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Savings and Low Interest Rates

Can Low Interest Rate Environments Change the Effects of Determinants of Savings?

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Abstract

This thesis examines the effects of a low real interest rate environment on household savings. It specifically analyses whether there can be an increased importance of the income effect relative to the intertemporal consumption substitution effect and whether there can be an increased potency in the wealth effect of the stock market due to the financial assets substitution effect in this environment. The analysis is conducted by means of time series regression analysis using data from Sweden between the first quarter of 1962 and the second quarter of 2017 and from the United States between the first quarter of 1962 and the first quarter of 2017. We study short-term real interest rates, long-term real interest rates, and the real valuation of the stock market, while normalizing savings with disposable household income and controlling for lagged savings and the unemployment rate. The results do show changes in the importance and potency of the effects, however not in any way that supports the hypotheses. As the econometric model suffers from issues, the accuracy of the results can be questioned, and the area thus needs further research.

Keywords: *interest, savings, substitution, income, wealth.*

Contents

1 Introduction

The relationship between savings and interest rates is one of the foundations of macroeconomic theory, taught in virtually any introductory economics course. With the close relationship of savings with consumption and investment, it has direct effects on the macroeconomy (Burda & Wyplosz, 2013, pp. 61-68). As most mandates and tools of central banks around the world concern these relationships (Chorafas, 2013), it is always at the center of attention in the financial world. After the global financial crisis of 2007-2008 the measures to exploit the relationship have appeared less effective, perhaps exposing new dimensions of this relationship. During the slow recovery during this difficult post-crisis period, central banks have been searching for new ways to exploit it. The new measures, have been controversial, as they consist of direct interventions in government interest rate markets (Sveriges Riksbank, 2013; Williams, 2012). Furthermore, whether they have been successful is a matter of debate (Czeczeli, 2016).

With declining interest rates over the past decade, the household savings rates in e.g. Sweden or the United States have not followed suit, as traditional macroeconomic theory would expect (Gylfason, 1981). Why is this? One possible explanation is the demographic changes that have occurred in the past decades. With older populations, the required stock of savings increases, a fact that is at the core of the secular stagnation theory (Baldwin & Teulings, 2014). An alternative explanation, or perhaps complementary, is that the low interest rates cause worry among the population about low returns, positively affecting the savings rate. This alternative explanation will be the main focus of this thesis.

To expand upon this, we need to note that with a prolonged low-interest rate environment like the present one, retirement funds and life insurance companies should not expect to be able to reach their actuarial investment return assumptions over the long term (OECD, 2015). It is therefore not beyond the realm of possibilities that at particularly low real interest rate levels, decreases in interest rates may increasingly incentivize higher household savings rates, as workers see their prospects of the comfortable retirement they were once promised diminishing. In these contexts, economists usually talk of two effects counteracting each other, the intertemporal consumption substitution effect and the income effect (Gylfason, 1981), and in the current interest rate environment there could be an increase in the relative importance of the latter, which would lessen the positive macroeconomic effects of a decreased interest rate. Investigating this possibility should be of great concern to monetary policy makers, as it carries not only macroeconomic implications but also ethical ones.

There are empirical studies supporting the validity of the question whether lower levels of interest rates can in fact have weaker positive effects than interest rates at normal levels do. Kochaniak (2016) published a study examining the effects of a low-interest rate environment on savings motives and savings behavior in the euro area. The scope of the study was broad, however most importantly for the intended focus of this thesis, they studied the effect of already low real interest rates falling even further on the savings of households. Using monthly data between January 2009 and August 2015, she found that deposits relating to retirement and bequest were in fact negatively correlated with interest rates. Additionally, the Magyar Nemzeti Bank (2013) has also addressed the issue of savings behavior after the financial crisis in developed countries, in which both Sweden and the United States are included. They see that the real interest rates in these countries during this period have often and widely-spread fallen below zero, while the positive impact on consumption is being gradually less perceivable. They attribute the cause of the diminished positive qualities of the effect to a general desire among households to decrease debts and increase savings. This explanation is not sufficient however, especially with regards to Sweden where the household debt has risen during this period (Blom & van Santen, 2017). The explanation must therefore be another, perhaps that the income effect has become stronger in relation to the intertemporal consumption substitution effect.

There is a lack of extensive empirical studies of these exceptionally low real interest rates and the existence or non-existence of this phenomenon, it is therefore a matter that needs further investigation. In this thesis we focus on the short-term effects of interest rates on the savings rate as these effects are typically less ambiguous and because these variables logically should affect one another the most in the short term. In addition, the strong relationship between interest rates and other financial assets (Benitez, et al., 2016; Ferrer, et al., 2017; Zekaite, 2017) make it necessary for the effects of the stock market to be considered as well, in order to provide thorough discussion and analysis. The relationships are quantitatively analyzed and tested, using a linear regression model in which dummy variables will play a central role.

While normalizing household savings with disposable household income and controlling for lagged household savings and the unemployment rate, we study short-term and long-term interest rates and their short-term effects on household savings in the two countries Sweden and the United States. The regression results exhibit econometric issues and show little evidence of stock market importance in savings considerations, in contrast to previous research (Berg & Bergström, 1995; Poterba & Samwick, 1995), however the interest rate coefficients do actually show some signs of non-linearity in Sweden on the other hand, albeit with the relative importance of intertemporal consumption substitution effect increasing instead of the other way around. Whether the results are a consequence of the econometric issues is a matter of discussion.

The remainder of this thesis will be structured as follows. Section 2 will describe the theoretical framework and the hypotheses that follow. Section 3 will describe the data, econometric model, regression results, and provide an analysis of the results. Section 4 concludes the thesis.

2 Savings, Interest Rates & the Stock Market – Two Hypotheses

Interest rates affect savings in several ways, ways that often counteract each other. Firstly, there are the intertemporal consumption substitution effect and the income effect that directly counteract each other, the former implying a positive effect of interest rates on the personal savings rate and the latter a negative effect (Elmendorf, 1996, pp. 5-6). It is important to note that it is the balance or imbalance between these two effects that is interesting, and the importance of the effects should only be interpreted as the importance relative to each other. This is not an unusual approach (Poole, 1972, p. 211). Secondly, there is the wealth effect, which posits that wealth negatively affects the personal savings rate, and is connected with interest rates through the asset valuation channel (Hannoun, 2015). Lastly, the financial assets substitution effect causes people to substitute between assets through the portfolio balance and risk-taking channel, for reasons regarding risk and yield (Hannoun, 2015). This last effect is the link between interest rates and the stock market and can increase or decrease the importance of the riskier assets relative to risk-free assets in households' decision making regarding savings, depending on in which direction the substitution is conducted.

Two hypotheses based on these effects will be formulated and presented in this section. The two hypotheses together investigate the question whether interest rate changes in have the same effects in low interest rate environments as they do in normal real interest rate environments. If this environment causes a higher propensity to save, the policies are not as effective.

2.1 Hypothesis H1

In this subsection, the intertemporal consumption substitution effect and the income effect will be explained. These two effects counteract each other and the balance or imbalance between them is of interest to hypothesis H1.

2.1.1 The Ambiguity of the Direct Effects of Interest Rates on Savings – Two Effects

Assuming that people are forward-looking, the interest rate will play a role in how they save. There are two effects that are usually discussed in this context, the first being the *intertemporal consumption substitution effect* and the second being the *income effect* (Elmendorf, 1996, pp. 5-6). While the traditional view that aggregate savings is a strictly increasing function of interest rate is based upon the former effect, it is now often acknowledged that latter effect offsets it (Gylfason, 1981, p. 233; Elmendorf, 1996, p. 6).

The fundamental logic of the intertemporal consumption substitution effect is that the higher the interest rate, the more willing one is to postpone consumption (Hall, 1981). This goes for both net savers and net borrowers, net savers will save more as the future consumption possible will increase with a higher interest rate, and net borrowers will borrow less as their future consumption possible will decrease. This implies a positive relationship between interest rates and savings. The primary determinants of the relative importance of this effect are the patience of people and the time they have left to live (Elmendorf, 1996, pp. 5-6).

An alternative way of thinking about savings is as means to finance a target future consumption, and interest rates as a variable deciding how much savings are needed for the specific target consumption (Ng, 1990, p. 102). This effect would be the income effect. A person saving to fund a future target level of consumption will respond to decreases in interest rates by increasing their savings, as the present value of the target consumption increases with the decrease in interest rates. It is because it implies a negative relationship between interest rates and savings that the income effect counteracts the intertemporal consumption substitution effect (Elmendorf, 1996, p. 6; Gylfason, 1981, p. 233).

The balance between these effects becomes interesting to question e.g. when considering retirement savings in a low interest rate environment. Recent studies have shown that retirement decisions are made based upon a rather fixed perception of affordability (Bütler, et al., 2005; Lynn Coronado & Perozek, 2003), indicating that while declining interest rates negatively changes the amount of funds needed for retirement, the desired consumption during retirement stays the same. The current environment is therefore a problem for both present and future retirees. This problem was addressed by the OECD (2015) in a report discussing the imminent risks of the deteriorating ability of retirement funds and life insurance companies keeping their promises towards retirees as a result of current monetary policy. Assuming that the population is aware of these issues and understand the implications of them, households should only see three alternatives to secure a comfortable retirement: to either work longer, to consume less during retirement, or to save more while still working. With the desired consumption during retirement being quite fixed, consuming less during retirement does not seem like a satisfactory option, and they will likely find some appropriate combination of the remaining two to be the best solution. The relative importance of the income effect should therefore be greater in this environment than it normally is.

2.1.3 H1 – The Hypothesis

H1. In an environment of low real interest rates, there is an increased importance of the income effect relative to the intertemporal consumption substitution effect.

The increased importance of the income effect relative to the intertemporal consumption substitution effect would be due to households becoming worried that the very low returns on their retirement savings jeopardize their possibilities of a comfortable retirement, causing them to be more inclined to increase their savings with each decrease in interest rates. If hypothesis H1 holds any validity, this would suggest that the effects of changing interest rates on savings changes negatively in a low real interest rate environment.

2.2 Hypothesis H2

In this subsection, two effects relating to the relationship between the stock market and savings will be explained: the wealth effect and the financial assets substitution effect. In this thesis, the latter effect is hypothesized to increase the potency of the former in a low interest rate environment, by increasing the importance of the stock market for savers when making decisions relating to the amount to save. The effects are important to consider when discussing interest rates because the stock market is widely acknowledged to be influenced by interest rates through various channels, although the extent differs between countries (Benitez, et al., 2016; Ferrer, et al., 2017; Zekaite, 2017).

2.2.2 The Importance of the Stock Market for the Savings Ratio – Two Effects

There are two effects relating to the stock market that can potentially influence the savings ratio in a low interest rate environment. There is the direct effect of the stock market, the *wealth effect*, and then there is an effect that works indirectly on savings by affecting the stock market and its wealth effect, the *financial assets substitution effect*.

The wealth effect states a negative correlation between wealth and personal savings (Blanchett & Blanchett, 2008, p. 48). While the evidence points towards there being more important drivers of savings, like disposable income, the wealth effect remains an important consideration (Chailloux & Jaramillo, 2015). Central bankers share this view with Bernanke (2010), former Chair of the Board of Governors of the Federal Reserve System, predicting that the quantitative easing policies would encourage stock market investment, driving up asset prices and in turn inducing a wealth effect and inflationary second-round effects, while having limited direct effects on currency in circulation. While corporate stock is not the only asset type in which to store wealth, it has been empirically shown that the stock market in particular does have this effect (Juster, et al., 2006; Poterba & Samwick, 1995).

To understand the potency of the wealth effect in a low interest rate environment, we need to introduce the financial assets substitution effect. Furthermore, although risk is not studied in this thesis, we also need to establish some relationships that involve risk, without discussing risk excessively.

According to the efficient markets hypothesis, investors that desire higher levels of returns are generally required to tolerate higher risk (Bodie, et al., 2014), which means that when investors decide the level of risk they are willing to take, an important factor is the rate of return they expect. This relationship has been empirically shown (Curl & Yao, 2011). Adjustments in risk taking according to these preferences are made through a substitution effect, for example between government interest rates and corporate stock (Hong, et al., 2014). The implication is that as the risk adjusted excess returns of the stock market increase with the lowered risk-free rate of return, there is an increased willingness among investors to allocate more capital to riskier assets. This effect does not necessarily only involve the substitution between government interest rates and corporate stocks however, but also the substitution between government interest rates of different maturity, with investors seeking to adjust only their term risk in order to achieve desired returns when the general levels of yield in the economy shift (Wang, 2017). If the effect exists, there should therefore be a high positive correlation between short-term and long-term interest rates, which would be the easiest way to observe it.

The financial assets substitution effect is especially noticeable in low interest rate environments. When the risk-free yields are so low, life insurance companies and retirement funds have no alternative but to turn to riskier assets in order to manage their solvency position. This issue is brought up by the OECD (2015, pp. 111-147) in a report discussing whether life insurance companies and retirement funds can keep their promises and whether they are becoming excessively involved in what is called the “search for yield”, the practice of replacing the low-yielding government bonds with higher-yielding fixed-income assets. However, as this substitution in the search for yield occurs, the importance of the stock market in savings considerations increases, which is hypothesized in this thesis to also cause the potency of the wealth effect of the stock market to increase. Simultaneously, stock market wealth is in this thesis hypothesized to play a role in mitigating the worriedness about retirement savings in this low interest rate environment, even further strengthening the wealth effect.

2.2.3 H2 – The Hypothesis

H2. In an environment of low real interest rates, there is an increased potency of the wealth effect.

This would be due to the financial assets substitution effect between interest rates and riskier financial assets such as stocks increasing the importance of riskier assets in this environment, and due to stock market wealth mitigating the worriedness about low interest rates. If hypothesis H2 holds any validity, it would indicate that a high relative valuation of the stock market could compensate for any additional relative importance of the income effect at these interest rate levels.

3 Empirical Analysis

The hypotheses will be tested using time series regression analysis. It has previously been empirically shown that the effects of interest rates on savings vary between countries (Egwaikhide & Nwachukwu, 2007; Ertac, et al., 2003) and between larger categories of countries such as developing countries and industrialized countries (Hossein, et al., 1998), which could make panel data less useful. Although time series analysis over shorter periods of time has difficulties accounting for certain factors that are slow to change, this should not be a particularly big issue as for the same reason, they should not change enough to obscure any relevant results. Therefore, instead of using panel data, a side-by-side comparison of two countries will be made using time-series regression analysis, to see whether there are any clear tendencies in any of the countries. The chosen countries to compare are Sweden and the United States, two countries that were chosen mainly with their similarities in mind. Relevant fiscal policy and demographic factors, factors that are slow to change, should be relatively similar, as the countries are both industrialized and have similar age structures (NationMaster, n.d.)

Due to the current unconventional policies of central banks desiring to directly control the long-term interest rates as well (Williams, 2012; Sveriges Riksbank, 2013), we want to in addition to comparing two countries, see whether the long-term interest rates have the same effects on savings as short term interest rates. In order to do this, we run all regression models for both countries twice, once using short-term interest rates and once using long-term interest rates.

The Swedish data used was made up of quarterly observations from the first quarter of 1962 to the second quarter of 2017 was used, making a total of 222 observations over the whole period. The United States data used was quarterly observations from the first quarter of 1962 to the first quarter of 2017, making a total of 221 observations over the whole period. This sort of quantitative approach has the benefits of making the results less subjective and less vulnerable to theoretical disagreement than can be achieved using qualitative analysis.

3.1 Data

The effect of interest rates on household is studied using six different quarterly data time series: The savings rate, short-term interest rates, long-term interest rates, stock market returns, the unemployment rate and the inflation rate. Where seasonal patterns were discovered, they were adjusted for using the X-13 ARIMA-SEATS quarterly seasonal adjustment method provided in EViews, created by the United States Census Bureau (U.S.

Cencus Bureau, 2017). Any data provided in real terms were then adjusted for using the inflation rate.

The Swedish savings rate data used in the regression analysis is a linked set of two different time series. The first time series was the seasonally adjusted household savings rate as a percentage of disposable income time series, provided by the OECD (2012), discontinued in the end of 2007. In order for the amount of data points to be sufficient and for the sake of relevance of recent time experiences, a supplementary time series provided by Oxford Economics (2017) was needed for the remaining years. This second time series was used from the first quarter of 1980.

Similarly to the data over the Swedish savings rate, the data used to calculate real stock market growth in Sweden needed to be retrieved from two different sources for the whole period between 1962 and 2017 to be represented. The real stock market time series available in Waldenström (2014) was used between the first quarter of 1962 and the first quarter of 1980, whereas the second stock market time series data was the OMX Stockholm PI index provided by Nasdaq Inc. (2017), used between the second quarter of 1980 and the first quarter of 2017 after being adjusted for inflation.

In absence of sufficient historic stock market relative valuation data – such as P/E ratios, Tobin's Q etc. – a need to create such a measurement using stock market indices arose. For a point in time t, representing a quarter, the measurement was calculated using a geometric mean of the stock market returns of $t,\ t-1, \ldots ,\ t-39$. That is, it is a geometric mean of the returns in the ten years prior to t. The logic of this measurement is that high recent historical returns, over a period of circa one to two business cycles, indicates a high relative valuation.

3.3 Descriptive Statistics

In Figure 1 we can observe short-term government treasury bill real quarterly yields of the two considered countries, short-term ones and long-term ones respectively. They are calculated as $\frac{i}{4} - \pi$ where i is the yearly nominal interest rate and π is the quarterly inflation rate. The first thing we notice when looking at these figures is the spikiness. This will cause some issues later in the regressions and is due to volatile inflation that deviate from the normal even after adjusting for seasonal patterns.

The second thing we notice is that although the novelty of negative nominal interest rates still confounds, negative real interest rates is an old phenomenon. Out of the 222 Swedish observations, 61 instances of negative short real interest rates were observed, most of which occurred during the 1960's, the 1970's, the 2000's and the 2010's. Out of the 221 United States observations, 74 instances of negative short real interest rates were observed, most of which occurred during the 1970's, the 2000's and the 2010's. That is, in both cases approximately 30% of observations were negative. The fact that negative rates can be observed during several different time periods makes conclusions drawn from these observations more robust through time. Any findings or non-findings should therefore not be immediately disregarded as consequences of any other event or circumstance unique to a particular period of time rather than of the low real interest rate environment.

Figure 2 shows the long-term government bond real yields for both countries, calculated as $\frac{i}{4} - \pi$, where i is the yearly nominal interest rate and π is the quarterly inflation rate. We see the same issue in this time series as in the former, spikiness that is caused by inflation that deviates from the normal. Furthermore, we notice that these interest rates also often fall below zero.

Figure 3 shows the 10-year average quarterly real returns of the stock market, which is the measurement of the relative valuation of the stock market used in this thesis. As can be seen, there are periods of very high such returns, and periods with very low, even negative ones in real terms. Observe however, that the indices used to calculate this measure do not include dividends.

In figure 4 we can observe the household savings rate to disposable income. We see here most clearly in Sweden, that it has actually considerably risen during periods in the last two decades while real interest rates have been low and show a declining trend, e.g. the period between the the beginning of 2003 and the end of 2013. In the United States, although the general trend of the savings rate is declining, it actually also increased during some years after 2007 while real interest rates sunk.

In table 1, a correlation matrix of the relevant variables of the Sweden is presented. In table 2, a correlation matrix of the relevant variables of United States is presented. Before these correlation matrices were calculated, however, non-stationarity in each time series was suspected. Performing Dickey-Fuller tests on the time series in level, we found great likelihoods of unit roots in each time series which means that there is a risk for regressions on these variables to be spurious. Although no cointegrating relationship was found between the variables, the problem of non-stationarity could be solved by simply having the first differences taken as we do not look for long-term relationships. After having performed

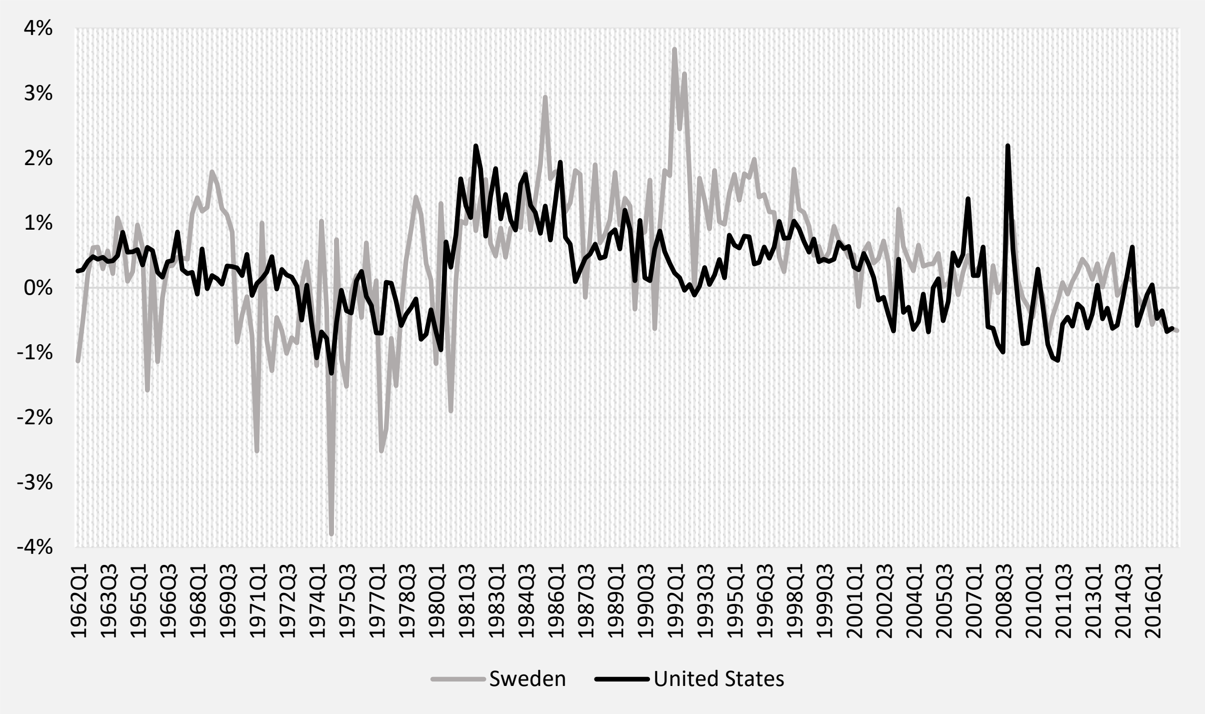

Figure 1 – Short-Term Real Quarterly Interest Rates

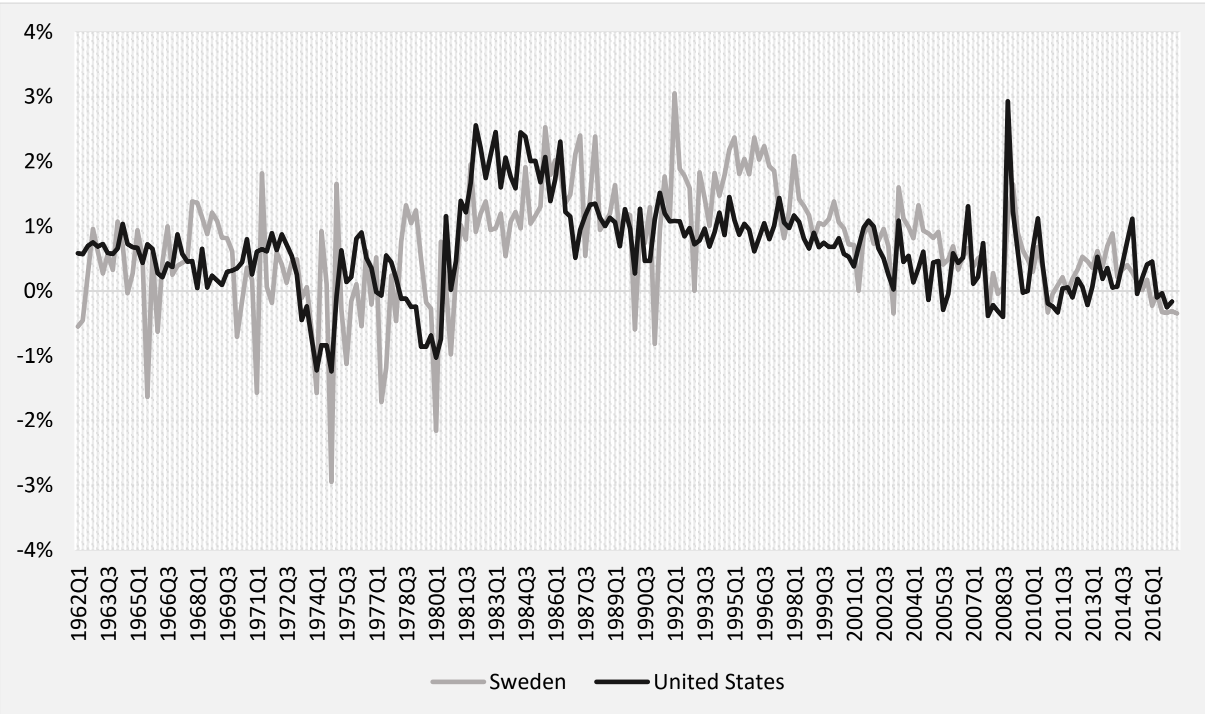

Figure 2 – Long-Term Real Quarterly Interest Rates

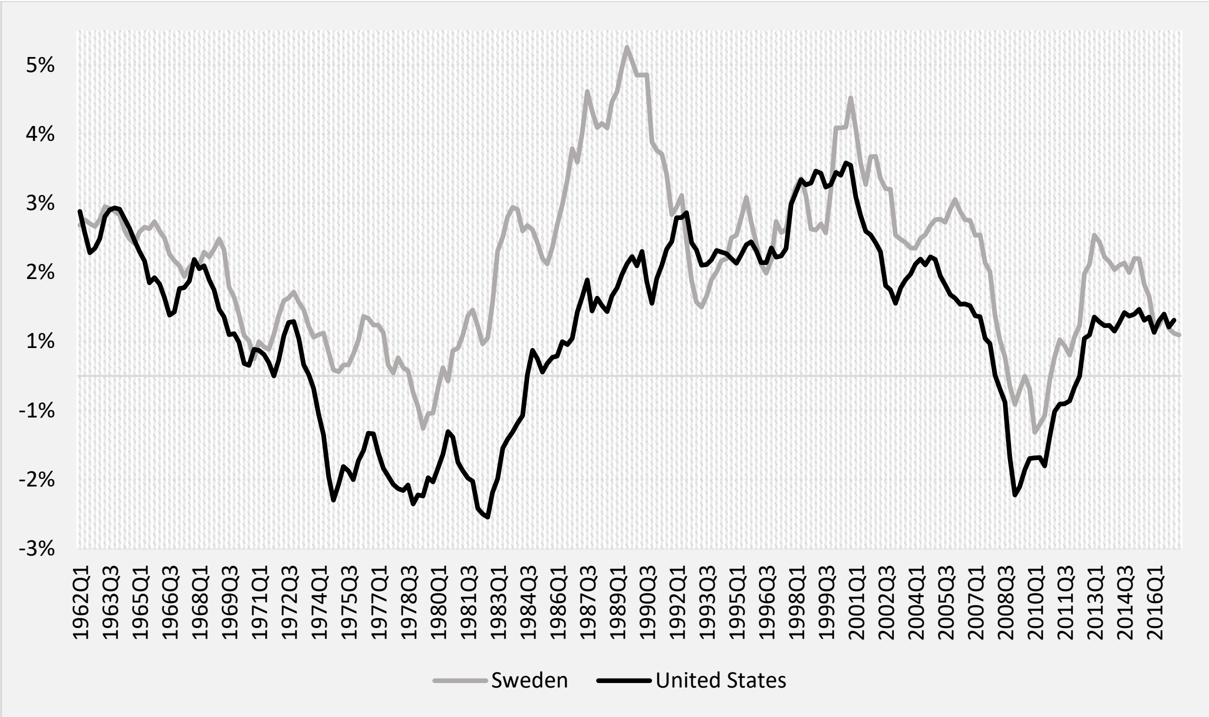

Figure 3 – Relative Stock Market Valuation (10-year Average Quarterly Real Returns)

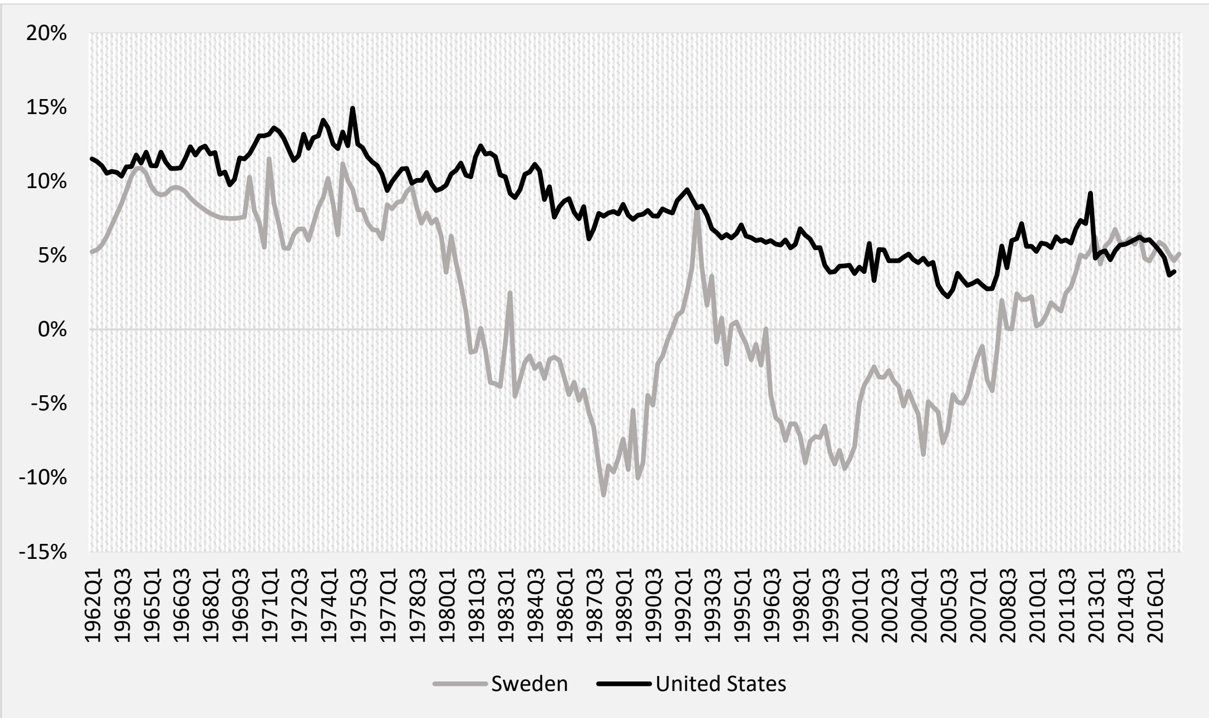

Figure 4 – Household Savings Rate to Disposable Income

Table 2: *Correlation Matrix over the Sweden Data (First Differences)*

	Household Savings Rate to Disposable Income	Short-term Real Interest Rate	Long-term Real Interest Rate	Real Stock Market Relative Valuation	Unemployment Rate
Household Savings Rate to Disposable Income	1.000 ---				
Short-term Real Interest Rate	-.075 (.266)	1.000 ---			
Long-term Real Interest Rate	-.053 (.431)	.956 (.000)	1.000 ---		
Real Stock Market Relative Valuation	-.065 (.336)	-.009 (.892)	-.003 (.961)	1.000 ---	
Unemployment Rate	-.053 (.437)	.013 (.85)	.04 (.555)	-.151 (.025)	1.000 ---

Not: The values inside parentheses are the p-values of the respective coefficient.

Table 2: *Correlation Matrix over the United States Data (First Differences)*

	Household Savings Rate to Disposable Income	Short-term Real Interest Rate	Long-term Real Interest Rate	Real Stock Market Relative Valuation	Unemployment Rate
Household Savings Rate to Disposable Income	1.000 ---				
Short-term Real Interest Rate	.096 (.157)	1.000 ---			
Long-term Real Interest Rate	.106 (.115)	.959 (.000)	1.000 ---		
Real Stock Market Relative Valuation	-.061 (.368)	-.003 (.962)	-.008 (.907)	1.000 ---	
Unemployment Rate	.102 (.131)	-.003 (.9622)	.096 (.157)	-.14 (.039)	1.000 ---

Not: The values inside parentheses are the p-values of the respective coefficient.

Dickey-Fuller tests in the first differences, no unit root was found, thus spurious regressions will not be an issue. Taking the first difference on these variables also removes the otherwise potentially obscuring factor that the neutral real interest rate, the level of interest rates where the economy is in equilibrium, has been lowered as is argued by some economists (Baker, et al., 2017).

Not too surprisingly, in both data sets the correlation between the savings rate (SR) and the real interest rate (RR) is not statistically significant. It is not very surprising for two reasons, the first is that there could be some balance between the income effect and the intertemporal consumption substitution effect. The second reason is that the result could also indicate support to the hypothesis that the relationship is simply not linear. Regarding the relative valuation of the stock market, the lack of significance in its correlation with the savings rate indicates that there may not be a wealth effect. As regards the financial assets substitution effect, the high correlation between the long-term interest rates and the short-term interest rates suggests that there must be such an effect between these two types of assets that drives the long-term interest rates to follow the short-term interest rates set by the central banks.

3.4 The Econometric Model & Variables

The interest rate usually discussed in these contexts is the short-term government treasury bill interest rates, as these are typically considered risk free (Waldenström, 2007). However, with central banks are now trying to exploit the relationship using long-term interest rates as well using quantitative easing (Sveriges Riksbank, 2013; Williams, 2012), whether these long-term interest rates are effective in determining savings is also of concern. The effects and hypotheses will therefore be explored in terms of two different kinds of models, with the difference being that one uses short-term interest rates and the other one uses long-term interest rates. The interpretation of the coefficients will be the same, however short-term interest rate models are expected to perform better.

The dependent variable of the model is the household savings rate, expressed as a percentage of household disposable income and the independent variables of which the effects on the dependent variable are investigated are the real interest rate, the stock market relative valuation and the unemployment rate. Before conducting the regression analysis, suspicion of a few issues that could make changes to the model necessary arose. The actions taken to further investigate as well as, if necessary, solve the issues will be described independently.

Heteroscedasticity was found in all regressions, and as this can lead to poor estimations of the error terms, we needed to account for this using robust standard errors. Although robust standard errors normally lead to wider confidence intervals, this measure is necessary to reduce the risk of making incorrect inference decisions.

As all time series used in the regression tested positively for unit roots, indicating autocorrelation, models that could account for this were necessary to avoid spurious regressions. Before deciding how to do so we also needed to perform Engel-Granger tests for cointegration with the savings rate as the dependent variable, where we found no such relationship. This issue of no cointegration is not a serious one, however, as the long-run relationship between these variables is not particularly relevant to this thesis. Therefore, we could solve the issue of autocorrelation using by taking the first differences.

When these issues were accounted for, the regressions were made in two forms. One where the real interest rates used are short-term and one where they are long-term assets.

The first model was specified as follows:

$$\Delta SR_t = \alpha + \rho \Delta SR_{t-1} + \theta_1 \Delta RR_{t-1} + \theta_2 \Delta RV_{t-1} + \theta_3 \Delta UR_{t-1} + \varepsilon_t \quad (1)$$

where t denotes time, SR denotes the savings rate to disposable income, α denotes a constant, RR denotes the real interest rate, RV denotes the real relative valuation of the stock market and UR denotes the unemployment rate. As we expect a lagged effect, the simultaneous effects could be removed. θ_1 denotes the marginal effect of the first difference real interest rate in period $t-1$ on the first difference savings rate. If the intertemporal consumption substitution effect is dominant, then this coefficient should be positive, however if the income effect is dominant it should be negative. θ_2 denotes the marginal effect of the first difference real valuation of the stock market in period $t-1$ on the first difference savings rate. If there is a wealth effect, then this coefficient should be negative. The unemployment rate variable enters the analysis as a control variable, as unemployment has substantial and obvious effects on household finances. By using the savings rate normalized with disposable household income, we also directly control for that disposable household income.

The second model is an expansion of model (1), investigating the lag structure. Although the lag structure itself is not particularly interesting, it is nonetheless important to investigate it for the purpose of detecting significant relationships. The model looks as follows:

$$\Delta SR_t = \alpha + \rho_1 \Delta SR_{t-1} + \rho_2 \Delta SR_{t-2} + \theta_1 \Delta RR_{t-1} + \theta_2 \Delta RR_{t-2} + \theta_3 \Delta RV_{t-1} + \theta_4 \Delta RV_{t-2} + \theta_5 \Delta UR_{t-1} + \theta_6 \Delta UR_{t-2} + \varepsilon_t \quad (2)$$

where all explanatory variables are lagged one more period. Wald tests will be performed on the coefficients of each pair of the explanatory variables to test whether their effect together is significant, with the hypothesis that $C_1 = C_2 = 0$, where C denotes the coefficients.

The third model is also an expansion of model (1) and is designed to be a step further towards investigating hypothesis H1. It adds a dummy variable $RRLOW$ that interacts with the real interest rate ΔRR. The model looks as follows:

$$\Delta SR_t = \alpha + \rho \Delta SR_{t-1} + \theta_1 \Delta RR_{t-1} + \varphi RRLOW_{t-1} \Delta RR_{t-1} + \theta_2 \Delta RV_{t-1} + \theta_3 \Delta UR_{t-1} + \varepsilon_t \quad (3)$$

where the dummy variable $RRLOW$ takes a value of 1 when the real interest is below the 15^{th} percentile of observations in the sample, otherwise taking a value of 0. The coefficient φ denotes the marginal effect in a low real interest rate environment of the first difference real interest rate in period $t-1$ on the first difference savings rate, and if hypothesis H1 is to not be rejected, it should be negative. This would mean that the relative importance of the income effect is greater when real interest rates are low than when they are at normal levels.

The fourth model is an expansion of model (3) and is designed to be a step further towards investigating hypothesis H2, whether the wealth effect is a stronger factor at lower interest rates, which could compensate somewhat for an increased relative importance of the income effect. It adds another interaction term, between the dummy variable $RRLOW$ and the ΔRV variable. The model looks as follows:

$$\begin{aligned}\Delta SR_t = \alpha + \rho \Delta SR_{t-1} + \theta_1 \Delta RR_{t-1} + \varphi_1 RRLOW_{t-1} \Delta RR_{t-1} + \theta_2 \Delta RV_{t-1} \\ + \varphi_2 RRLOW_{t-1} \Delta RV_{t-1} + \theta_3 \Delta UR_{t-1} + \varepsilon_t \end{aligned} \quad (4)$$

where hypothesis H2 expects φ_2 to be negative, indicating additional potency to the wealth effect during periods of low real interest rates.

We will also specify a fifth model that is an expansion of model (4), in order to see whether further differentiation of real interest rates levels will make a difference in explaining the savings rate. We do this by adding the dummy variable $RRHIGH$ and interacting it with both the RR and the RV variables.

$$\begin{aligned}\Delta SR_t = \alpha + \rho \Delta SR_{t-1} + \theta_1 \Delta RR_{t-1} + \varphi_1 RRLOW_{t-1} \Delta RR_{t-1} + \varphi_2 RRHIGH_{t-1} \Delta RR_{t-1} + \theta_2 \Delta RV_{t-1} \\ + \varphi_3 RRLOW_{t-1} \Delta RV_{t-1} + + \varphi_4 RRHIGH_{t-1} \Delta RV_{t-1} + \theta_3 \Delta UR_{t-1} + \varepsilon_t \end{aligned} \quad (5)$$

where the dummy variable RRHIGH takes a value of 1 when the real interest is above the 15^{th} percentile of observations in the sample, otherwise taking a value of 0. Hypothesis H1 expects φ_1 to be negative and H2 expects φ_3 to be negative, just like before. The new coefficients φ_2 and φ_4 are not interesting in and of themselves, they are only there to further differentiate between real interest rate levels.

3.5 Empirical Results

Using both long-term and short-term interest rates, we begin by estimating model (1) and model (2) for both countries. This is done to investigate the lag structure and to take full advantage of the data to achieve the best fit possible with these variables. The results of these regressions (1), (2), (6) and (7) are presented in table 3 and table 4, where it should be noted that as heteroscedasticity was found in all regressions using White's test for heteroscedasticity, robust standard errors are presented inside parentheses in all regressions. It should also be noted that looking at the Jarque-Bera statistic, we see that the data is not normally distributed. It is likely that the non-normality is caused by the many outliers in the inflation data, and even removing two of the regression outliers in Sweden and one in the United States only improves the results slightly. With persisting non-normality in the error terms, inferential conclusions should be made with caution. With regards to autocorrelation however, the Durbin-Watson statistic suggests that the model suffers from no issues.

Looking more closely at the tables we see that in Sweden, the fit is better with only one period of lag, for both long-term and short-term interest rates, while in America the fit is marginally better with two periods in both cases. However, the difference is not substantial enough to matter and in neither case are there any additional significant coefficients with the two-lag regression, and the Wald test provides no additional information. We therefore settle with one period of lag in the rest of the models in both countries, as the results will be easier to interpret this way.

In Sweden, the short-term real interest rates and the real long-term interest rates seem to perform similarly, although short-term interest rates somewhat better in general in terms of fit. Surprisingly however, the opposite is true for the United States, long-term real interest rates yield better results when considering levels of significance of the interest rate coefficients of some models and the fit of the model.

The very low fit of all regressions is potentially due to a combination of issues. Firstly, although models using only similar variables have been used to produce good fits before (Wilcox, 1990), there may be more variables affecting savings that this model does not take into consideration to hold constant when evaluating the effects of interest rates. Examples of missing variables are fiscal, demographic factors (Hossein, et al., 1998; Doker, et al., 2016), or uncertainty (Leland, 1968; Weil, 1993). However, only knowing this does not give this

Table 3: *The Connection Between Real Interest Rates and Savings in Sweden*

Dependent variable: Household Savings Rate to Disposable Income	(1)	(2) Wald Prob. (F)	(3)	(4)	(5)	(6)	(7) Wald Prob. (F)	(8)	(9)	(10)
	Short-Term Interest Rates					Long-Term Interest Rates				
1. Interest Rate (-1)	-.018 (.129)	.045 (.128)	-.151 (.173)	-.152 (.174)	-.294** (.145)	-.091 (.122)	-.069 (.139)	-.074 (.148)	-.074 (.148)	-.037 (.186)
		.724					.815			
2. Interest Rate (-2)		.112 (.14)					.014 (.157)			
3. Low Real Interest Rates (-1)			.445* (.257)	.443* (.26)	.57** (.255)			-.059 (.301)	-.057 (.302)	-.098 (.298)
4. High Real Interest Rates (-1)					.84** (.35)					-.101 (.283)
5. Real Stock Market Relative Valuation (-1)	-.348 (.48)	-.298 (.509)	-.351 (.478)	-.406 (.54)	-.225 (.462)	-.348 (.482)	-.304 (.512)	-.349 (.484)	-.268 (.539)	-.048 (.453)
		.545					.566			
6. Real Stock Market Relative Valuation (-2)		-.352 (.437)					-.331 (.441)			
7. Real Stock Market Relative Valuation in Low Real Interest Rate Environment (-1)				.392 (.917)	.229 (1.115)				-.566 (1.137)	-.793 (1.107)
8. Real Stock Market Relative Valuation in High Real Interest Rate Environment (-1)					-.728 (.966)					-1.326 (1.08)
9. Household Savings Rate to Disposable Income (-1)	-.168** (.084)	-.181** (.088)	-.156* (.085)	-.155* (.085)	-.153** (.065)	-.17** (.084)	-.185** (.088)	-.172** (.086)	-.172** (.086)	- 0.188*** (.066)
		.122					.113			
10. Household Savings Rate to Disposable Income (-2)		-.053 (.081)					-0.051 (.081)			
11. Unemployment Rate (-1)	-.165 (.408)	.014 (.551)	-.158 (.42)	-.167 (.421)	-.308 (.331)	-.156 (.417)	.007 (.568)	-.159 (.42)	-.147 (.417)	-.207 (.332)
		.757					.777			
12. Unemployment Rate (-2)		-.376 (.657)					-.353 (.648)			
Amount of Observations After Adjustments	220	219	220	220	220	220	219	220	220	220
Adjusted R^2	.150	.145	.159	.155	.173	.153	.143	.149	.146	.144
Normality Prob. (JB)	.004	.001	.004	.004	.029	.006	.003	.007	.009	.011
Durbin-Watson Stat.	1.98	1.967	2.007	2	1.973	1.997	1.949	1.974	1.984	1.968
White's Test Prob. (F)	.024	.000	.000	.000	0.001	.023	.000	.003	.006	.000

Not: The values inside parentheses are the robust standard errors of each coefficient.
All variables are first differences.
***/**/* represent the levels of significance 1%/5%/10% respectively.

Table 4: *The Connection Between Real Interest Rates and Savings in the United States*

Dependent variable: Household Savings Rate to Disposable Income	(1)	(2) Wald Prob. (F)	(3)	(4)	(5)	(6)	(7) Wald Prob. (F)	(8)	(9)	(10)
	Short-Term Interest Rates					Long-Term Interest Rates				
1. Interest Rate (-1)	.168* (.096)	.194* (.103)	.159* (.096)	.158 (.096)	.174 (.147)	.195** (.098)	.243** (.101)	.143 (.09)	.144 (.091)	.144 (.15)
Wald Prob. (F)		.143					.058			
2. Interest Rate (-2)		.023 (.126)		.063 (.362)			.072 (.124)			
3. Low Real Interest Rates (-1)			.064 (.363)		.059 (.307)			.426 (.471)	.448 (.486)	.467 (.324)
4. High Real Interest Rates (-1)					-.107 (.239)					-.064 (.215)
5. Real Stock Market Relative Valuation (-1)	-.216 (.278)	-.141 (.288)	-.218 (.277)	-.226 (.29)	-.111 (.299)	-.22 (.278)	-.133 (.286)	-.244 (.274)	-.166 (.286)	.091 (.297)
Wald Prob. (F)		.529					.576			
6. Real Stock Market Relative Valuation (-2)		-.237 (.261)					-.259 (.261)			
7. Real Stock Market Relative Valuation in Low Real Interest Rate Environment (-1)				.047 (.818)	-.065 (.6)				-.411 (.779)	-.681 (.59)
8. Real Stock Market Relative Valuation in High Real Interest Rate Environment (-1)					-.525 (.605)					-.962* (.573)
9. Household Savings Rate to Disposable Income (-1)	-.264*** (.081)	-.261*** (.081)	-.262*** (.081)	-.263*** (.081)	-.263*** (.063)	-.265*** (.081)	-.269*** (.08)	-.257*** (.08)	-.256*** (.08)	-.266*** (.063)
Wald Prob. (F)		.005					.003			
10. Household Savings Rate to Disposable Income (-2)		.031 (.067)					.029 (.066)			
11. Unemployment Rate (-1)	.125 (.225)	.244 (.246)	.123 (.219)	.123 (.219)	.12 (.156)	.096 (.221)	.214 (.241)	.065 (.196)	.064 (.2)	.008 (.155)
Wald Prob. (F)		.379					.384			
12. Unemployment Rate (-2)		-.277 (.206)					-.301 (.205)			
Amount of Observations After Adjustments	219	218	219	219	219	219	218	219	219	219
Adjusted R^2	.192	.191	.189	.185	.18	.196	.197	.2	.198	.201
Normality Prob. (JB)	.022	.049	.027	.024	.03	.028	.056	.057	.082	.105
Durbin-Watson Stat.	2.029	2.072	2.025	2.036	2.032	2.038	2.073	2.01	2.012	2.012
White's Test Prob. (F)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.000

Not: The values inside parentheses are the robust standard errors of each coefficient.
All variables are in first differences.
***/**/* represent the levels of significance 1%/5%/10% respectively.

issue a simple solution. The former two factors would likely not make any substantial contribution as while they are easily quantified, they are too slow to change for time series data with quarterly frequency to adequately determine them. The latter factor suffers from the problem of not being easily quantified.

Secondly, the models could be poorly defined in terms of the basic linear approach, lag structure, etc. For example, empirical studies have shown asymmetric effects of interest rates unexpected by theory, meaning that the impacts of increases in interest rates differ from decreases (Jackman & Sutton, 1982; Karras, 1996; Cover, 1992). Such phenomena could obscure the results in this sort of linear model.

Thirdly, the econometric method may altogether be flawed in terms of data, assumptions, etc. The mistakenly made assumptions could be assumptions such as the relationship being constant with respect to time during the entire considered period in both countries, which could be an issue whether linear with respect to interest rate levels or not.

3.5.1 Hypothesis H1

Looking more specifically at the coefficients, beginning with the Swedish regressions (1), (2), (6) and (7) in table 3, we observe that the interest rate variable is not significant, neither the short-term nor long-term ones. Not considering the potential econometric issues, this result has two interpretations.

The first and most obvious interpretation is that there is no effect of interest rates at all, that it is not even a factor for the ratio of savings to disposable income, in which case a substantial part of macroeconomic theory is incorrect. The second interpretation lies in the theoretical foundation of this thesis, that there is some balance between the intertemporal consumption substitution effect and the income effect under normal circumstances. That is, the real interest rate is a factor for individuals but cancel each other out, either already at the individual level or at the aggregate level. These two explanations rely on the regression results being accurate, however previous studies of Sweden show that both short-term and long-term interest rates actually do have significant effects (Bharat, 1995), indicating that the results may be inaccurate.

Looking at the United States regressions (1), (2), (6) and (7) in table 4 however, all interest rate coefficients under normal circumstances are positively significant, in line with previous findings such as Gylfasson (1981). Although he used the aggregate propensity to consume rather than the household savings rate to disposable income as the dependent variable, it shows a similar tendency. In terms of the theoretical foundation of this thesis, these four regressions all suggest a dominance of the intertemporal consumption substitution effect over the income effect, which stands in contrast to the Swedish regressions. There still may be econometric issues, however no matter these issues, somewhat contradicting results of the two countries are not surprising considering the theoretical ambiguity and previous studies suggesting that different countries do react differently to changes in interest rates with regards to savings (Egwaikhide & Nwachukwu, 2007; Ertac, et al., 2003). These models should therefore not be doubted for that reason alone.

Although a linear model better explains the relationship in the United States than in Sweden, the interpretation of the econometric issue that this linear model may be insufficient is actually not entirely unexpected by hypothesis H1. H1 states that the relationship should actually change at low real interest rates, and this seeming lack of effect of real interest rates on savings using this model could indicate this kind of non-linear relationships. To further explore this, we use Model (3) where we introduce the first interaction term, with which we can continue investigating the relationship between low real interest rates and the savings rate. Defining "low" as the bottom 15 percent of interest rate observations in the sample, we expect to clearly see any dominance of the income effect without excessively foregoing sample size. The model we use to investigate this is model (3) and we can see the regression results in regressions (3) and (8) in tables 3 and 4.

Using this model, the fit is improved slightly in all Swedish regressions. And in Sweden we can actually see a non-linear relationship. The short-term real interest rate coefficient in low real interest rate environment is significantly different from zero on the 10% level. However as the coefficient is positive, not negative, this does not imply that a dominance of the income effect becomes present in this environment. Rather the opposite, it implies that the intertemporal consumption substitution effect is dominant in this environment. Whether this result is accurate is a matter to be questioned, partly because it contradicts previous studies suggesting it should be significant in normal interest rate environments (Bharat, 1995) and partly because explaining this phenomenon in economically intuitive terms would need to involve statements about either the greater patience or the younger demographics of the Swedish population only present in low real interest rate environments. It is reasonable to disregard this result at this point. Interestingly, comparing this to the long-term real interest rate coefficients, this dominance cannot be seen in the long-term interest rate coefficient. That households would change their savings behavior in a low short-term interest rate environment but not in a low long-term real interest rate environment could indicate that people are more concerned about short-term real interest rates than long-term real interest rates when making decisions related to savings, at least when making decisions regarding the ratio to save.

In the United States, the long-term real interest rate coefficients lose their significance from the previous regressions, giving some further support to the reasoning that short-term interest rates matter more than long-term real interest rates, although contradicting the previous result when the level of significance was higher using long-term real interest rates. Going onwards to regression (4) in table 4, the short-term real interest rate coefficient also loses its significance. However, in this last case we need to note that comparing regressions (3) and (4), we can see that the t-statistics of these short-term real interest rate coefficients actually barely differ by looking at the coefficients in relation to their respective standard error. They are merely very closely on different sides of the critical t-statistic.

The final set of regression results can be seen in regressions (5) and (10) in tables 3 and 4. Here we have further differentiated between levels of real interest rates, adding high real interest rate coefficients – defined as the highest 15 percent of the observations in the sample – still suspecting that a linear model is insufficient. Indeed, the Swedish short-term interest rate results show us clearer evidence of non-linearity in the relationship between real interest rates and the savings rate. Its fit has increased, and it shows us a significant and negative coefficient in a normal real interest rate environment, indicating dominance of the income effect, whereas a low real interest rate environment the coefficient is significantly positive and indicates an increased relative importance of the intertemporal consumption substitution effect. In short, the results directly contradict hypothesis H1, and it is still difficult to explain in economically intuitive terms. These results need further investigation before any final conclusions can be drawn. Moving on to the long-term real interest rate regressions, we do not find this effect, again indicating that Swedish savers are more responsive to short-term real interest rate changes.

In the United States we do not find any additional interesting results and the fit is actually worsened in the case of short-term interest rates.

3.5.2 Hypothesis H2

As regards the real valuation of the stock market, we can see in regressions (1), (2), (3), (6), (7), and (8) in tables 3 and 4 that it does not seem to have any significant effect on savings rates in either country, indicating that the wealth effect of the stock market is not a very important factor, if even a factor at all. However, so far we have not considered the extent to which the wealth effect of the stock market may change in a low real interest rate environment. To do this we look at the new interaction term in regressions (4) and (9) in tables 3 and 4, where the low real interest rate dummy variable interacts with the real stock market valuation variable.

The results of these regressions show us that the fit is slightly worsened in all cases compared to the regressions using model (3), with the additional coefficient not being significantly different from zero in any of the countries and using neither short-term interest rates nor long-term interest rates. As hypothesis H2 expects the coefficient of the added interaction term to be negative, the results do not support our hypothesis. Looking at the last regressions, (5) and (10) where we add another dummy variable and interact it with the relative valuation of the stock market, there still seems to be no wealth effect during normal or low real interest rate environments. The simple interpretation is that the wealth effect does not exist with respect to the stock market, and that whatever financial assets substitution effect there is between interest rate-yielding assets and the stock market, it does not cause increased importance of the stock market for savings rate considerations.

This interpretation seems unsupported by previous studies however. One previous study by Berg and Bergström (1995) shows that financial wealth, in which the stock market wealth is a component, does have a significant effect on savings in Sweden. In the United States, evidence of a stock market wealth effect has also been found (Poterba & Samwick, 1995). The results of this thesis may therefore simply mean that it may just not be very easily observed with the simple model used. Poterba (2000, pp. 100-105) discusses that there has for some time been some question regarding estimating the effect. He argues that discussions regarding whether a wealth effect exists or not are misguided. At some point in time, a wealthier individual will consume more than a less wealthy individual. However, if there is a major lag between new wealth and its effect on consumption, a matter of perhaps many years, stock market fluctuations may not have that big of an impact on savings over the short to medium term. Without knowing this lag, investigating whether there really is an increased potency of the effect in low real interest rate environment is problematic. He also notes that it is useful to consider the distribution of corporate stock ownership in the population in order to truly determine the wealth effect of the stock market, however this would be more interesting in a micro setting than in a macro setting.

3.5.3 Summary of the Results

In summary, when considering all regressions together, we find no results supporting the any of the two hypotheses. Although there are some significant interest rate coefficients, they contradict hypothesis H1. For example, the Swedish results suggest that while there may be a dominance of the income effect in a normal real interest rate environment, the relative importance of the intertemporal consumption substitution effect is increased at low short-term real interest rate levels, whereas hypothesis H1 states that it is the income effect that should have its relative importance increased. This phenomenon is difficult to explain in economically intuitive terms. The only economically intuitive result in the Swedish regressions is that savings considerations are made principally based upon short-term interest rates, which is supported by some results in the United States, however directly contradicted by other. As for the balance of the effects in the United States, it seems that the intertemporal consumption substitution effect is always dominant and always equally so, no matter levels of real interest rates. Contradicting results regarding the interest rate coefficients are not surprising considering the theory and previous empirical evidence (Egwaikhide & Nwachukwu, 2007; Ertac, et al., 2003). Regarding hypothesis H2, little evidence of a wealth effect of the stock market is found, which is somewhat unexpected considering previous studies of financial wealth and the stock market (Berg & Bergström, 1995; Juster, et al., 2006; Poterba & Samwick, 1995).

4 Conclusion

During times of unusual macroeconomic circumstances, it is useful to study similar environments in the past and what they have led to. Using regression analysis this thesis has empirically analyzed the effect in Sweden and the United States of a low real interest rate environment on the effect of short-term and long-term real interest rates on savings and on the potency of the stock market wealth effect. In Sweden we do find results suggesting the relative importance of the intertemporal consumption substitution effect and the income effect changes at different low real interest rate levels, although the effect is the opposite of what was expected by the related hypothesis, while in the United States the relationship seems to never change. As for the stock market wealth effect, the study finds no evidence in the regression results that its potency would increase in a low real interest rate environment. Results regarding whether short-term interest rates or long term interest rates have the strongest effect on savings differ between the countries, in Sweden most results seem to suggest that the effects of short-term interest rates are stronger, whereas the results in the United States are more unclear. At the same time, there are questions whether the explanations for the results are econometric issues such as missing variables, not taking asymmetric effects into accounts, indeterminable lags, and an otherwise flawed econometric method, rather than the regression results actually accurately representing the real relationships.

Lastly, it is clear that this area needs further studying if we want to acquire an understanding of the effects that concern the savings rate, whether their respective importance can change under certain circumstances. As great as the implications are for macroeconomic theory, the area is inadequately studied as a consequence of the assumption that savings behavior is linear with respect to interest rates. This thesis has provided a new vantage point that may challenge this assumption.

Appendix A

Table A.1: *Data Description (Sweden)*

Data and Units	Sources and Notes
Savings Rate (%)	OECD (2012) & Oxford Economics (2017), both retrieved from Datastream. Household Saving Rate. Seasonally adjusted. Quarterly data. Linked data sets, the OECD data set used during the time period 1962Q1-1979Q4 and the Oxford Economics dataset used during the time period 1980Q1-2017Q2. Pearson's correlation coefficient during the time period for which both sets contain data (first differences): $\rho = .452$
Short-Term Interest Rate (%)	IMF (2017) & Sveriges Riksbank (2017). 3-month treasury bills. Monthly data.
Long-Term Interest Rate (%)	Waldenström (2014) & Sveriges Riksbank (2017). 10-year government bonds. Monthly data.
Stock Market Index (%)	Waldenström (2014) & Nasdaq Inc. (2017). Riksbanken Real Stock Price Index & OMXSPI respectively. No seasonal patterns detected. Monthly and daily data respectively. Data sets linked after adjusting Nasdaq data for inflation, with the Riksbanken data used during the time period 1962Q1-1980Q1 and the Nasdaq data used during the time period 1980Q2-2017Q2. Pearson's correlation coefficient during the time period for which both sets contain data (first differences): $\rho = .963$
Unemployment Rate (%)	OECD (2017). Unemployment rate. Seasonally adjusted quarterly data.
Price Index (1914=100)	Statistics Sweden (2017). CPI. Seasonally adjusted. Monthly data.

Table A.2: *Variables Description (Sweden)*

Variables and Units	Calculations
Savings Rate (%)	No calculations made.
Short-Term Interest Rate (%)	Monthly data converted into quarterly using the formula $i_Q = \frac{i_M + i_{M+1} + i_{M+2}}{3}$ Yearly rates converted into quarterly as: $Qr_Q = \frac{r_Q}{4}$ Quarterly real interest rates calculated as: $Qr_Q = Qi_Q - \pi_Q$
Long-Term Interest Rate (%)	Monthly data converted into quarterly as: $i_Q = \frac{i_M + i_{M+1} + i_{M+2}}{3}$ Yearly rates converted into quarterly as: $Qi_Q = \frac{i_Q}{4}$ Quarterly real interest rates calculated as: $Qr_Q = Qi_Q - \pi_Q$
Real Valuation of the Stock Market (%)	Daily data converted into monthly as: $index_M = \frac{index_D + index_{D+1} + \cdots + index_{D+n}}{n+1}$ Monthly data converted into quarterly as: $index_Q = \frac{index_M + index_{M+1} + index_{M+2}}{3}$ Quarterly returns calculated as: $i_Q = \frac{index_Q}{index_{Q-1}}$ Nasdaq data adjusted for inflation as: $r_Q = i_Q - \pi_Q$ Real valuation of the stock market calculated as a 10-year (40 quarters) average of quarterly real returns: $RV_Q = \frac{r_Q + r_{Q+1} + \cdots + r_{Q+39}}{40}$
Unemployment Rate (%)	No calculations made.
Inflation (%)	Monthly data converted into quarterly as: $CPI_Q = \frac{CPI_M + CPI_{M+1} + CPI_{M+2}}{3}$ After which it was seasonally adjusted. Quarterly inflation rate (%) calculated as: $\pi_Q = \frac{CPI_Q}{CPI_{Q-1}}$

Table A.3: *Data Description (United States)*

Data and Units	Sources and Notes
Savings Rate (%)	United States Bureau of Economic Analysis, retrieved from Federal Reserve Economic Data (2017). Personal Savings Rate. Seasonally adjusted.
Short-Term Interest Rate (%)	Board of Governors of the Federal Reserve System, retrieved from Federal Reserve Economic Data (2017). 3-month treasury bills. Monthly data.
Long-Term Interest Rate (%)	Board of Governors of the Federal Reserve System, retrieved from Federal Reserve Economic Data (2017). 10-year Treasury Constant Maturity Rate. Daily data.
Stock Market Index (%)	Yahoo Finance (2017). S&P500. No seasonal patterns detected. Daily data.
Unemployment Rate (%)	OECD (2017). Harmonized unemployment rate. Seasonally adjusted. Quarterly data.
Price Index (1982-84=100)	U.S. Department of Labor Bureau of Labor Statistic, retrieved from US Inflation Calculator (2017). CPI-U. Seasonally adjusted. Monthly data.

Table A.4: *Variables Description (United States)*

Variables and Units	Calculations
Savings Rate (%)	No calculations made.
Short-Term Interest Rate (%)	Monthly data converted into quarterly using the formula $$i_Q = \frac{i_M + i_{M+1} + i_{M+2}}{3}$$ Yearly rates converted into quarterly as: $$Qr_Q = \frac{r_Q}{4}$$ Quarterly real interest rates calculated as: $$Qr_Q = Qi_Q - \pi_Q$$
Long-Term Interest Rate (%)	Daily data converted into monthly as: $$i_M = \frac{i_D + i_{D+1} + \cdots + i_{D+n}}{n+1}$$ Monthly data converted into quarterly as: $$i_Q = \frac{i_M + i_{M+1} + i_{M+2}}{3}$$ Yearly rates converted into quarterly as: $$Qi_Q = \frac{i_Q}{4}$$ Quarterly real interest rates calculated as: $$Qr_Q = Qi_Q - \pi_Q$$
Real Valuation of the Stock Market (%)	Daily data converted into monthly as: $$index_M = \frac{index_D + index_{D+1} + \cdots + index_{D+n}}{n+1}$$ Monthly data converted into quarterly as: $$index_Q = \frac{index_M + index_{M+1} + index_{M+2}}{3}$$ Quarterly returns calculated as: $$i_Q = \frac{index_Q}{index_{Q-1}}$$ Adjusted for inflation as: $$r_Q = i_Q - \pi_Q$$ Real valuation of the stock market calculated as a 10-year (40 quarters) average of quarterly real returns: $$RV_Q = \frac{r_Q + r_{Q+1} + \cdots + r_{Q+39}}{40}$$
Unemployment Rate (%)	No calculations made.
Inflation (%)	Monthly data converted into quarterly as: $$CPI_Q = \frac{CPI_M + CPI_{M+1} + CPI_{M+2}}{3}$$ After which it was seasonally adjusted. Quarterly inflation rate (%) calculated as: $$\pi_Q = \frac{CPI_Q}{CPI_{Q-1}}$$

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