BI Norwegian Business School - campus Oslo

GRA 19502

Master Thesis

Component of continuous assessment: Thesis Master of Science

Human Capital and its Implications on Financial Risk-taking

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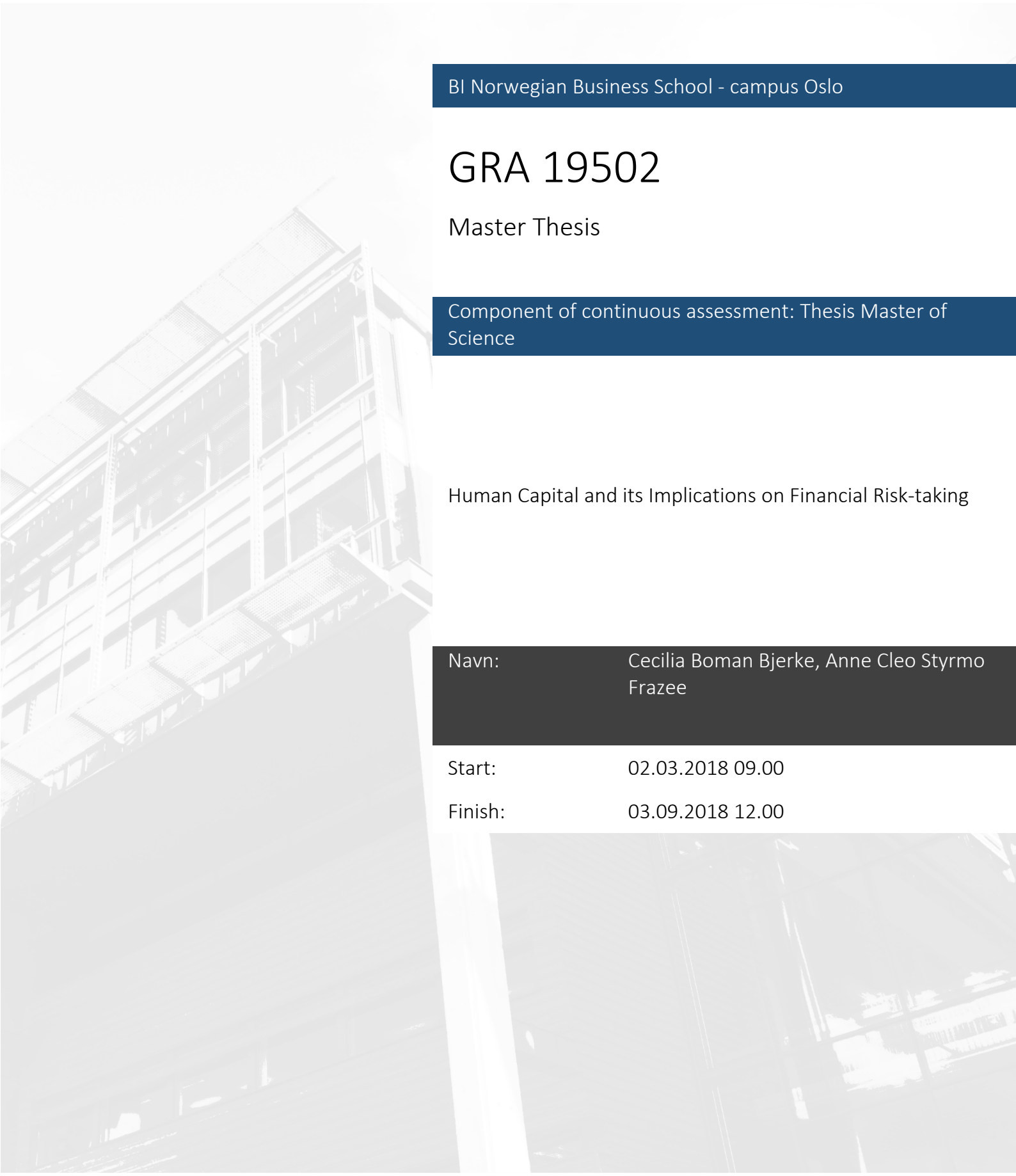
Start:	02.03.2018 09.00
Finish:	03.09.2018 12.00



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GRA1952 – Master Thesis

Hand-in date:
19.06.2018

Campus:
BI Oslo

Supervisor:
Espen Henriksen

Programme:
MSc in Business (Finance) / Financial Economics

Acknowledgements

We are sincerely grateful for all the help and encouragement received during the process of writing this master thesis.

First and foremost, we would like to thank Espen Henriksen, our supervisor at BI Norwegian Business School's department of Finance, for his inspiration, advice and guidance.

We would also like to express our appreciation to the Bank for making this study possible by giving us access to their database and trusting us with such sensitive information.

Oslo, June 2018
Cecilia Boman Bjerke and Anne Cleo Styrmo Frazee

Abstract

When most people think of portfolio composition and optimal asset allocation, words like stocks, bonds, real estate and diversification come to mind. However, people tend to ignore one specific and highly important asset class: namely *human capital*. Human capital is defined as the present value of all future income of an individual. The total wealth of an individual is composed of two parts: human capital and financial capital. Theory tells us that intertemporal decisions and wealth management should take *a total wealth perspective.* Accordingly, one will consider the correlation between *all assets* and thus, gain more from diversification. Hence, human capital should be valued as an asset class in line with other financial assets. In this thesis, we attempt to understand how households consider the properties of their human capital when making their portfolio choices.

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1.0 Introduction

In this thesis, we attempt to understand to what extent households consider the properties of their non-financial assets when making their portfolio decisions. We study the two main dimensions of how non-financial assets are relevant for financial portfolio choices:

1. *Proportion of risky assets in one's portfolio*
2. *The composition of these risky assets*

When analyzing the proportion of risky assets in one's portfolio, we investigate the stock proportion over the life cycle of individuals. To explore further, we examine possible gender and sector differences. Concerning the composition of risky assets in the portfolio of individuals, we base our analysis on the proportion of Norwegian holdings in addition to commodity fund holdings. Finally, we attempt to illustrate the potential economic gains from taking a total wealth perspective when making financial portfolio decisions.

Non-financial assets, in this thesis, are referred to as human capital. Human capital is defined as the present value of all future income of an individual. We also define the total wealth of an individual as composed of two parts: human capital and financial capital. Hence, real estate and other non-financial assets are hereby excluded. Implicitly, when individuals take a total wealth perspective, they include their human capital as an asset class in line with other financial assets.

In fact, through a series of portfolio optimizations, Morningstar research shows that the optimal allocation of an investor's financial assets varies for different compositions of total wealth. In other words, the value of human capital throughout the life cycle, as well as the underlying risk are two important aspects. Their findings suggest that narrow focused portfolio optimization techniques, which ignore human capital and other outside wealth are insufficient, and that a total wealth perspective is necessary to build truly efficient portfolios (Blanchett & Straehl, 2014).

The household selection and allocation issue is an important theme to researchers and policy makers. Theory tells us that intertemporal decisions and wealth management should take *all wealth* into account. For that reason, one will consider the correlation between *all assets* and thus, gain more from diversification. Hence, decisions on the level of financial risk-taking and portfolio composition of marketable financial assets must be seen in relation to the size and characteristics of other non-marketable income and assets (Mork-utvalget, 2016).

The topic is of great importance both on a national and individual level. One can also argue that the topic is of further significance for portfolio advisors and their field. On a macro-level, increased value through diversification gives economical gains and therefore, maximizes the long run welfare of households.

The welfare gain also settles on a household/individual level when assuming that individuals will always prefer more to less, but at a decreasing rate. From the point of view of a portfolio advisor, greater knowledge of this topic will potentially increase value for their clients through greater guidance and quality of advisory. Accordingly, such information would contribute to higher revenues and a better reputation in the marketplace.

There are few nations who face similar challenges as Norway, considering our position within oil and gas export. This might explain why there are no current studies on Norwegian data within the field of household portfolio compositions, when taking non-financial risk into account (Mork-utvalget, 2016).

The inspiration of this thesis takes root in the advice The Norwegian Bank Investment Management (NBIM) on November 14, 2017 gave to the Ministry of Finance. They advised that oil and gas stocks should be removed from the oil fund's benchmark (Norges Bank, 2017). It is fundamental to base financial portfolio decisions on a total wealth perspective and further analyze how the marketable assets can be allocated in such way that the ratio between expected value and risk is optimal. For the nation of Norway and the management of the oil fund (Statens Pensjonsfond Utland), this means that practice should take root in the national wealth and then analyze how the fund should be allocated.

In other words, the NBIM's starting point is that the properties of non-financial assets should be taken into consideration when making financial portfolio choices.

When examining market data on a household level, one can see that the stock proportion over the life cycle of an individual tends to be hump-shaped, as indicated in (Ameriks & Zeldes, 2004) and (Campbell, 2006). Middle-aged investors have the highest proportion of stocks in their portfolios, whereas youth and the elderly have less. This may indicate that people do actually consider the risk of their human capital when making portfolio choices. Otherwise we would expect a flat curve over the life cycle. There are, however, many remaining questions regarding to what extent households take their entire wealth into account when making decisions on the financial part of their portfolio.

We use data obtained in collaboration with a well-positioned Nordic bank that will remain anonymous throughout this thesis. The dataset contains detailed information of the financial portfolio of each individual who has invested in the bank's funds.

Our analysis indicates that our sample seem to consider the properties of their non-financial assets when it comes to the level of financial risk-taking over the life cycle. As individuals age, the present value of their human capital decreases, and consistent with market data, we find a decrease in financial risk-taking. However, individuals do not seem to take the risk profile of their profession (sector) into account when making financial portfolio decisions. To the contrary, we find that the riskiest professions hold the riskiest financial portfolios.
We also find significant differences in financial risk-taking between the genders. Females seem to be more risk averse than males, and hold lower stock proportions in their portfolios throughout the whole life cycle.

This said, our dataset might suffer from shortcomings. Firstly, the data only contain observations from one specific bank, which may cause client characteristics bias. In addition, it may be that our data do not contain the total financial portfolio of the individuals as they might have holdings in other banks.

Secondly, it may be that the individuals are affected by the financial advisory and policy of the bank when constructing their portfolios. Thirdly, as we only have fund data and no information about single-stock holdings, the analysis of the composition of risky assets is constrained. The content of each fund changes regularly. Hence, the composition of risky assets also changes. The composition of stocks in each fund is up to the fund managers to decide, not the individuals. Lastly, our dataset only contains “balance as of” data, which means that we are not able to identify patterns over time, further constraining the analysis.

2.0 Literature Review

To understand to what extent individuals consider the properties of their non-financial assets when making portfolio decisions, and also, to what degree risk-taking changes over the life cycle and differs between genders, we need to become familiar with previous research within the field. Classical contributions, in terms of portfolio composition, did not include non-marketable assets at all. In other words, they implied that all income was derived from financial marketable assets.

2.1 Static models

In the 1950s, Harry Markowitz published his pioneering contribution to the field of financial economics. He developed a theory on household optimal portfolio allocation under uncertainty. The Markowitz model presents the mean-variance analysis where individuals should make optimal portfolio decisions based on balancing the expected return and the risk of each asset. His model embodies the power of diversification principles. Markowitz argues that by investing in assets that are not perfectly correlated, investors can reduce risk (by elimination of unsystematic risk) through diversification. Markowitz also argues that investors tend to choose portfolios that generate the highest possible return, with the least amount (or a given amount) of risk. This set of investment opportunities was later to be known as *the efficient frontier*. An efficient frontier is a set of portfolio returns that maximizes return for a given level of risk, or equivalently the minimum variance portfolio for a given level of return (Markowitz, 1952).

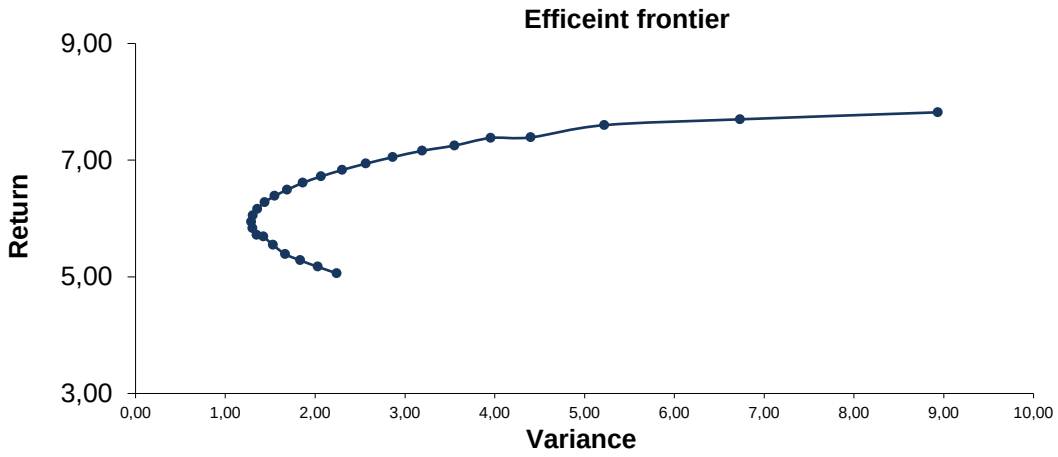

Figure 1: The efficient frontier

The Modern Portfolio Theory, as it is referred to, can be considered as groundbreaking at that time within the field of portfolio selection. Despite this, the model has some drawbacks: The theory is based on rigid assumptions such as frictionless and complete financial markets where investors do not pay taxes or transaction costs, something that can be perceived as unrealistic.

When introducing a risk-free alternative, investors have the opportunity to borrow and lend at the risk-free rate and the ability to diversify away all risk except the covariance of an asset with the market portfolio (Capital Asset Pricing Model). The efficient set becomes a straight line (Capital Market Line) from the expected return of the risk-free asset, tangent to the efficient frontier.

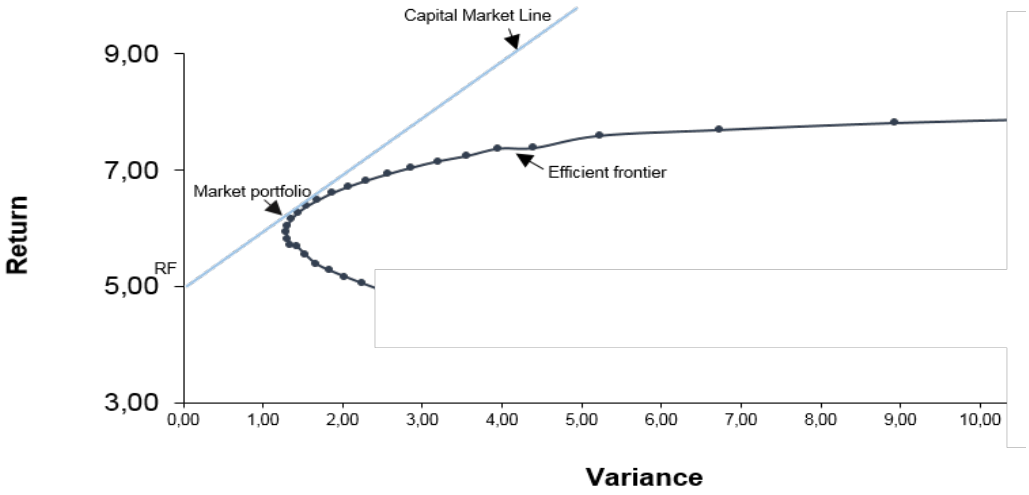

Figure 2: The capital market line

The market portfolio is obtained at the tangent point. Investors should construct a portfolio that lies on the CML. The proportion of risky assets, however, will be dependent on individual risk aversion. The Markowitz and CAPM models are one-period models that insufficiently explain the life cycle allocation issue. This issue would be more clearly explained by multi-period models as discussed in the following chapters.

2.2 Dynamic models

Early contributions on dynamic portfolio choices where financial markets exist in isolation are the models of (Mossin, 1968), (Merton, 1969) and (Samuelson, 1969)(MMS). These early contributions are based on specific predictions: Investors should, independent of age, participate in the stock market. The framework also assumes complete markets, absence of labor income and that the stock proportion of the portfolio will not vary over the life cycle. Hence, the MMS model implications are in contrast with the hump-shaped function as can be seen in market data.

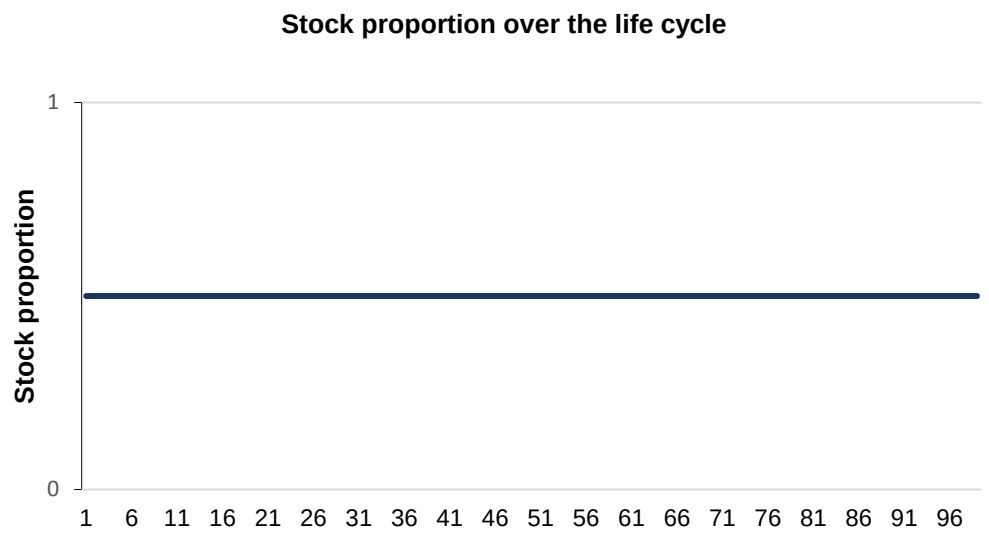

Figure 3: Stock proportion over the life cycle by the MMS model

There are also models of portfolio choice where financial markets do not exist in isolation. Merton (1973) developed the intertemporal CAPM (ICAPM). The model is an extension of the CAPM taking multi-periods into account. The intertemporal model is consistent with both the expected utility maxim and the limited liability of assets. Compared to the one-period model, the uncertainty of changes in future investment opportunities are taken into consideration when constructing one's portfolio. It captures effects that would not appear in a static model. However, labor income and consumption goods, whose relative prices change over time, are two important factors that the model does not take into consideration (Merton, 1973).

2.3 Non-financial assets and portfolio composition

(Merton, 1971) was one of the earliest contributions to include riskless tradeable human capital in a complete market setting. Taking this into account, it creates a strong incentive to participate in the stock market early in the lifecycle. At that point, the human capital holds the same characteristics as a large endowment of riskless bonds. Accordingly, effective diversification of individual's total wealth requires optimal allocation of financial capital to counterbalance the risks of human capital. Hence, when your human capital is bond-like, either through your profession or your stage in the life cycle, you are able to take on more risk. As individuals approach retirement, the human capital changes towards a more stock-like characteristic. Hence, to counterbalance, the financial portfolio should be rebalanced towards less riskier assets.

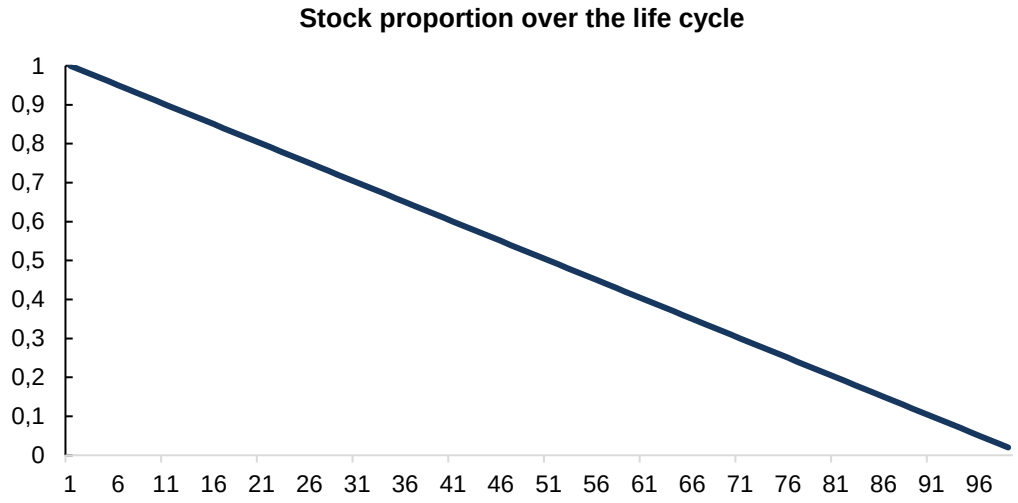

Figure 4: Stock proportion over the life cycle, decreasing with age

Others who have emphasized the importance of non-financial assets for portfolio composition are (Mayers, 1972) and (Fama & Schwert, 1977). Bodie, Merton, and Samuelson (1992) also include non-financial assets in their model. They examine the effect of the labor-leisure choice of portfolio and consumption decisions over an individual's life cycle (Bodie, Merton, & Samuelson, 1992). Individuals with greater labor market flexibility, such as working extra hours, having multiple jobs or postponing retirement, should invest a greater portion of wealth in risky assets compared to individuals with lesser flexibility. They state that labor income varies much less than stock returns over time and that the correlation between them is close to zero. Therefore, labor income carries the same portfolio characteristics as bonds and thus, savings should be almost exclusively stock-based. As the

household grows, the value of future income will gradually decrease and to rebalance their portfolio, the household will reduce the stock portion and increase the bond portion (as proposed by Merton 1971). However, empirical studies show a different result: a hump-shaped function over the proportion of stocks held over the lifetime of individuals. Middle-age investors tend to have a relatively higher proportion of stocks compared to younger and older individuals in their portfolio. This indicates that people do actually consider the riskiness of their human capital (labor income) when making portfolio choices. Otherwise, we would expect a flat curve over the lifecycle.

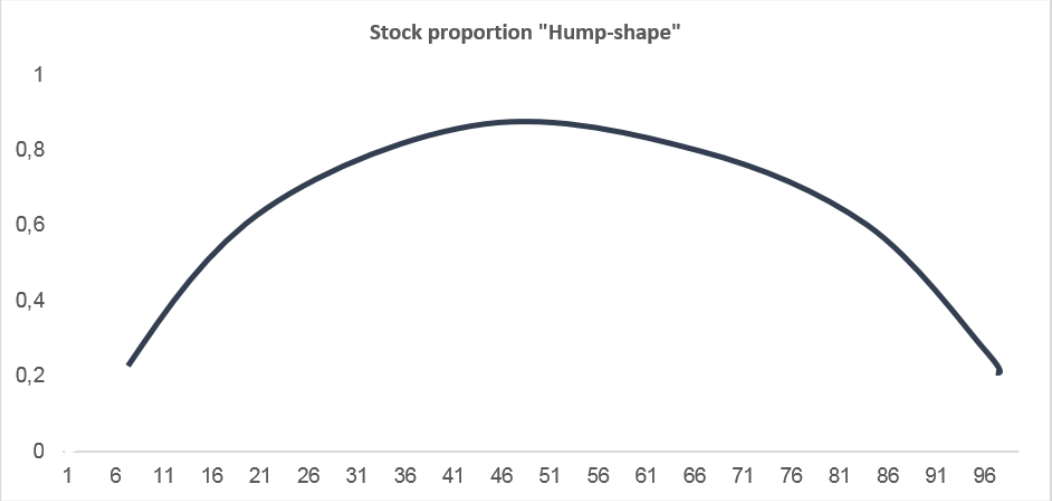

Figure 5: Hump shaped function of stock proportion over the life cycle

Luca Benzoni, Pierre Collin-Dufresne and Roberts Goldstein explained this hump-shape further in a paper from 2007. By showing that although immediate correlation between labor income and stock returns are close to zero, there seems to be a positive correlation between changes in labor income and stock returns five-to-fifteen years ahead. This indicates that for a young household with a long labor-time horizon, the value of their future income will have a positive correlation with stock returns. Hence, the labor income of young households will have many of the same characteristics as stock, and to rebalance their portfolio, they should invest a larger proportion in bonds. A middle-aged household approaching retirement will have a more bond-like human capital and to counterbalance the risk, their financial portfolio should be more heavily stock weighed (Goldstein, Collin-Dufresne, & Benzoni, 2007).

Human capital (in the form of labor income) is also taken into account in the models of Viceira (2001), Heaton and Lucas (2000b) and Gomes and Michaelides (2004). Viceira (2001) examines how risky labor income and retirement affect optimal portfolio choices of individuals. He argues that increased unsystematic labor income risk raises the willingness for the investor to save, and therefore they reduce the stock proportion of their portfolio. His findings support the argument that people should invest more in stocks when they are working than when they are retired. When labor income risk is unsystematic, this advice is always wealth maximizing and the proportion of the portfolio invested in stocks is positively related to the retirement horizon of the investors (Viceira, 2001). His results are partly consistent with the hump-shape model, at least from middle-aged to retirement age.

Based on empirical estimates of the correlation between stock returns and individual earnings, Gomes and Michaelides (2004) show that labor income is a closer substitute to long-term bonds than to stocks. As a result, more risk-averse investors hold a smaller proportion of stocks in their portfolio. Moreover, this explanation is consistent with the recommendation that younger households should be more heavily invested in stocks than older households (Gomes & Michaelides, 2004).

Heaton and Lucas, publishing papers in 2000, are also contributors within the field of risk and household investments, taking risky non-financial assets into account. Their most comprehensive study is Heaton and Lucas (2000b). Here they improve their first study by focusing on how background risk from both human capital (labor income) and entrepreneurial income influences portfolio allocations. Their findings can help us understand why individuals take different portfolio choices over the life cycle by showing that households more exposed to background risk (labor and entrepreneurial income), tend to hold smaller proportions of stocks in their portfolios (Heaton & Lucas, 2000b).

2.4 Gender differences

To further investigate risk-taking by individuals, we found it interesting to examine possible gender differences. There are several studies on gender differences in risk-taking behavior, both within the field of economics and finance, but also within the field of psychology. Byrnes, Miller and Schafer published one of the largest meta-analyses in 1999. They compared risk-taking tendencies between the genders in 150 separate studies. Their results indicate greater risk-taking in male participants (Byrnes, Miller, & Schafer, 1999).

The same result also holds for financial risk. Most studies analyzing financial risk tolerance by gender, either inferring it based on portfolio allocations or using some direct measure of attitude toward financial risk, have found that women are less risk tolerant than men (Yao & Sherman D., 2005). For instance, (Powell & Ansic, 1997) studied gender differences in risk behavior in financial decision-making. They find that females are less risk seeking than males. The same results hold for the study of (Jianakoplos & Bernasek, 1998), using U.S data to examine household's holdings of risky assets. They find that single women exhibit relatively more risk aversion in financial decision-making than single men. Also, as wealth increases, the proportion of the wealth invested in risky assets is estimated to increase by a smaller amount for single women than for single men. To mention more recent contributions, Charness and Gneezy (2011) also find very large gender differences in financial risk-taking where males are more risk tolerant (Charness & Gneezy, 2011).

3.0 Data

The data used in this study is obtained in collaboration with a well-positioned Nordic bank that wishes to remain anonymous. The dataset contains the financial portfolio of 2,707 individuals who have invested in the bank's funds (both equity and bond funds). The data contains each individual's balance as of January 2018. Unfortunately, the bank was not able to give us access to time series data, as they were not able to extract such information on a sufficient sample size. A full list of variables is found in figure 6.

List of variables	
CUST_SEQ_NO	*Sequence number to identify specific funds held by an indivdual*
Age	*8-88 years*
Gender	*Male, Female*
Balance Equity Funds	*Holdings in 100% equity funds*
Balance Bond Funds	*Holdings in 100% bond funds*
Balance Combination Funds	*Holdings in funds that are a combination of equity and bond funds*
Combination Active 30	*Holdings in 30% equity funds and 70% bond funds*
Combination Active 50	*Holdings in 50% equity funds and 50% bond funds*
Combination Active 70	*Holdings in 70% equity funds and 30% bond funds*
Combination Active 100	*Holdings in 100% equity funds*
Zip code	*Postal code (address) of individuals*
Sector	*0-10 (Specified in figure 7)*

Figure 6: List of variables

3.1 Sorting

We filtered the data such that it only contained individuals who have invested in either equity or bond funds (or both). Also, to know the individual employers, we had to sort the data such that it only contained individuals with known employers. The gender variable is chosen to be able to further investigate different relationships between gender and financial risk taking. To enlighten the difference in risk profile across sectors, the individual employers were given a sector classification based on how cyclical the specific industry is, but also to emphasize the position of important Norwegian industries such as oil & gas, shipping and seafood. For some individuals, human capital is more volatile than others. For instance, careers within the public sector are considered as "safe" and produce human capital with bond-like characteristics. On the contrary, as an example, careers within the oil & gas sector are more stock-like and may be correlated to the economic cycle and stock market returns.

The classification and distribution can be seen in figure 7. Sector 0 represents employers that we were not able to classify. Hence, this group was excluded from parts of the study. This also holds for sector 10 (students).

3.1.1 Sorting by sector

Observations per sector	
1	1415
2	695
3	195
4	12
5	43
7	47
8	78
9	161

Sector Classification	
Unknown	0
Private sector	1
Public sector	2
Oil & Gas	3
Seafood	4
Shipping	5
Banking & Finance	7
Construction	8
Retiree/ Disability Pension	9
Students	10

Figure 7: Sector classification and distribution

A large proportion of the individuals are employed by the private sector (53.5%). There is also a large proportion in the public sector (26.3%) as well as the oil and gas industry (7.4%). Retirees account for 6.1% of the observations.

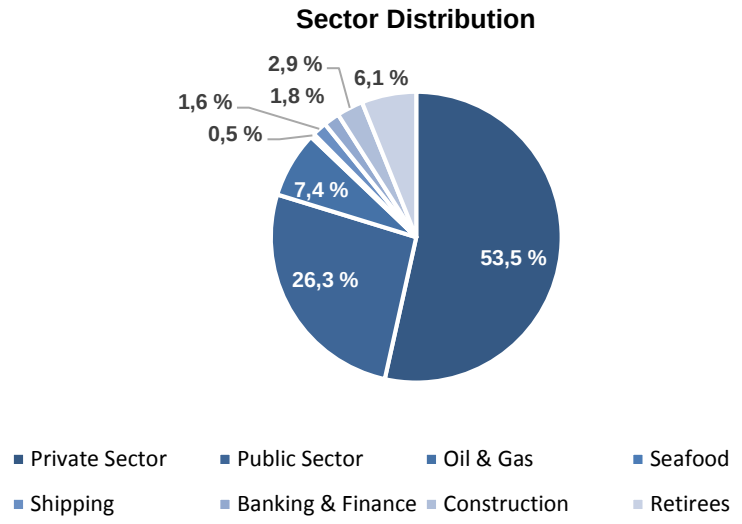

Figure 8: Sector distribution as pie chart

Further, we investigated the percentage of males and females working within each sector. When examining the figure below, one can see clear differences between the genders when it comes to private and public sector. The largest proportion of males can be found in the private sector, whereas the largest proportion of females work in the public sector.

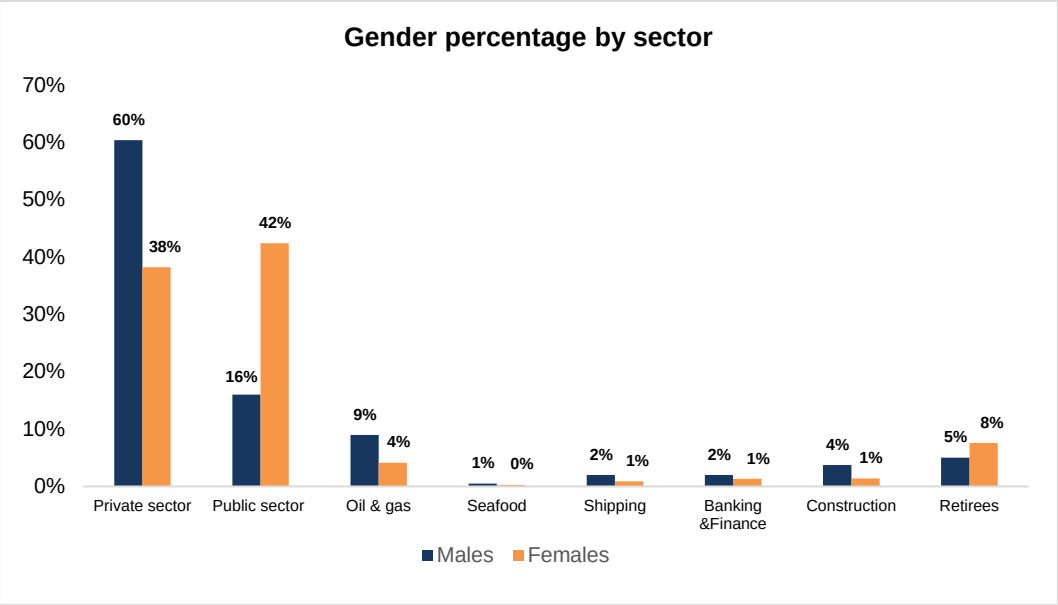

Figure 9: Gender percentage by sector

3.1.2 Age distribution

The age distribution from our dataset can be seen in figure 10. A large proportion of the individuals are in their mid-twenties to mid-sixties.

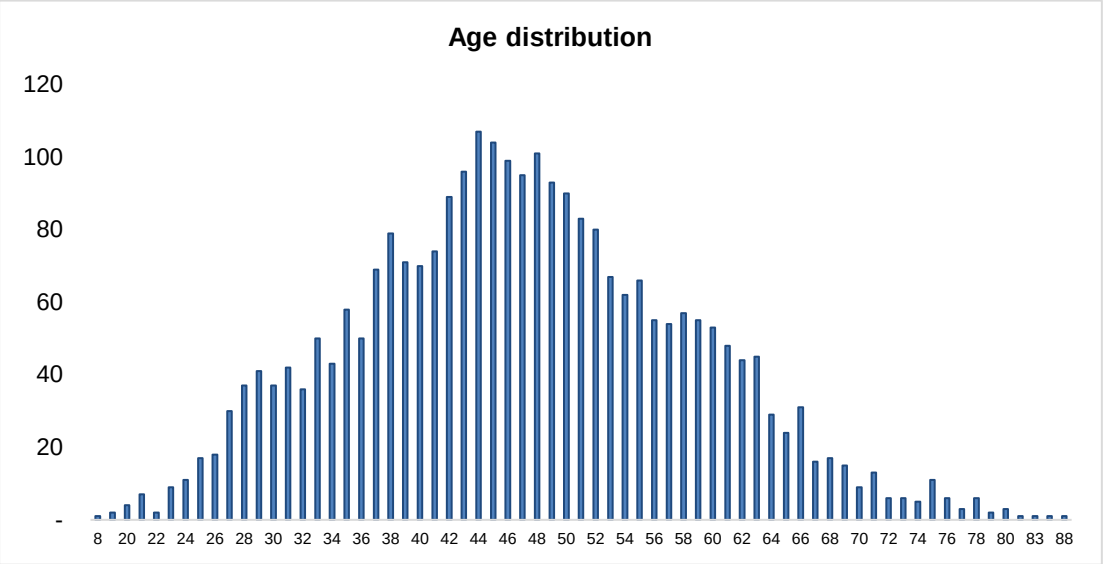

Figure 10: Age distribution

3.2 Calculations

To examine the financial risk-taking of each individual, we calculate the portfolio stock proportion. The following formulas were used:

$$\boldsymbol{TSH = Equity\ funds + 0,3 * Active\ 30 + 0,5 * Active\ 50 + 0,7 * Active\ 70 + Active\ 100}$$

$$\boldsymbol{TBH = Bond\ funds + 0,7 * Active\ 30 + 0,5 * Active\ 50 + 0,3 * Active\ 70}$$

The "active" funds are funds combined of both bonds and equities. For example, "active 30" consist of 30% equities and corresponding 70% bonds.

$$\boldsymbol{SH\ in\ portfolio = \frac{Total\ stock\ holdings}{(Total\ stock\ holdings + Total\ bond\ holdings)}}$$

Where TSH equals total stock holdings and TBH equals total bond holdings.

When calculating the sum of Norwegian holdings, we obtained the "Norway benchmark" for each fund as of 31.12.2017 from the bank. This made it possible to calculate the exact holdings for each individual in Norwegian stocks.

The following formula was used for each individual:

$$\boldsymbol{Norwegian\ holdings = Norway\ benchmark * Fund\ holdings}$$

3.3 Descriptive statistics

In figure 11, we present descriptive statistics for the full dataset. The dataset contains 2,707 observations. Of these, 991 are female individuals and 1,716 are male. The average individual is 46.95 years old with a minimal difference in gender. The standard deviation of age for the total sample is 11.41 years. The median age values of both genders are very close to the mean.

Average stock holdings equal 125,145.36 NOK and average bond holding equals 57,811.53 NOK. However, the standard deviations are large. The median values for stock and bond holdings are significantly lower than the mean values. This is

due to some observations with large holdings, affecting the mean values. The average proportion (share) of stocks is 81% with a corresponding 19% bond share. Accordingly, the median values also shows similar tendencies with a stock proportion of 1 and bond proportion of 0.

Descriptive statistics	Total			
	Obs	Mean	Std Dev	Median
Demograhics				
Age Female	991	46,41	11,34	47,00
Age Male	1 716	47,26	11,38	46,50
Sample Total	2 707	46,95	11,41	47,00
Total				
Fund holdings in NOK:				
Stocks		125 145,36	515 711,22	31 588,79
Bonds		57 811,53	331 182,44	0
Share				
Stocks		0,81	0,32	1,00
Bonds		0,19	0,32	0
Female				
Fund holdings in NOK:				
Stocks		91 279,37	176 492,87	25 265,18
Bonds		55 306,92	229 392,72	0
Share				
Stocks		0,76	0,34	1,00
Bonds		0,24	0,34	0
Male				
Fund holdings in NOK:				
Stocks		144 630,25	632 942,23	36 775,19
Bonds		59 257,96	377 728,65	0
Share				
Stocks		0,84	0,30	1,00
Bonds		0,16	0,30	0

Figure 11: Descriptive statistics, full sample

Descriptive statistics per sector and per life cycle stages can be found in appendix 1 and 2.

4.0 Empirical study

Diversification is essential for optimal asset allocation and to minimize unsystematic risk. Hence, human capital should be considered as an asset class in an individual's portfolio. Its risk characteristics, as well as the correlation between human capital and the financial portfolio, are essential aspects of optimal portfolio composition.

Do the individuals in our dataset consider the properties of their non-financial assets when making their portfolio choices? Do the risk characteristics of their human capital affect asset allocation? In other words, are there any structural differences in asset allocation in different sectors in our sample?
Also, does financial risk-taking change during the life cycle as indicated by theory? And are there any differences between the genders? In addition, do the proportion of Norwegian fund holdings vary by sector?

In this chapter, we will ascertain possible differences, mainly by examining the two main dimensions of how non-financial assets are relevant for financial portfolio choices:

1. Proportion of risky assets in one's portfolio
2. The composition of these risky assets

The first dimension is explored by examining variations in portfolio stock proportion by different genders, employment sectors and during different life cycle stages. The second dimension examines the composition of risky assets, mainly by looking at the proportion of Norwegian holdings by sector, in addition to commodity fund holdings.

4.1 Proportion invested in risky assets

4.1.1 Gender differences

It is common knowledge that men and women think and behave differently in some situations. Hence, it is no surprise that this may also be reflected in their financial behavior.

4.1.1.1 Methodology

In order to examine structural differences by gender, we study males and females separately. We analyze average stock proportion and average stock holdings as well as structural differences in stock proportion by sector.

4.1.1.2 Results / discussion

Females (K) have a smaller average stock proportion (76%) in their portfolios compared to males (84%) (M). In addition, they have a lower average fund holding in both stocks and bonds. Females have on average 91,279 NOK in stocks compared to males with 144,630 NOK. Females have on average 55,306 NOK in bonds and males have 59,257 NOK.

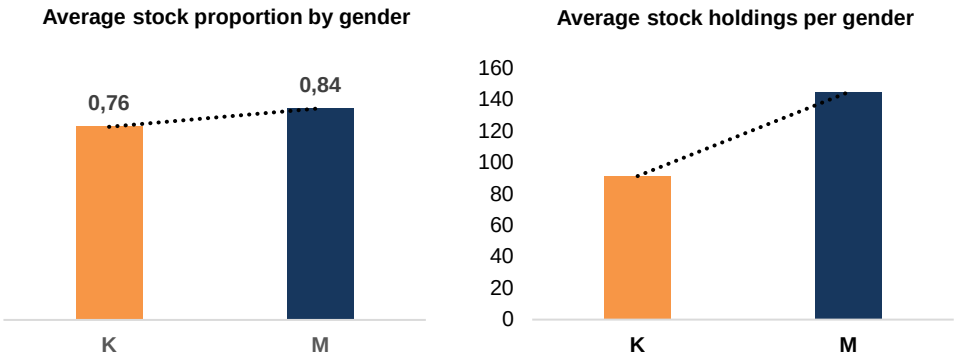

Figure 12: Average stock proportion by gender and average stock holding (in thousands) by gender

Further, we analyze stock proportion by gender in each sector. On average, females have a significantly lower stock proportion compared to males in the private, public, oil & gas and seafood sector. In the remaining four sectors however, the difference is less revealing. That said, these four sectors have fewer observations.

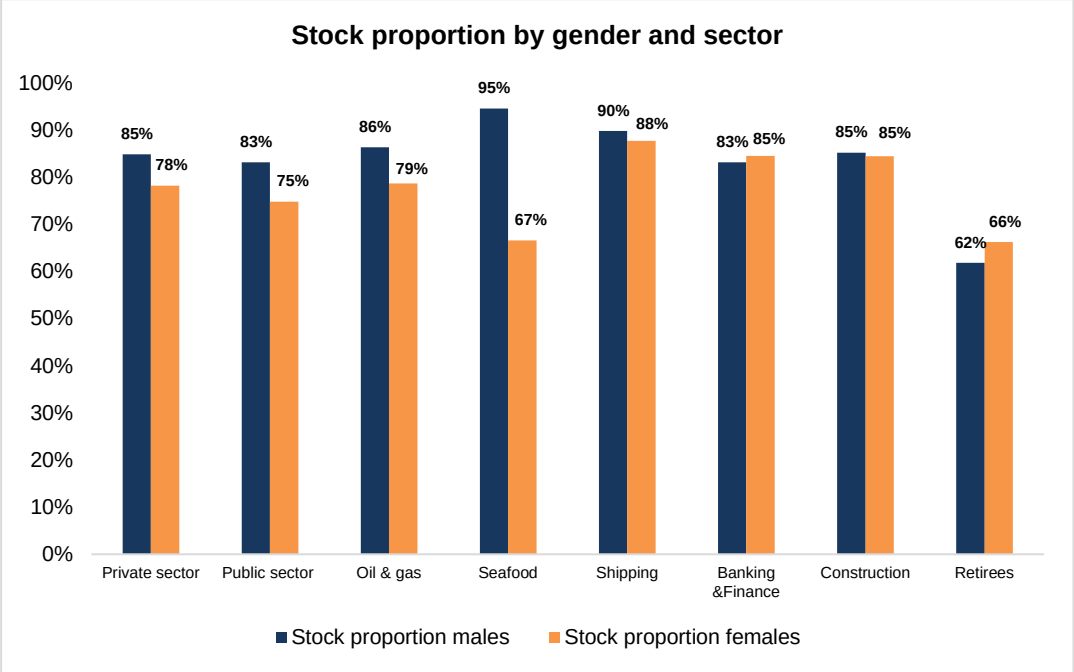

Figure 13: Stock proportion by gender and sector

Most studies analyzing financial risk tolerance by gender, either inferring it based on portfolio allocations or using some direct measure of attitude toward financial risk, have found that women are less risk tolerant than men (Yao & Sherman D., 2005). We can also see indications towards these tendencies. However, it is important to keep in mind the data limitations as it constrains our ability to draw reliable conclusions for the population as a whole.

4.1.2 Life cycle stages

As a young individual, the present value of all future income is high compared to individuals further down the life cycle. The characteristics of the human capital of individuals early in the life cycle have resemblance to a large bond endowment. Therefore, one could argue that those individuals should counterbalance with a financial portfolio more heavily weighted in stocks. However, market data shows a hump-shaped function of stock proportion over the life cycle where young individuals tend to have a somewhat low stock proportion compared to the middle-aged investors. Benzoni, Collin-Dufresne and Goldstein explain this apparent contradiction in detail. Retirees and individuals approaching retirement have a present value of future income that is low compared to earlier life cycle stages. As a retiree, you also have less chance to recoup losses. Thus, risk taking

should be significantly reduced. Consequently, they should hold portfolios more heavily weighted in bonds.

4.1.2.1 Methodology

To examine differences in risk-taking over the life cycle we have separated the data into different life cycle periods. This separation is based on our own assessment of "degree of establishment" (see figure 14).

Life-cycle classifications	
0-30	*Unestablished*
31-40	*Approaching establishment*
41-50	*Established*
51-60	*Well established*
67+	*Retirees*

Figure 14: Life cycle classifications

4.1.2.2 Results / discussion

When plotting our sample by life cycle stages, for males and females separately one can see a clear tendency towards this "hump shape" that earlier empirical studies have shown. Furthermore, we can see, consistent with theory, a decreasing stock proportion towards later life cycle stages (with exception of the models by Mossin (1968), Merton (1969) and Samuelson (1969) who suggest a flat curve). This may indicate portfolio rebalancing towards safer assets as the present value of human capital decreases.

When comparing the genders, we can see that the males have a more concave function over the life cycle (see figure 15). The females have a smoother line and on average a lower stock proportion throughout the whole life cycle, supporting the findings that females may be more risk averse than males.

The unestablished in our sample, both males and females, however, have a relatively high proportion compared to market data. This is in line with some of the theories discussed earlier, see (Merton,1971) and (Bodie, Merton, & Samuelson, 1992). However, few observations at early life stages constrain our ability to draw reliable conclusions for the population as a whole.

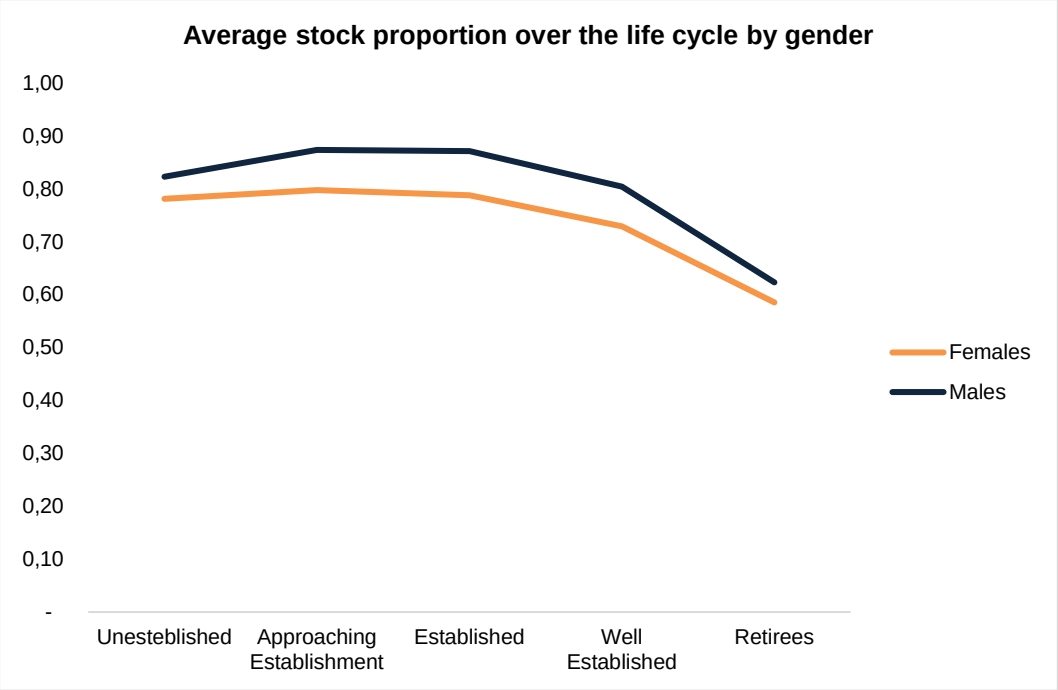

Figure 15: Average stock proportion during different life cycle stages

4.1.3 Sector differences

4.1.3.1 Methodology

To understand human capital as an asset, one has to know its risk characteristics. Variables such as job stability and income volatility have an impact on the present value of future income (human capital). These characteristics should influence how you allocate your financial capital. As an example, individuals working in "safe" sectors such as the public sector should be able to carry more risk than individuals working in cyclical industries such as oil & gas, seafood, shipping and construction. To examine this, we have studied structural differences in risk-taking by sector.

4.1.3.2 Results / Discussion

The graph shows the average proportion of stocks held by each sector. Our sample shows that the highest average stock proportion is held by the most cyclical industries.

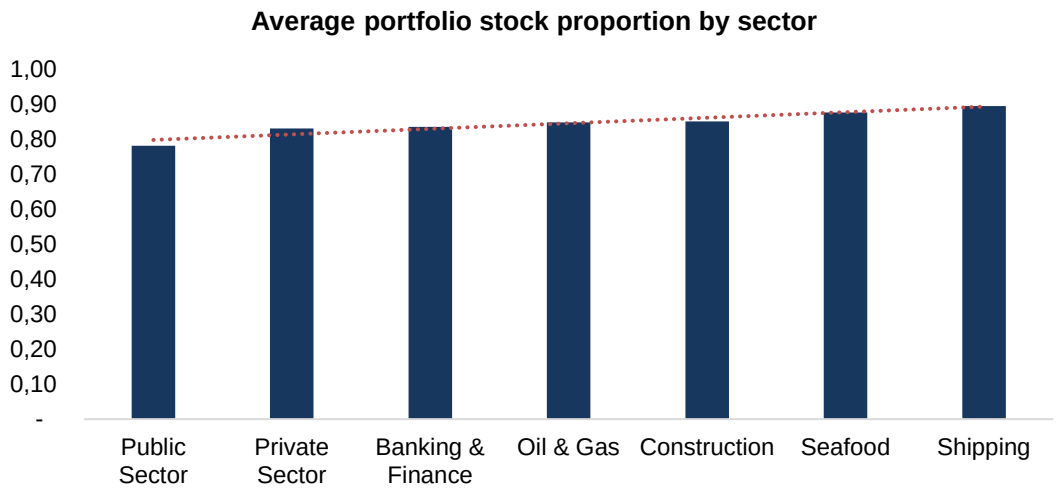

Figure 16: Average portfolio stock proportion by sector

This interesting result is not at all consistent with diversification principles. These individuals have a more stock-like human capital, which may be correlated to the economic cycle and stock market returns. To counterbalance this, and thus gain the most from diversification, they should hold a more bond-like financial portfolio.

4.2 Composition of risky assets

4.2.1 Norwegian holdings

4.2.1.1 Methodology

To truly capture the benefits of diversification, investors should not only be exposed to domestic equities, but also to foreign. To examine if there are structural differences in Norwegian holdings by sector we have studied the proportion of Norwegian stocks held by each sector.

4.2.1.2 Results / discussion

The following graph shows the percentage of Norwegian fund holdings by different sectors. In general, there seems to be a high fraction of holdings invested in Norwegian stocks. In addition, the largest proportion of Norwegian holdings is held by the most cyclical sectors, with the exception of oil & gas.

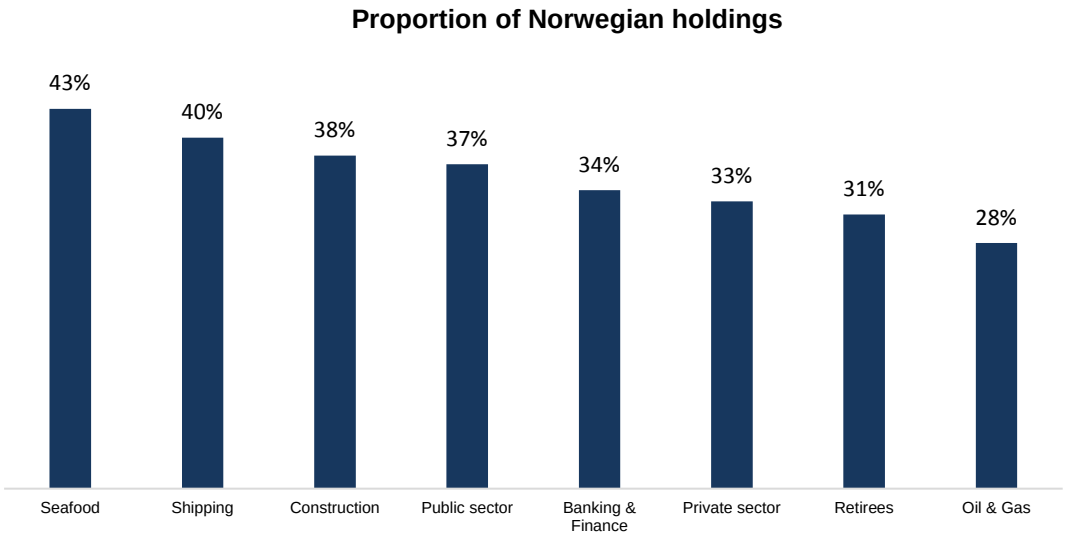

Figure 17: Average portfolio stock proportion by sector

This can be argued to be an indication of familiarity bias (or home bias), which is a behavioral bias where investors invest in what they are familiar with. In this case, investors may be more familiar with, or have greater knowledge about, the domestic stock market compared to the foreign. Hence, a greater proportion of their holdings will be placed there.

In the scenario where returns of individuals' human capital is more correlated with the domestic stock market than it is with the foreign, the risk associated with human capital can me more efficiently hedged if an individual holds a financial portfolio which is internationally diversified. If we had the correct estimate of the correlation of human capital returns within and between countries, we could say something about how different sectors should diversify their portfolios with foreign assets. However, since we do not know this correlation, we can only speak in general terms. Human capital derived from cyclical industries such as seafood, shipping, construction and oil & gas are more likely to be correlated with the economic cycle and stock market. Therefore, these individuals should hedge their exposure by investing more in foreign equities.

4.2.2 Commodity holdings

4.2.2.1 Methodology

Further, we examined individuals holding commodity funds. To our surprise, and despite very small commodity holdings overall in our sample, individuals working in the oil & gas sector hold the largest proportion.

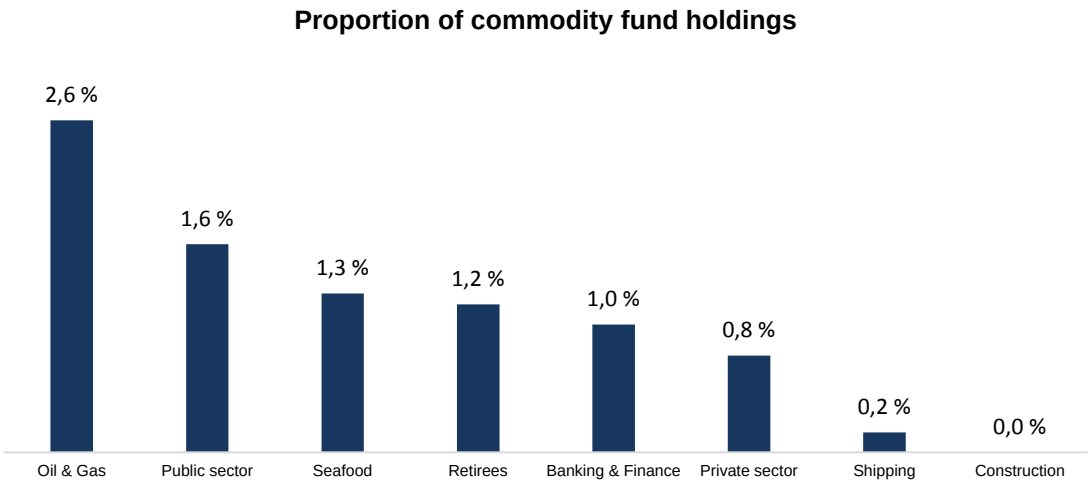

Figure 18: Proportion of commodity fund holdings

4.2.2.2 Results / discussion

The bank states that the commodity fund is comprised of around 15 different commodities important to the Nordic economies, heavily weighted in oil, electricity, copper, aluminum and gold. This, in addition to the home bias discussed in the previous chapter, can be argued to be some sort of familiarity bias. The individual investors working in the oil & gas sector may have invested in commodity funds due to the familiarity of the investment. Despite the seemingly obvious gains from diversification. This can lead to misallocated suboptimal portfolios and loss of diversification benefits.

5.0 Benefits of diversification –Illustration

Throughout this thesis we have emphasized the power of diversification. We have embraced human capital as an important asset class that truly deserves the attention of investors. To illustrate the benefits of diversification we present examples connected to asset allocation focusing on the correlation between human capital and the financial portfolio of investors.

First, we illustrate the basic calculations of portfolio variance and return based on the lecture notes of Professor Jessica A. Wachter (department of finance at the Wharton School, University of Pennsylvania).

The return of a portfolio consisting of two assets are given by the following:

$$E(R_p) = w_1 R_1 + w_2 R_2 \qquad (1)$$

Where $w_1 and\ w_1$ represents the asset weights and $R_1$and R_2 are the returns on each asset.

The portfolio standard deviation is given by the following expression:

$$\sigma_p = [w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1 w_2 \sigma_1 \sigma_2 \rho]^{1/2} \qquad (2)$$

Where rho(ρ) represents the correlation coefficient between the two assets. The correlation ranges in the interval between -1 and 1.

To further illustrate the benefits of diversification examine three intuitive examples.

Case I: Perfect positive correlation ($\boldsymbol{\rho = 1}$)

Replacing ρ from equation (2) with 1 gives:

$$\sigma_p^2 = [w_1^2\sigma_1^2 + w_2^2\sigma_2^2 + 2w_1 w_2 \sigma_1 \sigma_2]$$

This equation is a perfect square and can be rewritten as the following:

$$\sigma_p^2 = (w_1 \sigma_1 + w_2 \sigma_2)^2$$

Which is the same as:

$$\sigma_p = (w_1 \sigma_1 + w_2 \sigma_2)$$

In this case every point in the mean variance diagram becomes a straight line (see figure 19). Thus, when we strive for higher expected return, we always have to pay in terms of higher standard deviation. We can thereby conclude that we receive no gains from diversification in the case of perfect positive correlation.

Case II: Perfect negative correlation ($\boldsymbol{\rho = -1}$)

The portfolio variance with a perfect negative correlation equals the following:

$$\sigma_p^2 = [w_1^2\sigma_1^2 + w_2^2\sigma_2^2 - 2w_1 w_2 \sigma_1 \sigma_2]$$

As in case I, this equation is also a perfect square and can be rewritten as:

$$\sigma_p^2 = (w_1 \sigma_1 - w_2 \sigma_2)^2$$

The standard deviation σ_p must be a positive number due to it being the square root of the variance.

$$\sigma_p = |w_1 \sigma_1 - w_2 \sigma_2|$$

Recall that $w_1 + w_2 = 1$. Thus, we can write: $w_1 = 1 - w_2$. To find the asset weights, the standard deviation is set to zero and we obtain the following expression:

$$(1 - w_2)\sigma_1 - w_2\,\sigma_2 = 0$$

Rearranging we get:

$$\sigma_1 - w_2(\sigma_1 + \sigma_2) = 0$$

Solving for w_2 we get

$$w_2 = \frac{\sigma_1}{\sigma_1 + \sigma_2}$$

As an example we use $\sigma_1 = 0.2$ and $\sigma_2 = 0.10$:

$$w_2 = \frac{0,2}{0,2+0,1}$$

This gives us $w_2 = 0.67$, which then implies that w_1 has to be 0.33.
Using fictional asset returns of R_1=0.15 and R_2=0.08 we get the following portfolio return:

$$R_p = 0.33\ (0.15) + 0.67\ (0.08) = 0.1031$$

This gives us the intercept with the y-axis. Hence, as the graph shows, in the case of perfect negative correlation, we have large gains from diversification.

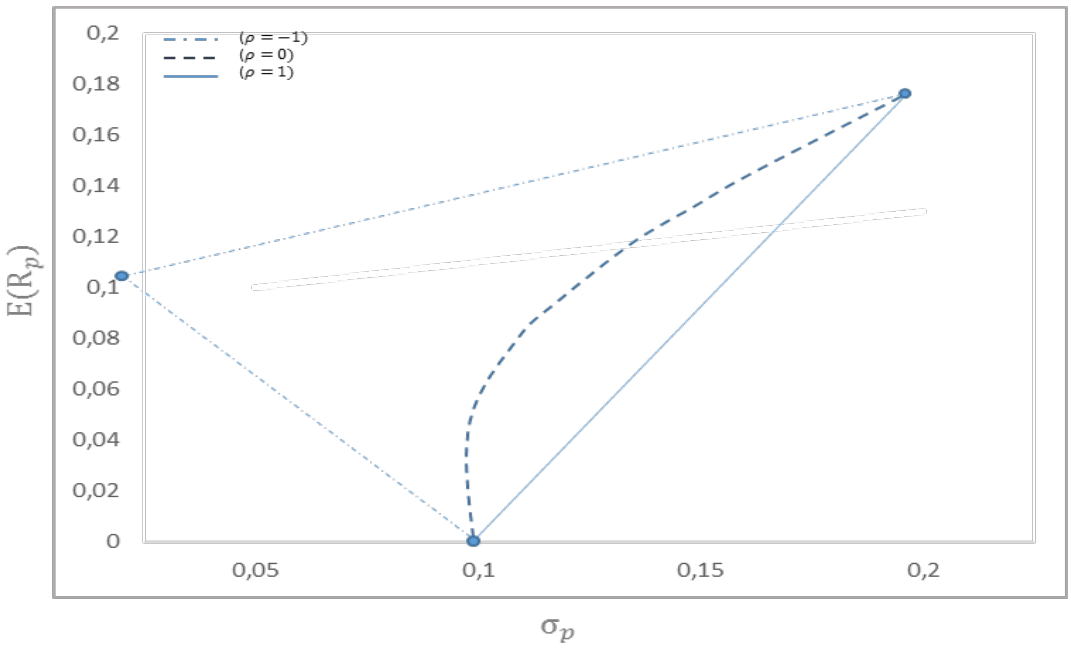

Figure 19: Three cases of correlation

Case III: Zero correlation ($\rho = 0$)

When the two assets are independent (i.e. correlation equals zero) we obtain the following from equation (2):

$$\sigma_p^2 = [w_1^2\sigma_1^2 + w_2^2\sigma_2^2]$$

In this case, compared to the two earlier ones, the squares of weights sum to less than 1:

$$\sigma_p = [w_1^2\sigma_1^2 + w_2^2\sigma_2^2]^{1/2} < w_1\sigma_1 + w_2\sigma_2$$

Hence, the standard deviation is smaller than it would be for the case with perfect positive correlation. This is also reflected in figure 19 (Wachter).

Up to this point we have briefly introduced the basics of diversification. Bringing this in the light of our thesis theme, we emphasize one of the two risky assets as human capital. Further, we examine two cases, one with human capital derived from a cyclical industry (oil & gas) and one where the human capital stems from a more "safe" environment. Hence, the underlying risk differs.

The matrix and graph illustrated below help make the case stronger. The numbers are purely chosen to illustrate a point and do not reflect the real world, nor our thesis data.

The higher the correlation between the two assets, the fewer benefits one can achieve by diversifying. In other words, the higher correlation between your human capital and your financial portfolio, the fewer gains you will achieve. To be able to extract the most benefits from diversification, investors should bear this in mind and invest in assets that are less correlated to their human capital.

	Public sector	*Oil & gas*	*Financial Portfolio*
Public sector	1	0,1	0,05
Oil & gas	0,1	1	0,3
Financial Portfolio	0,05	0,3	1

Figure 20: Fictional correlation matrix

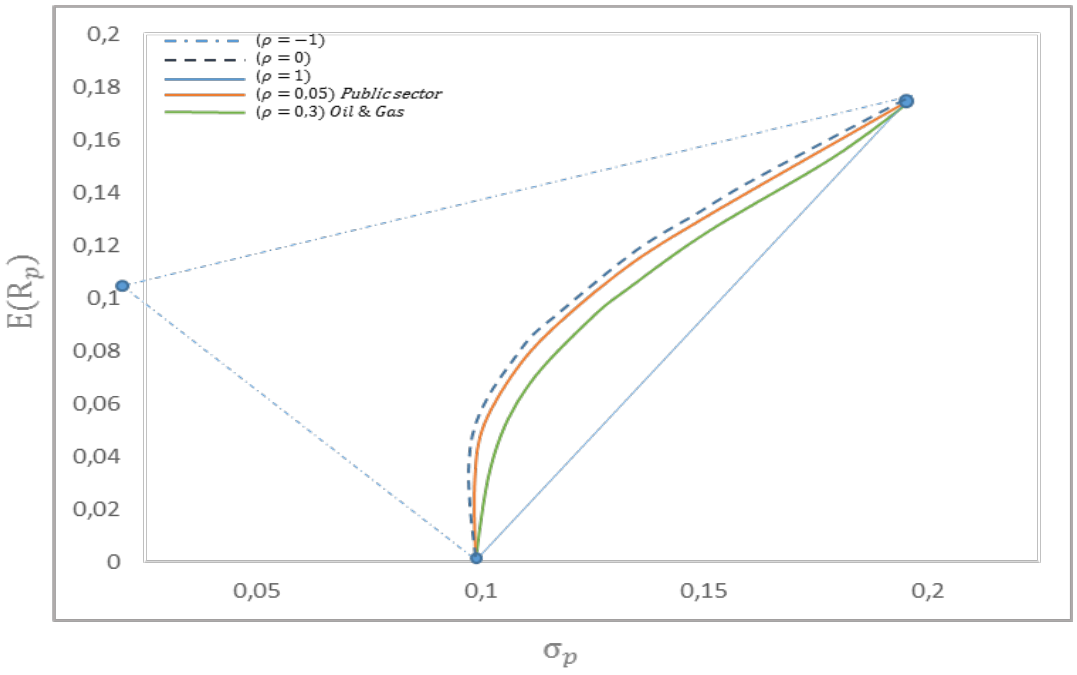

Figure 21: Benefits from diversification when correlation differs

6.0 Conclusion

To conclude, when individuals make financial portfolio decisions based on their financial assets in isolation, independent of a total wealth perspective, they might misallocate their portfolios. A portfolio overweighed or underweighted in risky assets might generate a loss in terms of diversification gains. Therefore, it is fundamental to base financial portfolio decisions on a total wealth perspective. Individuals should further analyze how marketable assets can be allocated in such way that the ratio between expected value and risk of the total wealth is optimal.

Throughout this thesis, we have performed several analyses to try to understand how our sample considers the properties of their non-financial assets when making portfolio choices over two dimensions. 1: the proportion of risky assets in one's portfolio, and 2: the composition of these risky assets.

First of all, there seems to be revealing differences between the portfolio stock proportions of the genders. Females hold on average a smaller stock proportion than males. This manifests itself throughout the whole life cycle and is consistent with most of the earlier research within the field of risk tolerance differences by gender. However, it is important to keep in mind the data limitations as it constraints our ability to draw reliable conclusions for the whole population.

Secondly, we can see a clear tendency of a hump-shaped stock proportion over the life cycle. This may indicate that the individuals do actually consider the properties of their human capital when making portfolio choices. Otherwise, one would see a flat curve over the life cycle. That said, there seems to be a somewhat higher stock proportion in younger life stages in our sample compared to market data (see Benzoni, Collin-Dufresne and Goldstein).

Thirdly, we find that the most cyclical industries hold the highest stock proportions. This is not consistent with diversification principles. These individuals have a more stock-like human capital, which may be correlated to the economic cycle and stock market returns. To counterbalance, and thus gain the most from diversification, they should hold a more bond-like financial portfolio.

Lastly, when it comes to composition of risky assets, there seems to be an overall high level of Norwegian stocks in the individual portfolios. In the scenario where returns of individuals' human capital is more correlated with the domestic stock market than it is with the foreign, the risk associated with human capital can be more efficiently hedged if an individual holds a financial portfolio which is internationally diversified.

Another interesting result is the fact that individuals working in the oil & gas sector hold the largest proportion of commodity funds, which are highly weighted in oil & gas. This may be explained by the familiarity bias. These individuals might have invested in commodity funds due to the familiarity of the investment. Despite the seemingly obvious gains from diversification. This can lead to misallocated suboptimal portfolios and loss of diversification benefits which can be directly linked to the economic wealth.

The total wealth perspective can help financial advisors build their clients' portfolios more efficiently. We hope that this study will bring awareness, guidance and knowledge about human capital as an asset class, as well as show its impact on portfolio asset allocation. In such ways, we believe the study can contribute to higher quality in financial advisory, higher gains from diversification and thus, increased welfare.

References

Heaton, J., & Lucas, D. (2000b). Portfolio Choice in the Presence of Background risk. *The Economic Journal*, 1-26.

Ameriks, J., & Zeldes, S. (2004). *How do Household Portfolio Shares vary with age?*

Blanchett, D., & Straehl, P. (2014). *No portfolio is an island.* Morningstar, Morningstar Investment Management, Chicago.

Bodie, Z., Merton, R., & Samuelson, W. (1992). Labor Supply Flexibility and Portfolio Choice in a Life Cycle Model. *Journal of Economic Dynamics and Control*, 427-449.

Brooks, C. (2014). *Introductory Econometrics for Finance.* Cambridge: Cambridge University Press.

Byrnes, J., Miller, D., & Schafer, W. (1999). Gender Differences in Risk Taking:A Meta-Analysis. *Psychological Bulletin*, 367-383.

Campbell, J. Y. (2006). Household Finance. *The Journal of Finance,* 1553–1604.

Charness, G., & Gneezy, U. (2011). Strong Evidence for Gender Differences in Risk Taking. *Journal of economic Behaviour & Organization*, 50-58.

Fama, E., & Schwert, G. (1977). Human Capital and Capital Market Equilibrium. *The Journal of Finance*, 115-130.

Goldstein, R., Collin-Dufresne, P., & Benzoni, L. (2007). Portfolio Choice over the Life Cycle when the Stock and Labor Markets are Cointegrated. *The Journal of Finance*, 2123-2167.

Gomes, F., & Michaelides, A. (2004). *A Human Capital Explanation for an Asset Allocation, working paper* .

Jianakoplos, N., & Bernasek, A. (1998). *Economic Inquiry*.

Markowitz, H. (1952). Portfolio Selection. *The Journal of Finance* , 77-91.

Mayers, D. (1972). Nonmarketable assets and capital market equilibrium under uncertainty. In M. J. (ed), *Studies in the theory of capital markets.* New York: Praeger.

Merton, R. (1969). *Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case.*

Merton, R. (1969). Lifetime Portfolio Selection under Uncertainty: The Continuous-Time Case. *The Review of Economics and Statistics*, pp. 247-257.

Merton, R. (1971). Optimum consumption and portfolio ruled in a continous-time model. *The Journal of economic theory*, 373-413.

Merton, R. C. (1973, September Volume 41). An Intertemporal Capital Asset Pricing Model. *Econometrica*, pp. 867-887.

Mork-utvalget. (2016). *Norges offentlige utredninger- Akjeandelen i Statens pensjonsfond utland.*

Mossin, J. (1968). Optimal Multiperiod Portfolio Policies. *Journal of Business*, 215-229.

Norges Bank. (2017). *Investeringsstrategien for Statens pensjonsfond utland.* Oslo .

Powell, M., & Ansic, D. (1997). Gender differences in risk behaviour in financial decision-making: An experimental analysis. *Journal of Economic Psychology*, 605-628.

Samuelson, P. (1969). Lifetime Portfolio Selection by Dynamic Stochastic Programming. *The Review of Economics and Statistics*, 239-246.

Viceira, L. M. (2001). Optimal Portfolio Choice for Long-Horizon Investors with Nontradable Labor Income. *The Journal of Finance*.

Wachter, J. A. (n.d.). *Gains from diversification for 2 risky assets.*

Yao, R., & Sherman D., H. (2005). The effect of gender and marital status on financial risk tolerance. *Journal of personal finance*, 66-85.

Appendix

Appendix 1: Sector classification

Descriptive statistics	Public Sector		
	Obs	Mean	Std Dev
Total (age)	695	46,56	10,13
Fund holdings in NOK:			
Stocks		83 656,08	211 019,73
Bonds		35 358,58	123 528,72
Share			
Stocks		0,78	0,34
Bonds		0,22	0,34

Descriptive statistics	Private Sector		
	Obs	Mean	Std Dev
Total (age)	1415	45,85	10,40
Fund holdings in NOK:			
Stocks		125 266,15	256 995,55
Bonds		56 645,87	360 944,73
Share			
Stocks		0,83	0,30
Bonds		0,17	0,30

Descriptive statistics	Banking & Finance		
	Obs	Mean	Std Dev
Total (age)	47,00	45,06	11,20
Fund holdings in NOK:			
Stocks		64 862,51	96 974,87
Bonds		30 712,20	91 552,48
Share			
Stocks		0,84	0,31
Bonds		0,16	0,31

Descriptive statistics	Retiree / Disability Pension		
	Obs	Mean	Std Dev
Total (age)	161,00	66,02	9,87
Fund holdings in NOK:			
Stocks		310 579,23	1 887 483,79
Bonds		214 964,49	751 568,97
Share			
Stocks		0,64	0,40
Bonds		0,36	0,40

Descriptive statistics	Oil & Gas		
	Obs	Mean	Std Dev
Total (age)	195	45,75	9,89
Fund holdings in NOK:			
Stocks		160 263,76	249 648,88
Bonds		53 631,33	159 060,56
Share			
Stocks		0,85	0,26
Bonds		0,15	0,26

Descriptive statistics	Shipping		
	Obs	Mean	Std Dev
Total (age)	43	48,47	9,36
Fund holdings in NOK:			
Stocks		77 242,24	104 961,22
Bonds		5 048,88	14 917,01
Share			
Stocks		0,89	0,21
Bonds		0,11	0,21

Descriptive statistics	Construction		
	Obs	Mean	Std Dev
Total (age)	78,00	42,60	8,90
Fund holdings in NOK:			
Stocks		29 871,00	115 474,13
Bonds		99 985,53	194 158,55
Share			
Stocks		0,85	0,28
Bonds		0,15	0,28

Descriptive statistics	Seafood		
	Obs	Mean	Std Dev
Total (age)	12,00	40,08	9,42
Fund holdings in NOK:			
Stocks		11 563,04	22 257,77
Bonds		115 619,83	140 957,26
Share			
Stocks		0,88	0,29
Bonds		0,12	0,29

Appendix 2: Life cycle stages - separation

Descriptive statistics yrs 0-30	Obs	Mean	Std Dev
Demograhics			
Age Female	89	26.2966	2,5954
Age Male	127	27,1653	3,1440
Female			
Fund holdings in NOK:			
Stocks		58 714,89	145 316,42
Bonds		40 980,93	128 530,67
Share			
Stocks		0,78	0,31
Bonds		0,22	0,31
Male			
Fund holdings in NOK:			
Stocks		55 665,33	113 692,66
Bonds		12 264,73	34 853,67
Share			
Stocks		0,82	0,29
Bonds		0,18	0,29

Descriptive statistics yrs 31-40	Obs	Mean	Std Dev
Demograhics			
Age Female	221	36,01	2,77
Age Male	347	36,20	2,82
Female			
Fund holdings in NOK:			
Stocks		63 445,15	96 470,48
Bonds		22 591,23	79 764,41
Share			
Stocks		0,80	0,33
Bonds		0,20	0,33
Male			
Fund holdings in NOK:			
Stocks		83 678,45	176 998,39
Bonds		19 132,08	85 327,15
Share			
Stocks		0,87	0,26
Bonds		0,13	0,26

Descriptive statistics yrs 41-50	Obs	Mean	Std Dev
Demograhics			
Age Female	323,00	45,63	2,79
Age Male	625,00	45,56	2,76
Female			
Fund holdings in NOK:			
Stocks		91 593,66	218 964,77
Bonds		40 859,88	170 668,03
Share			
Stocks		0,79	0,32
Bonds		0,21	0,32
Male			
Fund holdings in NOK:			
Stocks		115 092,18	225 541,10
Bonds		23 278,59	130 044,19
Share			
Stocks		0,87	0,27
Bonds		0,13	0,27

Descriptive statist yrs 51-66	Obs	Mean	Std Dev
Demograhics			
Age Female	318,00	56,71	4,40
Age Male	535,00	57,44	4,41
Female			
Fund holdings in NOK:			
Stocks		111 047,56	166 822,13
Bonds		84 322,17	339 104,36
Share			
Stocks		0,73	0,36
Bonds		0,27	0,36
Male			
Fund holdings in NOK:			
Stocks		169 920,77	334 003,39
Bonds		99 594,00	526 367,56
Share			
Stocks		0,80	0,32
Bonds		0,20	0,32

Descriptive statistics yrs 67+	Obs	Mean	Std Dev
Demograhics			
Age Female	40,00	72,10	4,37
Age Male	82,00	71,80	4,38
Female			
Fund holdings in NOK:			
Stocks		157 824,36	232 324,72
Bonds		153 925,20	249 660,68
Share			
Stocks		0,59	0,42
Bonds		0,41	0,42
Male			
Fund holdings in NOK:			
Stocks		600 479,97	2 636 524,82
Bonds		312 906,17	966 880,68
Share			
Stocks		0,62	0,40
Bonds		0,38	0,40

Master Thesis

BI Norwegian Business School

Preliminary Master Thesis

Hand-in date:
15.01.2018

Campus:
BI Oslo

Supervisor:
Espen Henriksen

Programme:
MSc in Business (Finance) / Financial Economics

Master Thesis

In this thesis, we are interested in trying to understand how Norwegian households consider the properties of their non-financial assets when making their portfolio choices, and if they do not, what can be the reasons? In addition, how big are the potential gains of doing so?

The household selection and allocation issue is an important theme to researchers and policy makers. Theory tells us that intertemporal decisions and wealth management should take *all wealth* into account. Hence, decisions on the level of financial risk-taking and portfolio composition of marketable financial assets must be seen in relation to the size and characteristics of other non-marketable income and assets, as well as the future use of these. In other words, a household's composition of financial assets must be seen in connection with size, risk and characteristics of the household's other balance (Mork-utvalget, 2016).
When examining market data, one can see that the stock proportion over the life cycle of an individual tends to be hump-shaped, for example: (Ameriks & Zeldes, 2004) and (Campbell, 2006). Middle-age investors have the highest proportion of stocks in their portfolio, whereas youth and the elderly have less. This indicates that people do actually consider the riskiness of their human capital (the net present value of future labor income) when making portfolio choices. Otherwise we would expect a flat curve over the life cycle. There are, however, many remaining questions on what extent household do take their entire wealth into account when making decisions on the financial part of their portfolio.

The topic has great importance both on a national and individual level. One can also argue that the topic is of great significance for portfolio advisors and their field. On a macro-level, increased value through diversification will maximize the long run welfare of households. The welfare gain also settles on a household/individual level when assuming that individuals will always prefer more to less, but at a decreasing rate. From the point of view of a portfolio advisor, greater knowledge of this topic will potentially increase value for their customers. Accordingly, such information would contribute to higher revenues and a better reputation in the marketplace.

There are few nations, which face similar challenges as Norway, considering our position within oil and gas exports. This might explain why there are no current studies on Norwegian data within the field of household portfolio compositions, when taking nonfinancial risk (human capital) into account. (Mork-utvalget, 2016)

Consistent with theory, the Norwegian Bank Investment Management (NBIM) on November 14th 2017 advised to the Ministry of Finance that oil and gas stocks should be removed from the oil fund's benchmark (Norges Bank, 2017). Their main point is that the national wealth of Norway is overexposed to the sector and that the fund therefore should sell this segment of the portfolio to add value through diversification. In other words, the NBIM 's starting point is that the properties of non-financial assets should be taken into consideration when making financial portfolio choices. The managers of our national wealth wish to proceed in the same direction as theory underlines, and consider both non-financial and financial assets, and the correlation between them in the optimal portfolio composition of our investment fund. But how do households make these considerations?

Literature Review

When considering our questions in the light of previous research, one can see that classical contribution, in terms of portfolio composition, did not include non-marketable assets at all. In other words, they implied that all income was derived from financial marketable assets.

Static models

In the 1950's, Harry Markowitz published his pioneering contribution to the field of financial economics. He developed a theory on household optimal portfolio allocation under uncertainty. The Markowitz model presents the mean- variance analysis where individuals ought to make optimal portfolio decisions based on balancing the expected return and the riskiness of each asset. His model embodies the power of diversification principles. Markowitz argues that by investing in assets which are not perfectly correlated, investors can reduce risk (by elimination of unsystematic risk) through diversification. Markowitz also argues that investors

tend to choose portfolios that generate the highest possible return, with the least amount (or a given amount) of risk. This set of investment opportunities were later to be known as *the efficient frontier.* An efficient frontier is a set of portfolio returns that maximizes return for a given level of risk, or equivalently the minimum variance portfolio for a given level of return (Markowitz, 1952). The Modern Portfolio Theory, as it is referred to, can be considered as groundbreaking at that time within the field of portfolio selection. Despite this, the model has some drawbacks: The theory is based on strong assumptions such as frictionless and complete financial markets where investors, as an example do not pay taxes or transaction costs which can be argued to be unrealistic.

When introducing a risk-free alternative, where investors have the opportunity to borrow and lend at the risk-free rate and investors can diversify away all risk except the covariance of an asset with the market portfolio (Capital Asset Pricing Model). The efficient set becomes a straight line (Capital Market Line) from the expected return of the risk-free asset, tangent to the efficient frontier.

The market portfolio is obtained at the tangent point. Investors should choose a portfolio which lies on the CML. The proportion of risky assets, however, will be dependent on individual risk aversion.
The Markowitz and CAPM models are one period models who insufficiently explain the life cycle allocation issue, which would rather be expressed as a multi period model which is discussed in the following chapter.

Dynamic models

Early contributions on dynamic portfolio choices where financial markets exist in isolation are the models of Mossin (1968), Merton (1969) and Samuelson (1969) (MMS). These early contributions have sharp predictions: Investors should, independent of age, participate in the stock market. The framework also assumes complete markets and the absence of labor income and the stock share of the portfolio should not vary over the life cycle. Hence, the MMS model implications are in contrast with the hump-shaped stock participation function.

There are also models of portfolio choice where financial markets do not exist in isolation. Merton (1973) developed the intertemporal CAPM (ICAPM). The

model is an extension of the CAPM taking multi periods into account. The intertemporal model is consistent with both the expected utility maxim and the limited liability of assets. Compared to the one-period model, the uncertainty of changes in future investment opportunities are taken into consideration when constructing ones portfolio. It captures effects that would never appear in a static model. Although, labor income and consumption goods, whose relative prices change over time are two important factors that the model does not take into account (Merton R. C., 1973).

Nonfinancial assets and portfolio composition

Merton (1971) was one of the earliest contributions to include riskless tradeable human capital in a complete market setting. He argued that that the presence of riskless tradable human capital creates a strong incentive to participate in the stock market early in the lifecycle. At that point, the human capital holds the same characteristics as a large endowment of riskless bonds. Hence, one is able to take on more risk. As we approach retirement, the value of our human capital decreases. Thus, one should rebalance the portfolio towards less riskier assets.

Others who emphasized the importance of nonfinancial assets for portfolio composition were (Mayers, 1972) and (Fama & Schwert, 1977). Bodie, Merton, and Samuelson (1992) also include nonfinancial assets in their model. They examine the effect of the labor-leisure choice of portfolio and consumption decisions over an individual's life cycle (Bodie, Merton, & Samuelson, 1992). They argue that individuals with greater flexibility in labor, such as working extra hours, having multiple jobs or postponing retirement, should invest a greater portion of wealth in risky assets compared to individuals with lesser labor flexibility. They state that labor income varies much less than stock returns over time and that the correlation between them is close to zero. Therefore, labor income carries the same portfolio characteristics as bonds. As a young individual, the present value of your future labor income is high, which is comparable to having significant wealth consisting of bonds. Hence, in a young household, savings should be almost exclusively stock based. As the household grows, the value of future income will gradually decrease and to rebalance their portfolio, the

household will reduce the stock portion and increase the bond portion (As proposed by Merton 1971). Empirical studies, however, show a different result: a hump-shaped function over the proportion of stocks held over the lifetime of individuals. Middle-age investors tend to have a relatively larger proportion of stocks compared to younger and older individuals, indicating that people do actually consider the riskiness of their human capital (labor income) when making portfolio choices. Otherwise we would expect a flat curve over the life cycle.

Luca Benzoni, Pierre Collin-Dufresne and Roberts Goldstein explained this hump-shape further in a paper from 2007. They showed that although immediate correlation between labor income and stock returns are close to zero, there also seems to be a positive correlation between changes in labor income and stock returns five-to-fifteen years ahead. This indicated that for a young household with a long labor time horizon, the value of their future income will have a positive correlation with stock returns. Hence, the labor income of young households will have many of the same characteristics as stock and to rebalance their portfolio, they should invest a larger proportion in bonds. A middle-age household approaching retirement will have a value of future labor income with characteristics more similar to bonds and can therefore take on more stocks (risk) in their portfolio (Goldstein, Collin-Dufresne, & Benzoni, 2007)
Human capital (in the form of labor income) is also taken into account in the models of Viceira (2001), Heaton and Lucas (2000b) and Gomes and Michaelides (2004). Viceira (2001) examines how risky labor income and retirement affect optimal portfolio choice of individuals. He argues that increased unsystematic labor income risk raises the willingness for the investor to save, and therefore they reduce the stock proportion of their portfolio. His findings support the argument that people should invest more in stocks when they are working than when they are retired. When labor income risk is unsystematic, this advice is always wealth maximizing and the proportion of the portfolio invested in stocks is positively related to the retirement horizon of the investors (Viceira, 2001). Which is partly consistent with the hump-shape model, at least from middle-aged to retirement age.

Based on empirical estimates of the correlation between stock returns and individual earnings, Gomes and Michaelides (2004) show labor income is a closer substitute to long-term bonds than to stocks. As a result, more risk averse investors hold a smaller proportion of their risky portfolio in equities. Moreover, this explanation is consistent with the recommendation that younger households should be more heavily invested in stocks than older households (Gomes & Michaelides, 2004). Heaton and Lucas have also made contributions within the field of risk and household investments, taking risky nonfinancial assets into account. They published two important papers in 2000. The most comprehensive study by Heaton and Lucas is Heaton and Lucas (2000b) where they improve their first study by focusing on how background risk from human capital (labor income) and entrepreneurial income influences portfolio allocations instead of focusing on income risk of entrepreneurs alone, as they did in Heaton and Lucas in 2000a. Their findings suggest that there is heterogeneity in exposure to background risk, and that a household more exposed to background risk (labor and entrepreneurial income) tends to hold smaller proportions of stocks in their portfolios (Heaton & Lucas, 2000b). Hence, the greater the risk of your nonfinancial assets (in the form of human capital), the lesser the risk you should take in your financial portfolio.

Data

We have been in touch with the wealth management department of a well-known bank in Norway. Our goal is to get as much information as possible on a selected number of individuals-

- Financial portfolio (from fund placements, both national and international)
- Nonfinancial: where do they work(the source of their labor income)
- How old are they
- Where in Norway do they live?
- Debt?
- Other assets?