Equity Premium Puzzle:

100 Years of Bad Luck

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Preface

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Abstract

This master thesis investigates the Norwegian equity premium puzzle for the period 1900-2008. I give a detailed overview over the stock, bill and bond market and follow the consumption based asset pricing model to relate the equity premium to the volatility in consumption innovation and the coefficient on relative risk aversion (RRA). I find that the Norwegian data implies a lower coefficient on RRA compared to what is calibrated for other countries.

Mehra and Prescott (1985), Abel (1999) and Campbell and Cochrane (1999) implicitly assume perfectly correlated stock returns and consumption innovation in their assessment of the equity premium puzzle. Following this approach the implied RRA from the Hansen-Jagannathan bound equation is 6 for the whole period and 15 for the post WWII period. If the calculations are performed with the observed correlations between consumption innovation and stock returns, the implied RRA jumps to 37 for the whole period and 85 for the post WWII period.

The implied RRA of 6 does not constitute an equity premium puzzle for Norway, however it implies a time preference parameter of 50%, and hence a risk-free rate puzzle.

The relatively low RRA parameter for Norway arises from a low Sharpe ratio for excess returns (synonymously a relatively more volatile stochastic discount factor) and more volatile consumption innovation compared to other countries. The equity premium puzzle is definitely smaller in Norway than other countries.

The observed high equity premium of 7.33% can perhaps be explained by theories from the field of behavioral economics, heterogeneous agents and the use of geometric returns as opposed to arithmetic returns, all of which are lightly discussed in this thesis.

In accordance with the Common Stock Theory put forward by E. Smith (1924), I find that stocks outperformed bonds, providing both a higher return and a lower standard deviation in the period 1900-1970.
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0.0.1 Introduction

The behavior of the stock markets is a subject of fascination for investors, policy makers and economists. Many economic researchers have spent much time analyzing and modeling the markets and its agents. Understanding the limitations of their own economic models, these researchers have had no ambition of foreseeing the future, but rather understanding the past. However, in the field of financial economics researchers, working primarily with US data, have found that the financial markets continue to show cyclical patterns and many have fallen for the temptation to extrapolate the past into the future. With investors and policy makers pushing for models that can predict the future, economic models are often relied on to predict the future in despite of the inventors advice and intention.

My claim is that the most successful of these ”Wizard models” \(^1\)have been the models that use common or stylized facts of the market at hand to their advantage. Fama and French (1993) ”Three factor model” is a recent and well known example of such a model that claims to have found three factors that explain the average return on stocks. ”The first model that was published with a claim to outperform the market was made by Smith (1924) in his book ”Common Stock as Long Term investments”. Smith showed that over a 17-22 year period, a portfolio of well diversified stocks outperformed a portfolio of bonds. This ”Common Stock Theory (CST)” gave rise to the fundamental questions of the relationship between risk and return in the financial markets. The notion that an investor should be rewarded a premium for taking on risk was not new, but the immediate following question of how large this premium should be turned out to be both interesting and challenging to answer.

One purpose of capital markets is to allocate the risk to the agent with the lowest cost of bearing it; In return the agent requires a reward, a risk premium. Considering a long term investment an agent would according to the CST prefer a portfolio of stocks to one of bonds, yielding him a higher expected return at a lower risk.”Baatvik (2007)

For these and other ”wizard models” to value to the practitioner, the stylized facts on which these models are based upon must continue to be valid tomorrow. That is, the practitioners must know when the model is applicable and when it is not, but just as important is where the model is applicable. In the wide field of economics, models are too often interpreted to hold through any market conditions, being booms or recessions, and little emphasis is made to set limitations of extrapolation of these models to the future or markets in other countries. The first step must nevertheless be to document what cyclical behavior the market has shown, and what stylized facts have shown persistence during these cycles. Since we can only make a prediction based on the past, a detailed overview should in itself be

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\(^1\)Wizard model: A model that is made with the intention of predicting the future.
interesting.

Arguably, the most influential stylized fact of stock markets around the world, is Mehra and Prescott (1985) equity risk premium. Mehra and Prescott showed that the equity premium in the United States from 1889-1978, had been so high that it was a puzzle, or to be more specific too high to be explained by intertemporal asset pricing models such as Lucas Jr (1978).

This paper will investigate if Norwegian stock market investors have received abnormal returns similar to those in the United States and many other countries, and if the stylized facts from other financial markets are coherent with what the Norwegian markets have shown over the last 100 plus years.

This paper is organized in the following way; in section I, I will give a brief introduction to the theory and intuition behind the equity premium puzzle as first presented by Mehra and Prescott (1985). Second, I will present the model that I will use to relate the equity premium to the coefficient on relative risk aversion. Section II will investigate the stylized facts for Norwegian consumption innovation, stock, bills and bond markets for the period 1900-2008. Then, following the model from section I, I will relate the equity premium to consumption innovation, and find the implied coefficient on relative risk aversion for different time intervals within 1900-2008. The implied parameter on relative risk aversion for the whole period will define whether or not the Norwegian the equity premium is a puzzle. This will be the main part of the paper. In section III I will present some plausible explanations from the field of behavioral economics of why we continue to observe seemingly irrational high equity risk premiums.

1 Section I - Theory and Model of the Equity Risk Premium

1.1 What is a Risk Premium?

The financial playground today is comprised of securities with all thinkable features, and more generally you can place a bet on almost anything you like. Sound economic intuition will predict that, for gambles with comparable features, competition between investors would equate the expected returns by changing the relative price of taking on these gambles. However, since there exists gambles with different moments the mechanism that determines the relative price of different classes of gambles must also take into account the possibility of holding a combination of different assets. In

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2 Semantics: When using the word ”investment” and ”investors” it is not the narrow use of the word ”acquisition of capital goods” for the productive purposes. An ”investor” is not one who necessarily makes decisions in this respect. An investment is simply buying something for money

3 All calculations are performed in Microsoft Excel 2003.
the financial playground, gambles are often investments in securities, and holding a combination of securities is called diversification.

Today’s financial theory\textsuperscript{4} and literature states that the relative price between securities should be determined by their covariance with the market, and not by the respective securities variance. In other words, a high covariance security that has the feature of yielding a high return in good times, and low return in bad times should attract fewer investors than an asset with low covariance with the market. This is because we assume that the marginal utility of the exact same return (or transferrable amount of consumption) is higher in bad times when it is more needed, compared to good times. Assets with a high covariance with the market must therefore offer a higher expected return to attract investors. \textsuperscript{5} If we assume that there exists a risk free asset, then this risk free asset will, by definition, have zero covariance with the market and will offer a lower (expected) payoff. The difference between the expected return of the risk free and a risky security is the price on risk, known as the risk premium.

\subsection*{1.2 Marginal Utility and Asset Prices}

Since the price of assets, like most other goods and services, are determined by supply and demand the price of a security will depend on the preference of the agents in the market. The agents preferences can be represented by a utility function where the curvature of this function will tell us the agents preference towards risk. When we have made some assumptions of the functional form of the utility function and established a measure for the agents preference towards risk, we are left with the most controversial part, namely relating the (marginal) utility of the agents to some observable parameter. By assuming log-normal distribution of asset returns and consumption innovation, and applying logarithmic properties we can address the size of the risk premium, by comparing the risk premium to the agents preference towards risk, or more precisely their risk aversion and the (risk free) interest rate.

The intuition behind asset prices/returns is straight-forward. The agent has the choice between consuming everything today or investing some fraction of the (consumable) asset and consume the extra return in the future. To make this decision a rational agent will equate the marginal utility loss from reducing consumption today with the marginal utility gain from consuming the payoff from the investment in the future. It follows that an asset’s price is equal to the expected discounted value of its cash flows, us-

\textsuperscript{4}The Sharpe-Lintner-Mossin mean-variance equilibrium model of exchange, known as the Capital Asset Pricing Model (CAPM) is probably the most applied financial theory today.

\textsuperscript{5}This relies partly on the assumption of homogeneous investors, I will address this assumption in further detail in section III.
ing the marginal utility to discount the payoff. To find the price of an asset one must therefore discount the future cash flow by a factor that represents the agents time preferences and risk preferences.

Time preference captures the agents impatience and the marginal utility captures the risk correction of an asset. These can be combined into one discount factor. But more importantly one can represent all the discount factors of every assets in the market by one single stochastic discount factor, where the stochastic part of the discount factor represents a the individual assets specific risk. This can be done without asserting unwanted properties on the agents\(^6\). I will address this in more detail under the chapter ”The Stochastic Discount factor”.

In the previous chapter I stated that it is the covariance of an asset’s return with the market return that should determine the relative price of assets. We now see that the price or more specifically the risk correction of an asset should be determined by the asset’s return covariance with the agent’s marginal utility. Since we can not observe marginal utility directly, we choose consumption\(^7\) as an indicator of marginal utility. When an agent has a low consumption level, the marginal utility of increasing consumption is high. On average, or synonymously for the economy as a whole we therefore assume that marginal utility is high when total consumption is low and vice versa. By relating marginal utility to consumption we can observe and measure the agents risk aversion and compare it to the asset returns. If the price of risk is high, the expected excess return on a stock should also be high.

1.3 The Utility Function

It is not obvious what the price of risk, the risk premium, should be. First we need to specify what the investors utility function looks like, and what properties we believe it to have. We have already assumed two basic properties to the utility function. Firstly that investors have positive marginal utility over consumption \(u'(c) > 0\), this means that investors get happier the more they consume. Secondly that their marginal utility of consumption is decreasing, in other words that the utility function is strictly concave \(u''(c) < 0\). This means that for any given level of consumption, the investor will have a larger negative change in utility from losing one unit then the positive change from gaining one extra unit of consumption. In other words, we assume that investors are risk averse.

\(^6\)Cochrane (2001), ”Asset Pricing”

\(^7\)There are other observable variables that can be used to predict marginal utility, this paper will follow the standard practice of using consumption as a indicator for marginal utility. Cochrane’s book ”Asset Pricing” gives a good overview over which variables one can use
The power utility function, \( u(c) = \frac{c^{1-\gamma}}{1-\gamma} \), displays these properties\(^8\), and in addition constant relative risk aversion. Risk aversion is a measure of how willing the agents are to take on risk.\(^9\) Constant relative risk aversion, \(-\frac{u''(c)}{u'(c)}\) has the advantage that it holds even if \( u''(c) \geq 0 \). This means that we allow for investors being risk loving and risk neutral. It also has the nice property that risk aversion is independent of wealth. This is important when looking at long time series where the scale of the economy is growing.

Using the power utility function to represent the investors it is possible to show that there will be a constant relationship between the Sharpe ratio\(^{10}\) in the stock market and the volatility of consumption, and that this relationship is linear in the parameter of relative risk aversion (RRA).

This paper follows the Consumption based asset pricing model, Rubin-stein (1976), Lucas Jr (1978), Breeden (1979), Grossman and Shiller (1981), Mehra and Prescott (1985), Campbell (2003) approach to the equity premium puzzle, where the smoothness of consumption innovation together with the high observed equity premium implies an unrealistic high coefficient on the relative risk aversion parameter. This approach to the equity premium puzzle shows that the standard intertemporal asset-pricing model fails to create a sufficiently volatile stochastic discount factor (low Sharpe ratio) under the observed conditions.

### 1.4 The Stochastic Discount Factor

The stochastic discount factor, \( M_{t+1} = \beta \left( \frac{C_{t+1}}{C_t} \right)^{-\gamma} \), represents the time preference and risk preferences of the agents. \( \beta \) captures the agents time preference, i.e. impatience and is often called the subjective discount factor. The subjective discount factor is used to quantitatively correct for the delay of cash flows. The curvature of the utility function captures the aversion to risk through the marginal intertemporal substitution. The marginal intertemporal substitution of consumption represents the marginal utility of the agents, it tells us how many units of consumption the agent is willing to give up for one extra unit of consumption in the next period.

The stochastic discount factor incorporates all the risk corrections for each and every asset in one single parameter. The correlation between the random components of the stochastic discount factor, and the asset specific payoff, will generate the expected asset specific payoff. The assumption of

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\(^9\)The Arrow-Pratt coefficient measures the rate at which the probability premium, the excess in winning probability over fair odds to be indifferent between a certain outcome and a fifty-fifty gamble with the same expected value \((x+e, x-e)\), increases with the small risk \( e \). (google it!)

\(^{10}\)Sharpe ratio, \( \frac{E(r - r_f)}{\sigma_r} \), was originally called "reward-to-variability" (Sharpe (1966))
one unique stochastic discount factor for all assets hinges on that the "law of one price" holds, and that there are no arbitrage opportunities. The "law of one price" states that if two portfolios have the same payoff in all states of nature, then their price is the same. If there in addition is no arbitrage opportunities (absence of arbitrage), then it can be shown that all discount factors can be represented by one single stochastic discount factor. See Cochrane (2001) for an elaboration and proof.

1.5 Smooth Consumption Innovation and Risk Aversion

In standard portfolio analysis consumption is thought of as a one to one function of wealth. One example is the Friend and Blume (1975) asset pricing model that often is cited for their calculations of risk aversion. These models impose the volatility of the stock market one to one with the wealth and hence one to one on the consumption of individuals. When the US stock market have shown a 16% standard deviation (Mehra and Prescott (1985)), it is not surprising that the Friend and Blume estimates of 3-5 is a sufficient risk aversion parameter for explaining why agents do not want a highly volatile consumption. However, nondurable consumption is only weakly correlated with the stock market, Campbell (2003) finds a correlation of 0.23 for US quarterly data, and 0.34 for 1-year horizon. Table 5 in this paper shows that the Norwegian correlation is 0.15 for a 1-year horizon in the period 1900-2008. The implicit assumptions of e.g. Friend and Blume is that they do not allow for investors to smooth consumption through other sources of wealth or income. In the long run there must be a one to one relationship between wealth and consumption, however smoothness of consumption makes the covariance with stock returns low. According to the standard consumption based asset pricing model, this covariance measures the quantity of risk. In order to generate the observed equity premium, the price of risk, the relative risk aversion parameter, must therefore be very high.

Based on studies of agents risk aversion Mehra and Prescott (1985) concluded that $10^{11}$ was the reasonable upper bound for the relative risk aversion parameter. If the Norwegian data imply a higher risk aversion, then the equity risk premium is a puzzle in Norway.

See Kocherlakota (1996) for a good summary and references to articles discussing the maximum plausible relative risk aversion parameter.
1.6 The Model

The power utility function ($\gamma > 1$)

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma}$$  \hspace{1cm} (1)

The constant relative risk aversion is

$$CRRA = -\frac{u''(c)}{u'(c)}c = -c \frac{-\gamma c^{-\gamma-1}}{c^{-\gamma}} = \gamma$$  \hspace{1cm} (2)

We maximize

$$\sum_{t=0}^{\infty} \beta^t E_t [u (C_{t+1})]$$  \hspace{1cm} (3)

Stochastic Discount Factor (or synonymously, intertemporal marginal rate of substitution)

$$M_{t+1} = \beta \left( \frac{C_{t+1}}{C_t} \right)^{-\gamma} = \beta \left( \frac{u'(c_{t+1})}{u'(c_t)} \right)$$  \hspace{1cm} (4)

Log SDF

$$m_{t+1} = \ln \beta - \gamma \Delta c_{t+1}$$  \hspace{1cm} (5)

Expectation and variance

$$E_t [m_{t+1}] = \ln \beta - \gamma E_t [\Delta c_{t+1}]$$  \hspace{1cm} (6)

$$Var_t [m_{t+1}] = \gamma^2 Var_t [\Delta c_{t+1}]$$  \hspace{1cm} (7)

$$Std_t [m_{t+1}] = \gamma Std_t [\Delta c_{t+1}]$$  \hspace{1cm} (8)

We have

$$M_{t+1} = e^{m_{t+1}}$$  \hspace{1cm} (9)

The Euler equation for gross returns

$$u'(c_t) = \beta E_t \left[ (1 + R_{t+1}) u'(c_{t+1}) \right]$$

The left-hand side is the marginal utility cost of consuming one unit less at time $t$; the right-hand side is the discounted expected marginal utility benefit from investing that unit at time $t$, selling it at time $t + 1$, and consuming the proceeds.

Dividing by $u'(c_t)$ the Euler equation becomes

$$1 = E_t \left[ (1 + R_{t+1}) \beta \frac{u'(c_{t+1})}{u'(c_t)} \right] = E_t [M_{t+1} (1 + R_{t+1})]$$  \hspace{1cm} (10)

The expectation of a product is the product of the expectations plus their covariance

$$1 = E_t [M_{t+1}] E_t [1 + R_{t+1}] + Cov_t (M_{t+1}, 1 + R_{t+1})$$  \hspace{1cm} (11)
Dividing by $E_t [M_{t+1}]$ and rearranging

$$\frac{1}{E_t [M_{t+1}]} = E_t [1 + R_{t+1}] + \frac{\text{Cov}_t (M_{t+1}, 1 + R_{t+1})}{E_t [M_{t+1}]} \quad (12)$$

$$E_t [1 + R_{t+1}] = \frac{1}{E_t [M_{t+1}]} - \frac{\text{Cov}_t (M_{t+1}, 1 + R_{t+1})}{E_t [M_{t+1}]} \quad (13)$$

$$E_t [1 + R_{t+1}] = \frac{1 - \text{Cov}_t (M_{t+1}, 1 + R_{t+1})}{E_t [M_{t+1}]} \quad (14)$$

An asset that yields a high return in good times and low return in bad times, has a low covariance (i.e. very negative) with the stochastic discount factor. A low covariance with the stochastic discount factor will typically be associated with a high expected return for that asset, because this asset will give a high payoff when the when the marginal utility of payoff is low and vice versa. In the Capital Asset Pricing Model (CAPM) this responds to a stock with a high $\beta$, that investors require a relatively higher premium to hold.

If we assume that there exists a risk-free asset, this asset will have zero covariance with the (random variable) stochastic discount factor. This gives the following equation for the risk free asset:

$$1 + R_{f,t+1} = \frac{1}{E_t [M_{t+1}]} \quad (15)$$

Then we take logs of (10)

$$0 = \ln E_t [M_{t+1} (1 + R_{t+1})] \quad (16)$$

$$= \ln E_t \left( e^{\ln[M_{t+1}(1+R_{t+1})]} \right) \quad (17)$$

$$= \ln E_t \left( e^{m_{t+1}+r_{t+1}} \right) \quad (18)$$

To be able to simplify the equation further the trick is, following Hansen and Singleton (1983), to assume that the joint conditional distribution of asset returns and the stochastic discount factor is lognormal.\(^\text{12}\)

We remember from Sydsæter et al. (1999) \(^\text{13}\) that lognormality gives the following property

$$E [X] = \exp \left[ \mu + \frac{1}{2} \sigma^2 \right] \quad (19)$$

$$\ln E_t \left( e^{m_{t+1}+r_{t+1}} \right) = E_t \left[ \ln \left( e^{m_{t+1}+r_{t+1}} \right) \right] + \frac{1}{2} \text{Var}_t \left( \ln \left( e^{m_{t+1}+r_{t+1}} \right) \right) \quad (20)$$

\(^{12}\)The distributions of stock returns and consumption innovation with normality plots are shown in section II.

\(^{13}\)Formula 34.14, page 204 in the Norwegian version
Continuing the calculations using the properties of log normal distributions.

\[ 0 = \ln E_t [e^{m_{t+1} + r_{t+1}}] \]

\[ = \ln \left[ \exp \left\{ E_t [m_{t+1}] + E_t [r_{t+1}] + \frac{1}{2} \text{Var}_t (m_{t+1} + r_{t+1}) \right\} \right] \]

\[ = E_t [m_{t+1}] + E_t [r_{t+1}] + \frac{1}{2} \text{Var}_t (m_{t+1} + r_{t+1}) \]  

(21)

(22)

(23)

This gives

\[ E_t [r_{t+1}] + \frac{1}{2} \text{Var}_t (r_{t+1}) = -E_t [m_{t+1}] - \frac{1}{2} \text{Var}_t (m_{t+1}) - \text{Cov}_t (m_{t+1}, r_{t+1}) \]  

(24)

Taking logs of (15), the equation for the risk-free rate:

\[ r_{f,t+1} = -E_t [m_{t+1}] - \frac{1}{2} \text{Var}_t (m_{t+1}) \]  

(25)

Inserting for the risk free asset, we get excess returns

\[ E_t [r_{t+1}] - r_{f,t+1} + \frac{1}{2} \text{Var}_t (r_{t+1}) = -\text{Cov}_t (m_{t+1}, r_{t+1}) \]  

(26)

Inserting for the covariance, in terms of correlation and standard deviations.

\[ E_t [r_{t+1}] - r_{f,t+1} + \frac{1}{2} \text{Var}_t (r_{t+1}) = -\sigma_t (m_{t+1}) \sigma_t (r_{t+1}) \text{Corr}_t (m_{t+1}, r_{t+1}) \]  

(27)

Knowing that the maximum correlation is 1, gives the Hansen-Jagannathan bound,

\[ \left| \frac{E_t [r_{t+1}] - r_{f,t+1} + \frac{1}{2} \text{Var}_t (r_{t+1})}{\sigma_t (r_{t+1})} \right| < \sigma_t (m_{t+1}) \]  

\[ < \gamma \text{Std}_t [\Delta c_{t+1}] \]  

(28)

(29)

We arrive at the conclusion that there must be a relationship between the Sharpe ratio on the left hand side and the parameter of relative risk aversion multiplied with the standard deviation of log consumption innovation on the right hand side.
2 Section II - The Norwegian Equity Premium Puzzle

2.1 Calculations and Data Sets

This subsection includes technical details about the considerations I have made when preforming the calculations for this paper, and details on how the data sets are constructed. The reader can skip to the next subsection "Findings for Norway", if not interested in performing a similar study or for the purpose of checking the validity of the results in this paper.

The observed variables are stock, bill and bond returns.

I have used the following formula to correct for inflation

\[
R_{\text{real}} = \left[ \frac{1 + R_{\text{observed}}}{1 + R_{\text{risk-free}}} \right] - 1
\] (30)

The equity premium is calculated as:

\[
EP = R_{\text{stock}}^{\text{real}} - R_{\text{Bill}}^{\text{real}}
\] (31)

Because the model is specified in logarithms, I have transformed the data series for real stock returns, bill returns and equity premium to logarithms. Consumption is also transformed to logarithms following this formula:

\[
r_{\text{observed}} = \ln(1 + R_{\text{observed}})
\]

\[
ep = \ln(1 + EP)
\]

These operations leaves me with a time series from 1900 to 2008 for the real returns on; stocks, bonds, bills and consumption, and the logarithmic transformation of these four series’.

2.1.1 Arithmetic vs. Geometric Returns

Arithmetic mean

\[
\frac{1}{T} \sum_{t=1}^{T} (1 + r_t)
\] (34)

Geometric mean

\[
\left( \prod_{t=1}^{T} (1 + r_t) \right)^{1/T}
\] (35)

The arithmetic return exceeds the geometric return. If the stock returns (or consumption returns) are lognormally distributed the difference between the two measurements is one half of the variance of the returns. The arithmetic mean is the correct mean if we assume that the year to year stock
market returns are uncorrelated, and the mean terminal value is therefore the compounded arithmetic mean. In other words the arithmetic mean is the return you will expect for period \( t+1 \), when standing in period \( t \), basing your expectation on previous years returns. This arithmetic mean does not answer the question, if I invested 100 NOK in the a stock index fund in 1900, what would have been my average yearly return in 2000. The answer to this question is the geometric return, that gives the rate of which your investment have grown over the 100 years. Following this reasoning, Mehra and Prescott (2008) concludes that the arithmetic return is the correct measure. In the model in this paper (following Campbell (2003)) the term \( \frac{1}{2} \text{Var}_t (r_{t+1}) \) is added to the the geometric average to convert it to an arithmetic average. \( \frac{1}{2} \text{Var}_t (r_{t+1}) \) is called Jensen’s correction term, this assumes the returns has a lognormal distribution. Since returns not are lognormally distributed, a Sharpe ratio calculated with the use of logs will only be an estimate of the theoretically true Sharpe ratio. The table below shows the difference in the implied parameters of relative risk aversion based on log conversion data (following the model just presented), level data and when using the geometric mean as the equity premium.

Table 1: Sharpe ratios and implied RRA using levels and logs

<table>
<thead>
<tr>
<th>Period</th>
<th>Years</th>
<th>Level data</th>
<th>Using Log</th>
<th>Geo. mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full sample</td>
<td>1900-2008</td>
<td>5.34</td>
<td>6.27</td>
<td>3.43</td>
</tr>
<tr>
<td>After the oil</td>
<td>1970-2008</td>
<td>14.16</td>
<td>16.28</td>
<td>8.34</td>
</tr>
<tr>
<td>Before the oil</td>
<td>1900-1970</td>
<td>4.33</td>
<td>4.77</td>
<td>2.96</td>
</tr>
<tr>
<td>After WWII</td>
<td>1947-2008</td>
<td>13.01</td>
<td>15.20</td>
<td>8.59</td>
</tr>
<tr>
<td>Before WWII</td>
<td>1900-1940</td>
<td>2.17</td>
<td>2.61</td>
<td>0.86</td>
</tr>
<tr>
<td>WWI+Interwar period</td>
<td>1914-1940</td>
<td>0.99</td>
<td>1.47</td>
<td>-0.29</td>
</tr>
</tbody>
</table>

Note that if the data is transformed to logarithms, the arithmetic mean is close to the geometric mean.

\[
\ln \left[ \left( \prod_{t=1}^{T} (1 + r_t) \right)^{\frac{1}{T}} \right] = \frac{1}{T} \sum_{t=1}^{T} \ln(1 + r_t)
\]  

(36)

The average of a log transformed data series is equal to the logarithm of the geometric average of the original level data. The right-hand side of the Hansen-Jagannathan bound (28) is the standard deviation of log consumption, this standard deviation is estimated using the mean of log consumption innovation, or equivalent a return that is closer to the geometric return of the level data. If instead the relationship showed by equation (28) is derived
with the use levels, the right hand side will be the standard deviation of consumption i.e. not of log consumption. In that equation one is free to choose the standard deviation of either the arithmetic or geometric return depending on one’s assumptions. In this paper I use the arithmetic standard deviation for consumption innovation when using levels and the arithmetic mean when using logs. Note that also the denominator on the left hand side (standard deviation of excess returns) is different when using logs compared to levels. Levels are the standard deviation from the arithmetic mean, while logs are associated with the average closer to the geometric mean. The table above shows how the results differ, and that using levels will underestimate the RRA, or alternatively that using logarithms overestimate the RRA.

When quoting the equity risk premium, Mehra and Prescott (2008) makes it as large as possible by taking the arithmetic mean of stock returns minus the geometric mean of relative risk free rate. Mehra and Prescott (2008) provides a proof (Appendix A) of why the arithmetic mean return is the correct return to use. As the table above shows, using the realized equity premium eliminates the puzzle for most periods. It is debatable if the arithmetic mean is the correct mean to use, but I choose to follow the common practice of using arithmetic means in this paper, to ease comparisons.

2.1.2 Stock Return, Bonds, Bills and Inflation Data

I have used the data set from The World Equity Premium: A Smaller Puzzle (Dimson et al. (2006)), kindly provided by Mike Staunton. The data set includes total equity return, bond returns, bill returns and the inflation rate from 1900-2007. The equity returns are total returns, this is important since some indexes omit dividend payments. Dividend payments are assumed to be reinvested without subtracting taxes. The equity return series is subject to survival bias in the sense that an investor standing in 1900 did not know that the market would exist 107 years later. Russia and China is example of domestic equity markets where investors incurred total losses (Dimson et al. (2006)). Inflation rates is the consumer price index end of year rates, unofficial rates are substituted in for the World War 2 period (1940-1946). This is the description of the data collection given in Dimson et al. (2006) paper:

"... Equity returns for 1900–17 are derived from an equally weighted index based on all stocks listed in Statistisk Arbok and supplemented with those shares listed in Kierulf’s Handbook for which there was information on year-end prices and dividends. The index contained between 33–36 shares until the end of 1914, but this fell to 21 by the start of 1918. For the period 1918–72 we use an all-share index including industrial, banking and
whaling/shipping shares calculated by Statistics Norway. From 1973 we use a comprehensive index compiled by Thore Johnsen, switching in 1981 to the Oslo Stock Exchange indexes. We first use the Industrial index, switching in 1983 to the General Index and then, from 1996, to the All Share index. During 1900–92 Norwegian bond returns are based on Global Financial Data’s government bond yields. From 1993, the index is the Datastream government bond index with maturity of ten years. For the riskless rate, during 1900–71 we use the central bank discount rate, followed by money market rates until 1983. From 1984 to date we use the rate on Norwegian Treasury bills. Inflation is measured using the consumer price index published by Statistics Norway.

2.1.3 Consumption Data

The consumption data series from 1899 to 1961 is manually collected from the official “National Accounts 1865-1960” (NA) (SSB (1965a)), supplemented with numbers from ”Statistical Yearbook 1965” (SY) (SSB (1965b)). The consumption data for period 1899-1961 is available as current prices and fixed prices, hereunder as a Paasche price index or Laspeyres quantity index. The data from 1962-2007 is in fixed prices divided in ”Private nondurable and services consumption data” (CPIV) available from Statistics Norway. I received the data set from Inger Holm, Unit for Macroeconomics at Statistics Norway.

1899-1929 Consumption data for the period 1899-1929 is unfortunately not divided into nondurables and services. I use total private consumption in fixed 1910 prices from table 51, page 348 (NA) for this period.

1929 To calculate consumption innovation for the year 1929, I use total private consumption (not ”nondurables”) listed in table 51 page 348 (NA) in 1910 prices and convert it to 1938 prices using the price index in table 52 page 352 (NA). The result is the level of total private consumption in the year 1929 in 1938 prices, this is compared with the total private consumption in 1930 from table 32 (NA), to get total private consumption innovation in 1930.

1939-1946 The consumption data from period of World War II, 1939-1946 is missing. I have therefore made estimates for periods ending before and starting after the WWII period. For the whole period I have estimated consumption innovation based on GDP from Grytten (2004). The figure below shows how the correlation between real GDP per capita and real consumption innovation per capita for the period 1900-2007. The WWII
data is estimated with the OLS regression $\Delta c = \alpha + \beta \Delta GDP$. This gave an $R^2$ of 65%. $\alpha = -0.0047 (-1.55)$ and $\beta = 0.9184 (13.66)$. T-values in parenthesis.

![Graph of GDP per capita and consumption innovation per capita](image)

Table 2: The Equity Premium Puzzle

<table>
<thead>
<tr>
<th>Equity premium puzzle</th>
<th>1900-2008</th>
<th>inc. WWII</th>
<th>3.12</th>
<th>22.34</th>
<th>4.14</th>
<th>13.84</th>
<th>0.26</th>
<th>45.31</th>
<th>6.27</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ex. WWII</td>
<td>2.96</td>
<td>22.91</td>
<td>3.86</td>
<td>19.34</td>
<td>0.25</td>
<td>33.60</td>
<td>6.50</td>
</tr>
</tbody>
</table>

The table above shows that estimating consumption innovation for the WWII period affected the correlation between excess returns and consumption innovation and therefore the $RRA(1)$ estimate significantly. $RRA(2)$ is not effected that much.

1930-1960 Consumption data for the period 1939-1960 is based on constant 1938 prices and constant 1955 prices, both series from table 32, page 252-263 (NA). These are reported into the following categories at page 262-263 (NA): Durable consumers’ goods, Semidurable consumers’ goods, Nondurable consumers’ goods, Housing services, Other services and Correction items. The sum of Semidurable consumers’ goods, Nondurable consumers’ goods, and Other services is used for this period, excluding housing services and durables. These and more definitions are available on page 90-91 (NA):

- Consumers’ expenditure on goods and services is defined as the value of
goods and services bought by households, private associations and non-profit institutions. Consumption of own products by the agricultural population and some similar items are included.

- Durable consumers’ goods, as automobiles, furniture and clothing (but not dwellings) are considered consumed in the year purchased.

- Semidurable: Goods with an expected lifetime of less than 3 years. Included here are: clothing (except furs), footwear, incandescent lamps, brooms, brushes etc., tires and tubes for automobiles and bicycles, maintenance materials, like oil and tar paints for boats, toys, writing supplies, batteries.

- Nondurable: Goods losing their economic value by first use such as food, beverages and tobacco, fuel and lighting, cleaning materials, drugs, gasoline and oil, flowers, coffins.

- Housing services: Rent: Space rent, excluding expenditure on light fuel, but including indoor maintenance. Imputed rent of owner-occupied dwellings is estimated on basis of prevailing legal rents

1961 and 1962  Consumption innovation in 1961 and 1962 is calculated from table 85 page 64 (SY), the data series is based on total private consumption (not ”nondurables”) in fixed 1955 prices.

1962-2007  Private nondurable and services consumption data series from 1962-2007 is based the consumption series (CPIV). The CPIV series is in constant 2005 prices, the data series from 1962-1969 is based on the unrevised national accounts numbers.

More details on how all of these consumption time series is constructed is available on page 52-55 (NA). In order to get per capita consumption I have corrected for population growth using growth rates from the StatBank Norway, available at the Statistics Norway homepage.\textsuperscript{14}

\textsuperscript{14}I have not used the end of year population, not the yearly average.
Comparing Total Private Consumption Innovation with Nondurables and Services Consumption Innovation

Since the consumption data I use from the period 1900-1930, is not divided into nondurables and services, I check to see if using total consumption data introduces a significant bias by plotting (the graph over) the continuation of the total consumption series against the data series I use for nondurables and services consumption. Overlapping data for these two series is available for the periods from 1931-1939 and 1947-1961 (both plotted above). I find that nondurable consumption (standard deviation 2.41%) has a slightly lower standard deviation than total private consumption (standard deviation 2.49%). This is as expected since, nondurables is comprised of goods, e.g. food, that people are more reluctant to cut back on compared to total private consumption that includes durables such as investing in a new car. In the period from 1931-1939 the standard deviation for nondurables and services is 2.40% compared to 2.52% for total consumption. For 1947-1961 the standard deviation is 2.36% for nondurables vs. 2.39% for total consumption. This graphical comparison suggests that the standard deviation of total consumption for the period from 1900-1930 should be a good estimator of nondurables and services consumption. However, it is likely that the estimated standard deviation for this period is higher than it would have been using nondurable and services consumption. I have not corrected for the possible bias arising from using total consumption instead of nondurables and services consumption.
2.2 Findings for Norway 1900-2008

I now present the empirical finding for Norway 1900-2008. I have chosen to present the data divided in the following sub periods; After the oil (1970-2008), Before the oil (1900-1970), After WWII (1947-2008), Before WWII (1900-1940), and WWI + Interwar period (1914-1940). The intervals are beginning of year references. E.g. 1900-2008 includes the year 1900 but not 2008.

In the early periods in this data set the stock exchange was a relatively small part of total Gross Domestic Product (GDP). Campbell (2003) in a study of 15 countries found that small and/or concentrated markets, and markets dominated by companies with claims on national resources, had a lower than average equity premium. Campbell’s study suggests a possible bias to the observed equity premium in Norway before the 1970’s.

2.2.1 Consumption Innovation

Table 3: Norwegian Annual Real Growth Rate of Per Capita Consumption of Nondurables and Services

<table>
<thead>
<tr>
<th>Years</th>
<th>E(c)</th>
<th>σ(c)</th>
<th>Skew</th>
<th>Kurt</th>
<th>Min</th>
<th>Max</th>
<th>Autoc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-2008</td>
<td>1.88</td>
<td>4.14</td>
<td>-0.46</td>
<td>9.44</td>
<td>-17.00</td>
<td>20.35</td>
<td>-0.063</td>
</tr>
<tr>
<td>1970-2008</td>
<td>2.48</td>
<td>2.00</td>
<td>-0.20</td>
<td>0.43</td>
<td>-2.13</td>
<td>7.42</td>
<td>0.492</td>
</tr>
<tr>
<td>1900-1970</td>
<td>1.56</td>
<td>4.89</td>
<td>-0.26</td>
<td>6.76</td>
<td>-17.00</td>
<td>20.35</td>
<td>-0.124</td>
</tr>
<tr>
<td>1947-2008</td>
<td>2.46</td>
<td>1.98</td>
<td>0.07</td>
<td>0.68</td>
<td>-2.13</td>
<td>7.95</td>
<td>0.306</td>
</tr>
<tr>
<td>1900-1940</td>
<td>1.46</td>
<td>5.57</td>
<td>-0.03</td>
<td>4.41</td>
<td>-17.00</td>
<td>20.35</td>
<td>-0.219</td>
</tr>
<tr>
<td>1914-1940</td>
<td>1.73</td>
<td>6.80</td>
<td>-0.19</td>
<td>2.90</td>
<td>-17.00</td>
<td>20.35</td>
<td>-0.235</td>
</tr>
</tbody>
</table>

Growth of real per capita nondurables and services consumption shows that consumption innovation has been relatively stable since WWII with a standard deviation of 2.00%. The table below (Campbell (2003)) shows that consumption innovation in Norway after WWII is comparable to what is
The Campbell and Cochrane (1999) model assumes that log consumption innovation follows a random walk, however Table 3 shows that autocorrelation for 1900-2008 is slightly negative and that the autocorrelation is significant and positive after WWII. The utility function put forward in this paper suggests one single risk aversion parameter for a whole period, autocorrelation supports other specifications of the utility function.

Habit-formation asset pricing models have power utility functions where utility is derived from the difference between consumption and "habit". Habit is a slow-moving nonlinear average of past aggregate consumption. This makes the agent more risk averse when consumption is high or low relative to the past. Positive autocorrelation supports the Constantinides (1990) model of habit formation, where habit depends on the agents own consumption. Negative autocorrelation supports the "external" habit models Abel (1999), Abel (1990), and Campbell and Cochrane (1999) where habit depends on aggregate consumption that is unaffected by the agents decisions. The external habit models rely on the "keeping up with the Joneses", where the agents compares his own consumption relative to the "neighbors".

<table>
<thead>
<tr>
<th>Country</th>
<th>Sample period</th>
<th>$\Delta c$</th>
<th>$\sigma(\Delta c)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>1947.2–1998.4</td>
<td>1.964</td>
<td>1.073</td>
</tr>
<tr>
<td>AUL</td>
<td>1970.1–1999.1</td>
<td>2.099</td>
<td>2.056</td>
</tr>
<tr>
<td>CAN</td>
<td>1970.1–1999.2</td>
<td>2.082</td>
<td>1.971</td>
</tr>
<tr>
<td>GER</td>
<td>1978.4–1997.4</td>
<td>1.681</td>
<td>2.431</td>
</tr>
<tr>
<td>ITA</td>
<td>1971.2–1998.2</td>
<td>2.200</td>
<td>1.700</td>
</tr>
<tr>
<td>JAP</td>
<td>1970.2–1999.1</td>
<td>3.205</td>
<td>2.554</td>
</tr>
<tr>
<td>NTH</td>
<td>1977.2–1998.4</td>
<td>1.841</td>
<td>2.619</td>
</tr>
<tr>
<td>SWD</td>
<td>1970.1–1999.3</td>
<td>0.962</td>
<td>1.856</td>
</tr>
<tr>
<td>SWT</td>
<td>1982.2–1999.1</td>
<td>0.524</td>
<td>2.112</td>
</tr>
<tr>
<td>UK</td>
<td>1970.1–1999.2</td>
<td>2.203</td>
<td>2.507</td>
</tr>
<tr>
<td>USA</td>
<td>1970.1–1998.4</td>
<td>1.812</td>
<td>0.907</td>
</tr>
<tr>
<td>SWD</td>
<td>1920–1998</td>
<td>1.770</td>
<td>2.816</td>
</tr>
<tr>
<td>UK</td>
<td>1919–1998</td>
<td>1.551</td>
<td>2.886</td>
</tr>
<tr>
<td>USA</td>
<td>1891–1998</td>
<td>1.789</td>
<td>3.218</td>
</tr>
</tbody>
</table>

Source: Cambell (2003)
Azeredo (2007) and Mehra and Prescott (2008) shows that positive autocorrelation of consumption innovation will make the equity premium decline with increasing risk aversion, and negative autocorrelation will make the equity premium rise with the risk aversion parameter. The positive autocorrelation for the postwar periods imply that equity premium is even higher than with the assumption of i.i.d. consumption innovation.

Figure 2 clearly shows that consumption innovation per capita is less volatile after WWII, a brief overview over the economic conditions that led to this is explained in Section 3.
These are the normality plots for log consumption innovation from 1900-2008. When there are no ties in the data set the Shapiro-Wilk normality test is preferred to most other normality tests Shapiro et al. (1968). If the W statistic is significant, then the hypothesis that the respective distribution is normal should be rejected. The closer W is to 1, the more normal the sample is. The Shapiro-Wilk normality test rejects the null hypothesis that the data is normally distributed, the W statistic is 0.82 and significant.

### 2.2.2 Geometric "Realized" Returns

Table 4: Realized Returns for Stocks, Bonds and Bills

<table>
<thead>
<tr>
<th>Years</th>
<th>Stock</th>
<th>Bond</th>
<th>Bill</th>
<th>EP bond</th>
<th>EP bill</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-2008</td>
<td>4.55</td>
<td>1.62</td>
<td>1.17</td>
<td>1.92</td>
<td>3.17</td>
</tr>
<tr>
<td>1970-2008</td>
<td>8.23</td>
<td>3.05</td>
<td>2.63</td>
<td>5.13</td>
<td>5.50</td>
</tr>
<tr>
<td>1900-1970</td>
<td>2.60</td>
<td>0.85</td>
<td>0.38</td>
<td>0.24</td>
<td>1.92</td>
</tr>
<tr>
<td>1947-2008</td>
<td>5.61</td>
<td>1.49</td>
<td>1.01</td>
<td>4.03</td>
<td>4.56</td>
</tr>
<tr>
<td>1900-1940</td>
<td>3.48</td>
<td>1.43</td>
<td>2.39</td>
<td>-0.40</td>
<td>0.69</td>
</tr>
<tr>
<td>1914-1940</td>
<td>1.96</td>
<td>1.54</td>
<td>1.70</td>
<td>-3.13</td>
<td>-0.35</td>
</tr>
</tbody>
</table>

This table shows that if you invested $1 in the stock, bond and bill market in 1900 and waited until January 2008 it would, adjusted for inflation, have
grown to: $ 121.96 (stocks), $ 5.66 (bonds) and $ 3.50 (bills). This gives annual returns of 4.55%, 1.62% and 1.17%, respectively.

The realized equity premium over bills (bonds) is calculated as the geometric mean of the annual excess returns, it is not the mean premium of stocks minus the mean premium for bills (bonds). The realized equity premium over bills is 3.17% for the period (1900-2008), this is a lot smaller than the equity premium of 5.62%, I used to calculate the implied parameter of relative risk aversion for the same period or the arithmetic equity premium of the level series of 5.90%.

2.2.3 Real Annual Return in the Norwegian Stock Market.

The real annual return in the Norwegian stock market has become much more volatile after the 1970’s.

The table 5 shows the increased volatility in pre and post 1970 as an increase in standard deviation from 13.18 to 40.33. Table 9, "The Real Risk Premium over Bills for Different Periods", shows that this increase in volatility is matched by an increase in the equity risk premium from 5.90% to 11.36%. The last column in table 5 shows the correlation between real stock returns and log consumption. Correlation has decreased after 1970.
Table 5: The Real Total Return in the Norwegian Stock Market for Different Periods.

<table>
<thead>
<tr>
<th>Years</th>
<th>Mean</th>
<th>Std.dev</th>
<th>Skew</th>
<th>Kurt</th>
<th>Min</th>
<th>Max</th>
<th>(\rho(r, \Delta c))</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-2008</td>
<td>7.33</td>
<td>26.67</td>
<td>2.34</td>
<td>11.66</td>
<td>-50.56</td>
<td>167.89</td>
<td>15.00</td>
</tr>
<tr>
<td>1970-2008</td>
<td>14.32</td>
<td>40.33</td>
<td>1.54</td>
<td>3.99</td>
<td>-50.56</td>
<td>167.89</td>
<td>18.22</td>
</tr>
<tr>
<td>1900-1970</td>
<td>3.53</td>
<td>13.18</td>
<td>-0.70</td>
<td>6.76</td>
<td>-39.30</td>
<td>29.56</td>
<td>19.71</td>
</tr>
<tr>
<td>1947-2008</td>
<td>9.69</td>
<td>33.09</td>
<td>2.07</td>
<td>7.46</td>
<td>-50.56</td>
<td>167.89</td>
<td>18.12</td>
</tr>
<tr>
<td>1900-1940</td>
<td>4.64</td>
<td>14.56</td>
<td>-0.98</td>
<td>2.42</td>
<td>-39.30</td>
<td>29.56</td>
<td>28.59</td>
</tr>
<tr>
<td>1914-1940</td>
<td>3.60</td>
<td>17.28</td>
<td>-0.82</td>
<td>0.96</td>
<td>-39.30</td>
<td>29.56</td>
<td>30.73</td>
</tr>
</tbody>
</table>

from about 27% to 18%.
The Shapiro-Wilk normality test rejects the null hypothesis that the data is normally distributed, the W statistic is 0.95 and significant. We see that equity returns are fat tailed, with a skew of 0.38. According to the W statistic asset returns are more normally distributed than consumption innovation.

### 2.2.4 Real Annual Return on Bills

![Fig. 4. Real annual return on a relatively riskless security, 1900-2007 (percent)](Fig. 4. Real annual return on a relatively riskless security, 1900-2007 (percent))

<table>
<thead>
<tr>
<th>Real total return on bills</th>
<th>Years</th>
<th>Mean</th>
<th>Std.dev</th>
<th>Skew</th>
<th>Kurt</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1900-2008</td>
<td>1.43</td>
<td>7.24</td>
<td>0.23</td>
<td>4.25</td>
<td>-25.36</td>
<td>31.19</td>
</tr>
<tr>
<td></td>
<td>1970-2008</td>
<td>2.69</td>
<td>3.58</td>
<td>-0.56</td>
<td>0.92</td>
<td>-8.29</td>
<td>9.65</td>
</tr>
<tr>
<td></td>
<td>1900-1970</td>
<td>0.74</td>
<td>8.52</td>
<td>0.44</td>
<td>2.97</td>
<td>-25.36</td>
<td>31.19</td>
</tr>
<tr>
<td></td>
<td>1947-2008</td>
<td>1.10</td>
<td>4.09</td>
<td>-0.54</td>
<td>0.85</td>
<td>-10.74</td>
<td>9.65</td>
</tr>
<tr>
<td></td>
<td>1900-1940</td>
<td>2.90</td>
<td>10.13</td>
<td>0.02</td>
<td>1.73</td>
<td>-25.36</td>
<td>31.19</td>
</tr>
<tr>
<td></td>
<td>1914-1940</td>
<td>2.45</td>
<td>12.34</td>
<td>0.12</td>
<td>0.34</td>
<td>-25.36</td>
<td>31.19</td>
</tr>
</tbody>
</table>

The real annual return on bills show similarity with the real annual return on bonds (next page). Before WWII the mean return on bills and bonds is the same, the standard deviation is higher for bonds. For the other periods presented in the table 6 bills have both lower mean and standard deviation compared to bonds. The period before WWII is the period where an investment in bills would have yielded the highest return compared to investing in bills in any other period.

(46)
2.2.5 Real Annual Return on Bonds

The real annual return on bonds is interesting to compare against the return on stocks. Bonds were very volatile in the WWI period and until 1940. The the returns looks smooth until the roaring 1980’s.

Table 7: The Real Total Return of Bonds for Different Periods.

<table>
<thead>
<tr>
<th>Years</th>
<th>Mean</th>
<th>Std.dev</th>
<th>Skew</th>
<th>Kurt</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-2008</td>
<td>2.36</td>
<td>12.25</td>
<td>0.64</td>
<td>6.78</td>
<td>-48.02</td>
<td>62.14</td>
</tr>
<tr>
<td>1970-2008</td>
<td>3.47</td>
<td>9.35</td>
<td>0.38</td>
<td>0.50</td>
<td>-15.35</td>
<td>30.25</td>
</tr>
<tr>
<td>1900-1970</td>
<td>1.76</td>
<td>13.53</td>
<td>0.74</td>
<td>7.02</td>
<td>-48.02</td>
<td>62.14</td>
</tr>
<tr>
<td>1947-2008</td>
<td>1.82</td>
<td>8.31</td>
<td>0.59</td>
<td>1.27</td>
<td>-15.35</td>
<td>30.25</td>
</tr>
<tr>
<td>1900-1940</td>
<td>2.90</td>
<td>17.16</td>
<td>0.47</td>
<td>3.81</td>
<td>-48.02</td>
<td>62.14</td>
</tr>
<tr>
<td>1914-1940</td>
<td>3.68</td>
<td>20.62</td>
<td>0.31</td>
<td>2.11</td>
<td>-48.02</td>
<td>62.14</td>
</tr>
</tbody>
</table>

The table shows that bonds yielded a higher return than stocks in the WWI + interwar period (1914-1940), stocks yielded higher in all other of the presented periods. However, in the WWI + interwar period, where bonds yielded an higher return, bonds also had a higher standard deviation compared to stocks. Bonds had an higher standard deviation than stocks in the following periods; Before the oil (1900-1970), Before WWI (1900-1940) and the WWI + interwar period (1914-1940). In relation to the Common
Stock Theory (CST) it is interesting to note that for 70 years (1900-1970) stocks yield both higher return and a lower standard deviation. The mean for stocks was 3.53% compared to 1.76% for bonds, and the standard deviation was 13.18 for stocks compared to 13.53 for bonds. This is also related to shortcoming of Rietz (1998) ”Peso effect” argument, namely that bills, bonds and stocks are subject to many of the same macroeconomic shocks

2.2.6 The Equity Risk Premium over Bonds

The table of the real risk premium for stocks over bonds shows a negative equity premium for the WWI+interwar period (1914-1940), the other periods shows a positive equity premium. The results are similar to those for bills.

Table 8: The Real Risk Premium over Bonds for Different Periods.

<table>
<thead>
<tr>
<th>Years</th>
<th>Mean</th>
<th>Std.dev</th>
<th>Skew</th>
<th>Kurt</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-2008</td>
<td>4.96</td>
<td>26.98</td>
<td>2.50</td>
<td>14.73</td>
<td>-71.59</td>
<td>175.52</td>
</tr>
<tr>
<td>1970-2008</td>
<td>10.85</td>
<td>39.93</td>
<td>2.00</td>
<td>6.37</td>
<td>-40.54</td>
<td>175.52</td>
</tr>
<tr>
<td>1900-1970</td>
<td>1.77</td>
<td>15.11</td>
<td>-1.40</td>
<td>6.80</td>
<td>-71.59</td>
<td>35.54</td>
</tr>
<tr>
<td>1947-2008</td>
<td>7.86</td>
<td>32.56</td>
<td>2.50</td>
<td>10.69</td>
<td>-40.54</td>
<td>175.52</td>
</tr>
<tr>
<td>1900-1940</td>
<td>1.74</td>
<td>17.15</td>
<td>-1.71</td>
<td>7.34</td>
<td>-71.59</td>
<td>35.54</td>
</tr>
<tr>
<td>1914-1940</td>
<td>-0.08</td>
<td>20.35</td>
<td>-1.38</td>
<td>4.76</td>
<td>-71.59</td>
<td>35.54</td>
</tr>
<tr>
<td>1947-1970</td>
<td>2.23</td>
<td>11.32</td>
<td>-0.30</td>
<td>-0.18</td>
<td>-22.75</td>
<td>25.32</td>
</tr>
</tbody>
</table>
The histogram above shows the annual realized risk premium of stocks over bonds. It is very similar to the next histogram, showing the risk premium of stocks over bills.

2.3 The Equity Risk Premium over Bills

In this subsection I present the equity premium in detail for different holding periods. The first figure is for 1-year holding periods, the next figures are 20, 10, 5, and 3 year holding periods. The histogram that follows the last figure for the 3 year holding period, gives an overview over the maximum
and minimum returns for the different holding periods.

Figure 7 shows the annual risk premium for the 108 year period. 63 of these (58%) show a positive risk premium, where most of the negative equity premiums are clustered together.

To test the importance of a long investment horizon I deleted all the annual realized equity premium following a year with a negative equity premium. This reduced the geometric average from a positive 3.19% to negative 0.63%. Another experiment was to delete all the years with excess returns over 25% to see the importance of being part of the really good years. 13 (12%) of the years had an excess return of more than 25%, and when I removed these years the geometric equity premium fell to negative 1.94%. 8 years had an negative excess return of -25% or more. If all the above +25% returns were dropped the geometric average equity risk premium for the whole period was 1.43%.
Table 9: The Real Risk Premium over Bills for Different Periods.

<table>
<thead>
<tr>
<th>Years</th>
<th>Mean</th>
<th>Std.dev</th>
<th>Skew</th>
<th>Kurt</th>
<th>Min</th>
<th>Max</th>
<th>( \rho(ep, \Delta c) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-2008</td>
<td>5.90</td>
<td>26.30</td>
<td>2.33</td>
<td>11.54</td>
<td>-48.78</td>
<td>163.06</td>
<td>16.32</td>
</tr>
<tr>
<td>1970-2008</td>
<td>11.36</td>
<td>40.07</td>
<td>1.54</td>
<td>3.94</td>
<td>-48.78</td>
<td>163.06</td>
<td>19.32</td>
</tr>
<tr>
<td>1900-1970</td>
<td>2.76</td>
<td>12.95</td>
<td>-0.28</td>
<td>1.54</td>
<td>-40.64</td>
<td>36.46</td>
<td>23.47</td>
</tr>
<tr>
<td>1947-2008</td>
<td>8.59</td>
<td>32.53</td>
<td>2.01</td>
<td>7.42</td>
<td>-48.78</td>
<td>163.06</td>
<td>16.40</td>
</tr>
<tr>
<td>1900-1940</td>
<td>1.73</td>
<td>14.14</td>
<td>-0.26</td>
<td>1.88</td>
<td>-40.64</td>
<td>36.46</td>
<td>40.01</td>
</tr>
<tr>
<td>1914-1940</td>
<td>1.16</td>
<td>16.89</td>
<td>-0.19</td>
<td>0.65</td>
<td>-40.64</td>
<td>36.46</td>
<td>40.95</td>
</tr>
<tr>
<td>1947-1970</td>
<td>4.46</td>
<td>10.83</td>
<td>-0.15</td>
<td>0.16</td>
<td>-20.44</td>
<td>26.38</td>
<td>9.49</td>
</tr>
</tbody>
</table>

Fig. 8. 20 year’s ending realized risk premium, 1900-2007 (percent)

The 20 years ending realized risk premium shows that there has been several periods of 20 years where the return in the money market has been higher than in the stock market. For the postwar period this is surprising since all the 20 year periods in the US showed a positive risk premium (Associates (2001)). A total of 24% of the 20 year holding periods yielded
a negative risk premium with an average negative return of 40%.

The 10 years ending realized risk premium shows that for the postwar period, investors have received mostly positive equity risk premiums. It is also clear that the upside is larger than the down side.

Figure 10 shows 5 years ending realized risk premiums. The upside
dominates the down side.

Figure 11 shows that a 3 years ending holding period is considerable more risky than a 5, 10 and 20 year period. The downside is 23% of your initial investment.

The histogram above summarizes the figures 7-10 for maximum and minimum real annual equity premia for the different holding periods. It is
similar to the histogram below showing the real returns for holding periods for stocks.

It is clear that the maximum downside from investing in the stock market falls with the investment horizon. The histogram also shows that the longer you hold an investment, the less chance of experiencing a negative return. If you bought a portfolio of stocks at the peak of the market you could have lost 51% in one year, however you could expect to reduce your loss to 23%, simply by holding the portfolio two more years. This suggests that the value of being able to hold your portfolio through downturns is very decisive.

2.3.1 The Implied Parameter on Relative Risk Aversion

If we follow the conclusions from Mehra and Prescott (1985) that a relative risk aversion (RRA) parameter above 10 is unreasonable, table 10 shows that the Equity Risk Premium Puzzle is evident in Norway for some of the periods.

Remember that the averages in the table below are the arithmetic means of log equity returns. The calculations here are done according to the model specified. Sharpe is $\left[ \mu(ep) + \frac{1}{2} \sigma^2(ep) \right] / \sigma(ep)$, i.e. the Sharpe ratio for excess returns. $\rho(ep, \Delta c)$ is the correlation between excess returns and consumption innovation. RRA(1) is the implied coefficient on relative risk aversion with the observed correlation. RRA (1) is calculated as "Sharpe" divided by $\sigma(\Delta c) \times \rho(ep, \Delta c)$. RRA(2) is the implied coefficient on relative risk aversion setting the correlation $\rho(ep, \Delta c)$ equal to 1.
Table 10: The Equity Premium Puzzle

<table>
<thead>
<tr>
<th>Years</th>
<th>$\mu(ep)$</th>
<th>$\sigma(ep)$</th>
<th>$\sigma(\Delta c)$</th>
<th>$\rho(ep, \Delta c)$</th>
<th>Sharpe</th>
<th>RRA(1)</th>
<th>RRA(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-2008</td>
<td>3.12</td>
<td>22.34</td>
<td>4.14</td>
<td>16.32</td>
<td>0.25</td>
<td>37.21</td>
<td>6.07</td>
</tr>
<tr>
<td>1970-2008</td>
<td>5.36</td>
<td>32.96</td>
<td>2.00</td>
<td>19.32</td>
<td>0.33</td>
<td>84.62</td>
<td>16.35</td>
</tr>
<tr>
<td>1900-1970</td>
<td>1.90</td>
<td>13.27</td>
<td>4.89</td>
<td>23.47</td>
<td>0.21</td>
<td>18.27</td>
<td>4.29</td>
</tr>
<tr>
<td>1947-2008</td>
<td>4.46</td>
<td>26.84</td>
<td>1.98</td>
<td>16.40</td>
<td>0.30</td>
<td>92.59</td>
<td>15.18</td>
</tr>
<tr>
<td>1900-1940</td>
<td>0.69</td>
<td>14.77</td>
<td>5.57</td>
<td>40.01</td>
<td>0.12</td>
<td>5.41</td>
<td>2.16</td>
</tr>
<tr>
<td>1914-1940</td>
<td>-0.35</td>
<td>17.71</td>
<td>6.80</td>
<td>40.95</td>
<td>0.07</td>
<td>2.47</td>
<td>1.01</td>
</tr>
<tr>
<td>1947-1970</td>
<td>2.97</td>
<td>10.55</td>
<td>1.94</td>
<td>9.49</td>
<td>0.33</td>
<td>181.81</td>
<td>17.25</td>
</tr>
</tbody>
</table>

The high implied coefficients on relative risk aversion arises from three possible sources, too high (volatility adjusted) equity premium, too smooth consumption or too low correlation between excess returns and consumption. The RRA(2) column indicates how much of the high RRA that arises from low correlation between excess returns and consumption innovation. This correlation is sensitive to measurement errors, and RRA(2) indicates how robust the puzzle is to such errors (Campbell (2003)). RRA(2) indicates that much of the high RRA parameter can be explained by low correlation between excess returns and consumption innovation. RRA(2) is the risk aversion given in Mehra and Prescott (1985), implicit assuming correlation to 1.

The equity premium puzzle is an long horizon puzzle. It is not a puzzle that shorter time intervals imply unreasonable risk parameters of relative risk aversion. For the later periods it looks like Norwegian investors have become more risk averse. Before WWII, Norwegian economic conditions have led to relatively high volatility for consumption, and a relatively low equity premium, eliminating the equity premium puzzle for pre WWII period, but not for the full period and indeed not for the period after WWII. The estimate for Norway based on the longest time horizon that has been conducted for Norway, shows that the equity premium is not a puzzle in Norway if we assume perfect correlation between excess returns and consumption innovation. The parameter of relative risk aversion for the whole period (1900-2008) is 6.07. In other words, a more volatile consumption could have eliminated the equity premium puzzle in Norway. 6.07 is according to Mehra and Prescott not unreasonably high but, if we accept this high risk aversion parameter it implies an unreasonable time preference parameter or a higher than observed risk free rate. This is the risk free rate puzzle.
2.4 The Risk Free Rate Puzzle

Weil (1989) points out that it is not plausible that the agents really are as risk averse as the model predicts, given the low risk free rate. Risk averse agents dislike changes in the rate of consumption innovation over states, and they want consumption to be smooth over time. This means that they should not value consumption growth very highly. However, agents in the data set that Mehra and Prescott used, saved enough (in risk free bills) to have an average per capita consumption growth of 2%, even though the average real interest rate was very low. Norway had almost the same average consumption growth and real return on bills as Mehra and Prescott (1985) found in their paper. This is the risk free rate puzzle that asks why do people save at the low observed risk free rates, given the implied high risk parameter.

We remember equation (25) for the risk free asset. This should still hold.

\[ r_{f,t+1} = -E_t [m_{t+1}] - \frac{1}{2} \text{Var}_t (m_{t+1}) \]

Substituting for \( E_t [m_{t+1}] \) and \( \text{Var}_t (m_{t+1}) \) in terms of consumption innovation (6)

\[ r_{f,t+1} = -\ln \beta + \gamma E_t [\Delta c_{t+1}] - \frac{1}{2} \gamma^2 \text{Var}_t [\Delta c_{t+1}] \quad (56) \]

The last term \( \frac{1}{2} \gamma^2 \text{Var}_t [\Delta c_{t+1}] \) captures precautionary savings (Campbell (2003)). Precautionary savings captures that risk averse agents have a precautionary desire to save or borrow less when faced with an uncertain income stream. In the table below \( \mu (r_f) \) is the geometric mean of the risk free rate (bills), following the calculations performed by Campbell (2003).

The table below shows the implied time preference parameter (TPP) "it can be interpreted as the riskfree real interest rate that would prevail if consumption were known to be constant forever at its current level, with no growth and no volatility" Campbell (2003). A negative time preference parameter indicates that the agents value consumption in the future higher than consumption today! The risk free rate puzzle asks if this is plausible.

---

15.1.6% geometric mean bill rate in Norway compared to 1% (Mehra and Prescott (1985), correctly adjusted by Kocherlakota (1996)). Consumption innovation about 2% in both cases.
Table 11: The Risk Free Rate Puzzle

<table>
<thead>
<tr>
<th>Years</th>
<th>$\mu(r_f)$</th>
<th>$\mu(\Delta c)$</th>
<th>$\sigma(\Delta c)$</th>
<th>RRA(1)</th>
<th>TPP(1)</th>
<th>RRA(2)</th>
<th>TPP(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1900-08</td>
<td>1.17</td>
<td>1.88</td>
<td>4.14</td>
<td>37.21</td>
<td>49.73</td>
<td>6.07</td>
<td>-7.10</td>
</tr>
<tr>
<td>1970-08</td>
<td>2.63</td>
<td>2.48</td>
<td>2.00</td>
<td>84.62</td>
<td>-63.41</td>
<td>16.35</td>
<td>-32.50</td>
</tr>
<tr>
<td>1900-70</td>
<td>0.38</td>
<td>1.56</td>
<td>4.89</td>
<td>18.27</td>
<td>11.87</td>
<td>4.29</td>
<td>-4.10</td>
</tr>
<tr>
<td>1947-08</td>
<td>1.01</td>
<td>2.46</td>
<td>1.98</td>
<td>92.59</td>
<td>-58.91</td>
<td>15.18</td>
<td>-31.79</td>
</tr>
<tr>
<td>1900-40</td>
<td>2.39</td>
<td>1.46</td>
<td>5.57</td>
<td>5.41</td>
<td>-0.96</td>
<td>2.16</td>
<td>-0.04</td>
</tr>
<tr>
<td>1914-40</td>
<td>1.70</td>
<td>1.73</td>
<td>6.80</td>
<td>2.47</td>
<td>-1.17</td>
<td>1.01</td>
<td>0.18</td>
</tr>
<tr>
<td>1947-70</td>
<td>-1.61</td>
<td>2.43</td>
<td>1.94</td>
<td>181.81</td>
<td>176.74</td>
<td>17.25</td>
<td>-37.90</td>
</tr>
</tbody>
</table>

3 Section III- Why is the Risk Premium so High?

The risk premium with an arithmetic mean of 7.33% for the whole period, yielding an equity risk premium of 5.90%, is a high number for a period with two world wars and several depressions. Are people really that stock market averse? From 1970 until 2008 the equity risk premium has been 11.63% and from 1900 until 2008 the risk premium has been 5.90%. It looks like the risk premium is increasing. Is this because investors systematically under estimates the equity premium?

"The Norwegian central bank published a Staff Memo 06-2007 (Norges-Bank (2006)) where they sum up their long term predictions of the markets. They use this as the basis for the investment strategy of the fund. The fund concludes (on page 92) that it expects a 2.5% equity risk premium with a standard deviation of 1.5 in the US. This means that they conclude that the equity risk premium will be significantly different from historic returns. They site the Fama and Kenneth (2002) and Claus and Thomas (2001) approaches, the good luck and survivorship bias story, that find that the realized historic equity risk premium must have been significantly higher than the expected equity risk premium. They also refer to Mehra and Prescott’s consumption-based capital asset pricing model, concluding that the expected ERP could be below 1% given the historical consumption variability and reasonable risk aversion parameters." (Baatvik (2007))

Rietz (1988) have argued that a ”peso effect” can explain the high risk premium and why investors rationally underestimate the risk premium. Rietz argues that risk averse equity investors would demand a high return to be compensated for the extreme losses of an unlikely, but severe market crash. The high observed equity premium is coherent with the equity investors being compensated for that risk. The other way around one could argue that the equity premium should be lower because of serendipity. This could be
technological advancements or the discovery of natural resources such as oil. This paper finds that the equity premium in Norway has been significantly higher in the time of the oil. The discovery of oil is not the only determinant of the equity premium, but an interesting point for further research is whether the high equity premium can be explained by the unexpected high growth in oil prices. This underlines the importance of looking at the equity premium for longer periods.

3.1 History of Norwegian Economy 1900-1930

The time series for the stock, bill and bond market in this paper starts in 1900, and I would argue that the stock market was functional at that time. Christiania Stock Exchange was opened on March 1, 1881 with 22 monthly quoted stock, and was updated to weekly quotations in 1908 Ramm (1969). Already from 1890 several of Christiania stock brokers published lists of stocks and in 1897 these were merged into one common list. In 1913 a total of 82 companies was quoted, and Keilhau (1927) made an index from 1914 to 1926.

In the 1890’s there was a boom in the Norwegian stock and estate market, and according to Krohg (1921) the exclusive Grand Restaurant in Christiania (now Oslo) was in the year 1898 turned into a casino for stock brokers where the waiters ran back and forth with the newest stock quotes. The year after in 1899 the bubble burst, leading to a financial crisis where 13 banks went out of business. In 1905 the market had recovered from the crisis and the willingness to invest was back. The real equity premium for this period (1900-1930) was only 0,35% and a closer look at the economic conditions supports this finding.

The second bubble in the stock market was during the WWI followed by four years of declining stock values. The period from 1905 to 1920 was never the less viewed as a good period for the Norwegian economy (Klovland (2006)). From 1920 to 1933 the Norwegian economy experienced three depressions, after WWI, the par value crisis and the great depression. The depression after WWI was international, but especially severe in Norway (Grytten (1994)). The par value crisis was a led by Nicolai Rygg when he was appointed chairman of the central bank in 1920. Rygg was given the task to reverse the value of the Norwegian currency back to it pre WWI gold value. This led to a period with tight monetary policy and high interest rates which gave low economic growth. In 1923, deflation led to a bank crisis, and later to appreciation of the NOK to par value in 1928. The great depression did not hit Norway as hard as many of the other European countries and in 1936 the stock index was back to the highest level of the WWI boom. The investors in the Norwegian stock market had experienced almost one third of a century without being rewarded for the excess risk of investing in stock instead of putting money in the bank. Is it reasonable to expect that an
As figure 11 shows the money market (bills) gave a higher average payoff than stocks from the period 1900 until 1935, but after 1935 the stock market has provided a real equity premium of 8.62% over bills, and 7.31% over bonds. It is not reasonable to assume that the investors in 1935 could predict or expect the high equity premiums that we have observed after 1935. And it is reasonable to assume the a large part of the excess return following this period was due to the "peso effect" that investors was rewarded for taking the risk of a new depression.

3.2 Homogeneous Agents

"It is not reasonable to assume that agents are homogeneous, they are clearly not. However, what is important is that the observed equity premia is a reflection of the populations risk aversion and not the reflection of the risk aversion of a group of agents. The market can be divided into price setters and price takers, and in order for the equilibrium price to change, the preferences of the price setters must change. The equity risk premium should change only if the market actors that are robust to the high volatility of the stock market are price setters. These "long term" investors must be robust to fluctuations in the investment values, an attribute associated with high wealth.

The risk premium for bonds and stocks is not only set by the demand, but also the availability and supply. There is no doubt that there has been changes in the number of supplied bonds and stocks in the last century and some interesting behavioral patterns for retirement investment decisions.
have been made, suggesting that normal investors are very sensitive to the number of investment options available when deciding between bonds and stocks. One such theory, the $\frac{1}{n}$ heuristic theory (Huberman and Jiang (2004)), shows how difficult it is to measure real individual changes in preferences due to unpredictable changes in behavior. However, the investment organizations should both be able to hold the extra volatility from investing in stocks and effect the equilibrium prices in the market. Constantinides and Duffie (1996) addresses the question of who holds stocks and why. They find that investors are reluctant to invest in stocks because the risks of losing their investments is likely to be correlated with idiosyncratic labor market risks, making the representative agent look more risk averse than the individuals. However, wealthy investors and investments funds should be robust to these risks.

There is also a psychological reason that suggests that even rich investors should not be robust to fluctuations. Benartzi and Thaler (1995) suggests that investors have myopic loss aversion. That is the investors are both more sensitive to losses that gains (loss aversion) and that investors’ do mental accounting (Thaler (1985)). Mental accounting refers to the implicit methods individuals use to evaluate the outcome of their investments. Investors are therefore not robust to fluctuations as they have a psychological cost of frequent mental evaluations of their investment. If the average return of two investments is the same but have different volatility, myopic loss aversion suggests that the value \textit{ex ante} would be different because losses are weighted more than gains. Benartzi and Thaler suggests that myopic risk aversion applies to explain why even pension funds have a high allocation of bonds and treasury bills, even with their very long time horizon. The manager is afraid of losing his job and knows that the Board of Directors are influenced by myopic loss aversion. Acting in his own interest (an agency problem) he over diversifies in bonds. Lakonishok et al. (1992) did a study of the money management industry to investigate the relation between behavior structure and performance between different funds. Particularly interesting is their comparison of mutual funds and pension funds. Lakonishok, Shleifer and Vishny (LSV) pointed out the different agency costs in the funds that arise because investments in mutual funds are decided by individuals who allocate their own wealth, and investments in pension funds are governed by corporate treasurers. In agreement with Benartzi and Thaler (1995) theory, LSV finds empirical evidence of agency cost that distorts pension fund managers incentives. They find that pensions funds that invest in equity underperform by 1.5% per year. The study of LSV explain why agency cost can explain a part of the high equity premium. LSV argues that the agency cost arises from the pressure of corporate treasures, and that for the reasons argued by Benartzi and Thaler(1995) even pension funds do not have long term investment horizons. We see from the histogram (44) that a longer investment horizon reduces the downside of investing in stocks, and even
if the institutions show myopic behavior, short investment horizons could partly explain the high observed equity premium.

If we step back for a moment and assume that there is a group of the "rich" investors that follow a long term investment strategy, is it plausible that this group is large enough to change the equity risk premium?" Baatvik (2007)

3.3 Who Sets the Price in the Market?

"Contrary to intuition it is not necessary the case that it is the investment institutions that set the market equilibrium price. Lakonishok et al. (1992) in their study of the effect of institutional trading on stock prices finds a big diversity of trading styles and little evidence of herding. They suggest that the effects of institutional investors cancels out, however the high observed equity premium should lead to higher attractiveness of stocks, driving the equity premium down. Assuming that effectual demand created by the high equity premium should change the risk premium for stocks and bonds, the price should adjust by a price setting mechanism that has many similarities to that of auctions. In the market for stocks and bonds there will always be sellers attempting to sell above market price. Focusing on the demand side, the price is therefore set by the investors willing to pay the most (Smith (1985)). Malmendier and Lee (2006) found this behavior in a study of price setting behavior on the online auction web page Ebay. A particular board game, "Cash Flow 101" is available for sale from several sellers, and you have the option of bidding and participating in the auction or "buy it now" from one of the retail sellers. The auction price starts much lower than the "buy it now" price, even though the shipping costs and quality is the same (or better when choosing the buy it now option). Malmendier found that in 72% of the auctions the price of this board game ended above the "buy it now" price! Looking at the participants in the auction they found that as the price increased above the "buy it now" price only a very few participants (11%) kept bidding. The point to make here is that the price or risk premium in the context of investment not necessarily reflect the mainstream market behavior but rather the preferences or irrationality of a few market participants. It is not very conceivable that small individual investors set the price, but it is likely that the small investors have lagged market information compared to the investment institutions and that the final equilibrium price therefore not reflects the true price available to some groups in the market. All these reason suggest the risk aversion of investors not would be reflected in the equity risk premium.

A topic for further research is to find empirical support for the theory that suggests that investments that require larger initial investment (e.g. real estate), and therefore only is open to a rich investors, has a higher risk premium. The higher premium represents that it is fewer investors
that are able to consider these investments and the effectual demand is therefore lower. The conclusion is that the agents in the market do not bid for the same type of investments, because some agents do not have the ability to buy the best investments and must settle for second best, i.e. lower risk premiums due to barriers of entry of the high initial investment market. This is the same line of reasoning I applied to show that it is only optimal for a certain group of agents with certain abilities to have a long term investment horizon, and empirical tests should be made in its support. For now, I conclude that there is clearly some possible distortions in the price setting mechanism that explains part of the equity premium puzzle, keeping in mind that when we are looking at the equity risk premium we are comparing both short term and long term investments.

The equity premium puzzle is a quantitative puzzle and many researchers have spent much time on challenging the assumptions the puzzle builds on. The model as presented by Mehra and Prescott (1985), is the representative agent model put forward by Rubinstein (1976), Lucas Jr (1978), Breeden (1979), Grossman and Shiller (1981). The model assumes that the consumers have constant relative risk aversion, that they trade in friction less markets, where bills are completely risk free and with no leverage. Per capita consumption is perfectly correlated with the consumption available to the investor, and the risk correction of asset prices can be measured by their covariance with per capita consumption. The equity premium puzzle illustrates a problem with the representative agent model. Since the problem is that the equity premium is too high (not that there is a equity premium), it is possible that some of the assumptions of the model is violated. Models with for example heterogeneous consumers, trading frictions, more general preferences, leverage, a richer time-series of the endowment of consumption, departures from rational expectations and many more have been presented to solve the puzzle, the Handbook of the Equity Risk Premium Mehra and Prescott (2008) claims that this is still a puzzle.” Baatvik (2007)

4 Conclusion

This thesis has investigated the equity risk premium puzzle in Norway from the period 1900-2008. The arithmetic average total return in the stock market was 7.33% yielding an equity premium of 5.90%. Dimson et al. (2006) finds that the average equity risk premium for the period from 1900-2005 for 17 countries including Norway was 7.14%. The Norwegian equity premium was higher than average, but nevertheless not unreasonably high. The implied parameter on relative risk aversion estimated from the Hansen-Jagannathan bound for the whole period was only 6.07, not high enough to constitute a Norwegian equity premium puzzle when following Mehra and Prescott’s upper bound for the relative risk aversion coefficient of 10. Two
main reasons explain the low implied RRA for Norway.

First, the Norwegian private nondurables and services consumption has a standard deviation of 4.14% which is well above the US (1891-1998) estimate of 3.2%, the UK (1919-1997) and Sweden (1920-1997) estimate of 2.8%. Second the Norwegian stock market has generated a lower Sharpe ratio for excess returns (a more volatile stochastic discount factor) than what is found in other countries. This makes the equity premium puzzle less apparent in Norway than it is in many other countries, and shows that the findings from the US can not be extrapolated directly to the Norwegian market.

If we in Norway expect the next 107 years to be exactly like the last 107 years then the arithmetic equity premium of 7.33% yielding an equity premium of 5.90% (3.17% geometric) might be partly explained by the fact that Norwegian stock investors have experienced a negative equity risk premium for one third of the analyzed period (figure 12), and that 24% of the 20 year holding periods yielded a negative equity risk premium (figure 8). Another interesting finding is that for the period from 1900 to 1970 stocks outperformed bonds with a higher return and a lower standard deviation. The only period where bonds showed a higher return was during the WWI and interwar period (1914-1940) where bonds had a higher return, but also higher standard deviation. This raises the equity-bond puzzle of why people purchase bonds, maybe bond investors have experienced 100 years of bad luck.

References


