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COGNITIVE BIASES AMONG MILLENNIAL INVESTORS IN FINLAND AND THEIR EFFECT ON TRADING ACTIVITY IN VOLATILE MARKET CONDITIONS

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ABSTRACT

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During the 1980s academic researchers understood that people do not always act rationally on the stock market, which eventually lead to the inception of behavioral finance. Thereafter, researchers have devoted a substantial effort over the years in understanding equity investment behavior of market participants. Since millennials (people born between 1980-2000) have been exposed to information technology and social media from an early age, they are said to be particularly different than the older generations. This would indicate that their investment behavior could also be different compared with the older generations. This research studied eight cognitive investor biases among Finnish millennials, and how these biases have affected individual investors' trading activity during volatile market conditions throughout the corona crisis. A sample of 440 observations was collected with an online questionnaire, and the data was analyzed by using descriptive statistics, self-organizing maps (SOM), and fuzzy-set qualitative comparative analysis (fsQCA).

The findings of this study show that the most common cognitive biases among Finnish millennials are anchoring, representativeness, overoptimism, and herding. The results also suggest that women are more prone to experiencing these biases in general and that more educated individuals have lower levels of biases. The biases that have most affected individuals' trading activity during the corona crisis were overconfidence, hindsight bias, and loss aversion.

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Akateemiset tutkijat ymmärsivät 1980-luvulla, että ihmiset eivät aina toimi rationaalisesti osakemarkkinoilla. Nämä löydökset johtivat lopulta behavioristisen rahoituksen syntymiseen, jonka jälkeen tutkijat ovat vuosien mittaan pyrkineet ymmärtämään markkinaosapuolten sijoituskäyttäytymistä. Altistuttuaan informaatioteknologialle ja sosiaaliselle medialle jo varhaisesta iästä lähtien, milleeniaalien (vuosina 1980–2000 syntyneet ihmiset) sanotaan eroavan selvästi vanhemmista sukupolvista. Tämä viittaisi myös siihen, että milleeniaalien sijoituskäyttäytyminen saattaisi erota vanhemmista sukupolvista. Tässä tutkimuksessa tutkittiin sijoittajien kahdeksaa kognitiivista vinoumaa ja niiden vaikutusta nuoremman sukupolven kaupankäyntiaktiivisuuteen viimeaikaisissa epävakaissa markkinaolosuhteissa. Tutkimuksen 440 havainnon otos kerättiin Internet-kyselylomakkeella, ja siitä saatu data analysoitiin käyttämällä kuvaavia tilastoja, itseorganisoituvia karttoja (SOM) ja kuvailevaa vertailevaa analyysiä (fsQCA).

Tämän tutkimuksen tulokset osoittavat, että suomalisten milleeniaalien yleisimmät kognitiiviset vinoumat ovat ankkurointi, ”edustavuussääntö”, liiallinen optimismi ja laumakäyttäytyminen. Tulokset viittaavat myös siihen, että naiset ja vähemmän koulutetut henkilöt ovat yleisesti enemmän alttiimpia vinoumille. Koronakriisin aikana eniten henkilöiden kaupankäyntiaktiivisuuteen vaikuttaneet vinoumat olivat liiallinen itseluottamus, ylioptimistisuus sekä tappioiden karttaminen.

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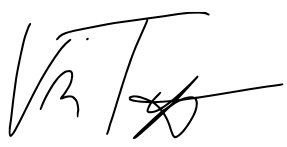
When I started by journey in LUT back in 2014, I didn't know what to expect. In the beginning, I wasn't even completely sure if I was studying the right subject as there were other things in life that felt more interesting and important at the time. However, with help of friends and fellow students, I slowly understood that this is the place for me.

They say time flies when you're having fun, and I couldn't agree more when thinking about these six years in LUT and Lappeenranta. Along the way I have gotten so many new skills, friends, and memories which will hopefully last for years to come. In addition, I've understood which subjects I'm most interested in, which was something I definitely didn't know back in 2014.

The Thesis project was mentally quite challenging as I was also working besides of my studies. The coronavirus epidemic also didn't help the situation as all libraries were closed, and I had to learn new routines along the way. The project offered a severe amount of stress and discomfort but also feelings of success and joy as I was able to write about a subject I really like. I want to thank my examiners for leading me throughout the process, and understanding my tight schedule to graduate. I also want to thank a couple of fellow students for peer support. Without you I'm not sure if I could have graduated in time. In addition, I want to thank my closest manager at work, who gave me freedom and flexibility to finish my studies on time. Last, I want to thank my family who supported and pushed me along the six years. Without you, I also couldn't have experienced my dream of studying a year in the U.S.

I couldn't be more satisfied that I chose to study in LUT. It has been enjoyable to see how the school has developed throughout the years, and I sincerely believe that LUT will continue its development and it will be even a better place to study for future students.

In Espoo, 22.6.2020



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LIST OF ABBREVIATIONS

OS	Overconfidence and Self-Attribution
HIND	Hindsight Bias
OVEROP	Overoptimism
ANCH	Anchoring
REP	Representativeness
LOSS	Loss Aversion
HERD	Herding
MA	Mental Accounting
TRADA	Trading Activity
MLA	Myopic Loss Aversion
SOM	Self-Organizing Map
FSQCA	Fuzzy-Set Qualitative Comparative Analysis

1. INTRODUCTION

In order to better understand fluctuations of the stock market, academic researchers have devoted a substantial effort over the years in understanding equity investment behavior of market participants. Today's academia recognizes two major branches of finance, traditional or standard finance, and behavioral finance. The first mentioned theory with its market efficiency hypothesis and rationality was generally considered fully valid until the 1980s. Even before, several small market anomalies had been identified but their impact was considered so marginal that they did not really threaten the market rationality hypothesis. During the 1980s, many scholars brought forward excessive volatility in stock prices into public debate, which by the time could not be explained by rational fundamentals. According to the model of an efficient market, prices at a given moment should reflect the optimum forecasts of future earnings (dividends). However, high volatility on the stock market during the 1980s could not alone be explained by fluctuations in future dividend flows. This led to a broad search for new behavioral causes that could better explain the phenomena, which eventually led to be the foundation for behavioral finance. (Shiller, 2003; Malkiel, 2003)

This Master's thesis focuses on the millennial generation in Finland, their cognitive biases, and how these biases have affected individuals' trading activity in volatile market conditions during the corona crisis. The age range for millennials, also known as Generation Y, differs slightly in the literature but in general they are said to be born between 1980 and 2000. As the large generations are gradually retiring from the workforce during the next decade, millennials will account for the majority of the available working hours in Finland, but also elsewhere around the world. According to Kontio & Tapio (2017) the generation will also become increasingly influential in the future with their continuously increasing financial assets. The generation's views, values, and perceptions of the future and lifestyle will most probably also affect their investment behavior, which makes studying them enormously relevant for the financial sector.

Even if both cognitive biases and investment behavior have been studied earlier, there is only a limited amount of research on cognitive biases among millennial

investors and millennials' investment behavior in general. As there are notable differences between the generations (Wheelwright, 2010, 47–52), this research will supplement existing literature on behavioral biases and equity investment behavior. This study is also needed as according to Lester, Forman & Lloyd (2005, 125) millennials are believed to be clearly different compared with the previous generations since they have been notably influenced by the Internet, social media, and information technology from a very early age. Authors like Barkhi and Wallace (2007) have also suggested that personality traits heavily influence consumer purchasing behavior. These factors among others indicate that millennials' investment behavior could also be very different compared with earlier generations (Generation X and Baby Boomers) particularly since the process of investing in the equity market has also changed significantly with technological development. Earlier almost all equity investments were made on the phone, where individuals usually called a broker and told the person what to do. In such, the interaction between the investor and the broker was much more noteworthy compared to today's Internet based equity investing. The use of Internet has also made today's equity investing much more easy and effortless. (Barber, 2001) Since the majority of millennials have most probably started equity investing within the last ten years, they have experienced a long growth market without any substantial bear markets. Combined with the fact that buying and selling equity investments are nowadays just a couple of clicks away, the interest in this research is also whether these millennials have kept their composure on the stock market or have they made spontaneous portfolio moves when they have seen their holdings lose value. Furthermore, it should also be noted that individual characteristics tend to differ when comparing population by country. For example, the biases in collective-oriented societies can be totally different when compared to more individualistic cultures. (Hofstede, 1980) Therefore, research for example on American millennials can have completely different results than similar kind of studies conducted in Asia or Europe. While the population by countries differ by cultural values and dimensions, also the life situations can vary drastically. For example, millennials in the U.S. most probably have bigger student loans than their counterparts in Finland. This is also one reason why studying the age cohort in different parts of the world is important and interesting.

The subject of this thesis has also economical and societal importance. Currently, the majority of Finnish households hold their monetary assets in regular bank accounts with marginal or zero interest. According to Bank of Finland's recent statistics, households had over 100 billion euros deposited on bank accounts at the turn of the year, while shares and equity funds only held 54 billion euros at the same time. Domestic companies accounted for over 90% of the equity investments. (Bank of Finland, 2020) In order to encourage households move their investments from bank account deposits to listed company shares, and to enhance the capital flow towards companies in the Helsinki Stock Exchange, the Finnish Parliament accepted the law initiative on equity savings accounts by The Finnish Ministry of Finance in March 2019. From the beginning of 2020, any individual person (natural person) regardless of age in Finland has had the opportunity to open an equity savings account in a bank or a financial institute. The product itself has a deposit limit of 50.000 euros, but the value of the investments can be higher or lower than this. The benefit of the account is that you can buy and sell listed shares without having to pay tax on individual sales, and receive dividend income also without getting taxed. The profit of the sales and dividends are taxed only when the money is withdrawn from the account. Every citizen is only to allowed to have one equity savings account at a time. (Finnish Ministry of Finance, 2018) According to Euroclear Finland's recent statistics, there are over 100.000 opened equity savings accounts as of beginning of May 2020. Millennials (ages 18-39) represent for over 50% of the opened accounts while the market value of the investments account for roughly 35%.

Age Distribution	# of accounts	% share	Market value	% share
-17	7 403	7,4 %	8 493 233 €	2,5 %
18-29	28 615	28,4 %	44 688 753 €	13,3 %
30-39	26 750	26,6 %	75 121 626 €	22,4 %
40-49	16 615	16,5 %	71 787 523 €	21,4 %
50-59	11 262	11,2 %	67 513 114 €	20,2 %
60-	8 488	8,4 %	64 819 379 €	19,3 %
foreign	1 585	1,6 %	2 564 049 €	0,8 %
	100 718	100,00 %	334 987 676 €	100,00 %

Table 1: All Equity Savings Accounts

Source: Euroclear Finland, 2020

Out of the opened equity savings accounts (100.718 in total) men have opened the clear majority of the accounts with around 72%. From Table 3 we can also see that men representing the millennial generation have also been the most active in terms of opening accounts (57,6% of all men). The same kind of trend can be seen with millennial women although the percentage is not quite as high (51,1%). In terms of market value, there are substantial differences between the genders. Equity savings accounts of men represent for about 82% of the market value. Even if millennials have been most active in terms of opening accounts, their accounts' market value is understandably not quite as large compared to older generations (see Table 1.). According to Euroclear Finland's statistics the amount of Finnish shareholders has also grown with nearly 8% to 871.126 from the end of 2019 to beginning of April 2020. While there are probably many reasons for this, the equity savings account has certainly had an impact on the growth.

Age Distribution	# of accounts	% share	Market value	% share
-17	3 319	12,5 %	3 881 607 €	6,8 %
18-29	7 186	27,1 %	7 251 097 €	12,8 %
30-39	6 345	24,0 %	10 239 901 €	18,0 %
40-49	3 840	14,5 %	9 937 102 €	17,5 %
50-59	3 306	12,5 %	12 188 349 €	21,4 %
60-	2 485	9,4 %	13 337 551 €	23,5 %
foreign				
	26 481	100,00 %	56 835 607 €	100,00 %

Table 2: Equity Savings Accounts of women

Source: Euroclear Finland, 2020

Age Distribution	# of accounts	% share	Market value	% share
-17	4 084	5,6 %	4 611 626 €	1,7 %
18-29	21 429	29,5 %	37 437 656 €	13,6 %
30-39	20 405	28,1 %	64 881 725 €	23,5 %
40-49	12 775	17,6 %	61 850 420 €	22,4 %
50-59	7 956	11,0 %	55 324 765 €	20,1 %
60-	6003	8,3 %	51 481 828 €	18,7 %
foreign				
	72 652	100,00 %	275 588 021 €	100,00 %

Table 3: Equity Savings Accounts of Men

Source: Euroclear Finland, 2020

1.1. OBJECTIVES, DELIMITATIONS, AND RESEARCH QUESTIONS

As the millennial generation will have increasing amounts of financial assets available in the future, the goal of this thesis is to be able to give banks and other institutions offering financial products insight on millennial' investment behavior and what kind of behavioral biases they possess. The aim is also give these institutions tools that they could use in their marketing to steer members of the generation towards investing more in the equity rather than having their asset on interest-less bank accounts. The results of this study can also help financial service providers to comply with the Markets in Financial Instruments Directive (MiFID), which requires for example that individuals' risk tolerance and investment objectives should be taken into account when offering equity investment alternatives. In addition, the aim of this research is to educate millennial investors about cognitive biases and how they affect equity investment decisions. This research will also, hopefully, help millennial investors to evaluate themselves as investors and make them recognize potential pitfalls in their own investment behavior. Being aware of these factors can help investors make more profitable equity investments in the future.

This research will be delimited to only addressing Finnish millennial investors and their selected behavioral biases. The behavioral biases scrutinized in this study are

overconfidence, hindsight bias, overoptimism, anchoring, representativeness, loss aversion, herding, and mental accounting. It should be noted that academia also recognizes several other behavioral biases that will not be examined in this research.

There is one main research question and three sub-questions in this Master's thesis. The main research question is:

"Which cognitive biases have most affected trading activity of Finnish millennials in recent volatile market conditions?"

The sub-research-questions are:

"What kind of cognitive biases do millennial investors in Finland have?

"What kind of investor profiles are there in terms of behavioral biases among Finnish millennials?"

"How should investing be marketed for the generation"?

1.2. STRUCTURE OF THE STUDY

This research will be divided into five chapters. After the introduction chapter, the second section will present the elements in the theoretical framework. The chapter will introduce millennials' key characteristics, and what has been written about marketing for the generation. In addition, the second part will include an overview on behavioral finance and the cognitive biases examined in this research. The following chapter will encase methodology used in this research, accompanied by questionnaire design, and description of the collected data. Chapter four will be used to present the findings of the data analysis. The last chapter will discuss the implications of the findings and conclude on the results companied by a future research suggestion.

1.3. THEORETICAL FRAMEWORK

The purpose of a theoretical framework is to establish an understanding to the reader of how the concepts are related and linked in a research. It can be viewed as guideline for the reader how the theory is linked to the research problem. The theoretical framework of this study combines millennials and investors' cognitive biases. By understanding the main characteristics of the generation and merging it with their investment behavior, the goal is to be able to give financial institutions insights how they could better market equity investing for them.

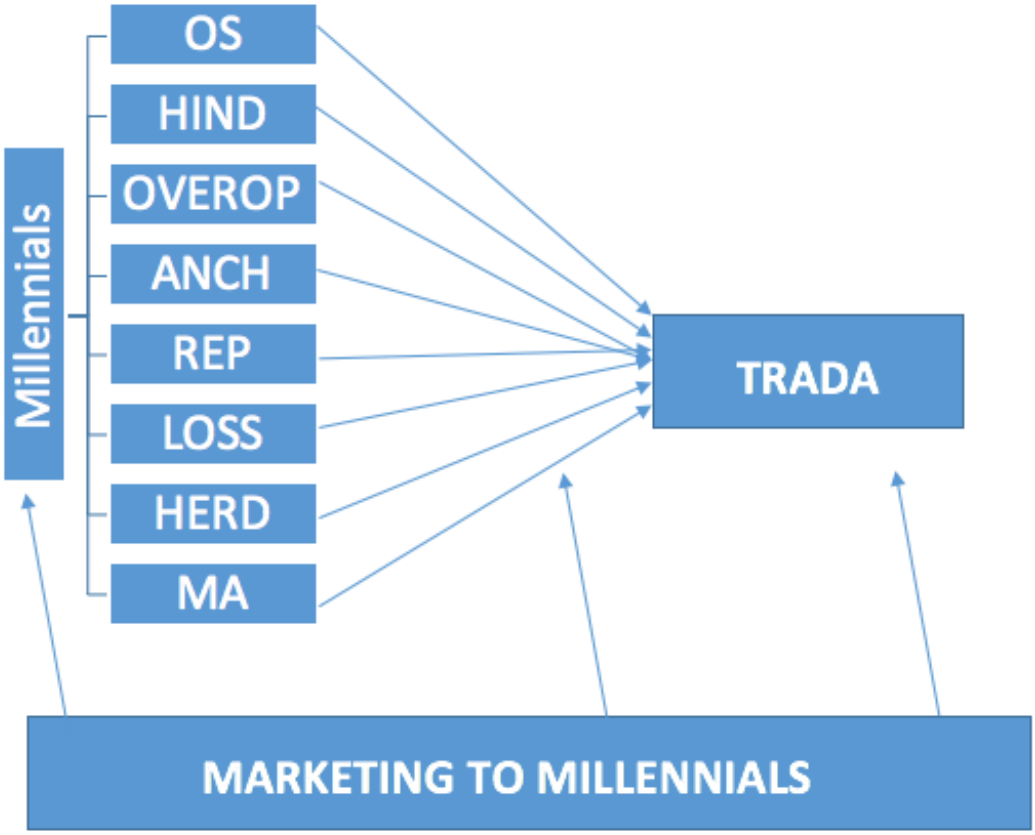

Figure 1: Theoretical framework

2. THEORETICAL BACKGROUND

This section of the paper presents the elements in the theoretical background, which also serve as the foundation for this research. First, the millennial generation and their key characteristics are introduced, which will be continued with a short section on marketing to the generation. Next, behavioral finance is briefly explained. The chapter will be concluded by introducing the cognitive biases that examined in the study, starting with heuristic driven biases and then moving on to frame dependent biases.

2.1. THE MILLENNIAL GENERATION

Millennials, Generation Y, Generation Next, Generation Me, this certain age group has a wide variety of names in the academic literature, but in general they prefer the first mentioned term. The term will also be the most used one in this research. Commonly, the generational experts Neil Howe and William Strauss (2000) are recognized for creating the phrase in 1987. As with the names, also the age range for the generation varies in the literature and sometimes the generation is even split in half. However, according to Weingarten (2009) and LaCore (2015) millennials range from people who were born between 1980 and 2000, and they are generally children of Baby Boomers and people from Generation X. The first mentioned generation consists of people born between the end of World War II and 1964, while the latter mentioned comprise of people born between 1965 and 1979 (Whitehouse & Steele Flippin, 2017).

Generational theorists, such as Howe & Strauss (2000), propose that environmental, economic, political, and social factors at a global level cultivate different consumer behavior patterns for people born at different times. In fact, the foundation for the generations lie in the tendencies and characteristics associated with individuals born approximately the same time in history. (Twenge, Campbell, Hoffman & Lance, 2010). As the world have drastically changed over the years, Wheelwright (2012, 47–52) suggests that the generations have major differences between them. Moreover, Lester et. al. (2005) believe that especially millennials differ considerably

from the earlier age cohorts having being exposed to information technology so early in their lives.

A review of millennial characteristics in the academic literature suggest that the generation want everything, and they want it fast. As the name Generation Me proposes, millennials tend to put more importance on themselves than the previous generations, which could be one reason why older generations often even see millennials as bad-mannered (DeVaney, 2015). Compared with the older generations, millennials tend to have more individualistic characteristics, which can for example be seen in valuing quality of life and work-life balance more rather than having a big paycheck (Syrett & Lamminman, 2004, 72). Having seen their parents work for long hours and spend much time away from home, only to get laid off by big corporations, millennials often have different expectations towards work life than Baby Boomers and Generation X (Loughlin & Barling, 2001). Lancaster & Stillman (2003) and Dries, Peperman & Kerpel (2008) add that millennials are also more likely to want an intrinsically rewarding job and rapid advancement in the corporate ladder. An intrinsically rewarding job usually offers enough challenge, responsibility, and variety (Deci & Ryan, 2000). The combination of having big expectations towards work life but still not wanting to put as much effort as before demonstrates the imbalance millennials' have regarding work. This could be linked with the increased amount of narcissistic characteristics among the generation as narcissism is often linked for example with overconfidence. On the other hand, Twenge et al. (2010) also suggest that older generations would value intrinsic rewards more than millennials, leaving the question about intrinsic values in work a little bit open. However, authors seem to agree on the fact that millennials are more socially responsible than for example their parents. The generation is also not afraid to switch their employer if a company's value does not support their own views.

Millennials tend to have a strong sense of identity and often like to go against the main stream. Among the generation, going against the main stream is frequently seen as being "cool", which is also a key characteristic of the cohort. Moreover, millennials are considered the most ethnically diverse of all the generations, and since the generation has travelled more than the earlier generations, they have become more open-minded and have established more tolerance towards other

cultures. These factors have even made some millennials think that it is impossible to do generalizations about the generation. (Furlow, 2011, 62)

As stated previously, millennials have been exposed to the Internet and social media early in their lives, which has lead to them being dependent on using technology. Therefore, millennials are commonly recognized as “digital natives”, whereas the older generations are considered “digital immigrants” having appeared online after spending a majority of their lives first offline. (Guo, Dobson & Petrina, 2008) As the younger generation is continuously connected through their smartphones, an essential characteristic of the millennials is also said to be multitasking. Not only do they like it, but usually they are good at doing multiple things at the same time. The continuous information flow through their smartphones also makes the generation to look for quick and flexible alternatives that are accessible on the go. While multitasking and constant connectivity have their upsides, many critics suggest that millennial lifestyle is too hectic, resulting in millennials being more anxious, stressed out, and sleep deprived than the older generations. (Alsop, 2008) In addition, the cohort is believed to have an increasing amount of problems in attention, social abilities, and in traditional skills like reading and writing. According to Carr & Ly (2009) millennials are commonly averse to reading, and like their media as short visual messages. The addiction to smartphones and consuming social media have even caused various phenomena that were previously unknown. The overabundance of alternatives to choose from have created a phenomenon called FOMO, the fear of missing out. Individuals who experience FOMO have a constant need to search for alternatives while giving less value to the present involvement. The overwhelming amount of information have also shaped millennials to speedy decision-makers. (Sashittal, Hodis & Sriramachandramurthy, 2015)

The technological development combined with the individual characteristics have also lead to an increase in “adultolescents”, young adults who postpone their transition to adulthood. Millennials are said to be more dependent on their parents both financially and emotionally than the older generations. Shaputis (2004) have even named millennials as the “Peter Pan generation” because of for example often getting married later than Baby Boomers and Generation X. Furthermore, Vizwanathan and Jain (2013, 487) suggest that millennials are often unable to think

about the outcomes of their choices and actions. Therefore, they are more likely to consult their friends and family when making long-term decisions, such as investments in the equity market or marriage.

2.2. MARKETING TO MILLENNIALS

As already stated, millennials' buying power is constantly increasing, which have made the generation an attractive target for many consumer industries. The marketing communication that once worked well with their parents is now being rejected by the younger generation, which has lead marketers look for alternative channels to reach with the millennials. Having grown up socializing and shopping in the Internet, marketers have shifted their focus to digital marketing to better reach with the generation. Digital marketing refers to promoting products and services online using a wide variety of channels such as smart phones, social media or computers. (Smith, 2012) According to Okazaki, Katsukura & Nishiyama (2007) it is the most promising way to communicate with the age cohort since most of them are connected to their device almost around the clock.

In terms of digital marketing, millennials tend to prefer online coupons and email marketing, while visually pretentious websites often also manage to secure attention of the younger generation (Smith, 2012). However, some researchers have also found out that some forms of digital marketing, such as banner marketing on websites or pop-up ads, are often seen annoying. The negative effect can also occur if the online advertisement hinders with individual's purchasing process. (Truong & Simmons, 2010)

Gerzema and D'Antonio (2011) state that millennials also have a tendency to act as market mavens, meaning that they have general product knowledge and they are eager to help others with the information imbalance. As the Internet have helped millennials to express their opinions freely, word-of-mouth (WOM) and online reviews have become increasingly important sources of information when buying products or services. As already mentioned, the generation likes to consult their friends and family when making making big decisions, and the same applies for purchases.

Many millennials view opinions of their fellow consumers much more trustworthy than traditional media or information provided by the selling company. Being satisfied of the purchased product or getting a compensation offer also regularly initiates millennials to write these reviews. (Smith, 2012) According to word-of-mouth is seen more credible than advertising because it is perceived as evaluation by “people like me.” Keller (2007) have even stated that WOM, or electronic word-of-mouth (eWOM), is nowadays the most influential form of communication.

As millennials care about the environment more than the older generations, green marketing has also become a major trend in the corporate world. Green marketing refers to a strategic effort made by companies to offer environmentally friendly or green merchandise and communicating about it to customers (Grewal & Levy, 2008). According to Smith & Brower (2012) most millennials possess positive outlook towards environment-friendly products and services, and they are even willing to pay a premium for green products or brands. As a result, green product characteristics have become a major factor when building loyalty among customers. The increase of environmental awareness has also made some companies to promote green products even if the products were either unchanged or the environmental statements were unconfirmed (Montague & Mukherjee, 2010). The practice is labeled green washing, and it refers to intentionally misleading customers through untruthful advertisement to gain short-term profits (Vermillion & Peart, 2010).

According to Suplico (2009) there are five types of green consumer segments. The most environmentally conscious group is called “true-blue green” consumers. They firmly believe that their activities have an influence on the environment. Moreover, they are willing to pay a higher premium on green products and they also like to engage in ecological actions, such as recycling. “True-blue green” consumers only buy products and services from responsible and eco-conscious companies. Second, “greenback green” individuals, invest in green, more high-priced products, but they are not willing to participate in environmentally friendly actions. These consumers want to maintain their high quality of life and lifestyle, and therefore they only contribute to the environment financially. Consumers that support eco-friendly regulation and products, but are still less likely to spend more money on them are called “sprouts”. “Grouser” segment, on the other hand, believe that it is not their

responsibility to save the environment, and therefore they avoid paying higher prices for greener products. Lastly, “basic brown” consumers think that personal choices, company regulation, and political effort does not affect environmental problems. Even if demand for green products have increased lately, Ginsberg and Bloom (2004) state that individuals are not willing to sacrifice convenience, quality, performance, and price even if the product or service was greener. To consider more environmentally friendly alternatives, individuals want greener products to at least match the attributes of regular products. Vermillion and Peart (2010) also suggest that consumers are not likely to buy a product solely for its eco-friendly qualities.

As the core product of banks is considered fairly homogenous, the need to differentiate itself with augmented product development have increased. The increased competition in the banking industry has also made banks to put more effort on their marketing. In addition, the need to distinguish itself has made banks to look for different marketing alternatives, which has led to a growing amount of research on bank marketing. (Heffernan, O’Neill, Travaglione & Droulers, 2008) Previous research on bank marketing has mainly focused on the importance of relationship development. According to Hawke and Heffernan (2006), the benefits of strong relationships include for example increased profit through reduced risk, positive word-of-mouth, and improved communication with the customer. Ennew & Binks (1999) and Tyler & Stanley (1999) add that increased customer satisfaction often leads to more loyal customers. Another key component of building long-lasting relationships with customers is trust (Morgan & Hunt, 1994).

The technological development has also changed the way banks use marketing. Today, the biggest trend in the banking industry, but also in many others, seems to be targeted marketing. Banks are dividing their customers into segments and then customizing their marketing efforts to provide their customers products that fulfill their needs. The development of modern technology has even made some doubt the future of regular banks. The expectation is that especially young, tech-savvy generations will increasingly use alternative banking applications on their smartphones that offer appealing perks at cheaper prices. Therefore, today’s banks will need to form and maintain their current relationships by taking care of their corporate image and positioning among younger age cohorts. (Tan & Lau, 2016)

2.3. BEHAVIORAL FINANCE AND COGNITIVE BIASES

The origin of behavioral finance can be dated back to the 1960's when theorists in cognitive psychology, economics, and finance started to combine their efforts to better explain investor behavior, market inefficiencies, stock market inconsistencies, and other findings that challenge the assumptions of standard finance. For example, Walter, Kellermanns & Lechne (2012) have confronted the classical decision-making process by suggesting that choices are based on individuals' values, emotions, preferences, and traits. Their findings suggest that people do not always act rational in the stock market, and they would be prone to emotional errors. This is also why many scholars have put additional effort into understanding the combination of rational thinking and feelings of investors. While normal people also tend to be rational and smart, sometimes the cognitive errors and affective dimensions make individuals do a myriad of mistakes, which makes studying behavioral finance increasingly interesting. (Baker, Filbeck & Ricciardi, 2017)

Shefrin & Statman (1984) argued that investors' desires, cognitive errors, and feelings affect their preferences for certain stocks, and that shares can sometimes have more meaning than the monetary return itself. Examples of these kind of situations could be that someone has received shares as a gift or as an inheritance. While people might not feel guilty for spending bequest money, selling acquired shares and then spending the money could again feel different.

While it may seem like people only want high profit with reasonable risks from their equity investments, in fact, normal investors want more than that. This is also very similar when thinking about other products. Generally speaking, normal investors and individuals want three kinds of benefits from their investments and products: utilitarian, expressive and emotional. As already stated, the utilitarian benefit of an investment is monetary profit. As comparison, the utilitarian benefit of a car is transportation from a place to another. Expressive benefits communicate our values, tastes, and status to others. Whereas investing to an environmentally friendly mutual fund may indicate that an investor is environmentally responsible, driving with a hybrid or electric car could suggest the same thing. Lastly, emotional benefits answer the question: "How does owning something make you feel?". While investing

to an environmentally friendly company or driving a hybrid probably makes you feel good about yourself, driving a premium car brand, such as Mercedes-Benz, is more likely to make you feel proud. As individuals are often unwilling to separate their roles as investors and consumers, it indicates that feelings, wants, and status have an effect on equity investment decisions. However, not all investors are alike, which means that normal investors can also be divided to range from normal-ignorant to normal-knowledgeable investors. The difference between these two types is that the normal-knowledgeable investors have learned to overcome some of their cognitive errors and misleading emotions. Even if knowledgeable investors are aware of some these potential pitfalls, they still sometimes fail to cope with them. (Statman, 2014)

Behavioral psychologists have defined a huge amount of action patterns in human behavior and many of these models can easily be applied to equity investment behavior. The core substance of behavioral finance is to explain investors' and market participants' actions with different behavioral models. These models also serve as evidence of investor irrationality. According to Landberg (2003), investors are guided by two basic qualities: fear and greed. In other words, investors seek to achieve maximum profit, which easily blurs their decision-making and, as a result, they take considerable risks. On the other hand, investors' activity is guided by the fear of losing money, which is usually realized as the investment changes to a negative profit. Fear is also the most documented emotion in the financial domain. Financial crises, like the one we are currently facing, usually add fear into the market, which again slows down the financial recovery process. These factors often steer investors into a more irrational direction, whereby investment decisions are not based on rational thinking but on emotional reactions. Next, the most common and significant behavioral models, and their features will be briefly introduced.

2.3.1. OVERCONFIDENCE

Probably the most common investor irrationality on the stock market is that people often tend to be overconfident about their own abilities regarding investing. Overconfident investors might think that it is easy to beat the market, or that they are superior when compared to an average investor, also know as the better-than-average effect. In addition, overconfident investors tend to overweigh positive market

news compared to negative ones, and have unrealistic beliefs about potential stock returns. Studying the matter of overconfidence is important because different types of investors are prone to this type of cognitive error. However, the effects of the bias are difficult to generalize because they have different outcomes on the behavior of different investors. Individuals who suffer from this bias usually take bigger risks than their true risk-profile would allow, which can for example be seen in excessive trading behavior or by having too little diversification in their investments. Moreover, overconfidence tend to increase investment volumes for all types of investors. (Barber & Odean 2000; Nofsinger, 2005) Even if some studies have reported that there are no gender differences in overconfidence (Lundeberg, Fox, Brown & Elbedour, 2000; Biais, Hilton, Mazurier & Pouget, 2005; Deaves, Lüders & Luo, 2008), the majority of academia seems to agree on that men are more commonly overconfident than women, especially in areas such as finance (Prince, 1993; Lundeberg, Fox & Punćochaŕ, 1994; Barber & Odean, 2000). Moreover, Oehler, Wendt, Wedlich and Horn (2018) studied how personal traits affect investing, and found out that extraverted individuals tend to take bigger risks and behave more overconfidently when making equity investments.

According to Milgrom & Stokey (1982) investors should not trade, in other words buy and sell shares frequently during a short time period, at all. Many theoretical models predict that overconfident investors have a tendency to trade more than than an average investor. To test this, Barber and Odean (2001) explored 35,000 individual investors over a six-year time-period, and found out that men trade 45 percent more than women. They also found out that single men trade more than single women. As a result, men are more prone to sell their shares at an incorrect time, while additionally incurring higher trading costs than women. In Barber's and Odean's study trading expenses decreased the net investment profit of men by 2.65 percentage points a year compared to roughly one per percentage point less for women. While one percentage point a year might not seem like that much, applying the effect on longer time-period makes the consequences much more radical. Barber and Odean also found out that younger individuals tend to hold risker assets in their portfolio than older people, which however, is only natural because of their longer investment time frame. Furthermore, for example Deaves, Lüders & Luo (2009), Grinblatt & Keloharju (2009) and Scheinkman & Xiong (2003) have had similar kind

of outcomes in their study as they found out that overconfident individuals tend to trade stocks more often.

According to Goetzmann and Kumar (2008) overconfident investors also tend to hold under-diversified portfolios. In their study, the level of under-diversification was superior amongst younger, lower-income, and less-educated individuals. Moreover, the overconfident investors were prone to overweigh shares with great price swings to both directions, in other words high volatility. Sapienza's and Zingales' (2013) results can also be linked with overconfidence. They examined average Americans and economic experts and whether they think predicting stock prices is hard. Sapienza and Zingales found out that all of the examined economic experts agreed that it is hard to predict stock prices, whereas only 55 percent of average Americans thought it is difficult. When the average Americans were told that 100% of the financial experts think forecasting share prices is challenging, the amount of average Americans thinking this way declined to 42%. Furthermore, Gervais and Odean (2001) suggest that previous success tend to aggravate overconfidence, while past failures are usually underestimated or even forgotten. As a result, for example individual investors who have had recent success might for a short period of time display more overconfidence than other market participants. However, when the time period is longer, investors' true knowledge is often revealed to others.

A trait that is often associated with overconfidence is sensation seeking. Individuals who are sensation seekers like to pursue new, intense, and different thrills generally related with real or fictional physical, social, and financial risks. (Zuckerman, 1998) In their study Grinblatt and Keloharju (2009) found out that heavy traders in Finland also tend to accumulate many speeding tickets when driving. Their risk taking and overconfidence on the road can therefore also be seen in their investment behavior. While some of the traders do not know that trading usually comes with high price, which can lead to decreased profit or loss, some of these sensation-seekers know the high price and are willing to pay for it.

2.3.2. HINDSIGHT BIAS

Being able to make better decisions in financial markets relies decisively on an investor's ability to process information and learn from previous events and mistakes. Effective learning, on the other hand, requires comparing new information to prior expectations. The hindsight bias, sometimes also known as creeping determinism or the knew-it-all-along phenomenon, refers to a condition where an investor is unable to accurately remember one's prior expectations after observing new information. In other words, the psychological condition allows people to convince themselves that they had correctly forecasted an occurred event before it actually happened. As investors are trying to optimize the timing of their stock trades, an example of the hindsight bias could be a situation when an investor suffers a loss. With a loss comes a regret of not acting earlier, and a feeling that they were able to see the price drop all along. (Biais & Weber, 2009)

Since being first documented by Fischhoff (1975), this bias has been widely studied in the fields of psychology and behavioral finance as it is a fairly common breakdown of individual investors. The downside of the bias is that it interferes with investors' learning and information processes. Misleadingly believing that one is able to predict the future often results in increased levels of overconfidence, and overreacting to new information (Camerer, Loewenstein & Weber, 1989). This can for example lead to choosing shares more on a hunch without analyzing their financial performance. Hindsight biased individuals often also have inaccurate expectations of share returns, which can lead to suboptimal trades.

2.3.3. OVEROPTIMISM

Overoptimism or excessive optimism bias refers to a condition where individuals overestimate the frequency of anticipated profitable results and underestimate less satisfactory outcomes. The bias is present with investors but also for example corporate managers often experience this bias by having unrealistic expectations for a new product or by downplaying debt problems. (Meinert, 1991) According to Brown and Cliff (2005) excessive optimism might hinder investors ability to value stock

prices and to process negative news about a company. It has also been stated that overoptimism is one reason why people often engage in trading of initial public offerings.

Excessive optimism and overconfidence have similar kind of characteristics, but they are not the same. While overoptimistic individuals may have unrealistic expectations of the occurrence of a positive outcome, they might still not be overconfident about their investing abilities. On the other hand, overconfident investors are also more likely to be overoptimistic because certainty in their own abilities often generate a feeling of achieving a profitable outcome or result. (Baumeister, Tice & Hutton, 1989)

2.3.4. ANCHORING

Anchoring bias describes a situation where individuals use “mental shortcuts” when forming numerical estimates in difficult and uncertain situations, such as predicting stock prices. Investors regularly form these estimations by starting with a reference value that is easily available, a 52-week high or low for example. Although this method alone is not problematic, various studies have revealed that individuals and investors typically fail to modify their final estimates away from the salient but sometimes even irrelevant starting point, also know as the anchor, which often leads to suboptimal investments or outcomes. (Cen, Hilary & Wei, 2013)

The bias has been widely studied after Kahneman and Tversky’s (1974) classic research where they explored individuals’ tendencies to use an easily available reference point when forming estimates. In their groundbreaking example, they asked subjects to estimate the percentage of African countries in the United Nations. Before the subjects gave their best guess, the authors involved a wheel of fortune to generate a number between zero and hundred. Interestingly, the evidently unrelated random number generated a systematic bias in the estimations. For example, the subjects who observed number ten in the wheel of fortune, had an average guess of 25% in the actual question. By contrast, the average estimate for individuals who saw number 65 was 45%. Russo & Shoemaker (1989) have also found similar kind of results in experimental settings.

Evidence from previous studies have also suggested that correcting the anchoring bias is very challenging. For example, Northcraft and Neale (1987) conclude that even professionals are prone to the bias even if the initial question would be asked in their own field of expertise. Experts are also less likely to acknowledge and admit their use of mental shortcuts when forming biased judgments. In addition, Wright & Anderson (1989) found out that the anchoring bias so strong that task familiarity does not diminish anchoring. The presence of the bias has also been tested when subjects have a monetary incentive included. However, the underlying finding seems to be that monetary incentives only have a marginal or no effect on anchoring. (Tversky & Kahneman, 1974; Wright & Anderson, 1989)

2.3.5. REPRESENTATIVENESS

Another bias in the heuristics department that can affect investment decisions is called representativeness. The bias refers to situation where the similarity of events or objects makes individuals miscalculate the probability of an outcome. Among investors this can for example mean assuming that an existing trend will continue or that investing with a same method will continue to provide exceptional profit in the future. (Hirshleifer, 2001) According to Kirs, Pflughoeft & Kroeck (2001) additional typical mental shortcuts among investors with the representative bias include focusing too much on a single factor and ignoring other aspects when determining stock prices, which leads to overreacting and making irrational decisions. In addition, when purchasing stocks, individuals might also overweigh noticeable recent information, such as abnormally high past returns. For example, Sohani (2012) have reported that the representativeness bias affects people when making equity investment decisions.

2.3.6. HERDING

Herding is a phenomenon where investors behave similarly to those people around them or where they follow other investors rather than making their own decisions. In other words, investors who engage in herding buys and sells investments almost

solely based on the fact that someone else is also doing the same thing. A usual driving force behind the behavior is the fear of missing out, usually on profitable investments. Sometimes the fear of missing out is so strong that investors ignore their own information about a certain stock or company, and mimic actions of others instead. The behavior has a history of starting substantial stock rallies and sell-offs that lack fundamental support. Herding is also said to be major driver of financial bubbles. (Bikhchandani & Sharma, 2001)

The majority of previous studies have focused on the herding of institutional investors, but there is also a growing amount of studies of individual investors. Previous studies suggest that herding is more common among individual investors than institutional ones, and that experienced investors are less prone for the behavior. (Merli & Roger, 2013) Venezia, Nashikkar & Shapira (2011) state that herding behavior increases in volatile market conditions, while Barber, Odean & Zhu (2009) add that herding is more common for investors who have other behavioral biases. Moreover, according to Merli & Roger (2013), individual investors who have had recent adverse performance on stock market, tend to opt for herding in the near future.

2.3.7. LOSS AVERSION

The roots of this concept date back to the 1960's, when Paul Samuelson (1963) asked his coworker whether he would be willing to accept a bet. The bet consisted of a 50% chance of winning $200 and a 50 percent chance of losing $100. Samuelson's colleague declined the bet, but declared that he would be willing to accept it if repeated 100 times. This conversation triggered Samuelson into proving a theorem showing that his colleague was acting irrationally.

The concept of loss aversion refers to investors applying more importance and mental effort on avoiding losses than trying to attain profits. When investors suffer an actual loss in terms of monetary value, they also often experience an emotional loss, a sentiment that can remain haunting them for a long period of time. The typical finding in the academia seems to be that the psychological emotion of a loss is twice

as powerful than in a situation of a profit. In other words, the upside of making a profit of 1,000 euros is equivalent to the downside of losing 2,000 euros in a diversified portfolio. It is also documented that a loss that comes after another loss feels even worse than the first one, which makes individuals even more sensitive and loss averse to additional setbacks. Traditional finance, on the other hand, proposes that gains and losses have an equal sentiment between them. (Tversky & Kahneman, 1992) Individuals and households with higher degrees of loss aversion have a lower probability to engage in equity investing. Loss aversion also significantly reduces the likelihood of owning stocks compared to mutual funds, for example. (Dimmock & Kouwenberg, 2010)

The concept of loss aversion also plays a major role in Kahneman and Tversky's (1979) prospect theory, which is an illustrative theory of decision making under risk. The theory uses experimental evidence to claim that individuals get different values from profits and losses in wealth. The theory is also based on the perception that people make their decisions based on bounded rationality instead of classical rationality. Another key principle of the theory is that individuals evaluate sets of alternatives on an individual basis and then use a reference point to make their decision, rather than making the choice in the context of an overall portfolio. In their study, Kahneman and Tversky (1979) requested subjects to evaluate a pair of alternatives and then to choose one of them. In the first question, the first alternative consisted of a 100% chance of earning $7,000, while the second option comprised of an 80 percent chance of gaining $8,000 and a 20% chance of getting nothing. Their evidence demonstrates that a clear majority of respondents chose the first alternative with the sure gain. Even if people tend to opt for the guaranteed profit, this alternative should be the less preferred option since the second option has a greater overall cumulative value of $8,000 (($10,000 x 0.80) + (0 x 0.20) = $8,000). The study also included a follow-up question, which similarly had two alternatives. The first one comprised of a realized loss of $7,000, while the second one consisted of a 20% chance of losing nothing and an 80 percent chance of losing $10,000. In this question, people favored the latter alternative because of the chance not losing anything even if the rational choice would have been the first one with a smaller overall cumulative loss. A similar kind of study in the behavioral finance domain was conducted by Oberlechner (2004), who asked stock traders comparable questions.

Interestingly, 70% of professional stock traders also preferred the riskier alternative from the subsequent question.

Benartzi and Thaler (1995) supplemented the standard loss aversion concept by combining two common features of human cognition, myopia and loss aversion, into a new model. Myopic loss aversion (MLA) refers to a situation where loss averse investors put too much significance on short-term views of equity investments. MLA typically occurs when loss averse investors view their assets or get frequent updates on how their portfolio is performing. In myopic loss aversion, investors react negatively to volatility, which makes them to do harmful financial decisions.

Myopic loss aversion also tries to provide an answer to the equity premium puzzle, which is a concept that has gained a considerable amount of effort across economics and financial domain. The equity premium puzzle addresses the substantial difference between the profits on shares and fixed income securities. As many scholars have shown, the average yearly return on stocks over the past century has been around seven to eight percent in the U.S. but also in other parts of the world, whereas the net return of riskless securities has been roughly one percent. In their study, Mehra and Prescott (1985) provided evidence that the premium between stocks and securities is too great to solely be explained by individuals' risk aversion.

There are numerous laboratory experiments complementing the MLA theory. For example, Thaler, Tversky, Kahneman & Schwartz (1997), Gneezy & Potter (1997), Haigh & List (2005) and Larson, List & Metcalfe (2016) have found evidence that students, retail investors and professional traders all suffer from myopic loss aversion. The structure of these subsequent studies have revolved around altering the amount of asset price feedback and then comparing how the information frequency affects investments patterns. The primary hypothesis has been that subjects who get price information more often tend to invest in lower risk products. Results from the academia has generally reported that individuals who get infrequent feedback accumulate more profit since they invest 30% to 80% more in riskier assets, a pattern consistent with the myopic loss aversion theory. Most of the studies also report that getting infrequent information leads to accumulating more profit.

More recently, the focus in the financial domain has shifted more from the feedback frequency to media consumption. For example, Garcia (2013) states that media has become a major influencer for market movements. Today, the most popular channels to consume written media are regular news media and social media. Prior studies have documented that both market-level and company-specific news stories have an affect on share prices. Tetlock (2007) found out that a high degree of media pessimism would forecast downward pressure on stock prices followed by a quick return to fundamentals. Moreover, Heston & Sinha (2017) made similar kind of findings when they tested whether news can predict share returns. In their study, they examined more than 900,000 new stories and found out that news can forecast stock prices for only one or two days.

2.3.8. MENTAL ACCOUNTING

Another concept that is strongly linked to loss aversion is mental accounting, a theory coined by Richard Thaler back in 1980. The concept revolves around the question of over which profits and losses the investor is loss averse. This is an important question because investors tend to reflect and evaluate their financial investments differently. For example, investors might view their gains and losses in terms of their total wealth, also know as the broad view. On the other hand, some investors may view their profits and losses over changes in their portfolio or even throughout alterations in the value of a single stock. The latter process is called the narrow view of wealth. Evidence from several prior studies suggest that people tend to be prone for narrow framing when doing mental accounting. Individual investors might experience regret over a decision to buy a certain stock, if it for example immediately starts performing poorly. Moreover, evidence suggests that investors are loss averse over individual share price volatility, and the aversion on a specific stock or portfolio depends on their past performances. This means that investors usually feel more pain when an unprofitable stock loses value compared to when a successful investment sees a price decrease. (Barberis & Huang, 2001)

According to Thaler (1990) prior profits and losses can also considerably influence investors' subsequent choices. For example, under some circumstances prior gains can significantly increase subjects' risk tolerance and willingness to accept gambles. The increased willingness to gamble is often labeled the house money effect, which roots from the gambling idiom "playing with the house money." The parlance is used by winning gamblers as losing some of "their money" usually does not feel as bad as losing your own cash. Both Thaler (1990) and Battalio, Kagel & Jiranyakul (1990) conducted similar kind of experiments in their studies. The test consisted of a subject who was gifted $30 in the beginning, which can be held equivalent to winning in a gamble. After the endowment, the subjects were offered a 50% chance of winning $10 and a fifty percent chance of losing ten dollars. Both studies reported that the majority of subjects opted for the gamble. Interestingly, only about 40% of the subjects chose to gamble when the test consisted of a $20 bet. This indicates that the house money effect decreases when the potential loss approaches the initial stake. Isen, Means, Patrick & Nowicki (1982) provided a possible explanation for the house money effect. The authors stated that the initial gain creates a positive mood, which can be linked to increased risk taking. Finance researchers, such as Hirshleifer and Shumway (2003), have even documented that the stock market performs better on sunny days than on rainy or cloudy days since investors usually have a more positive mood when the sun is shining.

Another concept that is applicable to investing is the break-even effect. In their study, Kahneman and Tversky (1979) also addressed the question about how prior losses affect following choices. While most of the times prior losses lead to choosing less risky alternatives, it is also commonly documented that the tendency to gamble on long shots, in other words riskier bets, grows for example during the course of a betting day. The tendency for this kind of behavior increases particularly if the following bet offers an opportunity to break even. While some risk-seeking bettors who have lost 100 euros for example, may opt to gamble another 100€ with 2-1 odds to break even, usually the more appealing alternative is to bet 5 euros on 20-1 gamble since it does not risk losing that considerably more money. (Thaler, 1990)

A concept that can also be connected with loss aversion and mental accounting is the disposition effect. This concept refers to a state where individuals are less likely

to sell investments at loss compared to investments that have gained value even if expected returns are held constant. The disposition effect generally makes investors lose money because of selling winners too early and holding on to losing securities for too long. (Ricciardi, 2008) For example, Grinblatt and Keloharju (2001) found out that the disposition effect is a major factor of the tendency to sell shares in Finland. According to them, the disposition effect is aggravated for all investor types when a loss is above thirty percent. Shares are also more likely to be sold when they have accumulated high profits in the past or when they are at their monthly high. Furthermore, the authors found out that investors tend to buy stocks with negative past returns more often than shares that have had a recent price increase. Having share prices at monthly highs and lows also exacerbates individuals' momentum investing style.

3. RESEARCH METHODOLOGY

This research was made as a quantitative study. The method was chosen because quantitative research is primarily used when the issues are known and it is desired to measure the occurrence of the matter in the population. The questions in quantitative research can be pre-coded or open and the results are presented as numeric values instead of words. (Hirsjärvi, Remes & Sajavaara, 2009) The data for this survey was collected by a questionnaire with pre-coded questions. This research uses descriptive statistics, self-organizing maps (SOM), and fuzzy set qualitative comparative analysis (Fs/QCA or fsqca) to observe the data. The data analysis will be made with R-software.

Descriptive statistics are used to get an overview of the examined sample. In short, they help to explain and comprehend the features of a data set by giving a brief summary of the descriptive coefficients, and therefore, they are widely used almost at all levels of statistics. (Bickel & Lehman, 2012) The measures used in this research are the mean (average), median, standard deviation, minimum and maximum, skewness, kurtosis, and standard error.

Self-Organizing Maps (SOMs) are an unsupervised data visualization method that can be used to visually simplify multidimensional data sets. The technique was invented by a Finnish professor, Teuvo Kohonen, back in 1982. (Deboeck & Kohonen, 2010) Self-Organizing Maps work similarly to multi-dimensional scaling (MDS) and its variations, but instead of trying to replicate distances, SOMs aim to reproduce topology, or in other words map similar observations close to each other (Wehrens & Buydens, 2007). Bação, Lobo, and Painho (2005) have even stated that the algorithm of SOMs is very close to algorithms of classical k-means clustering, and therefore, SOMs can be seen as a substitute to k-means clustering. Self-Organizing Maps have proven to be an effective tool in many topics in finance and economics as these branches often use data with multiple variables. The Self-Organizing Map used in this research exploits node weight vectors that are made of normalized values of the original variables to generate the map. Each node's weight vector is similar of the samples mapped to that cluster. By visualizing the weight vectors across the map, observers can see what kind of variable patterns there are

among the population. In addition to the actual SOM, a heat map of map is portrayed to visualize the counts of each node.

Fuzzy-set qualitative comparative analysis (Fs/QCA) is a social science technique developed in order to combine case- and variable-oriented quantitative analysis. The method began with the qualitative comparative analysis, introduced first by Charles Ragin in 1987, while fuzzy-sets were developed later to supplement the theory. The technique uses combinatorial logic, fuzzy set theory, and Boolean algebra to determine which combination of causal conditions have an effect on an outcome. Where conventional regression-based methods attempt to estimate the net effect of an independent variable on an outcome variable, fuzzy-set qualitative comparative analysis tries to recognize conditions that lead to a certain outcome. As a result, the method presents a data matrix which is reformulated as a “truth table”. While qualitative comparative analysis was first developed to fit political science, the method has also been successfully used in fields like business and human behavior. (Schneider, Schulze-Bentrop & Paunescu, 2010; Ragin, 2008)

3.1. QUESTIONNAIRE DESIGN

The questionnaire for this research was constructed based on previous studies on behavioral biases. For example, prior studies of Chun & Ming (2009) and Kudryavtsev, Cohen & Hon-Snir (2013) provide questions on measuring behavioral biases of individual investors. Some questions used in the survey were taken or modified from these studies. Rest of the of questions were formed based on other related literature. After the 34 questions were formed, both industry professionals and academics reviewed the questions so that they were understandable and did not have too much overlapping.

The survey comprised of 34 different questions that can be split into eleven groups based on their features. The groups were not visible in the questionnaire so the respondents did not know which questions measured what. The first group of questions consisted of demographic variables, while the rest of the questions measured behavioral biases, trading activity, and investors’ attitude towards

responsible and emotional investing. The demographic variables had pre-set alternatives, and the rest of the questions, except one, used a five-point Likert-scale where 1 = strongly disagree, 2 = partly disagree, 3 = neutral or I do not know, 4 = agree, and 5 = strongly agree. The one question that did not use the previous alternatives, used a Likert-like scale to measure individuals' beliefs about future average annual returns of the Helsinki Stock Exchange with 1 = 0% or less and 5 equaled to believing returns of 8% or more. After the first three demographic questions, the first group of questions (1-3) measured overconfidence bias among the population. The second set of questions (4-6) evaluated hindsight bias of the respondents. The third cluster of questions (7-9) dealt with overoptimism, while questions 10-12 had to do with anchoring. The fifth group of questions (13-16) measured representativeness, and the sixth set (17-20) weighed on individuals' loss aversion. Questions 21-23 were set to gauge herding bias, while the 24-26 cluster consisted of mental accounting questions. The following two questions measured trading activity, and the last three questions (28-31) addressed attitudes on responsible investing and what investors think is important in terms of equity investing. The full online questionnaire can be found in both English and Finnish in the appendices (1 and 2.

3.2. DATA COLLECTION

The target population for the research consisted of household investors in the Finnish stock market. As the corona epidemic was at its current peak during the sample collection, the data was collected by posting the questionnaire on Facebook. The survey was published to two Facebook groups, as well as the authors own Facebook page. One of the groups where the questionnaire was posted, Sijoituskerho, has over 60.000 likes, and it is a group to people who like equity investing. The second group, Enklaavin Jäsenet, has roughly 1300 followers and it consists mainly of students and graduates of LUT School of Business and Management. The questionnaire was open from May 4th to May 12th in 2020. The survey was assembled so that it did not have to be answered immediately, and the questions would always be exactly the same.

After getting the data from the questionnaire, the questions in each of the clusters were formed as a new variable. The new variables were labeled as the measured cognitive bias, and they were formed by calculating the average from the questions in each cluster. As a result, the data had 444 observations of thirteen variables. Before conducting the data analysis, a total of four outliers were removed from the observations, which reduced the sample size to 440 cases. According to Tabachnick and Fidell (2012) an observation is considered an outlier when it has an extreme value in a variable or an unusual combination of two or more factors. Hair, Black, Babin & Anderson (2010) state that an observation is considered a univariate outlier when its standardized score (Z-score) is ±2.5 in a small sample (80 or less) or ±3 in a bigger sample. Therefore, a standardized score (Z-score) was calculated for each observation. The results showed that the Z-score of four observations was over ±3, which meant removing them for the data set. Furthermore, a Mahalanobis distance D2 measure was also calculated for each observation in order to detect multivariate outliers. The Mahalanobis distance is a version of the Z-score that calculates a multidimensional mean (centroid) of a distribution, given the multidimensional variance (covariance). In larger sample sizes an observation is considered an outlier when its D2/df (degree of freedom) score is more than three. (Hair, 2010) As all of the observations had a Mahalanobis score of under 30 and each observation had ten variables, all cases had a D2/df score smaller than 3. Therefore, no more cases were removed from the data. The Mahalanobis scores of the cases can be seen in Appendix 3.

3.3. DESCRIPTION OF THE DATA

This section of the chapter briefly introduces the demographic distribution of the survey respondents. As already mentioned, a total of 440 cases were left for the analysis after removing the outliers.

Out of all the respondents, 279 (63.4%) were men, 159 (36.1%) were women, while two individuals (0,5%) chose “other” as their gender. The disproportion in the gender distribution can be explained by the fact that men are generally more interested in investing. When for example comparing the distribution of the respondents to the

distribution percentages of opened equity savings accounts in Finland (72% vs 28%), we see that the distribution is quite similar. Therefore, it can also be said that it is unsurprising that males account for the majority in the data set.

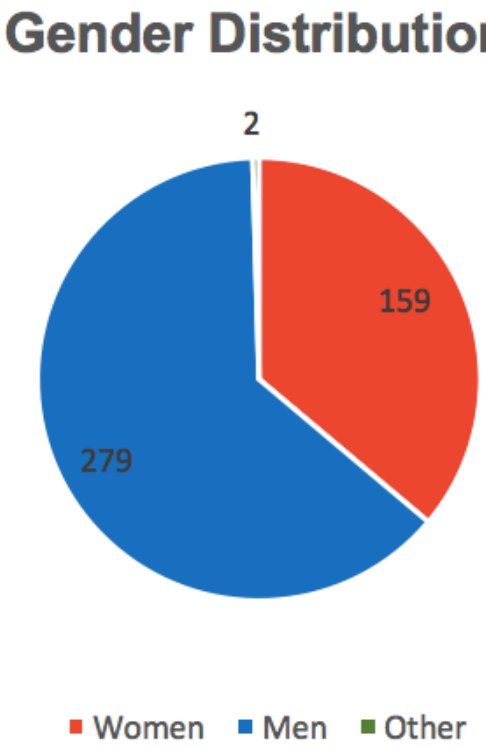

Figure 2: Gender Distribution of the Respondents

Next in the survey, the respondents were asked about their birth year. From all the respondents 33 (7,5%) were born between 1980 and 1983, 39 (8,7%) between 1984 and 1987, 76 (17,3%) between 1988-1991, 192 (43,6%) between 1992-1996, and 100 individuals (22,7%) between 1997 and 2000. Again if we compare these numbers with the age distribution of the opened equity savings accounts, we see that the distribution is somewhat similar. In addition, as the questionnaire was posted to Enklaavin Jäsenet, where the majority of members most likely consists of people born between 1988 and 2000, it is not surprising that the data had most observations in these age groups. Furthermore, as the questionnaire was posted on authors (born between 1992-1996) own Facebook page, it may also have a slight effect on why the majority of respondents are born between 1992 and 1996.

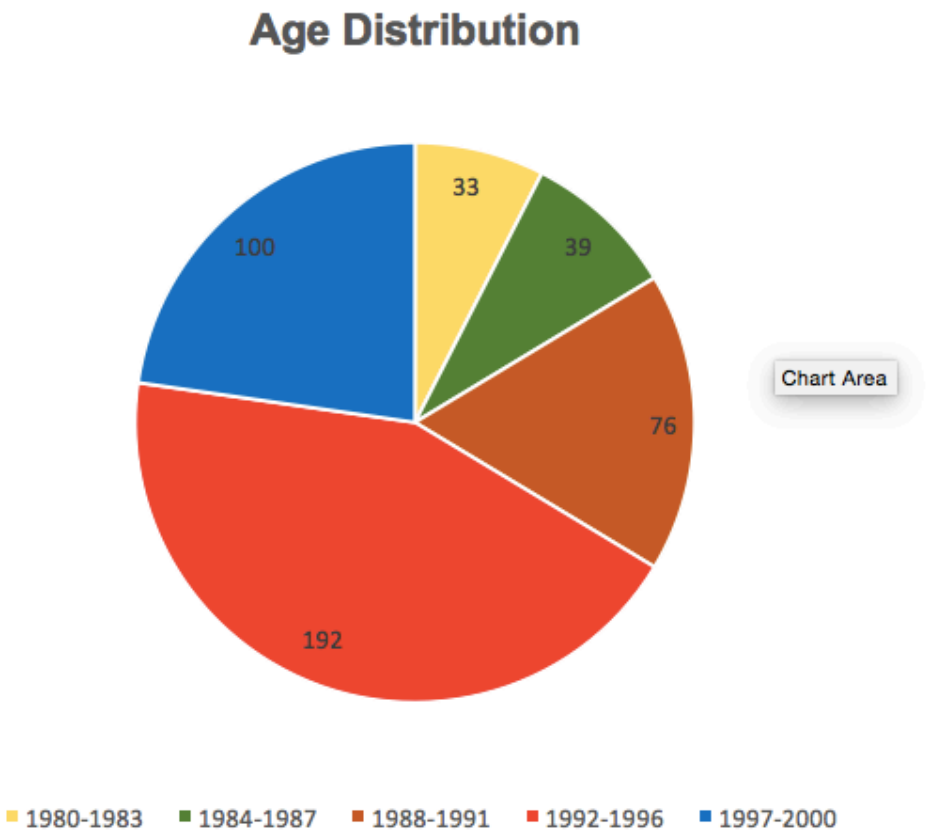

Figure 3: Age Distribution of the Respondents

The final demographic variable in the questionnaire was education level. Out of the 440 respondents 146 (33,2%) had a Master's degree from a university, 99 (22,5%) had a Bachelor's degree from a university, 88 (20%) had a degree from a university of applied sciences (AS), 93 observations (21,1%) had a high school diploma, while 14 individuals (3,2%) had not finished any additional education after primary school. As the online questionnaire was posted to groups on Facebook that probably mainly consists of people with some sort of additional education, it is not a surprise that the data mostly consists of people with higher education. Furthermore, it is also most likely that the topic of the questionnaire affects the education distribution as household investors in Finland most likely have also accumulated some additonal education after primary school. However, it should be noted that the education distribution of the respondents does not reflect the actual education distribution of the Finnish population. As of 2018, 26,7% of individuals aged over 15 years in Finland have not completed any additional education after primary school, while 40,7% of the population opt not to educate themselves after high school. In Finland, 11,7% of people aged over 15 years have completed a Bachelor's degree, while 9,7% have a Master's degree from a university. (SVT, 2020)

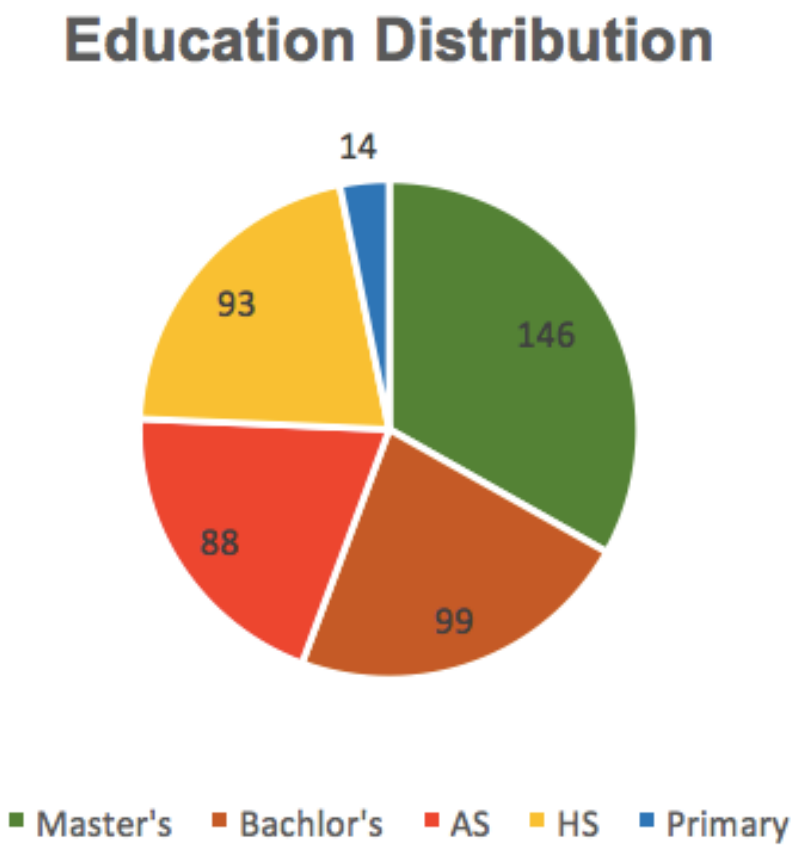

Figure 4: Education Distribution of the Respondents

3.4. RELIABILITY AND VALIDITY

Factors that all researchers need to be aware of when conducting studies are reliability and validity. Reliability refers to consistency of a research, in other words, to which extent will the study produce reliable findings. According to Saunders, Lewis & Thornhill (2009, 156) threats to reliability are for example participant error and participant bias. Participant error means a situation where participant's answers may be affected by some factor. An example of this could be that something significant happen during the time period when the data is collected, which makes people to answer the questionnaire differently prior and after the event. This is sometimes also referred as non-response bias or late-response bias. (Armstrong & Overton, 1977) Participant bias, or subject bias, refers a situation where participants of the survey consciously or subconsciously act in a way they think the researcher wants them to

act. This bias most often happens when the participants know the purpose of the study. (Saunders et al, 2009)

The probability for experiencing some kind of participant error in this study can be held relatively low as the questionnaire was collected during a short time span of nine days. There were also no major events on the stock market during this time period, which could have substantially altered answers of the respondents. To confirm this, a Wilcoxon test was conducted to see if the answers of the first 50 respondents differ in terms of the examined behavioral biases from the responses of the last 50 respondents.

	OS	HIND	OVEROP	ANCH	REP	LOSS	HERD	MA
Wilcoxon W	1406.5	1271	1332	1242.5	1120	1169.5	1361	1431.5
p	0.2773	0.8868	0.5677	0.9613	0.368	0.5787	0.4381	0.2081

Table 4: Testing of Non-Response Bias

The results in Table 4 decrease concern about the non-response bias as there are no statistically significant differences at the 0.05 level for the early and late respondents in any of the measured cognitive biases.

To ensure that the chance for participant bias in the research would as small as possible, the online questionnaire was anonymous. In addition, the participants did not know that the survey actually measured their behavioral biases. Therefore, it can be said that the possibility for participant bias is low.

Validity in study refers to the extent how of accurately a concept is measured (Heale & Twycross, 2015). The measured concepts in the study were the examined behavioral biases. To ensure that the questions in the survey measured the examined behavioral biases, the majority of the questions were taken or modified from previous literature. In addition, to ensure that the questions in they survey were understandable, both industry professionals and academics reviewed them before posting the survey online.

Another dimension of research validity is the external validity, also know as generalizability. It refers to which extent the findings of the study are generalizable. (Saunders et al. 2009, 157-158) As the majority of the respondents of the survey have a Bachelor's or a Master's degree, the findings of this research can not most likely be generalized to the whole Finnish population or populations of other countries. Being able to generalize the findings to the whole population would also require to know the education levels of the Finnish household investors. However, as the goal of this research is to better understand millennial investors and their cognitive biases, and to supplement existing theory rather than create new, the generalizability is not that big of a concern regarding this study.

4. DATA ANALYSIS AND FINDINGS

This chapter will introduce the performed data analysis and its findings. The data analysis was started by calculating descriptive statistics for each of the behavioral biases for the whole sample. The results for the all the respondents can be seen in Table 5 where the behavioral biases have been ranked from largest to smallest in terms of mean.

ALL (n=440)	mean (SD)	median [min, max]	skewness	kurtosis	standard error
1. ANCH	3.19 (0.82)	3.33 [1, 5]	-0.41	0	0.04
2. REP	3.12 (0.66)	3.25 [1.5, 4.75]	-0.16	-0.11	0.03
3. OVEROP	3.08 (0,61)	3.00 [1.67, 4.67]	0,09	-0.27	0,03
4. HERD	3.05 (0.62)	3.00 [1.33, 4.67]	-0.09	-0.19	0.03
5. MA	2.91 (0.82)	2.67 [1, 5]	0.28	-0.29	0.04
6. OS	2.79 (0,82)	2.67 [1, 5]	0.03	-0.48	0.04
7. HIND	2.66 (0,87)	2.67 [1, 5]	0.20	-0.37	0.04
8. LOSS	2.62 (0.7)	2.75 [1, 4.25]	0.05	-0.33	0.03

Table 5: Descriptive Statistics of Behavioral Biases Among the Whole Sample

From Table 5 we see that anchoring ranks as number one in terms of mean when comparing the behavioral biases for the whole sample. Representativeness, overoptimism, and herding also have mean score of over 3, which can be held as clear threshold for cognitive bias occurrence. Moreover, mental accounting has a mean score of 2.91, which is also very close to the threshold. Overconfidence, hindsight bias, and loss aversion have the lowest mean scores for the whole sample. From Table 5 we can also see that the scores for skewness and kurtosis are relatively small for all biases, which means that the answers are pretty close to being

normally distributed, and that there are very few extreme values among the respondents.

The same descriptive statistics were also calculated for the two last variables, which measured trading activity during the corona crisis, and individuals' attitude towards responsible and emotional investing. The scores for all the 440 respondents can be be seen in Table 6.

Table 6: Descriptive Statistics on Trading Activity and Emotional Investing

ALL (n=440)	**TRADA**	**MARK**
mean (SD)	2.3 (0.97)	2.77 [0.97)
median [min, max]	2.5 [1, 5]	2.67 [1, 5]
skew	0.45	0.1
kurtosis	-0.08	-0.72
se	0.05	0.05

From Table 6 we can see that millennials in Finland have kept their their composure quite well on the stock market during volatile market conditions. As the trading activity mean score is quite low (2.3), it suggests that people have not been especially active in terms of trading. However, it should be noted that the standard deviation score is close to one (0.97), which means that there are also more observations that are not that close to the mean score. The empirical rule states that 68% of the cases are within a standard deviation score of one (Everitt & Howell, 2005). From the same table we can also see that mean score of responsible and emotional investing is 2.77. This would suggest that the majority of Finnish millennials only care about the monetary profit when investing.

Next, the same descriptive statistics were calculated separately for both men and women in order to make some gender comparison. From tables 7 and 8 we can see that there are clear differences between the genders. While the behavioral biases

that score the highest in terms of mean are the same in top four for both genders, the order is different. Where women score the highest in anchoring (3.53), this bias only ranks as number four among men with a mean score of 3. This also indicates that women are clearly more prone to suffering from anchoring bias. On the other hand, men tend to be most prone to overoptimism (3.15), while excessive optimism ranks as number four among women (2.94). A similar kind of trend can be seen when comparing overconfidence scores between the genders. Where overconfidence ranked as number six among men in terms of mean (2.91), the bias ranked last among women with an average score of 2.56. Even if overconfidence and excessive optimism are not the same thing, they are closely related, which can also help to explain the gender difference among the latter mentioned bias. The difference between the genders regarding representativeness was not that substantial, while both genders had the same mean score of 3.05 in herding bias.

Other notable gender differences could be seen in loss aversion and hindsight biases. Where women had a mean score of 2.84 (rank 5) in loss aversion, men only had an average of 2.51 (rank 8) in the bias, while the averages were 2.78 for women, and 2.59 for men regarding hindsight bias.

Women (n=159)	mean (SD)	median [min, max]	skew	kurtosis	standard error
1. ANCH	3.53 (0.67)	3.67 [1, 5]	-0.44	0.61	0.05
2. REP	3.21 (0.65)	3.25 [1.5, 4.75]	-0.25	0.18	0.05
3. HERD	3.05 (0.59)	3.00 [1.67, 4.33]	0	-0.5	0.05
4. OVEROP	2.94 (0.58)	3.00 [1.67, 4.67]	0.24	-0.25	0.05
5. LOSS	2.84 (0.68)	2.75 [1.25, 4.25]	0.05	-0.58	0.05
6. MA	2.80 (0.78)	2.67 [1, 5]	0.21	-0.25	0.06
7. HIND	2.78 (0.84)	2.67 [1, 5]	0.21	-0.38	0.07
8. OS	2.56 (0.79)	2.67 [1, 4.33]	0.08	-0.65	0.06

Table 7: Behavioral Biases Among Women

Men (n=279)	mean (SD)	median [min, max]	skew	kurtosis	standard error
1. OVEROP	3.15 (0.61)	3.33 [1.67, 4.67]	0	-0.2	0.04
2. REP	3.06 (0.66)	3.00 [1.5, 4.75]	-0.11	-0.24	0.04
3. HERD	3.05 (0.64)	3.00 [1.33, 4.67]	-0.13	-0.09	0.04
4. ANCH	3.00 (0.82)	3.00 [1, 5]	-0.25	-0.21	0.05
5. MA	2.97 (0.84)	3.00 (1, 5]	0.28	-0.36	0.05
6. OS	2.92 (0.81)	3.00 [1, 5]	0	-0.40	0.05
7. HIND	2.59 (0.89)	2.33 [1, 5]	0.23	-0.38	0.05
8. LOSS	2.51 (0.69)	2.5 [1, 4.25]	0.06	-0.24	0.04

Table 8: Behavioral Biases Among Men

The same descriptive statistics were also calculated separately for both men and women for trading activity and attitude towards responsible investing. From Table 9 we can see that men (2.43) have been more active on the stock market during the corona epidemic period than women (2.06). As it is widely known that overconfident individuals tend to trade more, it is also not a surprise that men have recently been more active on the stock market.

Furthermore, there are substantial gender differences in attitudes towards responsible investing. Where women had an average score of 3.23 in this variable, men only had a mean score of 2.51. This suggests that women are more likely to also want something else from investing than just monetary profit. In other words, women are more likely to accept a smaller profit if they know they are investing for example in a sustainable investment product and that it is more important to invest in companies or industries they like.

	TRADA		**MARK**	
	women	men	women	men
mean (SD)	2.06 (0.9)	2.43 (0.99)	3.23 (0.87)	2.51 (0.93)
median [min, max]	2 [1, 5]	2.5 [1, 5]	3.33 [1, 5]	2.33 [1, 5]
skew	0.61	0.36	0.16	0.32
kurtosis	0.18	-0.17	-0.42	-0.58
se	0.07	0.06	0.07	0.06

Table 9: Gender Comparison for Trading Activity & Responsible and Emotional Investing

Descriptive statistics were also calculated for each oft the education levels to see if this variable has an effect on occurrence of behavioral biases. From Table 10 we can see that mean scores for the behavioral biases differ considerably when comparing education levels. For example, when comparing the mean scores overconfidence bias, we see that individuals with a Master's degree have an average score of 2.72, while people with no additional education after primary school have a mean of 3.24 in the bias. Furthermore, there are also differences between Bachelor's

graduates (2.77), people with a degree from university of applied sciences (2.65), and individuals with a high school diploma (2.98) regarding this bias.

When examining the mean scores of the hindsight bias, we see that individuals with a Master's degree have the lowest score (2.49), while the averages slightly increase for each of the lower levels of education. Regarding overoptimism, there are no noteworthy differences as the mean scores are quite close to each other.

Master's (3.11) and Bachelor's (3.07) graduates also have the lowest scores in anchoring, while graduates from university of applied sciences (3.26), high school graduates (3.33), and individuals with no additional education after primary school (3.4) have higher scores in this cognitive bias. Similar kind of trend can be seen with representativeness where the mean scores range from Master's graduates (3.02) to primary school graduates (3.55). Bachelor's students also have the lowest mean score (2.42) in loss aversion, followed by applied sciences graduates (2.59), and Master's graduates (2.66). Following the trend, both individuals with a high school diploma (2.76) and people with no additional education after primary school (2.84) also have the highest averages in loss aversion.

Similar kind of findings can be seen when examining both herding and mental accounting. When examining Table 10, we can see that overall trends to be that people with a lower level of education seems to have higher mean scores in the cognitive biases. However, it should be noted that each of the education groups have observations with both low and high scores regarding the biases. See Table 9 below for full coverage on the effect of education level on behavioral biases.

Table 10: Education Level Differences on Behavioral Biases

EDUCATION		OS	HIND	OVEROP	ANCH	REP	LOSS	HERD	MA
Master's (n = 146)	mean (SD)	2.72 (0.77)	2.49 (0.86)	3.00 (0.57)	3.11 (0.82)	3.02 (0.7)	2.66 (0.68)	3.02 (0.59)	2.86 (0.87)
	median [min, max]	2.67 [1, 4.33]	2.33 [1, 4.67]	3.00 [1.67, 4.67]	3.00 [1, 5]	3.00 [1, 4.5]	2.75 [1, 4.25]	3.00 [1, 4.33]	2.67 [1, 5]
	skew	-0.11	0.24	0.16	-0.23	-0.28	0.03	-0.43	0.25
	kurtosis	-0.49	-0.51	0.01	-0.37	0.01	-0.43	0.17	-0.36
	se	0.06	0.07	0.05	0.07	0.06	0.06	0.05	0.07
Bachelor's (n = 99)	mean (SD)	2.77 (0.92)	2.7 (0.94)	3.15 (0.66)	3.07 (0.82)	3.09 (0.67)	2.42 (0.68)	3.00 (0.63)	2.71 (0.8)
	median [min, max]	3.00 [1, 5]	2.67 [1, 5]	3.00 [1.67, 4.67]	3.33 [1, 4.67]	3.25 [1.5, 4.75]	2.25 [1, 4.25]	3.00 [1.33, 4.33]	2.67 [1, 4.67]
	skew	0.06	0.26	0.1	-0.52	-0.22	0.18	0.02	0.45
	kurtosis	-0.72	-0.54	-0.51	-0.18	-0.47	-0.4	-0.2	-0.29
	se	0.09	0.09	0.07	0.09	0.07	0.07	0.06	0.08
AS (n = 85)	mean (SD)	2.65 (0.72)	2.71 (0.87)	3.11 (0.6)	3.26 (0.78)	3.09 (3.25)	2.59 (0.71)	3.15 (0.65)	3.17 (0.81)
	median [min, max]	2.67 [1, 4.33]	2.67 [1, 5]	3.33 [1.67, 4.67]	3.33 [1, 5]	3.25 [1.5, 4.5]	2.5 [1.25, 4.25]	3.00 [2, 5]	3 [1, 5]
	skew	0.18	0.4	-0.24	-0.5	-0.14	0.2	0.28	0.21
	kurtosis	-0.2	-0.14	0.06	0.23	-0.12	-0.37	-0.08	-0.21
	se	0.08	0.09	0.06	0.08	0.07	0.08	0.07	0.09
HS (n = 93)	mean (SD)	2.98 (0.84)	2.77 (0.79)	3.11 (0.6)	3.33 (0.75)	3.23 (0.67)	2.76 (0.72)	3.04 (0.65)	2.9 (0.72)
	median [min, max]	3.00 [1.33, 4.67]	2.67 [1, 4.67]	3.00 [2, 4.33]	3.33 [1, 5]	3.25 [1, 4.75]	2.75 [1, 4.25]	3.00 [1.33, 4.67]	2.67 [1.33, 4.33]
	skew	-0.09	-0.01	0.01	-0.44	-0.27	-0.28	-0.03	0.21
	kurtosis	-0.79	-0.34	-0.72	0.51	0.48	-0.02	-0.15	-0.55
	se	0.09	0.08	0.06	0.08	0.07	0.07	0.07	0.07
Primary (n = 14)	mean (SD)	3.24 (0.81)	2.81 (0.89)	3.02 (0.62)	3.4 (1.06)	3.55 (0.67)	2.84 (0.76)	3.4 (0.63)	3.33 (0.86)
	median [min, max]	3.00 [2, 4.67]	2.67 [1, 4.33]	2.67 [2.33, 4.33]	3.5 [1.33, 5]	3.62 [2, 4.75]	2.88 [1.75, 4.25]	3.67 [1.67, 4]	3.17 [2.33, 5]
	skew	0.43	-0.16	0.77	-0.41	-0.34	0.21	-1.37	0.45
	kurtosis	-1	-0.68	-0.78	-0.85	0.1	-1.01	1.39	-1.29
	se	0.22	0.24	0.17	0.28	0.18	0.2	0.17	0.23

The same descriptive statistics were also calculated to see if education level has made a difference in people's trading activity and attitude towards responsible and emotional investing. By examining Table 11 we see that people with no additional education after primary school have made most moves to their portfolio recently as their mean score (3.04) in this variable is clearly the highest among other education classes. Among the other education groups there are no major differences as the average scores range from 2.14 to 2.35.

	mean (SD)	median [min, max]	skew	kurtosis	se
Master's	2.35 (1.04)	2.5 [1, 5]	0.64	0.1	0.09
Bachelor's	2.19 (0.95)	2 [1, 5]	0.36	-0.37	0.1
AS	2.14 (0.92)	2 [1, 4.5]	0.42	-0.55	0.1
HS	2.34 (0.91)	2.5 [1, 5]	0.21	-0.24	0.09
Primary	3.04 (0.84)	3 [1.5, 5]	0.43	0.22	0.23

Table 11: Education Comparison on Trading Activity

From Table 12 we can see that high school graduates and Master's graduates seem to be most interested about responsible investing as they have the highest scores in this variable. Bachelor's graduates (2.67) and graduates from universities of applied sciences (2.7) have the next highest mean scores in this variable, while people with no additional education after primary school (2.57) have the lowest average score in the variable.

	mean (SD)	median [min, max]	skew	kurtosis	se
Master's	2.82 (0.97)	3 [1, 5]	0.01	-0.68	0.08
Bachelor's	2.67 (0.91)	2.67 [1, 5]	0.12	-0.47	0.09
AS	2.7 (0.98)	2.67 [1, 4.67]	0.1	-0.99	0.11
HS	2.89 (1.01)	3 [1, 5]	0.03	-0.82	0.11
Primary	2.57 (1.09)	2.17 [1.33, 4.67]	0.67	-1.12	0.29

Table 12: Education Comparison on Responsible and Emotional Investing

Next, in order to find out what kind of investor profiles there are among Finnish millennials in terms of behavioral biases, a Self-Organized Map was created. By doing this, observers can see what kind of variable patterns there are among the population. As already stated, the Self-Organizing Map used in this research uses node weight vectors made of normalized values of the original variables to generate the map. In addition to the SOM, a heat map was created in order to visualize the amount of observations each of the clusters have.

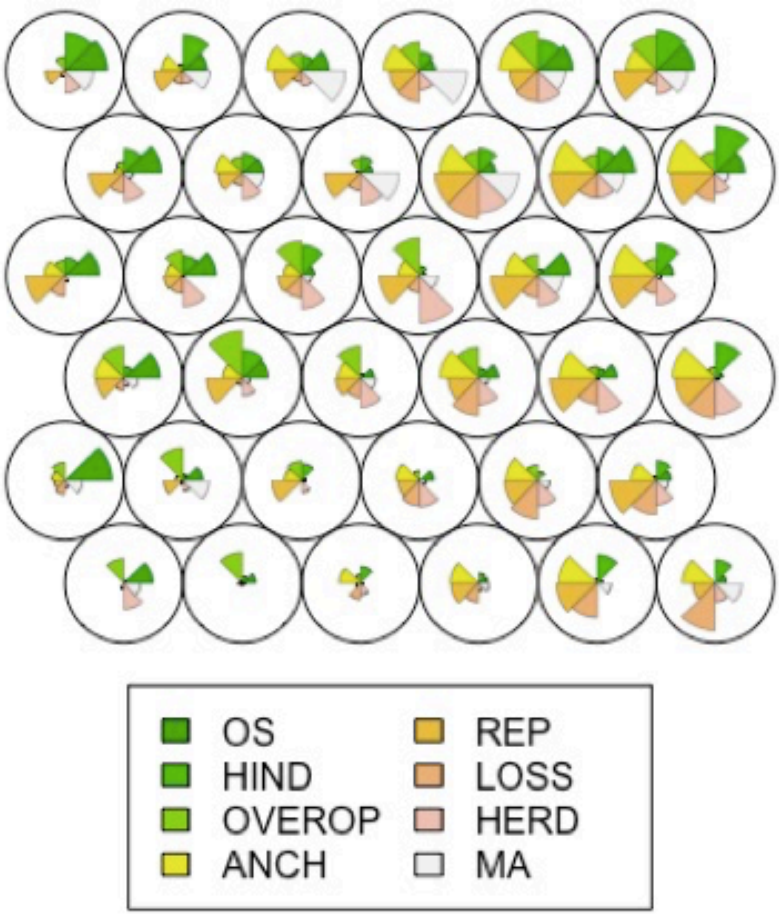

Figure 5: SOM on Behavioral Biases Among Finnish Millennials

From Figure 5 we can see what kind of behavioral biases the Finnish millennials possess together. In the lower left corner, we see profiles that score low on almost all of the biases, while the upper right corner portrays observations with several cognitive biases. By examining the heat map (Figure 6), we see that the most common observation is a profile with a low score in loss aversion and an average score in the other biases (lightest circle in the heat map). By observing the yellow

circles in the heat map, we see that there are also several profiles which possess all of the biases (upper right corner). Furthermore, a common profile seems to be a combination of high scores in representativeness and loss aversion, and a medium score in anchoring (lower right corner). By inspecting the light orange circles, we can also see that a mixture of hindsight bias, overoptimism, and overconfidence is a typical investor profile among Finnish millennials. In addition, the right side of the SOM suggests indicates that anchoring and representativeness are often experienced together, and often accompanied with an additional bias. The overall finding seems to be that the clear majority of all millennial investors in Finland possess some kind of behavioral bias as the middle circles in the lower row only have a few observations.

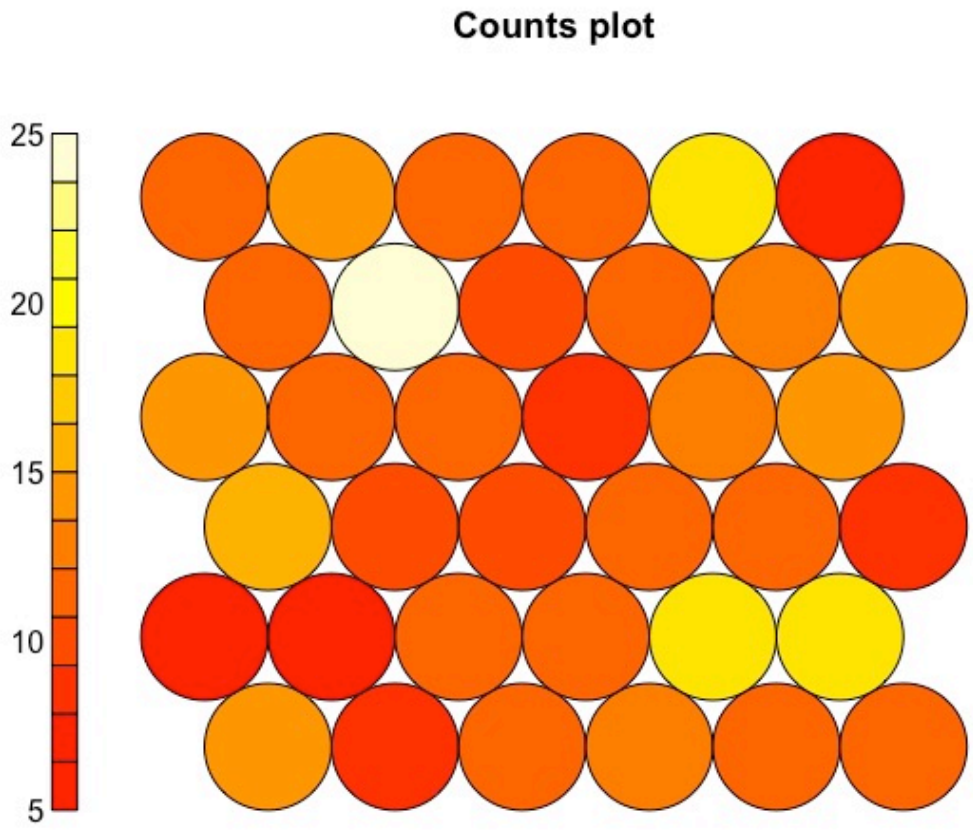

Figure 6: Heat Map of the Observations (SOM)

In order to find out which behavioral biases have affected most to trading activity during the corona epidemic, a fuzzy-set qualitative comparative analysis was conducted. First, the variables in the data needed to be calibrated to fuzzy sets. Calibrating the data into fuzzy sets means transforming each variable into a measure of membership degree. The membership degree can range from a value of 0.0 (full exclusion from a set) to 1.0 (full inclusion). According to Ragin (2008), fuzzy sets bridge the gap between qualitative and quantitative methods because they are quantitative and qualitative at the same time. Where full membership and full non-membership are qualitative conditions, the values in between are quantitative.

The calibration is this research was performed with a direct method. In the direct technique, the researcher specifies the values that resemble the three breakpoints of full membership, full non-membership, and the crossover point. These benchmarks are then used to convert the original Likert-scale scores to fuzzy membership values. As the data was collected by a Likert-scale from 1 to 5, the full membership score was chosen as five, and the full non-membership was selected as one. In order to avoid membership scores of 0.5, the crossover point was chosen as 2.9. The membership scores of the answer set can be seen in Figure 7.

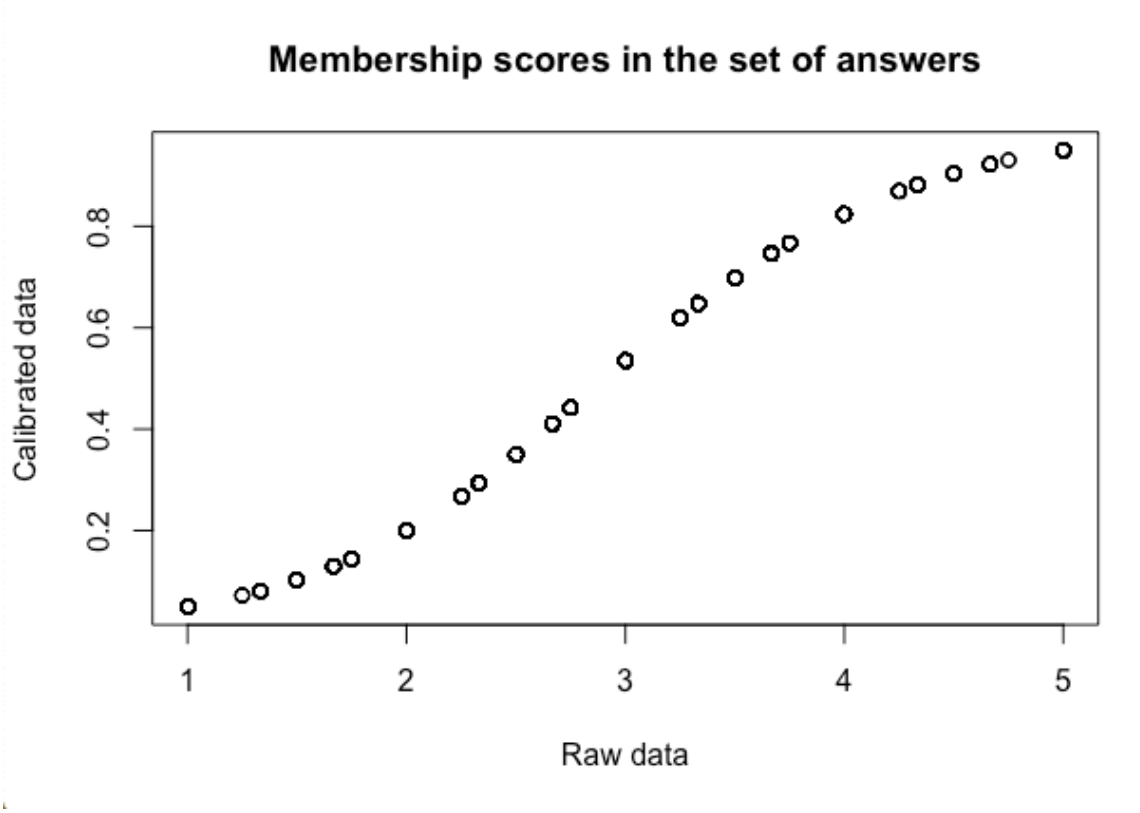

Figure 7: Membership Scores in the Set of Answers

Next step in the fsQCA is to construct a truth table, which requires selecting one variable as the outcome and the membership scores or “conditions” to explain the outcome. In this case, the examined behavioral biases were selected as the explanatory scores, and trading activity as the outcome. Table 13 portrays the truth table with sufficiency inclusion scores of >0.8, while the rest of the rows were left out for further analysis.

OS	HIND	OVEROP	ANCH	REP	LOSS	HERD	MA	OUT	n	inc	PRI
1	1	1	0	0	1	1	0	1	1	0.830	0.191
1	1	0	0	0	1	1	1	1	2	0.827	0.175
1	1	1	1	0	1	0	0	1	1	0.825	0.160
1	1	0	0	1	1	1	1	1	1	0.823	0.177
1	1	0	0	1	1	1	0	1	1	0.823	0.176
1	1	1	1	0	1	1	1	1	4	0.821	0.206
1	1	1	1	0	1	0	1	1	1	0.818	0.172
1	1	0	0	0	0	0	1	1	1	0.817	0.193
1	1	0	0	1	0	1	1	0	2	0.815	0.197
1	1	0	0	0	0	1	1	0	1	0.814	0.183
1	1	0	0	1	0	0	1	0	2	0.812	0.187
1	1	0	1	1	1	0	1	0	2	0.812	0.164
1	1	0	1	0	0	1	1	0	1	0.812	0.168
1	1	0	1	0	0	0	1	0	1	0.811	0.160
1	1	1	1	0	0	1	1	0	2	0.811	0.203
1	1	1	0	1	0	1	1	0	2	0.810	0.207
1	1	1	1	1	1	0	0	0	1	0.810	0.154
1	1	1	1	1	1	0	1	0	1	0.810	0.173
1	1	1	1	1	1	1	0	0	2	0.808	0.164
1	1	0	1	1	1	1	0	0	1	0.808	0.161
1	1	0	0	0	0	1	0	0	2	0.806	0.193
1	1	0	1	1	0	1	1	0	4	0.805	0.188
1	1	0	1	1	1	0	0	0	2	0.805	0.134
1	1	0	0	1	0	1	0	0	1	0.805	0.180
1	1	1	0	0	0	0	1	0	2	0.805	0.189
1	1	1	1	1	1	1	1	0	10	0.804	0.211
1	1	0	1	1	0	0	1	0	2	0.803	0.167
1	1	1	0	1	0	0	1	0	1	0.802	0.184
0	1	1	0	1	1	1	1	0	1	0.802	0.151
1	1	1	1	0	0	0	0	0	1	0.800	0.141
0	1	1	0	0	1	1	0	0	3	0.800	0.141

Table 13: Truth table (OUT = output value, n = number of cases in configuration, incl = sufficiency inclusion score, PRI = proportional reduction in inconsistency).

The “inc” column in the table measures consistency, which means that the membership score on the outcome is constantly greater than the membership score of the causal combination, weighted by the relevance of each case. For example, in a situation where five out of five cases are consistent, the proportion is 1.0, and when sixteen out of twenty cases are consistent, the proportion is 0.8. The consistency scores in a truth truth should be as close to 1.0 as possible (perfect consistency), but generally everything over 0.8 is held accountable. Consistency scores of under 0.8 contain significant inconsistency. (Ragin, 2008) The consistency score level for this analysis was set to >0.815.

OS	HIND	OVEROP	ANCH	REP	LOSS	HERD	MA	OUT	n	inc	PRI
1	1	1	0	0	1	1	0	1	1	0.830	0.191
1	1	0	0	0	1	1	1	1	2	0.827	0.175
1	1	1	1	0	1	0	0	1	1	0.825	0.160
1	1	0	0	1	1	1	1	1	1	0.823	0.177
1	1	0	0	1	1	1	0	1	1	0.823	0.176
1	1	1	1	0	1	1	1	1	4	0.821	0.206
1	1	1	1	0	1	0	1	1	1	0.818	0.172
1	1	0	0	0	0	0	1	1	1	0.817	0.193

Table 14: Truth Table with Consistency Score of >0.815

From Table 14 we can see that overconfidence, hindsight bias, and loss aversion are clearly the cognitive biases that have most affected trading activity of Finnish millennials during the corona crisis. The other biases have also influenced trading activity but their absence seems only to make little difference as their occurrence have altered more.

5. CONCLUSIONS AND DISCUSSION

The last chapter of this study will present the results and combine them with theory and findings from previous researches. This part of the study will also include limitations of this study and suggestions for future research. The chapter will start with answering each of the research questions, starting with the sub-questions and ending with the main research question.

The first sub-question of the research to be answered is:

"What kind of cognitive biases do millennial investors in Finland have?

This research measured the occurrence of eight pivotal investor cognitive biases among Finnish millennials. The measured biases were overconfidence, hindsight bias, overoptimism, anchoring, representativeness, loss aversion, herding, and mental accounting. Out of these eight biases, anchoring was the most common in terms of mean (3.19). Representativeness (3.12), overoptimism (3.08), and herding (3.05) also had an average score of over 3, which can be held as a threshold for the occurrence. Mental accounting had an average score of 2.91, which is also close to the threshold. Interestingly, overconfidence (2.79), hindsight bias (2.66), and loss aversion (2.62) had the lowest mean scores for the whole sample. This is somewhat surprising as according to Twenge et al. (2010) millennials tend to have an increased amount of narcissistic characteristics, which is for example linked with overconfidence. However, it should be noted that each of the biases had observations both low and high in the whole sample, which means they are present but their occurrence among the population is not that common.

When comparing the findings for example with the results of Baker et al. (2018), we see that Finnish millennials score less on all of the examined behavioral biases compared with Indian individual investors. However, most of the respondents in the sample of this research had accumulated additional education after primary, which can have a clear effect on the results. In addition, as India is for example a more

collective culture, it is not a surprise that household investors in the country are more prone to herding behavior.

As millennials are said to live more in a moment, and value quality of life and work-life balance more rather than having a big paycheck (Syrett & Lammiman, 2003, 72), it is logical that the generation have high average scores on overoptimism. Factors explaining herding behavior could include millennials' tendency to experience FOMO (fear of missing out), and inability to to think about the outcomes of their choices and actions (Vizwanathan & Jain 2013, 487). Vizwanathan & Jain (2013) have also suggested that millennials are more likely to consult their friends and family when making long-term decisions, which can also be seen as a factor contributing to high scores in herding. Previous studies have also suggested that experienced investors are less prone for herding (Merli & Roger, 2013). As the majority of millennials are probably relatively inexperienced investors because of their age, this would also partly explain the findings. Furthermore, Venezia, Nashikkar & Shapira (2011) have stated that herding behavior increases in volatile market conditions, which we have recently experienced.

The data analysis also included gender comparison for the cognitive biases. Among Finnish millennials, women have higher mean scores than men in anchoring, representativeness, loss aversion, and hindsight bias, while men are more prone to experiencing overconfidence, overoptimism, and mental accounting. Regarding herding there were no differences. The overall trend among the findings was also that women had higher scores overall among the biases. These findings that men tend to be more overconfident than women, especially in subjects like finance, are in line for example with findings of Prince (1993), Lundeberg et al. (1994), and Barber & Odean (2000), and as overconfident investors are also more likely to be overoptimistic (Baumeister et al., 1989), the findings of this research also support the latter. The results of this study also support the findings of Lee, Miller, Velasquez & Wann (2013) who reported that anchoring is more prevalent in women. According to Feng & Seasholes (2005) men are more likely to realize losses than women when talking about equity investments, which can also partly explain why women had a higher average score in loss aversion. However, according to Feng & Seasholes (2005), men and women in China have similar kind of cognitive biases. Combining

findings of previous studies indicates that individuals from different countries have different kind of biases.

Differences between education levels was also examined in this research. The overall trend among the population was that individuals with higher education had lower levels in all of the cognitive biases. The fact that educated individuals did not experience more overconfidence than people with no additional education can be held somewhat surprising and opposite to previous findings, at least when compared to findings from Asia. According to Mishra & Metilda (2015), overconfidence tend to be higher among experienced and educated individuals in India. Hofsteade (1980) have reported that especially collective-oriented societies, which Asian cultures mostly are, can cause educated and experienced individuals to be more overconfident. These findings indicate that individuals in different parts of the world experience education inversely.

Next, the following sub-question will be answered:

"What kind of investor profiles are there in terms of behavioral biases among Finnish millennials?"

The most common bias profiles among Finnish millennials are combinations of all the biases, either with average or high values in each of the biases. This is not surprising, as according to Lamberg (2003) all investors are guided by two basic qualities, fear and greed. Thus, it is normal that all investors experience some kind of biases, either consciously or unconsciously. Furthermore, an often experienced bias profile is a combination of representativeness, loss aversion, and anchoring. Representativeness and anchoring are also often encountered together with either overconfidence or overoptimism. A typical bias profile among Finnish millennials is also a mixture of hindsight bias, overoptimism, and overconfidence. Experiencing these three biases is supported by previous findings as according to Camerer et al. (1989) misleadingly believing that one is able to predict the future often results in

increased levels of overconfidence. Moreover, Baumeister et al. (1989) have stated that overconfident investors are also more likely to be overoptimistic. Barber, Odean & Zhu (2009) state that herding would be more common for investors who also have other behavioral biases. However, the bias profile analysis does not support this finding undoubtedly even if herding was quite common among Finnish millennials.

Next, last of the sub-research questions will answered:

"How should investing be marketed for the generation"?

With their continuously growing assets, millennials will become a vastly influential age cohort to target for banks but also for other industries in the near future. The development of modern technology has even made some doubt the future of regular brick and mortar banks, as millennials will increasingly use alternative banking applications such as white label banking and banking-as-a-service (BaaS). Therefore, the challenge for traditional, often conservative and large, banks will be how to maintain and cherish their current relationships with the younger generation in the increasingly competitive banking industry. In order to do so, banks might need to reform their marketing communication efforts to better reach with the tech-savvy generation. (Tan & Lau, 2016)

One way to make millennials commit to their current bank could be to attract them more to investing. As the younger age cohort is constantly connected through their smartphones, it is most likely the best channel to communicate with the generation (Okazaki et al., 2007). Millennials often live hectic lifestyles, which has made the generation to look for quick and flexible alternatives that are accessible on the go. The continuous information flow through their smartphones have also made millennials to experience FOMO (fear of missing out) (Hojnacki et al, 2017). Having used social media from an early age has certainly had an effect on that millennials like to consume their media as short messages (Carr & Ly, 2009). This could also be one reason why the generation is believed to have an increasing amount of

problems for example in attention and reading (Alsop, 2008). According to Smith (2012) visually pretentious websites also appeal to millennials. Combining these factors, banks should use short, visually pleasing messages to attract millennials into equity investing. Short videos could also be a working solution, as according to Carr & Ly (2009) millennials are commonly averse to reading.

According to Smith & Brower (2012) most millennials possess positive outlook towards environment-friendly products and services, and they are even willing to pay a premium for green products or brands. Grewal and Levy (2008) have added that the generation cares more about the environment than Baby Boomers and Generation X. Even if millennials are ready to pay more for a green product or service, according to the findings of this study, it is not always the case with equity investing. The findings of this research indicate that millennials in Finland are hesitant to accept a smaller profit even if they know they are investing for example in a socially responsible fund or company. However, when comparing men and women regarding the matter, the findings indicate that women are clearly more interested in investing responsibly and to companies they like. The findings also suggest that more educated individuals are more interested about the emotional side of investing than people with no additional education. However, the differences between education groups regarding this matter was quite marginal. It should also be noted that educated individuals probably have more monetary assets available, which could also affect the willingness to sacrifice a small percentage of profit for a responsible equity investment.

The key takeaways for banks should be that educated women are more likely to engage in responsible investing than for example men with no additional education after primary school. Women are also more likely to invest in companies they like, rather than just thinking about the possible profit. Therefore, banks should also divide their customers into segments and then customize marketing efforts to provide millennials content that fulfill their needs.

Lastly, the main research question will be answered.

"Which cognitive biases have most affected trading activity of Finnish millennials in recent volatile market conditions?"

The findings of this study suggest that out of the eight examined cognitive biases, overconfidence, hindsight bias, and loss aversion are the ones that have most affected trading activity of Finnish millennials during recent volatile market conditions. The fact that overconfidence has had an effect on trading activity is nothing new as many theoretical models have predicted that overconfident investors have a tendency to trade more compared to average investors. For example, Deaves, Lüders & Luo (2008), Grinblatt & Keloharju (2009) and Scheinkman & Xiong (2003) have made these kind of findings. Since hindsight bias often results in increased levels of overconfidence (Camerer et al., 1989), it is also not surprising that experiencing hindsight bias have also affected trading activity.

However, the finding that loss averse individuals have traded most in recent times is quite interesting. As loss aversion refers to investors applying more importance on avoiding losses than trying to attain profits, (Tversky & Kahneman, 1992), the finding would suggest that these loss averse investors have either cashed their winning stocks before them turning to losses or that they have minimized their losses during the worst stock downturn. Another possible explanation for the phenomena could be that these investors have suffered from myopic loss aversion (MLA). The condition usually occurs when investors get frequent updates on how their portfolio is performing (Benartzi & Thaler, 1995). This is a very possible explanation as getting stock price information is very fast and effortless in today's world. Thaler et al. (1997), Gneezy & Potter (1997), Haigh & List (2005) and Larson et al. (2016) have all found evidence that students, retail investors and professional traders suffer from myopic loss aversion.

5.1. LIMITATIONS AND FUTURE RESEARCH RECOMMENDATIONS

This research examined selected cognitive biases, their occurrence among Finnish millennials, and how they have affected investors' trading activity during recent volatile market conditions. It should be noted that the findings of this research can not be generalized, as millennials in different parts of the world possess diverse individual characteristics and they might have completely different life situations. In addition, as the sample of this study consisted of mainly highly educated individuals, which does not mimic the actual education levels of all Finnish investors, the results can not be generalized for the entire Finnish investor population. Even so, the findings of the study supplements existing literature on behavioral finance, and gives valuable insight for banks and other institutions about investor bias profiles. In addition, one of the aims of this study was to educate Finnish millennial investors about investor cognitive biases they might experience. This study will undoubtedly help them to understand these biases and how they work. Hopefully, these findings will also help millennials in making better equity investments. Furthermore, even if this study was narrowed to only address millennials in Finland, other Scandinavian countries, like Sweden, Norway, and Denmark, can also certainly benefit from these findings as the cultural dimensions of the populations are fairly similar.

In the future it would be interesting to conduct researches that would study points or marks when investors engage most in stock trading when facing a bear market, and what kind of investor bias profiles accumulate best results in these kind of market conditions. Obviously, this kind of study would need a data set from a bank or some other financial institute. In addition, it would be interesting to study how signing on to your portfolio affects ones trading activity. These kind of results would be interesting as earlier individuals had to see more effort to check stock prices, whether it is really effortless in today's technology driven world. This kind of study would also supplement existing literature on loss aversion, and the supplementing dimension of the bias (MLA).

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APPENDICES:

Appendix 1: Online Questionnaire in English

Gender:

- Female
- Male
- Other

Birth Year:

- 1980-1983
- 1984-1987
- 1988-1991
- 1992-1996
- 1997-2000

Educational Background:

- Primary School
- High School
- Degree from a University of Applied Sciences
- Bachelor's degree
- Master's degree

1. When my investment is winning, I feel that my actions and knowledge affected the result (1 = disagree, 5 = agree)
2. I believe that my skills and knowledge of the stock market can help me to outperform the market (for example OMXH, Helsinki)
3. I see myself better as an average investor
4. I was able to predict the recent market collapse
5. I would have been convinced if someone told me last year that the stock market will plummet in 2020
6. Looking back at the market collapse, it was pretty obvious it would happen
7. I live in the moment
8. I don't need a financial advisor
9. I think the average annual return on the Helsinki Stock Exchange is: (1 = 0 or less, 2 = 1-2%, 3 = 3-5%, 4 = 6-7%, 5 = over 8%)
10. I compare the current stock price with its recent 52-week high and low price to justify my stock purchase

11. When I decide to sell a stock, I keep its purchase price in mind
12. In a falling market, I hold a losing stock until its price returns to its purchase level
13. I forecast the changes in stock prices in the future based on recent stock prices
14. I rely on past performance to buy stock because I believe that good performance will continue
15. I try to avoid investing in companies with a history of poor earnings
16. Technical analysis increases my chance to buy a better performing stock
17. I rather focus on avoiding a large loss rather than missing a substantial gain
18. I have felt stress about my investments during the coronavirus
19. When it comes to an investment, no loss of capital (invested money) is more important than returns (profits)
20. Avoid selling shares that have decreased in value and sell shares that have increased in value
21. I consult others before making stock purchases or sales
22. Other investors' decisions of buying and selling stocks affect my investment decisions
23. I follow social blogs/ forums before making a stock purchase/sale
24. My investment in stock A does not affect my investment decision in stock B
25. My decision to buy a house does not affect my investment in the stock market
26. I tend to follow my stocks/products separately rather than following my my portfolio's overall development
27. I have sold the majority of my portfolio during the corona crisis
28. I have sold and bought more stocks during the corona crisis than usually
29. I'm ready to accept a smaller profit if I know I'm investing into a responsible company/fund
30. The most important thing in equity investing is responsibility
31. The most important thing in equity investing is that I like the company's products

Appendix 2: Online Questionnaire in Finnish

Sukupuoli:

- Nainen
- Mies
- Muu

Ikä:

- 1980-1983
- 1984-1987
- 1988-1991
- 1992-1996
- 1997-2000

Koulutus

- Peruskoulu
- Lukio
- Ammattikorkeakoulututkinto
- Alempi korkeakoulututkinto
- Ylempi korkeakoulututkinto

1. Kun sijoitukseni on voitolla, tunnen toimillani ja tietämykselläni olleen siihen vaikutus
2. Uskon pystyväni parempaan tuottoon omilla sijoituspäätöksilläni kuin markkinoilla yleensä (esim. verrattuna OMXH, Helsinki)
3. Pidän itseäni keskimääräistä parempana sijoittajana
4. Pystyin ennustamaan viimeaikaisen (helmi-maaliskuun) pörssiromahduksen
5. Olisin ollut vakuuttunut, jos joku olisi kertonut minulle viime vuonna osakemarkkinoiden laskevan 2020 alkuvuodesta
6. Jälkikäteen ajateltuna viimeaikainen (helmi-maaliskuun) pörssikurssien lasku oli jopa itsestäänselvyys
7. Elän hetkessä
8. En koe tarvitsevani talous-/sijoitusneuvojaa
9. Uskon Helsingin pörssin seuraavan viiden vuoden keskimääräisen vuosituoton olevan
10. Käytän viimeisen vuoden korkeinta ja matalinta kurssia perusteena ostaessani osaketta/tuotetta
11. Myydessäni osaketta/tuotetta pidän sen ostohinnan mielessä

12. Laskumarkkinassa pidän tappiollisesta osakkeesta/tuotteesta kiinni, kunnes sen hinta palautuu ostotasolle
13. Ennustan osakkeiden/tuotteiden hintoja niiden viimeaikaisen hintojen perusteella
14. Ostaessani osakkeita luotan yhtiöihin, jotka ovat tehneet aikaisemmin tulosta
15. Yritän välttää sijoittamista yrityksiin, jotka eivät ole aikaisemmin tehneet tulosta
16. Tekninen analyysi parantaa mahdollisuuksiani ostaa paremmin tuottava osake
17. Keskityn mieluummin suurten tappioiden välttämiseen kuin merkittävän voiton saavuttamiseen
18. Olen tuntenut stressiä sijoituksistani koronaviruksen aikana
19. Sijoittamisessa tappion välttäminen on tärkeämpää kuin voiton saavuttaminen
20. Vältän tappiollisten sijoitusten myyntiä ja myyn vain voitollisia sijoituksia
21. Konsultoin muita ostaessani tai myydessäni sijoituksia
22. Muiden myynti- ja ostopäätökset vaikuttavat omiin sijoituspäätöksiini
23. Seuraan blogeja/foorumeita ennen kuin myyn tai ostan osaketta/tuotetta
24. Sijoitukseni kohteeseen A ei vaikuta sijoitukseeni kohteeseen B
25. Päätökseni esim. asunnon ostosta ei vaikuta sijoituspäätöksiini
26. Seuraan omistamieni yksittäisten kohteiden arvonkehitystä tarkemmin kuin salkkuni kokonaiskehitystä
27. Olen valmis hyväksymään pienemmän tuoton, jos tiedän sijoittavani vastuulliseen yhtiöön/rahastoon
28. Sijoittamisessa tärkeintä on vastuullisuus
29. Osakesijoittamisessa tärkeintä on, että pidän yhtiön tuotteista
30. Olen myynyt suurimman osan omistuksistani koronavirustilanteen aikana
31. Olen viime aikoina ostanut ja myynyt enemmän sijoituksia kuin yleensä

Appendix 3: The Mahalanobis Scores of the Cases

1	2	3	4	5	6	7	8	9	10
8.927334	8.688540	18.270210	19.951847	13.995905	8.243558	15.428735	3.693759	10.639279	15.636439
11	12	13	14	15	16	17	18	19	20
11.308588	7.262345	20.504480	12.767159	12.957525	5.732834	5.059943	8.507311	8.217431	17.235404
21	22	23	24	25	26	27	28	29	30
11.727145	13.906314	12.576029	4.614325	16.304904	9.300873	2.468917	10.160933	8.471298	11.335204
31	32	33	34	35	36	37	38	39	40
11.092459	2.280709	7.993816	13.027212	18.652889	10.816746	12.079870	21.825236	7.485447	8.696724
41	42	43	44	45	46	47	48	49	50
4.054266	3.672281	8.377668	12.153133	5.520152	3.882060	4.787184	17.647718	12.380275	7.161117
51	52	53	54	55	56	57	58	59	60
7.174756	2.414830	5.511428	4.909746	13.817173	9.414696	6.368239	11.697431	7.418175	9.786966
61	62	63	64	65	66	67	68	69	70
13.687424	14.167238	9.848197	17.291641	16.662905	9.806881	4.173812	4.485362	8.549902	5.993934
71	72	73	74	75	76	77	78	79	80
8.867576	14.493846	12.579958	18.590675	5.124152	4.533792	4.070583	2.832907	13.543583	14.922873
81	82	83	84	85	86	87	88	89	90
7.299263	11.356388	9.044760	7.954831	10.894930	5.614942	4.154220	6.189669	6.031876	6.277164
91	92	93	94	95	96	97	98	99	100
5.180352	7.580292	15.168121	10.777143	8.783248	3.945604	14.888499	18.324669	6.058466	7.739402
101	102	103	104	105	106	107	108	109	110
4.612669	7.331006	8.811353	8.703890	24.555151	9.241758	21.495910	13.178296	6.642154	8.135987
111	112	113	114	115	116	117	118	119	120
13.388508	5.577522	14.878909	5.280826	5.736790	6.376206	8.487025	11.642906	5.274805	9.673211
121	122	123	124	125	126	127	128	129	130
5.709317	3.531016	6.369446	7.648572	7.150440	12.422532	6.061926	10.465791	19.839906	6.255069
131	132	133	134	135	136	137	138	139	140
11.763623	12.120374	6.126914	11.118439	4.881043	9.660888	13.894734	5.961041	10.183884	3.727153
141	142	143	144	145	146	147	148	149	150
8.415210	7.117263	11.608694	3.667257	9.146503	8.671807	16.437554	6.307429	16.930752	7.955503
151	152	153	154	155	156	157	158	159	160
11.688175	5.338735	6.511896	16.313310	15.465926	4.454049	3.374729	16.833592	14.172519	11.994084
161	162	163	164	165	166	167	168	169	170
9.989964	5.022362	6.494787	13.799850	17.424894	13.081429	10.396478	4.391888	14.442745	15.422015
171	172	173	174	175	176	177	178	179	180
6.715512	11.231630	17.059579	16.501310	20.805385	5.544030	18.882006	8.496805	11.753041	11.199320
181	182	183	184	185	186	187	188	189	190
3.558507	17.714259	6.686869	15.218725	5.105230	23.128269	17.463022	11.162839	16.595792	10.540967
191	192	193	194	195	196	197	198	199	200
12.939107	19.149062	12.099599	14.528246	3.989334	18.426133	25.994263	9.896306	11.196475	12.781555
201	202	203	204	205	206	207	208	209	210
5.119109	10.466904	4.209667	8.232025	10.079125	10.893386	9.370681	13.040217	5.624077	4.820266
211	212	213	214	215	216	217	218	219	220
2.955739	2.618329	12.973155	12.892834	13.418431	28.596671	7.257003	8.769824	14.249970	14.112428
221	222	223	224	225	226	227	228	229	230
6.745274	7.845010	10.139407	13.968895	9.059295	8.618183	13.695164	10.297004	6.821058	8.018606
231	232	233	234	235	236	237	238	239	240
12.036176	3.743189	9.801799	14.050262	9.417048	16.796785	6.343231	6.425218	4.474210	5.917972
241	242	243	244	245	246	247	248	249	250
8.143765	15.141780	10.616193	7.939141	12.994899	15.517060	3.989334	5.017654	9.246320	4.728598
251	252	253	254	255	256	257	258	259	260
2.359331	3.989334	4.324096	16.442255	7.358723	13.797767	5.189325	3.514740	9.475472	13.119286
261	262	263	264	265	266	267	268	269	270
17.214844	9.759578	11.490535	10.966813	11.114261	4.476020	19.333888	15.392557	8.773692	8.727260
271	272	273	274	275	276	277	278	279	280
8.650932	13.533040	9.935020	1.298826	8.996442	15.779101	16.826858	10.610954	10.660809	6.712237
281	282	283	284	285	286	287	288	289	290
22.516404	7.391112	12.776658	5.986663	18.753409	8.011149	10.998649	8.601783	7.782904	14.775195
291	292	293	294	295	296	297	298	299	300
7.847687	9.750322	12.052532	6.564280	5.706776	1.430479	2.775666	15.005957	6.541471	7.380034
301	302	303	304	305	306	307	308	309	310
4.369196	7.601853	9.683626	12.103904	11.954551	3.674551	7.600305	3.619017	6.294112	5.308499
311	312	313	314	315	316	317	318	319	320
12.438783	13.845403	9.209781	9.390218	11.723053	3.525011	8.893198	8.311088	17.810192	10.266720

321	322	323	324	325	326	327	328	329	330
6.490357	6.219411	7.687529	17.557192	8.411890	11.700846	12.077727	5.689566	9.577361	9.655751
331	332	333	334	335	336	337	338	339	340
15.554165	7.142703	14.074392	14.074392	17.003496	9.705544	8.801193	13.779807	10.652518	8.535136
341	342	343	344	345	346	347	348	349	350
13.247407	4.665921	14.496145	9.135501	6.960557	8.235133	8.597592	4.487534	15.632464	11.251031
351	352	353	354	355	356	357	358	359	360
15.718487	8.481081	2.806210	11.171487	12.221661	22.617402	9.098513	5.379796	6.431539	5.491316
361	362	363	364	365	366	367	368	369	370
4.365675	6.765539	10.028845	11.207650	8.587543	16.645563	14.410891	15.545995	3.895711	10.062195
371	372	373	374	375	376	377	378	379	380
12.788618	7.526311	5.542225	8.863839	9.571174	16.720099	9.894721	12.967833	17.822285	4.668986
381	382	383	384	385	386	387	388	389	390
14.945742	10.118416	5.675280	7.764014	7.502321	4.850415	10.778267	12.778577	4.679624	13.554671
391	392	393	394	395	396	397	398	399	400
10.907637	11.810540	9.741000	25.192395	6.313746	9.205622	7.414815	7.523620	15.042834	5.960107
401	402	403	404	405	406	407	408	409	410
13.730212	1.802018	7.267747	5.244469	6.481052	5.186546	5.893513	7.100483	11.399090	7.759050
411	412	413	414	415	416	417	418	419	420
7.192774	9.400194	10.198026	1.445726	10.898037	9.719081	8.152272	10.830406	10.382210	8.941448
421	422	423	424	425	426	427	428	429	430
10.820093	8.813319	9.973073	6.693096	10.335233	5.519343	7.233535	3.886752	1.874173	12.139826
431	432	433	434	435	436	437	438	439	440
3.499828	3.345513	8.267988	2.800526	13.897514	7.856352	17.118779	10.132147	7.218437	4.587716

Appendix 4: Codes Used in R-software

```
mahalanobis()

wilcox.test(x, y, paired = FALSE, alternative = "two.sided")
wilcox.test(x, y)

describe()


#kohonen package

som_grid <- somgrid(xdim = 6, ydim=6, topo="hexagonal")

som_model <- som(data_train_matrix,
                 grid=som_grid,
                 rlen=100,
                 alpha=c(0.05,0.01),
                 keep.data = TRUE,
                 normalizeDataLayers = TRUE)

plot(som_model, type="codes", codeRendering = "segments")

plot(som_model, type="count")


#QCA package

cali = calibrate(as.matrix(data3), type = "fuzzy", method = "direct", thresholds =
c(1,2.9,5), logistic = TRUE, idm = 0.95, ecdf = FALSE, below = 1, above = 1)

plot(as.matrix(data4), cali1, main = "Membership scores in the set of answers",
    xlab = "Raw data", ylab = "Calibrated data")

ttLC <- truthTable(cali1, "TRADA", sort.by = "incl, n", show.cases = TRUE)
ttLC
```