x$ in the next period.

In our simple model, we ran simulations of wealth tax at levels of 0, 1, 2 and 5 percent. Our expectation was that an increase in tax would cause a decrease in the saving rate, and that these decreases should not be dependent on demographics. As seen in Figure

5.1, both hypotheses largely hold true. An increase in τ_w leads to a decrease in saving by roughly three quarters of a percent. In every age distribution, the increase of τ_w from 1 to 2 had a slightly larger effect that 0 to 1, with this effect the most pronounced from 2000-2009. The first increase in tax led to a decrease of 0.70, while the second caused a decrease of 0.84. The 5 percent tax gives evidence that wealth tax has a linear effect on saving. In every demographic specification, the five percent tax had between 4.9 and 5.2 times the impact of the 1 percent tax. Under all tax schedules, saving was minimized in the late eighties and early nineties, and maximized in the 2000s. These values are visualized in Figure 5.1. The inclusion of a wealth tax improves the estimation of actual saving negligibly by R^2, increasing to 0.006 when matched with the true wealth tax. An increase in τ_w beyond 1.5 reduced the R^2 further. As a point of evidence towards the applicability of even this simple model, the R^2 of the $\tau_w = 1.5$ model is 0.31 when comparing only with the time period in which Sweden had a wealth tax, 1980-2007.

FIGURE 5.1: Wealth Tax and Household Saving Rate Through Time



Notes: The figure shows the household saving rate, expressed as a percentage of disposable income, for various wealth tax levels. Source: Calculation by Authors.

5.2.2 Income Tax Variations

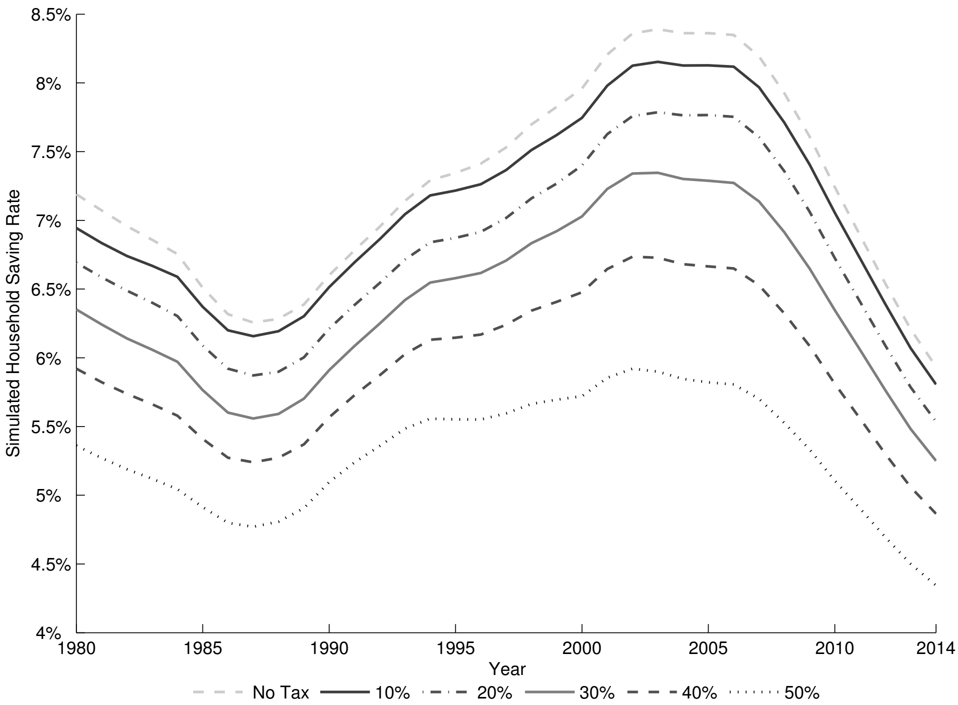
The second tax our simple model is able to incorporate is one upon income. The income tax has a less clear effect on saving than the wealth tax. The saving rate consists over a numerator of amount saved, and the denominator of disposable income. Disposable income is income less tax, which is thus reduced by a higher income tax. If amount saved was constant, the saving rate would increase. However, income tax also has an effect on the amount saved, generally expected to reduce the amount saved. In empirical work, including our own in section 3, an increase in the income tax is expected to cause a decrease in saving.

Our results, graphed in Figure 5.2, show this hypothesis to be valid within the simple model. However, it seems household saving's sensitivity to income tax in not exceptionally large. A ten percent income tax never causes a decrease in saving rate greater than 0.25. The effect of income tax seems to depend on the demographic makeup of the population, with the effect of a 50 percent tax (versus a no tax model) greatest in the years with high overall saving, and lowest when saving in low. This is perhaps due to a key assumption of our model: income taken via tax is never returned to the earner in the form of a benefit. Thus, large assets are rarely accumulated. In the low tax environment, over 20 percent of disposable income is saved by all individuals under 50. In the high tax milieu, this behavior continues only until age 35.

As we are simulating one representative household, our ability to truly match income tax policy with the τ_i is severely limited. In Sweden, as in most rich countries, income is taxed at different rates for different levels. Thus our one rate tax could bias results if saving behavior differs substantially between income groups. This bias worsens as inequality increases, as a wider swath of total income is controlled by those paying a higher tax rate. Sweden measured as one of the most equal countries by the GINI coefficient throughout the time period studied, minimizing the potential for invalid results from this effect. (World Bank)

As with τ_w, τ_i is able to increase the accuracy of the model when matched with values corresponding to actual tax rates. A model mixing $\tau_i = 0.3$ and $\tau_i = 0.5$ is able to increase R^2 to 0.06. This is still minuscule, but trends in the correct direction. The simple model is not able to capture the majority of saving behavior, but it does capture more when the model is modified to reflect Sweden. The next section displays the results of the extended model, which is more accurate in its predictions.

FIGURE 5.2: Income Tax and Household Saving Rate Through Time



Notes: The figure shows the household saving rate, expressed as a percentage of disposable income, for various income tax levels. Source: Calculation by Authors.

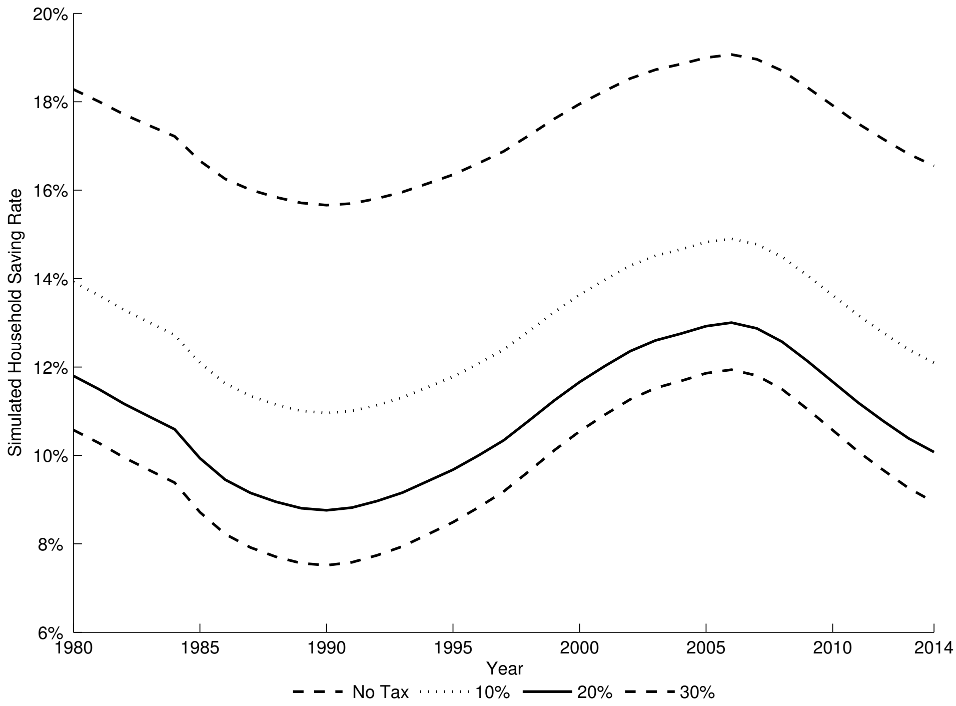
5.3 Extended Life Cycle Model

The Sweden specific extended life cycle model has significantly more degrees of freedom than our simple model, and thus allows for significantly more exploration into the interactions between our model and saving behavior in Sweden. The motivation for our choice of the bequest function and its parametrization is explained in an appendix. As in the model without a bequest motive, the most accurate model by R^2 is that which matches the evolution of Swedish tax policy. This verifies our preliminary econometric results, suggesting that the change in income, wealth, and bequest taxes have had a significant impact on Swedish household saving behavior. The basic model was again considered without taxes, and has an R^2 of 0.10.

5.3.1 Bequest Tax Variations

In Section 3, our dummy variable for the existence of a 30 percent bequest tax had an estimated effect almost an order of magnitude larger than all other variables in every specification in which it was included. The existence of a bequest tax was estimated to cause a reduction in the saving rate by between 4 and 8 percent. In our modeling with a bequest weight of 1.25, the simulation $\tau_b = 0.3$ has a household saving rate roughly 7 percentage points lower than that with no tax at all. With a bequest weight of 1, the rate was 4 to 5 points lower. This gives some immediate confirmation to our econometric work, and gives more evidence towards the removal of the bequest tax as a causal factor in the rapid rise of household saving in Sweden. This is shown in Figure 5.3.

FIGURE 5.3: Bequest Tax and Household Saving Rate Through Time



Notes: The figure shows the household saving rate, expressed as a percentage of disposable income, for various bequest tax levels. Source: Calculation by Authors.

As in almost every other simulation, the fluctuations in age demographics have a significant effect under all tax policies. The difference between peak saving in 2006 and the low point in 1990 is roughly 3 percentage points. This is an equivalent to the difference between a $\tau_b = 0.1$ and $\tau_b = 0.3$. Our simulations also show that each successive increase in bequest tax has a diminishing effect of saving rate. The first 10 percent accounts for five-eighths of the effect of the full 30 percent tax.

As stated above, this large effect could potentially be overstating the effect of a bequest tax, because we do not model the saving behavior of the receiver of a bequest and the taxes are not recycled in any way. A large bequest could cause less consumption for a bequest receiver, balancing out or reversing the effect modeled here.

When considered over the entire time period, an increase in τ_b from 0.1 to 0.2 to 0.3 takes R^2 from 0.11 to 0.12 to 0.13. When these are limited to just the time period where a bequest tax was in effect, this increases each estimation by 0.03. As a second piece of evidence, the inclusion of a bequest tax leads to a simulated bequest size of a similar magnitude to that which has been measured in Sweden. Our base model with no taxes has a simulated bequest size of three times average yearly income, whereas the Belinda database studied by Elinder et al. (2014) found the average bequest size in Sweden to be roughly one-third of average income. This study covered the period in time when Sweden had a 30 percent wealth tax. When $\tau_b = 0.1$, simulated bequests drop to twice yearly income, 1.5 times with $\tau_b = 0.2$, and 1.3 times with $\tau_b = 0.3$. As τ_b more closely reflects reality, so do simulated savings and bequests.

5.3.2 Income Tax Variations

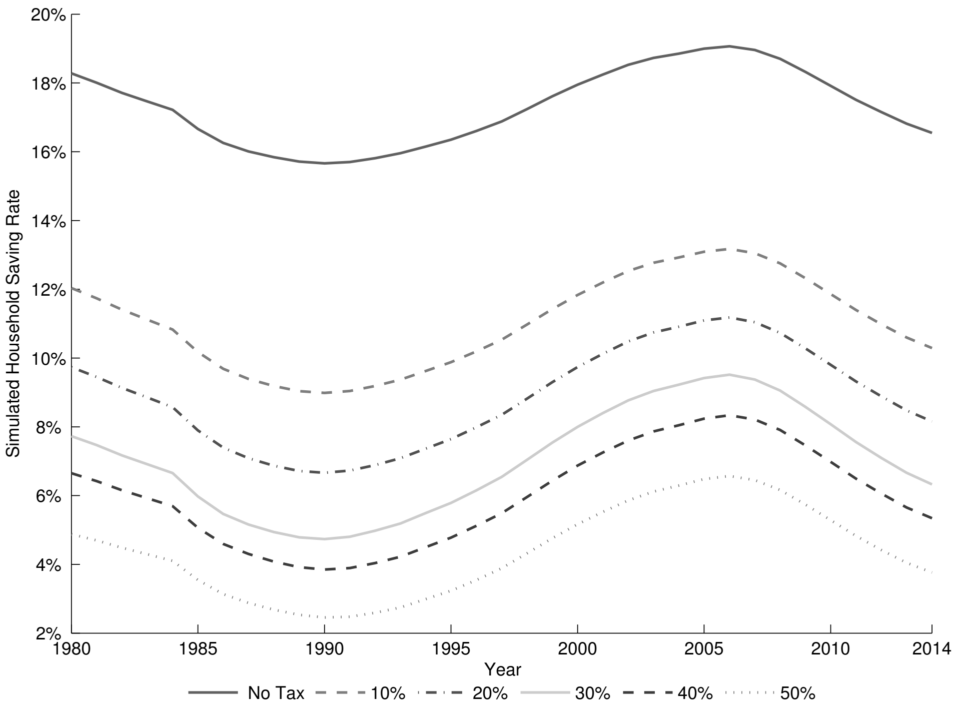
As seen in Figure 5.4, income tax τ_i behaves in a similar manner as it does in the simple model, implying that there is little interaction between income tax and the bequest motive. As with τ_b, it appears the existence of the tax causes the largest change in saving behavior. The difference between no tax ($\tau_i = 0.0$) and $\tau_i = 0.1$ is of a similar magnitude to that between $\tau_i = 0.1$ and $\tau_i = 0.5$. This gives some evidence to our empirical finding that income tax is highly significant in saving behavior, but at a much smaller magnitude than τ_b. It would seem that our regression might have been slightly misspecified, as τ_i does not appear to have a linear relationship with simulated saving.

When considering the entire time period, the level of τ_i does not significantly change R^2, staying between 0.12 and 0.14 for any level from 0.1 to 0.5. However, when the rates are paired with the years they were in affect, the R^2 increase to 0.28 across the entire period. Bequest sizes also vary with τ_i, from one quarter of average income when $\tau_i = 0.5$ to 1.4 times average income when $\tau_i = 0.1$.

5.3.3 Wealth Tax and Bequest Size

Similar to the simple model, τ_w has a negative effect on saving behavior. The R^2 of the model with only τ_w is 0.11 when judged across the entire time series, and 0.13 when judged against the time period in which wealth tax was in affect. When matching tax policy, the R^2 increases to almost 0.5. The bequest size is also quite reasonable, just over half average income. With only a wealth tax and a bequest motive, our model is able to capture almost half of all saving behavior variations.

FIGURE 5.4: Income Tax and Household Saving Rate Through Time, Extended Model



Notes: The figure shows the household saving rate, expressed as a percentage of disposable income, for various income tax levels. Source: Calculation by Authors.

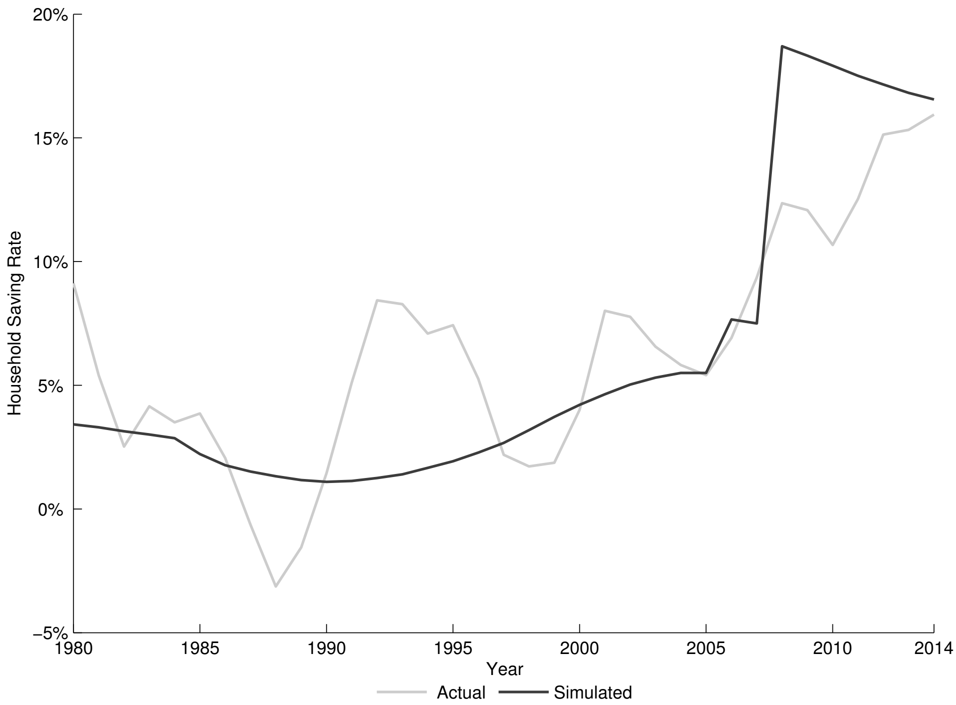
5.4 Discussion of Best Models

The model which best estimates Swedish saving behavior from 1980-2014 is the version of our extended model which most closely tracks Swedish tax changes. This model incorporates the reduction in personal income tax in 1990 as well as the changes in wealth and bequest taxes in the 2000s. With this, an R^2 of 0.65 is achieved, while all components of the model created a reasonable average bequest of about one-fifth of average yearly income. There is one period of time in which the simulated model performs consistently poorly, the early 1990s. This could relate to the recession experienced at that point in time. Our econometric work found evidence of counter-cyclical saving behavior in Sweden, which is not incorporated in this model. This recession would imply an increase in saving, leading our model to underestimate saving. This is indeed the case.

5.4.1 Demographic Change

Regardless of the specification of any given parameter in the figures above, almost every line follows the same basic pattern: saving is relatively high in the early 1980s, bottoms

Figure 5.5: Best Fit Model Overlay on Actual Data

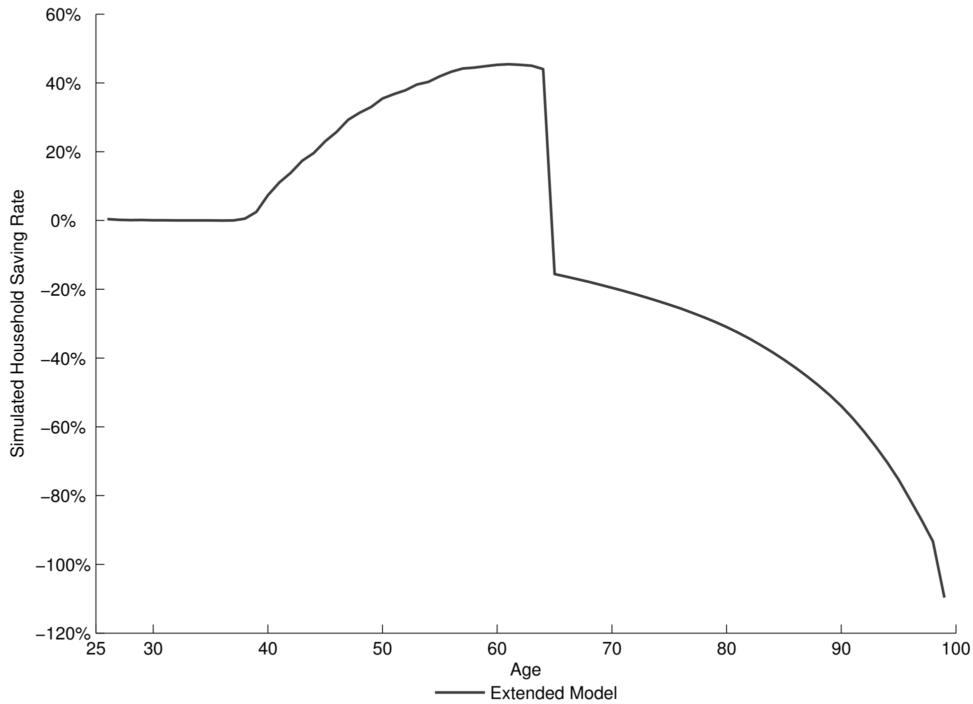


Notes: The figure shows the actual and simulated household saving rate from 1980-2014. Source: Calculation by Authors and OECD.

out in the later years of that decade and early portions of the next, and finally spikes upwards until the late 2000s. Even without considering the level of taxes, this largely flows with what has happened in Sweden the past 30 years if periods of recession are disregarded. In Section 3, we included dependency ratio as a measure of demographic change to account for how age demographics affect saving. In our research, and in a number of other studies, neither old, young, nor total dependency ratio had a significant impact as large as it would seem to have been in Sweden.

Our modeling specification, in which we split up saving and consumption behavior by age and calculated saving rate using average income at that age and the proportions of the population at that age, allows for significantly more in depth exploration of how age demographics affect household saving. In most of our extended specifications, the representative household has one period of very high saving behavior. This occurs in the years just preceding retirement, beginning to accelerate at 45 and jumping up considerably again at 50, ending in the last year of working life, 65. In the simple model, this period of high saving occurs in the very beginning of working life, from 25-30. The saving rate by age is displayed in Figure 5.6. Comparing this with the distribution of

Figure 5.6: Simulated Household Saving Rates



Notes: The figure shows the simulated household saving rate of each age. Source: Calculation by Authors.

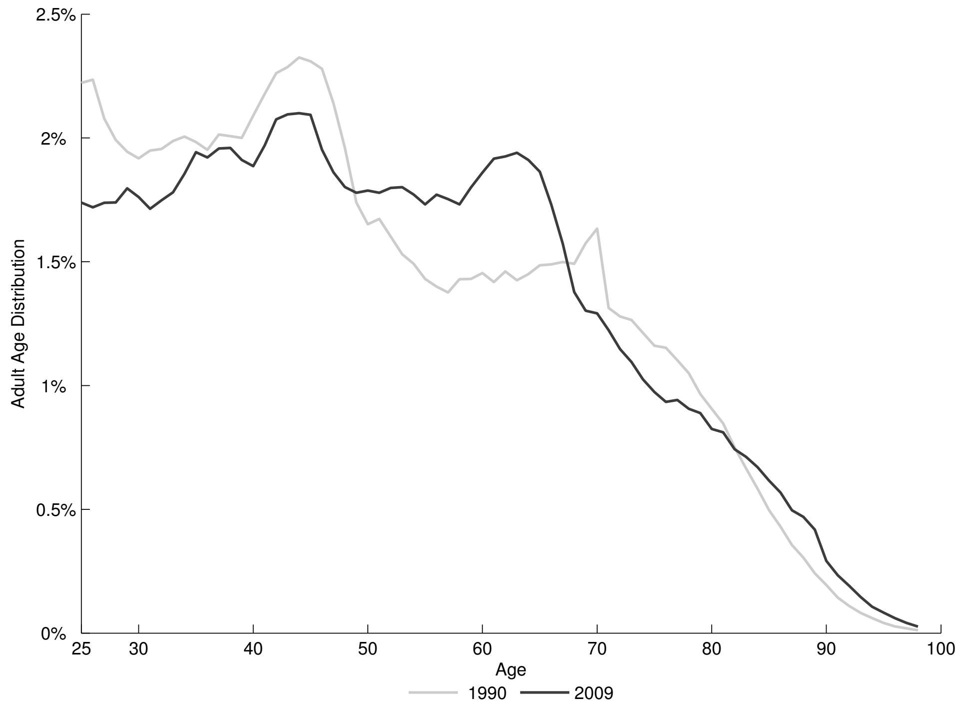
adults by age in Figure 5.7, one can see that the proportion of adults in peak saving age significantly increased from 1990 to 2009.

Age dependency ratio does a fine job at capturing the proportion of the population which has the lowest saving rate, but it would seem that a more accurate causal factor would be the proportion of the population which is of prime saving age. This demographic shift was anticipated, and was a large factor in the reconfiguration of the Swedish pension system.

5.4.2 Limitations Within the Modeling Framework

Despite our success in modeling the Swedish saving rate in a parsimonious manner, there are a number of limitations that must be considered. In this model saving is shifted though time by two primary factors: a change in tax policy and a change in demographic makeup. Our modeling of the first is extremely haphazard, as we simply toss aside tax revenue and never consider it returned to the representative household. This is not in itself a reason to discredit the results, as one could consider this money spent on military actions, or disaster relief efforts in other countries. Wars and relief are

Figure 5.7: Distribution of Adults by Age, 1990 and 2009



Notes: The figure shows the proportion of adults of each age in 2009 and 1990. Source: SCB.

both tax funded and generally not involved in returning utility to the taxed citizen. This could be a legitimate argument for the tax income from bequests and wealth, as both are negligible in proportion to the total tax receipts of the Swedish state. Income taxes, however, are such a substantial proportion of government income that assuming they are never returned as utility would be naive. The strong welfare state of Sweden is primarily built upon income tax. However, income taxes had a much smaller impact upon saving behavior than the bequest and wealth taxes, both in our preliminary econometric analysis and both the simple and extended model. Thus, our results are worthy of consideration even with the non-recycled income.

On a similar track, the bequest left behind by our modeled household are not recycled. This is not intuitive. If an average household is leaving behind 100000 SEK, then the average household should receive $100000(1-\tau_b)$ at some point in life. The "correct" saving rate of any given policy could be considered the steady state where taxed average bequest size is returned at some point. In our simulations, the significance of this omission depends heavily on when it was returned, and the tax policy in place. When we attempted to iterate for a steady state by setting initial assets in one simulation[9] equal

[9]One simulation meaning one set of 1000 simulations.

to average taxed bequest size of the previous simulation, without any taxes, bequests spiraled upwards. Although bequests were of a much larger magnitude generation to generation, consumption patterns remained similar leading to relatively consistent saving rates. The growing bequest effect was mitigated by allowing the initial assets to remain at zero, and the inheritance to enter later in life. This effect is also prevented by including a tax on income. In the specification with $\tau_i = 0.3$, equal to our simulation of the current day, an initial asset bequest of 0.56 leads to a left bequest of 0.58.

The above holds true so long as initial assets were less than year's average income. A change in saving rate occurs when initial assets are many times average yearly income. This in turn calls into focus another shortcoming of this analysis, the lack of multiple income levels in the simulations. This is important in two ways. First, by definition, the income of richer people is higher than that of the poorer. Thus, if a richer segment has both a high saving rate and a high proportion of all disposable income, the saving rate can be quite large despite little to no change among the majority of the population. In addition, neither bequests nor income are taxed at a flat rate in Sweden. Higher incomes and bequests were taxed at higher levels, and the tax levels used as τ in the analysis were the average rates across the country. This analysis is valid so long as the average household is a good representative for most of Sweden.

One area in which our representation is not an accurate representation on Swedish behavior is in our non-negative asset constraint. According to the Riksbank, the average household has debt of more than double their yearly disposable income, with over 95 percent of this debt related to mortgages (Winstrand and Ölcer, 2014). The factors behind this increase are touched upon in sections two and three, with access to cheap capital paired with laws designed to increase home ownership. We chose to keep our model compact, requiring us to sacrifice a home ownership component from the household saving equation.

A different sort of limitation arises when considering the calculation of simulated saving rate in our best fit model, which does not maintain the same tax parameters throughout. In our simulations, agents operate under perfect foresight, and age with the same taxes throughout life. To calculate results in a situation where variables change, we run multiple sets of simulation, one for each parametrization faced. We then calculate saving rate for the period in which that parametrization was in effect. For example, in our best fit model the calculations previous to 2005 draw from simulations which were run with an inheritance tax, while 2005 to 2013 are done without. This ignores the period where individuals adjust their actions to the new conditions. The simulated individual faces only one tax level their entire simulated life, a difference from a true household.

Despite these limitations, a simple combination of consumption, bequests, demographics, and taxes was able to account for a large chunk of Sweden's saving behavior over the last three decades. This result, paired with the econometric work presented in section three, implies that the Swedish saving rate increased over the past decades do to both the structural changes in the tax system and the aging of a large portion of the population into a high saving portion of their lives.

6 Summary and Concluding Remarks

We began this investigation with an observation, noting that Sweden has sustained a dramatic increase in its household saving rate. This saving rate increase seems to appear in contrast to its Nordic neighbors, all of which share significant economic similarities. In particular, all the Nordic countries have significant social safety nets for unemployment, retirement, and healthcare. These social safety nets are generally considered insurance against personal calamity and thus causes for a low household saving rate.

We continued our analysis with an extended exploration into past research on saving behavior. This research focused on the primary modeling tool for saving behavior, the Life Cycle Model/Permanent Income Hypothesis, and a number of individual factors which are considered to have causal effects on the saving rate. For the latter, we discussed how Sweden has evolved through 1980 to the present day with regard to each of these individual factors. From this overview, a number of potential causes of Sweden's saving behavior emerged, including counter cyclical saving behavior, tax changes, age-demographic evolution, and changes in the pension system.

After surveying previous literature, we moved forward into our empirical analysis. This analysis began with a series of econometric models on a panel of Nordic data aiming to provide clarity on what has driven saving within the past three decades. The analysis included specifications of OLS, GLS, and in an appendix, FGLS, with our preferred specification working to minimize the effects of heteroskedasticity and autocorrelation. Nordic area data is utilized to counteract the paucity of Swedish saving information. Due to this data constraint, and our limitations in providing an inclusive model of all saving determinants, we chose to take the results of this analysis needing confirmation rather than as gospel. These results including the expectation that tax changes, especially the elimination of a tax on bequests, had an extreme effect on saving behavior. The results also suggested that changes in the Swedish housing market have influenced saving.

Tying together previous research into saving with our econometric results, we moved forward by using two dynamic life cycle models parametrized to represent Sweden to simulate saving behavior under a wide variety of circumstances. In particular, we focused on the effects of tax changes in wealth, bequest, and income which simultaneously allowed for age demographics to mimic those which existed in Sweden under the period of observation.

As predicted by the econometric work, changes in tax policy had a significant effect throughout all simulations. As a vote of confidence towards our model, we found that the model which best simulates the Swedish data is that which follows Swedish tax and demographic evolution as closely as possible. This model was able to correctly account for over 60 percent of variation in household saving. However, it fell short in a number of areas. First, the model was unable to incorporate a counter cyclical saving element similar to that which is predicted to have a strong effect on saving in the literature and in our econometric work. The periods of time where our model was least accurate involved periods of either recession or rapid recovery from recession. In addition, it did not involve recycling tax income nor pensions. Preliminary tests indicated that these adjustments should not fundamentally alter our results, though further research is necessary. Lastly, our model is dependent on a representative household serving as an accurate representation of Sweden. If there is a high degree of elasticity in saving behavior with regard to income or bequests, this could fundamentally alter our results.

The question of Sweden's household saving rate is a unique one, deserving of further attention. This being said, our results confidently state that Sweden's increase of saving behavior in the last two decades was primarily due to changes in life, death, and taxes.

Appendix A

Data for Econometric Analysis

Table A.1: Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.	N
Age Dependency Ratio	52.301	2.949	46.819	58.416	136
GDP per capita	34240.74	19607.756	10724.25	100578.969	136
GPD per capita Growth	3.464	16.554	-84.31	40.969	135
Gross national savings	24.489	5.589	13.16	40.561	136
Inflation	3.729	3.332	-0.494	17.452	136
Inheritance Tax	0.934	0.25	0	1	136
Capital Account Openness	0.827	0.219	0.409	1	132
Mortgage Cap	0.14	0.348	0	1	136
Price-to-Income Ratio	84.828	17.226	54.284	141.311	135
Price-to-Rent Ratio	73.272	19.536	38.725	125.709	136
Real House Prices	68.19	22.103	34.841	124.019	136
Real Interest Rate	5.695	3.933	-5.812	16.751	104
Household Saving	2.866	4.36	-7.227	15.323	135
Tax on Personal Income	16.051	5.312	8.999	26.371	136
Unemployment Rate	6	2.924	1.558	16.606	136
Unemployment Growth	3.001	23.873	-79.755	106.437	135
Wealth Tax	0.757	0.43	0	1	136
Year			1980	2013	136

Table A.2: Description and Definition of Variables

Variable	**Description**
Age Dependency Ratio	Age-dependency ratios are a measure of the age structure of the population. They relate the number of individuals that are likely to be "dependent" on the support of others for their daily living – youths and the elderly – to the number of those individuals who are capable of providing such support. Source: OECD
Capital Account Openness	Our measure of capital openness is the Chinn-Ito Index. This index measures openness in cross border transactions, scaled between 0 and 1. Source: Portland State University
Gross Domestic Product per capita	Gross domestic product is an aggregate measure of production equal to the sum of the gross values added of all resident institutional units engaged in production (plus any taxes, and minus any subsidies, on products not included in the value of their outputs). The sum of the final uses of goods and services (all uses except intermediate consumption) measured in purchasers' prices, less the value of imports of goods and services, or the sum of primary incomes distributed by resident producer units. Source: WEO
Gross National Saving	Gross national saving is gross disposable income less final consumption expenditure after taking account of an adjustment for pension funds. Source: WEO
Inflation	Annual percentages of average consumer prices are year-on-year changes. Source: WEO
Inheritance Tax	Dummy variable for inheritance tax. Sweden abolished its inheritance tax on January 1st 2005. Norway has had no inheritance tax as of 2014.
Mortgage Cap	Dummy variable to account for the mortgage cap that Sweden introduced in late 2010.

Continued on next page

Table A.2 – *Continued from previous page*

Variable	**Description**
Real Interest Rates	Long term (in most cases 10 year) government bonds are the instrument whose yield is used as the representative 'interest rate' for this area. Generally the yield is calculated at the pre-tax level and before deductions for brokerage costs and commissions and is derived from the relationship between the present market value of the bond and that at maturity, taking into account also interest payments paid through to maturity. Source: OECD
Price to Rent Ratio	A ratio of the price of a given dwelling to the rent required to live in it without ownership. Is a measure of profitability of owning a house. In this dataset, real house prices are indexed to the average price of one and two dwelling homes in 1995. Source: OECD
Price to Income Ratio	A ratio of the median free-market price of a dwelling unit and the median annual household income. Source: OECD
Real House Prices	Real House Prices are built from an index of one and two dwelling buildings for permanent living, with 1981 = 100. Source: OECD
Tax on Personal Income	Tax on personal income is defined as the taxes levied on the net income (gross income minus allowable tax reliefs) and capital gains of individuals. This indicator relates to government as a whole (all government levels) and is measured in percentage both of GDP and of total taxation. Source: OECD

Continued on next page

Table A.2 – *Continued from previous page*

Variable	**Description**
Unemployment	Unemployment rate can be defined by either the national definition, the ILO harmonized definition, or the OECD harmonized definition. The OECD harmonized unemployment rate gives the number of unemployed persons as a percentage of the labor force (the total number of people employed plus unemployed). As defined by the International Labour Organization, unemployed workers are those who are currently not working but are willing and able to work for pay, currently available to work, and have actively searched for work. The data used in this work refers to the OECD definition. Source: WEO
Wealth Tax	Dummy variable for wealth tax. The wealth tax was removed in Sweden in 2010. Denmark abolished its wealth tax in 1995 and Finland in 2006.

Appendix B

FGLS Regressions with Autocorrelation within Panels

Based on the Buffer Stock assumption that households aim to keep a wealth target ratio it is reasonable to assume that consumption and saving decisions from the last period are relevant for this period's saving decision. Put differently, we expect lagged effects. In an attempt to control for autocorrelation within panels we test a cross-sectional time-series Feasible Generalised Least Squares (FGLS) model with autocorrelation within panels. FGLS is used to obtain consistent estimates when the covariance of errors is unknown and allows us regression estimation in the presence of AR(1) autocorrelation within panels. One of the disadvantages of FGLS is however that it can be less efficient than OLS for small to medium sample sizes. The model is given by

$$y_{it} = x_{it}\beta + \varepsilon_{it} \tag{B.1}$$

where $i = 1, ..., m$ is the number of units (or countries), and $t = 1, ..., T_i$ is the number of observations per country. Our dependent variable *household saving* is denoted by y_{it}. In this model we assume that β is the same for all panels. The vector of independent variables is denoted by x_{it}. The error term is specified as ε_{it}, where the structure of variance matrix of the disturbance term can be varied.

We begin by allowing for autocorrelation within panels to produce a more reasonable estimate of the regression coefficients. We assume that the variance matrix of the disturbance term has a common autocorrelation parameter in regressions (1) and (2) in Table B.1. This restriction is reasonable when the individual correlations are nearly equal and the time series are short. Note that all errors follow the same AR(1) process in this specification.

In a second specification we test our model assuming serial correlation where the correlation parameter is unique for each panel (Table B.1 (3) and (4)).

TABLE B.1: Cross-Sectional Time-Series FGLS Regressions with Autocorrelation within Panels

VARIABLES	(1) Household Saving	(2) Household Saving	(3) Household Saving	(4) Household Saving
GDP per capita	-9.73e-05***	-0.000117***	-0.000134***	-0.000145***
	(3.55e-05)	(3.21e-05)	(3.35e-05)	(3.04e-05)
Unemployment Rate	0.0276		0.104	
	(0.122)		(0.132)	
GPD per capita Growth	-0.0192*	-0.0218**	-0.0190**	-0.0176*
	(0.0104)	(0.0104)	(0.00968)	(0.00930)
Unemployment Growth	0.0240***	0.0300***	0.0222***	0.0239***
	(0.00793)	(0.00721)	(0.00721)	(0.00648)
Gross national savings	-0.107		-0.0631	
	(0.0785)		(0.0783)	
Inflation	0.371***	0.286***	0.447***	0.395***
	(0.102)	(0.0866)	(0.0954)	(0.0805)
Age Dependency Ratio	-0.0119		0.0769	
	(0.134)		(0.125)	
Price-to-Income Ratio	-0.333***	-0.334***	-0.435***	-0.480***
	(0.0460)	(0.0422)	(0.0449)	(0.0439)
Price-to-Rent Ratio	-0.0698		-0.0383	
	(0.0515)		(0.0454)	
Real House Prices	0.372***	0.307***	0.459***	0.460***
	(0.0804)	(0.0508)	(0.0732)	(0.0514)
Mortgage Cap	2.301**	2.355**	1.334	
	(0.970)	(0.935)	(0.874)	
Tax on Personal Income	-0.598***	-0.597***	-0.702***	-0.703***
	(0.0885)	(0.0713)	(0.0849)	(0.0715)
Wealth Tax	3.194***	2.675***	2.076***	1.494*
	(0.867)	(0.848)	(0.805)	(0.799)
Inheritance Tax	-4.780***	-4.641***	-3.264***	-3.039***
	(1.170)	(1.185)	(1.014)	(1.119)
Constant	27.22***	24.79***	23.67**	28.67***
	(9.943)	(2.441)	(9.326)	(2.234)
Observations	135	135	135	135
Number of country	4	4	4	4

Note: The dependent variable is household saving for the years 1980 to 2013 from Denmark, Finland, Norway and Sweden. The independent variables cover same time period and countries. All regressions are estimated with autocorrelated errors. Regressions (1) and (2) are estimated assuming serial correlation where the correlation parameter is common for all panels and (2) a more parsimonius version of (1). The regression command used in STATA is: xtgls saving [*indepvars*], panels(hetero) corr(ar1). Regressions (3) and (4) are estimated assuming serial correlation where the correlation parameter is unique for each panel. Here again (4) is a version of (3) with insignificant independent variables removed from the specification. The regression command used in STATA is: xtgls saving [*indepvars*], panels(iid) corr(psar1). Standard errors in parenthesis. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Either assuming the correlation parameter is common for all panels or allowing the correlation parameter to be unique for each panel, we do not see any significant changes in variables' signs or significance levels. Overall, we do not find that FGLS improves upon the results from previous specifications.

Appendix C

Bequest Function Motivations

To understand the results, a short explanation on bequests is necessary. A bequest occurs when wealth is transferred between generations, in our case via the death of the older generation. Our model focuses entirely on the saving behavior of the older generation, meaning we simulate the saving behavior of someone who does not receive an inheritance while young, but does bequeath one upon dying. This is the primary drawback to a life cycle model: to fully calculate the saving implications of bequest and bequest taxes, the effect of a lump sum gift in early adulthood on saving must be considered. As with our income and wealth taxes, revenue derived from bequest taxes is not recycled to the donor. Recycling the tax revenue to the donor has been modeled to reduce the effects of bequest taxes on saving (Gale and Perozek, 2001).

Three separate motives for bequests were considered in building this extended model: accidental bequests, bequests as an exchange with ones progeny, and altruism. The second of these three does not apply in a representative life cycle model, as it requires two generations to interact and exchange bequests for non-monetary goods such as visits, attention, or location of residents. Accidental bequests stem from imperfect knowledge about length of life, which is given in our framework. Even in a model without a bequest utility function, accidental bequests would arise. These can be calculated in our simple model via a simple multiplication of mean assets at a given age and the survival probability to the next year. However, the existence and vast reach of life insurance policies and bequest planning companies give evidence to some sort of purposeful leaving of bequests to progeny (Gale and Perozek, 2001).

With accidental bequests unreasonable, and intergenerational exchange not possible within our framework, we proceed with a pure altruistic motive for bequests. Parents care about both their own consumption and that of their children, which they endow with their bequests. We follow the work of Kopczuk and Lupton (2007) and assume that the bequest motive is linear in wealth. Different weights on the linear motive are discussed in the next appendix, with our choice of 1.25 made to match bequest data from Sweden.

Appendix D

Sensitivity Testing

In this appendix we present a number of simulations of our basic and extended model. We test the sensitivity of the models to changes in their parameters, and explain our reasoning for choosing those parameters.

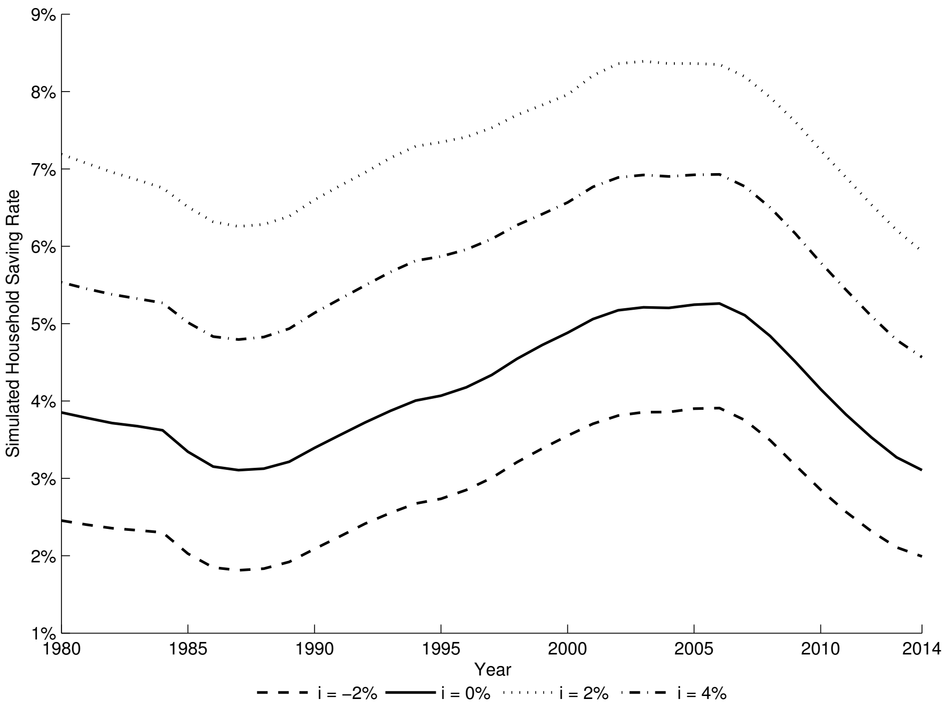
D.1 Basic Model

D.1.1 Interest Rate Variations

In our econometric work, we did not find a consistent or significant effect of real interest rate on saving. In section two, we mention that this could be due to the interaction between wealth and substitution effects. Within the simple model, however, no such ambiguity resides, and interest rate has a very clear positive relationship with saving. The groundwork of the model causes the interest rate to work in an extremely similar manner to τ_w. We simulated interest rates of 4, 2, 0, and -2 percent, and the decrease in each step was, as in wealth tax, almost linear.

A negative interest rate, as is currently in effect in Sweden at the time of this writing, does not in this modeling change behavior any more than a reduction between two positive interest rates. These results are shown through time in Figure D.1. This monotonicity of saving in interest rate suggests that our model is perhaps too parsimonious, and should be extended to better capture both the wealth and substitution effects. Our main model uses an interest rate of 4 percent, close to the mean value of our dataset.

Figure D.1: Interest Rate and Saving Rate Through Time, Basic Model



Notes: The figure shows the household net saving ratie, expressed as a percentage of disposable income, for various interest rates. Source: Calculation by Authors.

D.1.2 σ Variations

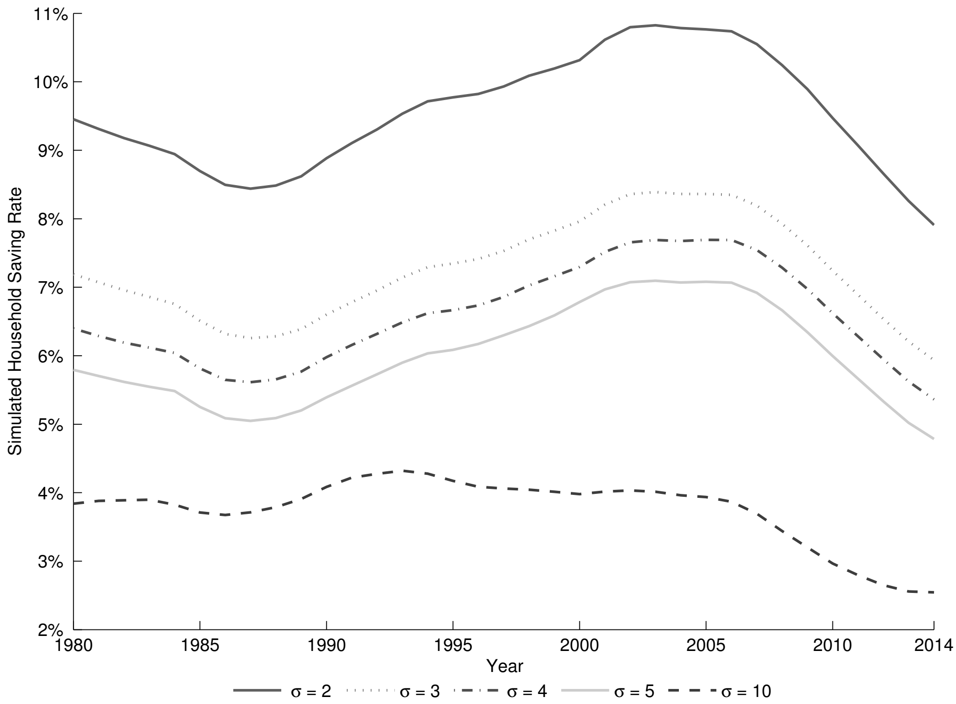
In Figure D.2, the results of our basic model are shown with the σ parameter varied between 1 and 10. σ is a measure of our household's willingness to substitute consumption between successive yearly time periods. The results of this variation do not shed much light on Sweden's saving behavior, but they are presented to show how the structure of the utility function can change modeled saving behavior.

Mehra and Prescott (1985) provide a substantial overview of the literature regarding the σ parameter. It suffices to say that through multiple decades of testing, the σ parameter can feasibly be found to lie between 0 and 10, depending on the type of good being consumed. Our base value of 2 was chosen to match the Carroll papers cited throughout section two, as well a substantial portion of the saving literature. Results for different values of σ are shown in D.2.

The magnitude of the σ parameter has a significant effect on saving behavior. Saving and σ have a negative relationship, with the lowest saving occurring in the specification with $\sigma = 10$, and the highest when $\sigma = 1$, the log utility function. The σ parameter also has a significant effect on how the demographics effect saving behavior. In the

$\sigma = 10$ environment, the demographic changes between 1980 and 2009 have almost no discernable effect, with a difference in saving rate of less than half a percentage point, or under ten percent drop from peak to trough. For comparison, $\sigma = 1$ has a drop with a magnitude of over two percentage points, over 20 percent of max saving. Thus, the magnitude of the σ parameter is of great importance in determining the magnitude of the age demographic effect in Sweden.

FIGURE D.2: Utility Functions and Saving Rate Through Time

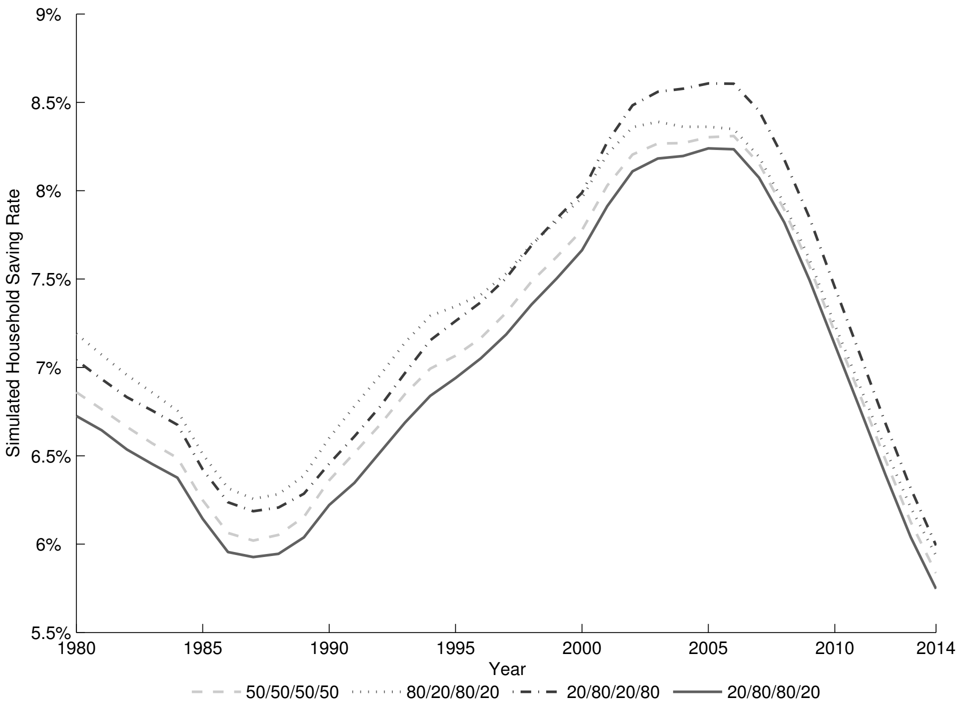


Notes: The figure shows the household net saving rate, expressed as a percentage of disposable income, for various σ levels. Source: Calculation by Authors.

D.1.3 Change in Unemployment Probabilities

The income uncertainty in our simple model stems from a Markov process of employment. Displayed in D.3 are the simulated savings rates under different unemployment probabilities. Saving tends to increase with uncertainty, but on a level so small as to be almost inconsequential. The highest saving rate through time is generally the model where employment state has an 80 percent chance of changing each period. The lowest saving rate is that where there is significantly more unemployment than employment. At a first glance, this would seem to run contrary to the Buffer-Stock theory of saving, which states that an increase in unemployment probability should lead to more precautionary savings. However, this only holds true within a single model, and not across separate steady states. Within each of our simulations, the chance of becoming unemployed remains constant. This would map to unemployment rate in our econometric specification, which we did not find to be significant at the standard levels.

FIGURE D.3: Markov Chain Probabilities and Saving Rate Through Time



Notes: The figure shows the household net saving rate, expressed as a percentage of disposable income, for different probabilities. Source: Calculation by Authors.

D.2 Extended Model Sensitivity Testing

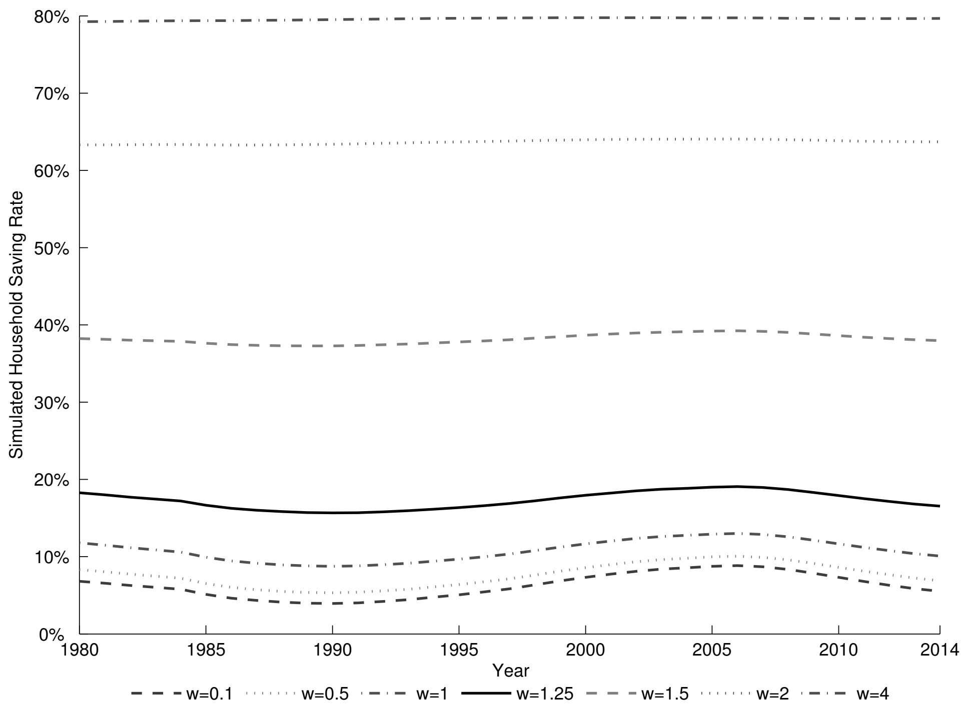
D.2.1 Bequest Function Variations

In Figure D.4, a variety of bequest weights, ranging from 0.1 to 4, are tested for their effect on saving in the extended model. As the bequest weight utility increase, so does saving, leading to larger bequests through time. Saving is most sensitive to bequest weight between weights 1.25 and 2. The increase from 1.25 to 1.5 increases the household saving rate by 20 percent, and the increase from 1.5 to 2 is of a similar magnitude. From 2 to 4 the increase lessens significantly, as saving approaches its reasonable upper bound. Our base specification makes use of a bequest weight of 1.25, as it serves as the closest match to Swedish behavior and falls in line with the estimates of Kopczuk. (2006)

However, simulations calculated with the weight of 1 are similar but just over half the magnitude.

Our choice of bequest weight 1.25 was made to most closely match behavior in Sweden. The weight of 1.25 was the estimate which gave simulated bequests of a similar order of magnitude to those found in Swedish data.

FIGURE D.4: Linear Bequest Function Weights and Saving Rate Through Time



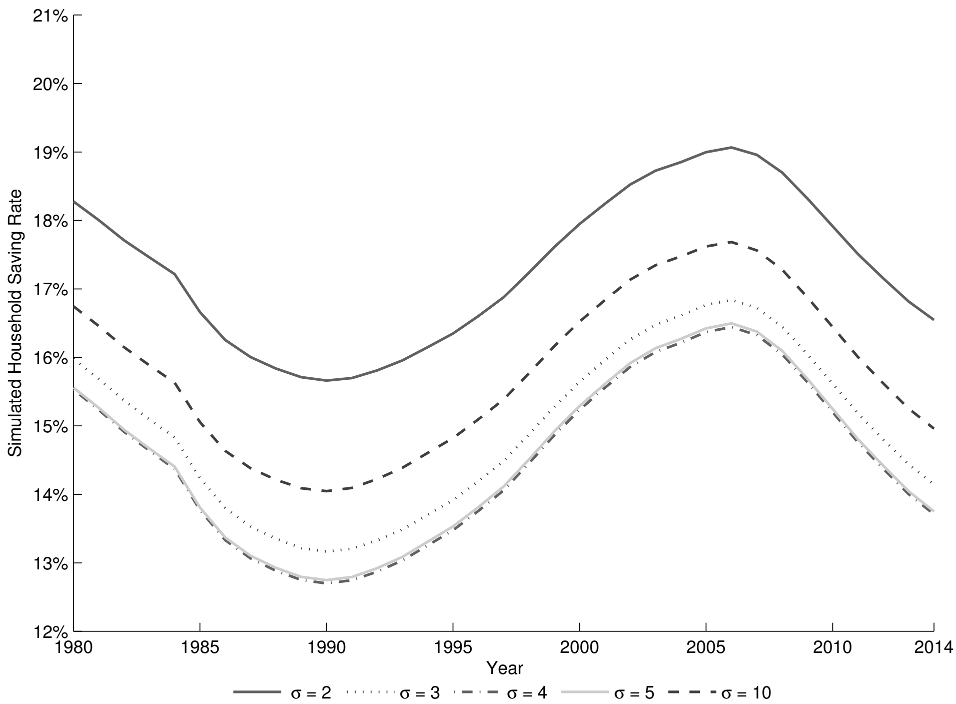
Notes: The figure shows the household net saving rate, expressed as a percentage of disposable income, for various bequest weights. Source: Calculation by Authors.

D.2.2 σ Variations

Unlike in the basic model, the value of the σ parameter does not appear to have a consistent effect on saving. All σ values have results within four percentage points of each other, and all appear similarly effected by demographic change with lows in the late eighties and peaks in the 2000s. The highest saving rate is driven by $\sigma = 2$, followed by $\sigma = 10$, and $\sigma = 3, 4, 5$ resulting in near identical saving rates just behind. The existence of a altruistic bequest motive causes the consumption utility function to behave oddly. This behavior is visualized in Figure D.5.

This behavior is a cause for some concern in the model, as one would expect sigma to have a monotonic effect on saving rate. However, having two separate utility functions with only one being of the CRRA form could explain the difficulties. When bequest motive is represented by a utility function of an identical structure, rather than by a linear utility function, σ moves similarly to the results in the simple model. However, such a utility function does not seem to accurately represent a bequest motive. The CRRA utility model is built to allow for risk aversion, however it is hard to argue that one can have aversions to risk through death. In an idea scenario, a bequest utility should grow larger as an individual ages, due to the increased likelihood of progeny among numerous other factors.

FIGURE D.5: Utility Functions and Saving Rate Through Time

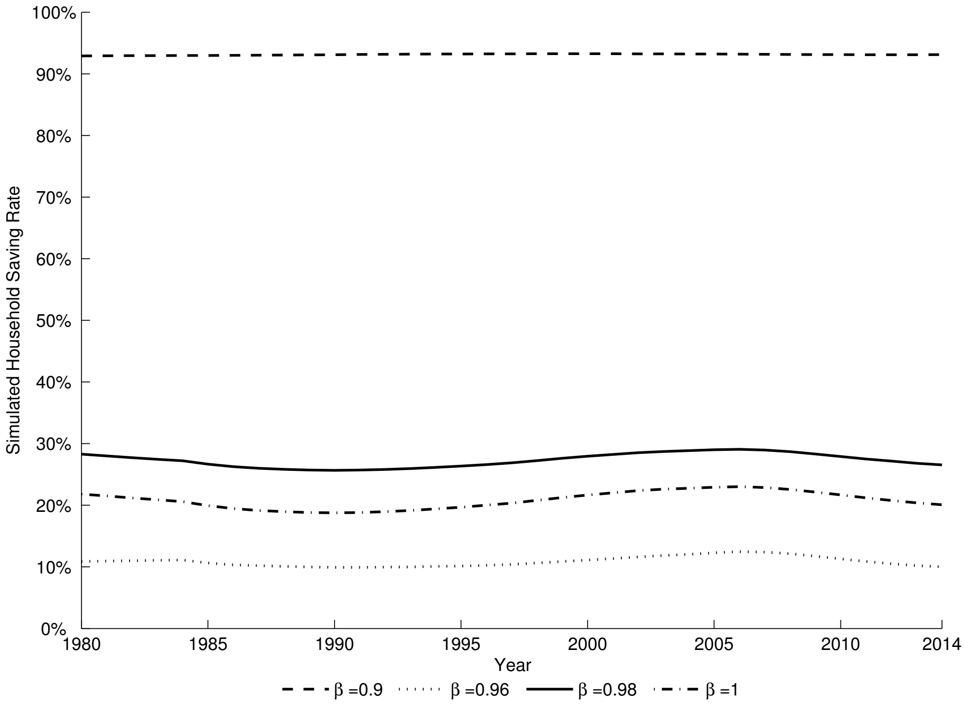


Notes: The figure shows the household net saving rate, expressed as a percentage of disposable income, for various bequest tax levels. Source: Calculation by Authors.

D.2.3 β Variations

The last structural variable of our model to be discussed is that of β, our subjective discount factor. Beta allows a consumer to value consumption today over that in the future at a given rate. It is expected to be increasing in saving, and that pattern appears in Figure D.6. In an ideal world where consumption is valued equally throughout a lifetime, saving would be upwards of 80 percent of disposable income. In a world where consumption next year will be worth only 0.9 of what it is today, saving would be fractions of a percentage point above zero. We use $\beta = 0.96$ as our base, going with what is standard in saving literature. As in interesting quirk, saving decreases between $\beta = 0.96$ and $\beta = 0.98$ before spiking at $\beta = 1.0$.

FIGURE D.6: Subjective Discount Rate and Saving Rate Through Time

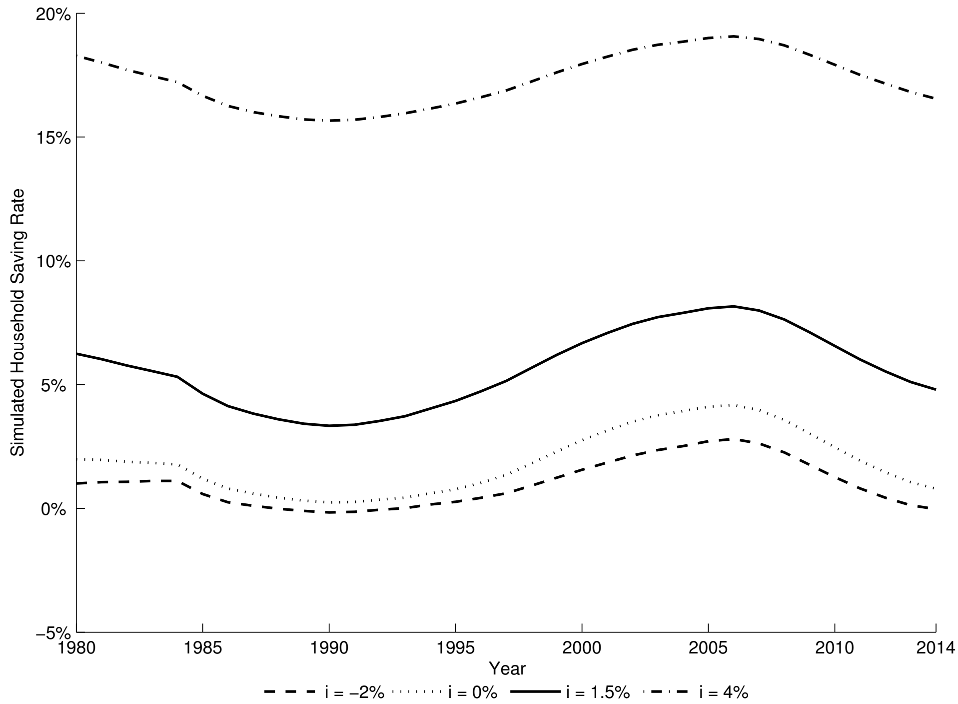


Notes: The figure shows the household net saving rate, expressed as a percentage of disposable income, for various beta levels. Source: Calculation by Authors.

D.2.4 Interest Rate and Wealth Tax Variations

The channels through which interest rate and τ_w affect saving are identical to those in the simple model, though the results differ slightly. As in the simple model, the modeled saving rate is increasing in interest rate and decreasing in τ_w. However, the roughly linear relationship between interest rate and saving which appeared in the simple model disappears in the more complicated specification. As with income tax, this could suggest an incorrect regression choice in section three. Both interest rate and wealth tax have extremely large effects on saving in the model. A $\tau_w = 0.015$ has approximately the same magnitude of saving shock as a $\tau_i = 0.5$ or $\tau_b = 0.45$. This is an entirely different result than that which comes from the simple model. A four percent interest rate causes household saving to increase by just under four percent in the simple model, while it has more than triple that effect in the extended. However, zero and negative interest rates behave quite similarly to the simple model. Interest rate effects are shown in Figure D.7.

Figure D.7: Interest Rates and Saving Rate Through Time



Notes: The figure shows the household net saving rate, expressed as a percentage of disposable income, for various interest rates. Source: Calculation by Authors.

Appendix E

Matlab Code

E.1 Basic Model

```
THIS FUNCTION SOLVES THE BASIC MODEL FROM 4.1
Created with Matlab 7.12.0.635 (R2011a) 64-Bit

function out=SolveBasic
    global Vars % use one parameter for ease of passing to other functions

    % Define Nation Specific Parameters
    Vars.interestrate =1.04;
    Vars.wealthtax = 0.03;
    Vars.incometax = 0.31;
    Vars.incomegrowth = 0;

    % Define Model Specific Parameters
    Vars.a_min = 0;
    Vars.a_max = 25;
    Vars.sigma = 2;
    Vars.c_min=0.0001;
    Vars.beta = .98;
    Vars.gridpoints=10;
    Vars.simulations=200;
    Vars.opts=optimset('Tolx',1e-4);
    Vars.interptype='spli';
    Vars.a_grid=logspace(log10(Vars.a_min+1),log10(Vars.a_max+1),Vars.
    gridpoints)-1;
```

```
    % Define Wage Parameters for Income Process, including Pensions
    Vars.employmentstates=[1;2];
    Vars.employmentincome=[1;2];
    Vars.numberofemploymentstates=length(Vars.employmentstates);
    Vars.P=[0.8 0.2; 0.2 0.8];
    Vars.maxage=60;
    Vars.retirement=40;
    Vars.pensionbenefit=0.5;
    Vars.startingasset=0;

    % Create Value and Policy Vectors, which are a 3 dimensional arrays
    % sized by the number of income possibilities, asset possibilities,
    % and year in life span. The consumption vector gives the consumption
    % choice for each location in the asset/income/age matrix, and the
    % asset matrix gives next period assets in the same. The value vector
    % stores the utility garnered from these paths.

    ValueVector=zeros(Vars.gridpoints,Vars.numberofemploymentstates,Vars.maxage);
    ConsumptionPolicy=zeros(size(ValueVector));
    SavingPolicy=zeros(size(ValueVector));

    % Create the value function by backwards shooting from time period 60.
    % In time period 60 all assets are consumed (for every possible
    % remaining amount of assets from zero to a_max). This utility is
    % stored, and the function progresses to period 59. In period 59
    % (and all others) utility is maximized given current assets,
    % employment state, current age, and the utility from all future
    % consumption decisions. This uses the minimizing command fminbnd.

    for t=Vars.maxage:-1:1
        year=t;
        for i=1:Vars.gridpoints
            for k=1:Vars.numberofemploymentstates;
                a=Vars.a_grid(i);
                zed=Vars.employmentstates(k);
                state=[a zed];
```

```
                c_max=(1-Vars.wealthtax)*Vars.interestrate*a+wage(state,
year);
                if t==Vars.maxage
                    consumption=c_max;
                    val=-utility(consumption);
                else
                    [consumption,val]=fminbnd(@value,Vars.c_min,c_max,Vars
.opts,state,t,ValueVector(:,:,t+1));
                end
                ValueVector(i,k,t)=-val;
                ConsumptionPolicy(i,k,t)=consumption;
                SavingPolicy(i,k,t)=nextperiodasset(consumption,state,t);
            end
        end;
    end;

    % This optimal consumtion matrix is used to simulate a large number of
    % households who are subjected to the income shocks specificed in the
    % Markov Chain. By simulating a large number of these shocks, over a
    % large number of people, a steady state of saving can be observed
    % across the entire economy.

    AssetStore=zeros(Vars.maxage+1,Vars.simulations);
    ConsumptionStore=zeros(Vars.maxage,Vars.simulations);
    EmploymentShocksStore=zeros(size(ConsumptionStore));

    % Create a large set of random numbers to use for the employment
    % process
    rr=rand(Vars.maxage,Vars.simulations);
    % Create a employment path for every individual, which starts with
    % some initial asset and in employment
    for i=1:Vars.simulations
        zed=2;
        state=[Vars.startingasset zed];
        for t=1:Vars.maxage
            consumption=interp1(Vars.a_grid,ConsumptionPolicy(:,state(1,2)
,t),state(1,1),Vars.interptype,'extrap');
            AssetStore(t,i)=state(1);
            ConsumptionStore(t,i)=consumption;
```

```
            EmploymentShocksStore(t,i)=state(2);
            nextperiodassets=nextperiodasset(consumption, state, t);
            zed=incomeshock(rr(t,i),Vars.P(zed,:));
            state=[nextperiodassets zed];
        end
        AssetStore(t+1,i)=nextperiodassets;
    end

    % Solve for Steady State via Averaging
    meanassets=mean(AssetStore,2);
    meanconsump=mean(ConsumptionStore,2);
    plot(meanassets);

    out=struct('SimulatedAssets', AssetStore, 'SimulatedConsumption',
    ConsumptionStore, 'NextPeriodAssets', nextperiodassets,'
    EmploymentShocks',EmploymentShocksStore, 'Variables', Vars);
end

% Employment Shock Function
function out=incomeshock(randomn,probabil)
% Read in a random number and a probability distribution. If the random
% number is below a certain threshold on the distribution, the output is
% the index of unemplyed, else employed occurs.
global Vars
CumDist=cumsum(probabil);
for i=1:Vars.numberofemploymentstates
    if randomn<CumDist(i)
        out=i;
        break
    end
end
end

% Utility Function
function out=utility(consumption)
    global Vars
    if(consumption<Vars.c_min)
        error('only non-zero consumption allowed')
    elseif(Vars.sigma==1)
```

```
        out=log(consumption);
    else
        out=consumption^(1-Vars.sigma)/(1-Vars.sigma);
    end
end

function out=wage(state,year)
    global Vars
    if year>=Vars.retirement
        out=Vars.pensionbenefit;
    else
        out=(1-Vars.incometax)*Vars.employmentincome(state(2));
    end
end

function out = nextperiodasset(consumption,state,year)
    global Vars
    out = state(1)*Vars.interestrate*(1-Vars.wealthtax)+wage(state,year)-consumption;
end

function out=value(consumption,state,year,ValueVector)
% Gives the expected value of current assets and emplotment, given
% probability for the future employment states.
    global Vars
    employmentstatus=state(2);
    anext=nextperiodasset(consumption, state, year);
    val=utility(consumption);
    for s=1:Vars.numberofemploymentstates

        val=val+Vars.beta*Vars.P(employmentstatus,s)*interp1(Vars.a_grid,ValueVector(:,s),anext,Vars.interptype);
    end
    out=-val;
end
```

E.2 Extended Model

```
THIS FUNCTION SOLVES THE EXTENDED MODEL FROM 4.3
Created with Matlab 7.12.0.635 (R2011a) 64-Bit
% Set Path to use compecon Tools
% cepath='c:\compecon\'; path([cepath 'cetools;' cepath 'cedemos'],path);

function out=solve_extended
    global Params

    % Number of Gridpoints and Bounds
    Params.na=10;Params.nb=10;Params.nz=3;
    Params.amin=0;Params.amax=50;Params.bmin=0;Params.bmax=1;Params.zmin=-0.01;Params.zmax=0.01; % Bounds
    Params.national_pension=0.2; % This is set relative to average wage (before retirement) which is 1.
    % Specify Interpolation Scheme
    Params.interptype='spli1'; % See InitializeInterpolation.
    Params=InitializeInterpolation(Params);

    Params.opts=optimset('Tolx',1e-4); % We need this for fminbnd
    Params.n_indivs=1000; % Number of simulated individuals

    % Preference Parameters
    Params.sigma=2.0; % Risk-aversion
    Params.sigma_bequest=2.0; % Curvature of the Bequest Motive Function
    Params.bequestutility = 1.25;
    Params.bequestweighting = 1;
    Params.beta=0.96; % Subjective Discount Factor
    Params.R=1.04; % Interest Rate (1+r)

    % Income Shock Process
    Params.rho=0.89;
    Params.var_shock=0.00000002;Params.std_shock=sqrt(Params.var_shock);
    Params.nepsilons=5; % Number of ass oints when discretizing the income shock
    [Params.epsilons Params.probs_epsilons]=qnwnorm(Params.nepsilons,0,Params.var_shock); % Discretize the income shock using Gaussian quadrature
```

```
% Life Cycle Parameters
Params.J=75; % Max age. For instance, we might assume that j=1
corresponds to real age 25. Then j=75 corresponds to real age 100.
Params.Jr=40; % Retirement age
Params.wealthtax=1.0; % One  minus this is the tax
Params.incometax=1.0;
Params.bequesttax=1.0;

if Params.J==75
    % In this case we assume that J corresponds to real age 99 and age
    % 1 corresponds to real age 25. Columns of M are: age, average
    % wage income and survival probability. Estimated from Finnish
    % data.
    M=xlsread('wages_survivalprobs.xls');
    Params.h=M(:,2);
    Params.S=M(:,3); % Age-specific survival probabilities
    Params.Jr=40; % Corresponds to real age 66
else
    Params.S=ones(Params.J,1); % Survival probs;
    Params.h=ones(Params.J,1); % Age-wage profile
end

% Construct the value and optimal consumption arrays.
Val=cell(Params.J+1,1);
Cons=cell(Params.J,1);
ValVec=zeros(Params.N,1);
ConsVec=zeros(Params.N,1);

% Compute basis function coefficients for interpolation. The value
% function for J+1 is identically zero.
Val{Params.J+1}.coef=funfitxy(Params.fspace,Params.stategrid,zeros(
Params.N,1));

% Start the value function iteration, and solve it
for j=Params.J:-1:1
    disp('solving age');
    disp(j)

```

```
    for i=1:Params.N
        state=Params.stategrid(i,:);
        c_min=0.001;
        c_max=Params.R*Params.wealthtax*state(1)+Income(state,j); % Borrowing constraint: a'>=0.
        [c,val]=fminbnd(@value,c_min,c_max,Params.opts,state,j,Val{j+1});
        ValVec(i)=-val; % fminbnd minimized -val.
        ConsVec(i)=c;
    end;
    Val{j}.ValVec=ValVec;
    Val{j}.coef=funfitxy(Params.fspace,Params.stategrid,ValVec); % Compute basis function coefficients for interpolation.
    Cons{j}.ConsVec=ConsVec;
    Cons{j}.coef=funfitxy(Params.fspace,Params.stategrid,ConsVec);
end

% We have now solved the household problem recursively.

% Finally, simulate life cycles

% Initialize matrices to store savings, consumptions, and the state of the income process.
A=zeros(Params.J+1,Params.n_indivs);
C=zeros(Params.J,Params.n_indivs);
Z=zeros(size(C));
B=zeros(size(C));

rng(1); % Fixes the seed of the random number generator. As a result, we always get the same "random" numbers. This is sometimes useful when comparing e.g. different parameterizations.

disp('Simulating...')

for i=1:Params.n_indivs;

    state=[0 0 0]; % The initial state. No savings, no accrued pension rights, and all have initially z=0.
    for j=1:Params.J
```

```
            c=funeval(Cons{j}.coef,Params.fspace,state);
            A(j,i)=state(1);B(j,i)=state(2);Z(j,i)=state(3);C(j,i)=c;
            state=NextStates(c,state,j); % NextStates with one output argument determines epsilon randomly.
        end
        A(j+1,i)=state(1);
    end
    MA=mean(A,2);
    MC=mean(B,2);
    % Collect all the results to the output argument.
    out.A=A;out.B=B;out.C=C;out.Val=Val;out.Cons=Cons;out.Z=Z;out.Params=Params;
    out.MA=MA;
    out.MC=MC;
end

function out=value(c,state,age,NextVal)
    global Params
    [nextstates,probs]=NextStates(c,state,age);
    util_bequest=Params.bequestweighting*bequestMotive(nextstates(1,1)); % The possible bequest equals next period savings.
    val=util(c)+Params.beta*Params.S(age)*probs'*funeval(NextVal.coef,Params.fspace,nextstates)+(1-Params.S(age))*util_bequest;
    out=-val; % Need to multiply by minus one because fminbdn minimizes.
end

function [nextstates,probs]=NextStates(c,state,age)
global Params
    [income,accrual_base]=Income(state,age);
    anext=state(1)*Params.R*Params.wealthtax+income-c;
    bnext=state(2)+0.015*accrual_base;
    if nargout==2
    znexts=Params.rho*state(3)+Params.epsilons;
    n=Params.nepsilons;
    nextstates=[anext*ones(n,1) bnext*ones(n,1) znexts];
    probs=Params.probs_epsilons;
    elseif nargout==1
    epsilon=Params.std_shock*randn(1,1);
    znext=Params.rho*state(3)+epsilon;
```

```
    nextstates=[anext bnext znext];
    else
        error('wrong number of output arguments in NextStates');
    end
end

function [income,accrual_base]=Income(state,age)
    global Params
    if age>=Params.Jr
        income=state(2)+max(0,Params.national_pension-0.5*state(2));
        accrual_base=0;
    else
        income=Params.incometax*exp(state(3))*Params.h(age);
        accrual_base=income;
    end
end

function out=util(c)
    global Params
    if(c<0.001)
        error('consumption too small in util')
    elseif(Params.sigma==1)
        out=log(c);
    else
        out=c^(1-Params.sigma)/(1-Params.sigma);
    end
end

function out=bequestMotive(beq)
    global Params
    if(beq<0.00001)
       error('bequest to small in bequestMotive')
    else out=Params.bequestutility*Params.bequesttax*beq;
    end
end

function Params=InitializeInterpolation(Params)

a_grid=logspace(log10(Params.amin+1),log10(Params.amax+1),Params.na)-1;
```

```
b_grid=logspace(log10(Params.bmin+1),log10(Params.bmax+1),Params.nb)-1;
z_grid=linspace(Params.zmin,Params.zmax,Params.nz);

if strcmp(Params.interptype,'spli1')

[n,a,b,params_a]=splidef(a_grid',0);
[n,a,b,params_b]=lindef(b_grid',0);
[n,a,b,params_z]=lindef(z_grid',0);

pp={{'spli',params_a{:}},{'lin',params_b{:}},{'lin',params_z{:}}};

Params.fspace=fundef(pp{:});
snodes=funnode(Params.fspace);
Params.stategrid=gridmake(snodes);
Params.N=length(Params.stategrid);

elseif strcmp(Params.interptype,'spli2')

[n,a,b,params_a]=splidef(a_grid',0);
[n,a,b,params_b]=splidef(b_grid',0);
[n,a,b,params_z]=lindef(z_grid',0);

pp={{'spli',params_a{:}},{'spli',params_b{:}},{'lin',params_z{:}}};

Params.fspace=fundef(pp{:});
snodes=funnode(Params.fspace);
Params.stategrid=gridmake(snodes);
Params.N=length(Params.stategrid);

elseif strcmp(Params.interptype,'spli3')

[n,a,b,params_a]=splidef(a_grid',0);
[n,a,b,params_b]=splidef(b_grid',0);
[n,a,b,params_z]=splidef(z_grid',0);

pp={{'spli',params_a{:}},{'spli',params_b{:}},{'spli',params_z{:}}};

Params.fspace=fundef(pp{:});
snodes=funnode(Params.fspace);
```

```
Params.stategrid=gridmake(snodes);
Params.N=length(Params.stategrid);

else
    error('wrong intertype in InitializeInterpolation')
end
end
```

Bibliography

Adema, Yvonne and Lorenzo Pozzi. Business cycle fluctuations and private savings in OECD countries: a panel data analysis. Discussion Paper VI, Tinbergen Institute, Amsterdam and Rotterdam, 2012.

Aiyagari, S. Rao. Uninsured idiosyncratic risk and aggregate saving. *Quarterly Journal of Economics*, 109(3):659–684, 1994.

Alan, Sule, Thomas Crossley, and Hamish Low. Saving on a Rainy Day, Borrowing for a Rainy Day. Koç University-TUSIAD Economic Research Forum Working Papers 1212, Koc University-TUSIAD Economic Research Forum, Istanbul, 2012.

Andersen, Torben M., Bengt Holmström, Seppo Honkapohja, Sixten Korkman, Söderström H. Tson, and Juhana Vartiainen. The Nordic Model. Embracing globalization and sharing risks. Report, The Research Institute of the Finnish Economy (ETLA), Helsinki, 2007.

Attanasio, Orazio P., Lucio Picci, and Antonello E. Scorcu. Saving, growth, and investment: a macroeconomic analysis using a panel of countries. *Review of Economics and Statistics*, 82(2):182–211, 2000.

Bayoumi, Tamim. Financial deregulation and household saving. *The Economic Journal*, 103(421):1432–1443, 1993.

Callen, Tim and Christian Thimann. Empirical determinants of household saving: evidence from oecd countries. *IMF Working Paper*, 181:1–26, 1997.

Campbell, David W. Explaining Japan's saving rate. *Journal of Asian Economics*, 15 (4):797–815, 2004.

Campbell, John Y. Does saving anticipate declining labor income? An alternative test of the permanent income hypothesis. *Econometrica*, 55(6):1249–1273, 1986.

Campbell, John Y. and N. Gregory Mankiw. Permanent income, current income, and consumption. *Journal of Business and Economic Statistics*, 8(3):265–279, 1990.

Carroll, Christopher D. Buffer-stock saving and the life cycle/permanent income hypothesis. *Quarterly Journal of Economics*, 107(1):1–56, 1996.

Carroll, Christopher D. Why do the rich save so much? *NBER Working Paper*, (6549), 1998.

Carroll, Christopher D., Robert E. Hall, and Stephen P. Zeldes. The buffer-stock theory of saving: Some macroeconomic evidence. *Brookings Papers on Economic Activity*, 1992(2):61–156, 1992.

Carroll, Christopher D., Misuzu Otsuka, and Jiri Slacalek. How large are housing and financial wealth effects? A new approach. *Journal of Money, Credit and Banking*, 43 (1):55–79, 2011.

Carroll, Christopher D., Jiri Slacalek, and Martin Sommer. Dissecting saving dynamics: measuring wealth, precautionary and credit effects. *ECB Working Paper*, (1474), 2012.

Challe, Edouard and Xavier Ragot. Precautionary saving over the business cycle. *Economic Journal*, 2015.

Chinn, Menzie D. and Hiro Ito. What matters for financial development? Capital controls, institutions, and interactions. *Journal of Development Economics*, 81(1): 163–192, 2006.

Deaton, Angus. Saving and liquidity constraints. *Econometrica*, 59(5):1221–1248, 1991.

Directorate-General for Economic and Financial Affairs, . Macroeconomic imbalances Country Report- Sweden. Occasional Papers 226, European Economy, Brussels, 2015.

Edwards, Sebastian. Why are Latin America's savings rates so low? An international comparative analysis. *Journal of Development Economics*, 51(1):5–44, 1996.

Elinder, Mikael, Oscar Erixson, Sebastian Escobar, and Henry Ohlsson. Estates, bequests, and inheritances in Sweden - A look into the Belinda databases. Working Paper Series, Center for Fiscal Studies 14, Uppsala University, Department of Economics, 2014.

Engen, Eric M. and Jonathan Gruber. Unemployment insurance and precautionary saving. *Journal of Monetary Economics*, 47(3):545–579, 2001.

Feldstein, Martin. International differences in social security and saving. *Journal of Public Economics*, 14(2):225–244, 1980.

Floden, Martin and Jesper Lindé. Idiosyncratic risk in the United States and Sweden: Is there a role for government insurance? *Review of Economic Dynamics*, 4(2):406–437, 2001.

Gale, William G. and Maria G. Perozek. Do estate taxes reduce saving? *Rethinking Estate and Gift Taxation*, 216:217–218, 2001.

Giavazzi, Francesco and Michael McMahon. Policy uncertainty and household savings. *Review of Economics and Statistics*, 94(2):517–531, 2012.

Gourinchas, Pierre-Olivier and Jonathan A. Parker. The empirical importance of precautionary saving. *American Economic Review*, 91(2):406–412, 2001.

Henrekson, Magnus and Gunnar Du Rietz. The rise and fall of Swedish wealth taxation. *Nordic Tax Journal*, 1(1):9–35, 2014.

Kopczuk, Wojciech and Joseph P. Lupton. To leave or not to leave: The distribution of bequest motives. *Review of Economic Studies*, 74(1):207–235, 2007.

Kopits, George and Padma Gotur. The influence of social security on household savings: A cross-country investigation. *IMF Staff Papers*, 27(1):161–190, 1980.

Koskela, Erkki and Matti Viren. Social security and household saving in an international cross section. *American Economic Review*, 73(1):212–217, 1983.

MATLAB, . *Version 7.12.0 (R2011a).* The MathWorks Inc., Natick, 2011.

McCandless, George. *The ABCs of RBCs: An introduction to dynamic macroeconomic models.* Harvard University Press, Cambridge, 2008.

Mehra, Rajnish and Edward C. Prescott. The equity premium: A puzzle. *Journal of Monetary Economics*, 15(2):145–161, 1985.

Miranda, Mario J. and Paul L. Fackler. *Applied Computational Economics and Finance.* MIT Press, Cambridge, MA, 2002.

Modigliani, Franco. The life cycle hypothesis of saving, the demand for wealth and the supply of capital. *Social Research*, 33(2):160–217, 1966.

Määttänen, Niku. Introduction to life cycle models with idiosyncratic uncertainty. Unpublished teaching paper, 2014.

Rietz, Gunnar Du and Magnus Henrekson. Swedish wealth taxation, 1911-2007. *IFN Working Paper*, (1000), 2014.

Rietz, Gunnar Du, Magnus Henrekson, and Daniel Waldenström. The Swedish inheritance and gift taxation, 1885–2004. *IFN Working Paper*, (936), 2012.

Riksbank, . House price developments in Sweden and abroad. Financial Stability Report 2, Sveriges Riksbank, Stockholm, 2005.

Scherman, Karl-Gustav. The Swedish pension reform: A good model for other countries? *Scandinavian Insurance Quarterly*, 4(2003):304–318, 2003.

Skinner, Jonathan. Risky income, life cycle consumption, and precautionary savings. *Journal of Monetary Economics*, 22(2):237–255, 1988.

Swedish National Institute of Economic Research, . Macroeconomic effects of a decline in housing prices in Sweden. (Specialstudie 41), 2014.

Winstrand, Jakob and Dilan Ölcer. How indebted are Swedish households? *Riksbank Economic Commentaries*, (1), 2014.