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Bachelor's thesis, Business Administration

Strategic Finance

Is Disruptive Technology Investing Worth it? Performance Comparison of Thematic ETFs and Sectoral ETFs

Kannattaako disruptiiviseen teknologiaan sijoittaminen? Teema ETF-rahastojen ja sektori ETF-rahastojen suoriutumisen vertailu

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ABSTRACT

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This thesis uses data from Thomson Reuters datastream to compare the performance of disruptive technology thematic ETFs and sectoral ETFs to the Standard and Poor's 500 Composite index from the start of 2015 to the end of 2020. The thesis is conducted quantitative with a sample of 34 ETFs, 12 thematic and 22 sectoral ETFs. The ETFs are compared by annualized returns, volatility, expense ratio, and risk-adjusted measures Sharpe ratio, Jensen's alpha, and Treynor ratio. Disruptive technology thematic ETFs and sectoral ETFs are categorized by the ETFs' investment objectives. The aim of this thesis is to find answers if thematic ETFs beat the sectoral ETFs, if equally weighted disruptive technology ETF portfolio beats the Standard & Poor's 500, if thematic ETFs manage alpha returns, and does higher expense ratio leads to higher returns. Thematic ETFs did beat the sectoral ETFs in the timeframe. Disruptive technology thematic ETFs also managed to beat the comparison index and also the broader sectoral ETFs beat the comparison index by some margin. In the thesis timeframe from the start of 2015 to the end of 2020 equally weighted disruptive technology ETF portfolio gave above-market returns underlining the superior performance of the technology sector in recent years. The results if a higher expense ratio leads to higher returns are ambiguous. While thematic ETFs with a higher average expense ratio managed to beat the sectoral ETFs, some of the higher expense ratio ETFs performed poorly and very low expense ratio ETFs exceptionally.

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Tämä kandidaatintutkielma vertaa disruptiiviseen teknologian teema ETF-rahastojen, -sektori-ETF rahastojen sekä -kuolleiden ETF-rahastojen menestymistä suhteessa Standard and Poor's 500 indeksiin vuosina 2015–2020. Tutkimus toteutettiin kvantitatiivisella tutkimusmenetelmällä 34 ETF-rahaston aineistolla, joista 12 on teema ETF rahastoja, ja 22 sektori ETF rahastoja. ETF rahastoja verrataan annualisoitujen tuottojen, volatiliteetin, ja riskisuhteutettujen mittareiden Sharpen luvun, Jensenin alphan sekä Treynorin luvun avulla. Disruptiivisen teknologian teema ETF rahastot ja sektori ETF rahastot on kategorisoitu rahastojen investointi tavoitteiden perusteella. Tämän kandidaatin tutkielman tavoitteena on tutkia menestyvätkö teema ETF rahastot sektori ETF rahastoja paremmin valitulla aikavälillä, tuottaako tasaisesti painotettu disruptiivisen teknologian ETF rahasto portfolio Standard & Poor's 500 indeksiä paremmin, ja tuottavatko korkeampien kulujen ETF rahastot matalakuluisimpia paremmin. Teema ETF rahastot menestyivät tutkielmaan valitulla aikavälillä sektori ETF rahastoja paremmin. Sekä teema ETF rahastot, että sektori ETF rahastot tuottivat aikavälillä annualisoiduilla tuotoilla vertailu indeksiä selvästi paremmin. Tutkielmaan valituista ETF rahastoista koostettu tasaisesti painotettu portfolio pystyi aikavälillä tuottamaan markkinan ylittäviä tuottoja korostaen teknologia sektorin loistavaa menestymistä viime vuosina. Tulokset tuoton ja ETF rahaston kulujen suhteesta eivät ole yksiselitteiset. Vaikka teema ETF rahastot keskimäärin korkeammilla kuluilla tuottivatkin sektori ETF rahastoja paremmin, jotkin korkeammilla kuluilla tuottivat heikommin ja toiset hyvin matalilla kuluilla erittäin hyvin.

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1. Introduction

Since first introduced in the early 1990s ETFs have been continuously reinventing itself and gaining popularity resulting in enormous growth in assets under management of the investment vehicle (Meziani, 2017). Just in a little over five years, ETFs have gone from 2,9 trillion assets under management to 7,7 trillion dollars in 2020 (Figure 1). (Stastista, 2020a)

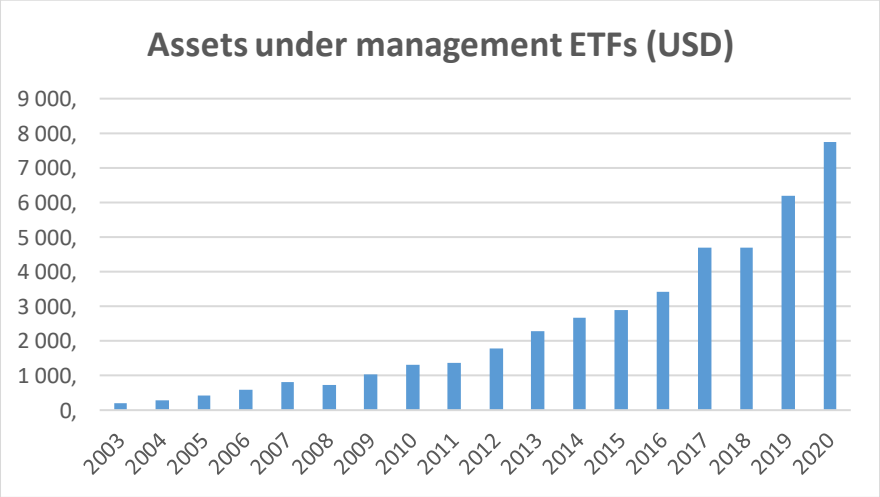

Figure 1. ETFs: assets under management. Statista. (2020a)

Meanwhile, the number of ETFs have in the United States saw an almost 40% increase. In recent times many megatrends that have been in motion for a while accelerated due to COVID-19. Investment vehicle providers have answered with instruments trying to catch the wave of these trends with alternatives for investing. Thematic funds have been one of the answers, targeting disruptive technologies and societal trends such as robotics, the internet of things, or genomics. (Liu, 2021) As illustrated in figure 2, The number of ETFs has increased worldwide by 70 % and according to research commissioned by JP Morgan and conducted by CoreData Research, thematic ETF class will be second-biggest grower in the next years after ESG ETFs (Figure 2) (Statista, 2020b; J.P. Morgan, 2020).

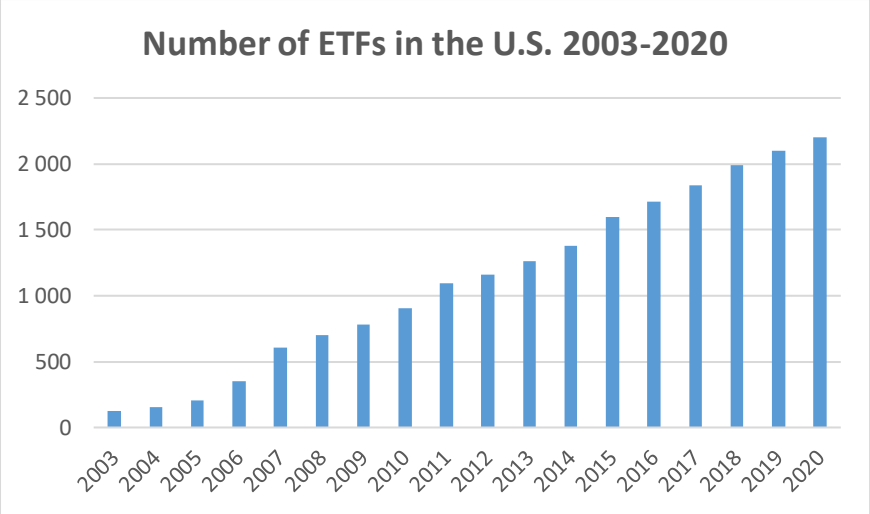

Figure 2. Number of ETFs in the United States 2003-2020. Statista. (2020b)

This paper studies exchange traded funds (ETFs) as an investment vehicle and compares the risk-adjusted performances of disruptive technology thematic ETFs and sectoral ETFs with the Standard & Poor's 500 index. This thesis analyses a sample of 34 US-listed technology ETFs. Risk-adjusted performance is analyzed for the period 2015–2020 using different methodologies: Sharpe ratio, Jensen's alpha, and Treynor ratio.

Technology as a theme is focused on because the majority of thematic fund flows of recent years have been going into disruptive technology ETFs (Global X, 2020 Q 4 Thematic flows), and technology ETFs have at the same time gathered the most interest (Figure 3). (Statista, 2019) The portfolio of thematic ETFs will be formed with equal weights since with evidence from Dheeriya and Malladi it is possible to deliver alpha with an investment strategy focusing on ideology or theme and equally weighted portfolio. (Dheeriya & Malladi, 2019)

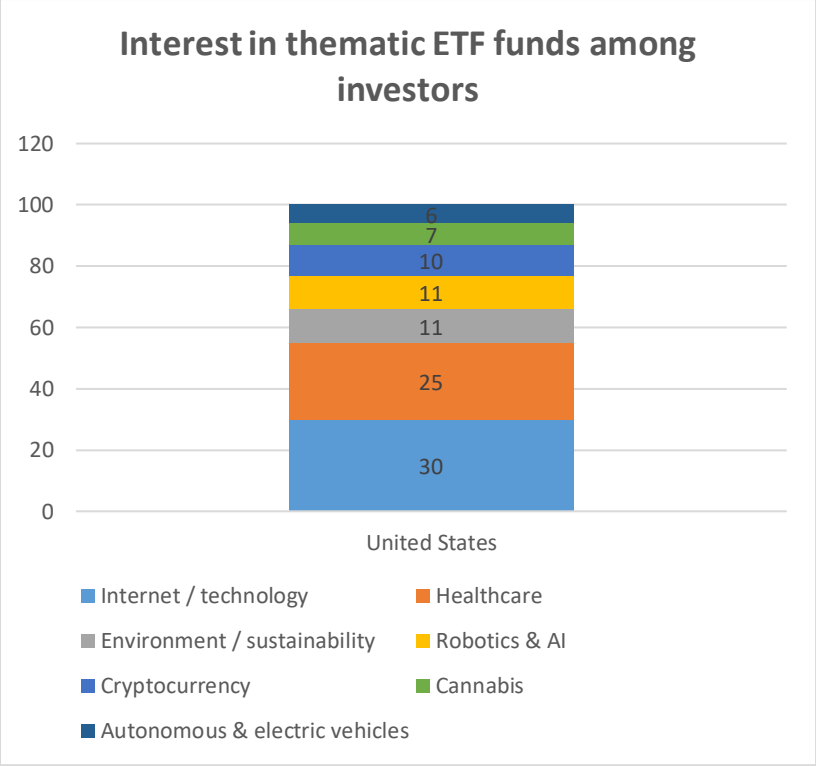

Figure 3. Interest in thematic ETF funds among investors. Statista (2019).

1.1 Research questions

This thesis analyzes the performance of thematic and sectoral ETFs in comparison to the Standard and Poor's 500 index. Sharpe ratio, Jensen's alpha, and Treynor ratio are used as the measures of performance. Also, annualized returns and volatilities are used to examine the data sample and compare the ETFs and the chosen index. Timeframe of the thesis is from 2015 to 2020 and only ETFs listed in the United States with inception date before 2015 are taken into the study.

The main research question is:
Do thematic ETFs deliver higher returns compared to sectoral ETFs?

Sub-questions of the study are:
Do disruptive technology thematic ETFs beat the Standard & Poor's 500 index from 2015 to 2020?
Does equally weighted disruptive technology ETF portfolio deliver alpha returns?
Does higher expense ratio result to higher returns?

1.2 Research limitations

This thesis focuses on comparing returns between instruments but leaves out of its scope taxational perspectives, optimal diversification, trading, and other investing strategies. Various interesting subjects are left out of further examination from this study such as ETF tracking errors and the underlying risks of ETFs. Only expense ratios are considered for the expenses of the ETFs. The timeframe chosen for the thesis is 2015-2020, it focuses on the US-markets making assumptions on other than the US markets based on the results dubious. To avoid survivorship bias dead ETFs were searched from Thomson Reuters datastream. The search yielded four dead ETFs fitting for the study: MSCI All Country Asia Information Technology Index Fund (AAIT-US), WisdomTree Japan Hedged Tech, Media and Telecom Fund (DXJT-US), SPDR S&P International Telecommunications Sector ETF (IST-US), and SPDR S&P International Technology Sector ETF (IPK-US). All of the four dead ETFs would have been in the sectoral ETF category and only affected the sectoral ETF portfolio causing bias in the results. Due to the lack of disruptive technology thematic ETFs all of the dead ETFs were left out of the study and survivorship bias will have an effect on the results. Due to the shortness of the time period and short history of thematic ETFs as investment vehicles the results of this study are sensitive to time series noise.

2 Literature Review

2.1 Introduction

Literature review of the thesis aims to give the reader a thorough understanding of the advancements and findings in the earlier academic literature about the subject of this thesis. This section synthesizes the existing literature and findings of thematic ETFs, thematic investing, and ETFs while pointing out the pros and cons of the investment vehicle. Specialized thematic ETFs are quite new in the financial markets and therefore haven't been thoroughly studied.

ETFs are financial instruments that commonly track an index, benchmark, or other as closely as possible. The big difference between ETFs and mutual funds is that while mutual funds are usually bought from a mutual fund company or brokerage, ETFs are listed on an exchange and therefore offer a good promise of liquidity. (Deville, Gresse & De Séverac, 2014)

The common conception seems to be in the academic discussion that despite animosities ETFs are one of the best financial innovations in the recent decades. (Deville et al., 2014.; Lettau et al., 2018)

When first introduced, ETFs were more broad-based and focused on tracking a certain index. The first ETF listed in the US was issued by State Street and introduced in 1993 that tracked S&P 500 index. (Hill, Nadig & Hougan, 2015) After that, more specific ETFs were launched. In recent years ETFs have developed into more specialized direction investment options varying from genomic revolution to catholic values.

2.2 Disruptive innovation

The term disruptive in itself has a negative ring to it. It gives a feeling that something is changing but there's uncertainty if the development is good or societally beneficial. Innovation on the other hand is usually perceived as positive. Disruption can be encapsulated like in Merriam-Webster "the act or process of disrupting something or a break or interruption in the normal course or continuation of some activity, process or else". (Merriam-Webster, 2021a) Innovation can be stated as a new idea or method or as an introduction of something new. (Cambridge Academic Content Dictionary, 2021, Merriam-Webster, 2021b)

Terms disruptive innovation and disruptive technology were brought to the public in the late 1990s and the use of the terms have since grown massively. (Kilkki, Mäntylä, Karhu, Hämmäinen & Ailisto, 2018) Disruptive innovation and disruptive technology can be described in many ways such as change when new technology eclipses old by simply performing in a superior manner in dimensions meaningful to the customers. (Sood & Tellis, 2011; Schmidt & Dhruel, 2008) As Schmidt et al. write, disruptive innovation is often made by market entrants rather than incumbents, but the definition in itself does not define it having to be this way. (Schmidt & Dhruel, 2008) Kilkki et al. raise the point of the internet being a driver of disruption across sectors once the sector specialized technology gets connected with the internet. (Kilkki et al., 2018) The main focus of this thesis is on the most prominent disruptive technologies that are entangled with the internet.

2.3 Thematic investing

Thematic investing dates back to the 1990s when the first publicly available thematic fund was launched by Sarasin Switzerland, the Sarasin EquiSar Global Thematic Fund. (Dheeriya et al., 2019) Thematic investing is an investment strategy that aims to find securities benefiting from long term trends in technology, society, the environment, demographics or other popular

themes, trends, or concepts. Thematic investing isn't restricted by a sector and usually invests across sectors in securities that are seen to benefit from the trend it's trying to capture. "Thematic investing refers to the process of identifying powerful, disruptive macro-level trends and the underlying investments that stand to benefit from the materialization of those trends" (Global X, 2020). When investing in a theme ETF managers' main questions are whether they believe that the trend is going to have a disruptive impact, if there are more than 20 stocks that are seen to benefit from the trend, and if the trend is a very long-term one and has an impact during next decades (Carlson, 2020). Thematic investing has started to gain interest in 2020 and by assets under management thematic investing saw growth by threefold. (Global X, 2020) Challenging the traditional capital asset pricing model, Dheeriya et al. exhibit that it's possible to achieve risk-adjusted alpha returns by investing in a theme. (Dheeriya et al., 2019)

Thematic ETFs are the investment vehicles in the ETF space that are focused on capturing long-term trends. Thematic ETFs can be used to gain exposure to niche concepts and as a way to diversify portfolio in an alternative way. As reported by ETF.com theme ETFs have around 68 billion USD under management with an average expense ratio of 0,62 %. (ETF.com, 2021) The largest investment house by assets under management Blackrock emphasizes five mega-trends that are going to have a major impact in the future: technological breakthrough, demographics and social change, rapid urbanization, climate change, and resource scarcity, and emerging global wealth. (Blackrock, 2020)

While thematic ETFs can offer a way for investors to invest very precisely according to their sentiment and predictions about the market, thematic ETFs can deliver negative returns after launch (Ben-David, Franzoni, Byungwook & Moussawi, 2021). In their paper Ben-David et al. claim that specialized thematic ETFs with higher fees target investors with less knowledge of the financial markets while more trained investors invest in low-cost broad ETFs. The new breeds of specialized ETFs are according to the researchers the ETF industry's effort to make a profit since the fee competition has been so hard in the industry. It is also pointed that thematic ETFs' attraction is often based around hype over certain trends and therefore the stocks in the ETFs portfolio have a risk of being overvalued. (Ben-David et al., 2021) This can lead to risk-adjusted negative returns or even absolute negative returns in a few years' timeframe. While some thematic ETFs can perform superbly others can deliver major losses.

2.4 Exchange-traded funds

Exchange-traded funds are investment vehicles that are the most used to track index, sector, or theme to capture a certain view of the market and its trends to provide revenue. Depending on the investment scope of the ETF the risks involved may vary drastically. The main risk of an ETF is dependent on the securities and other assets held in the portfolio and the level of diversification of the portfolio. Relatively predictable and stable revenue can be expected when investing in a well-known index. ETFs provide attributes like liquidity, low expenses, benefits in taxation, and transparency. ETFs have, on average, lower expense ratios than their often-compared counterparts, mutual funds (Hill, Nadig & Hougan, 2015). On the other hand, ETFs, especially highly specialized ones may expose investors to unexpected risks and volatility. (Lettau et al., 2018)

ETFs are an investment vehicle that changed the global markets by enabling individual investors to track the index with very low expenses while maintaining high liquidity. The global ETF study conducted by JP Morgan indicates that the five most valuable positive attributes of ETFs are low investment costs, liquidity, simplicity, diversification and risk management, and flexibility for portfolios. Other highly valued positives were transparency, tax benefits, and accessibility (J.P. Morgan, 2020). Although Bernstein found no evidence of tax evidence compared to counterpart index mutual funds (Bernstein, 2004). Unlike it's often believed the liquidity of ETFs doesn't stem from the volume of daily trading of the ETF but it's dependent on the liquidity of the underlying securities in the fund's portfolio. (Meziani, 2017)

2.5 Previous studies

In research conducted by Dheeriya et al., the researchers form an index of stocks based on a common theme providing evidence that investment strategy based on ideology or theme can provide above-market returns. In the study, the researchers create an equally weighted index of 39 stocks to make a case for a theme and ideology-based investing. The equally weighted index in the study is formed based on industry classification and aimed on companies manufacturing products or producing services for children. Dheeriya et al. explain that parents buy products and services to fulfill the needs of their children even in times of financial crises. This makes children focused sectors less vulnerable for economic fluctuations as long as birth rate remains the same. The index manages to beat the comparison index S&P 500 in the research time frame from the start of 2006 to the end of 2018. The researchers further demonstrate that

the equally weighted index performs better than an index formed from the same stocks for the same time frame that is weighted based on maximum Sharpe Ratio. The study makes a clear point that portfolios weighted by mean-variance optimization technique does not always deliver alpha returns. (Dheeriya et al., 2019)

The researchers also question the traditional styles of portfolio allocation and bring forward the "nowhere to hide" phenomenon that occurred in recent financial crises. In nowhere to hide phenomenon diversification doesn't work because the markets around the world are moving in the same direction. During financial crises portfolio diversification might have the opposite effect than wanted. The "nowhere to hide" phenomenon isn't completely universal. As illustrated in Tronzanos' research, gold, oil, and Swiss Franc have maintained their safe haven status even through crises in the last two decades. (Tronzano, 2020)

A Swiss Finance Institute study conducted by Ben-David, Franzoni, Kim, and Moussawi dives deep into the ETF space and makes a case against highly differentiated specialized ETFs. The researchers describe specialized thematic ETFs as investment vehicles driven by investor sentiment, media, and track record. The researchers claim that these instruments are targeted to "unsophisticated investors".

The results give support to the claim that less sophisticated investors tend to find appeal in specialized ETFs. Fund flows in broader ETFs are more sensitive to fund fees than specialized ETFs while flows in specialized ETFs show little or no sensitivity to fees but are more reactive to funds past performance. It is also found that when stocks in ETFs holdings receive attention from media, fund flows are less sensitive to fees. This implies that specialized ETF investors are less concerned about the costs of their investment and their investment decision is more driven by sentiment.

The study finds that specialized ETFs perform often poorly after launch. A specialized ETF portfolio constructed in the study delivers negative alphas after risk adjustments. The research explores two optional rationales for specialized ETF investing. First, rational hedging against risk factors and using thematic ETFs as a way to further diversify, and second, investors investing into concepts that support their view of the world via specialized ETFs. The researchers raise a point that since often the trends that thematic ETFs base around receive media attention around launch, the underlying stocks tend to be overvalued causing underperformance soon after launch.

The research finds no evidence of specialized ETF investing happening based on rational hedging. In the case of hedging poor performance would be expected but instead specialized ETF fund flows have been systematically negative when poor performance takes place. Also, a reduction in media exposure of specialized ETF stocks after the ETF launch is documented implying that the launch of the ETF itself was sentiment-driven.

The researchers find supporting evidence for the second option implying concept-based investing in thematic ETFs with holdings in overvalued stocks. Launched specialized ETFs tend to have holdings that have recently experienced high media attention, a significant rise in price, or express signs of overestimation such as high price-to-book value. Specialized ETFs are also associated with positive feedback trading referring to buying when stock price climbs up. Positive feedback trading hints that investors make investment decisions to specialized ETFs more often based on good past performance or sentiment than with other products in the ETF space. The research shows evidence from a large sample of data that specialized ETF investors invest based on media attention to ETFs with higher-than-average fees and overvalued holdings frequently leading to poor performance. The researchers conclude that while ETFs are a brilliant invention bringing new options for low-cost diversification, the more specialized options often fail to create value and target investors with less knowledge of the financial instruments. (Ben-David et al., 2021)

Methling and Nitzsh study the performance of naïve diversification strategies using a core-satellite approach in thematic investing. The study has a bi-criterion framework founded on the modern portfolio theory. The two assumptions of the study framework are as Markowitz presented: investors aim to maximize expected return while minimizing risk calculated as the standard deviations of returns (Markowitz, 1952). Core satellite approach bases on an idea of a core portfolio and an uncorrelated satellite portfolio. The core portfolio ensures that the capital is well diversified and controls risk exposure while the satellite portfolio is focused on delivering surplus yields with a thematic approach.

The study compares portfolios formed based on the following diversification methods: capital allocated equally between core and satellite portfolio, capital divided equally to all assets, and Herfindahl index-based concentration allocation. The last method utilizes Herfindahl index to invest inversely proportional to concentration. Herfindahl index is a measure of market concentration and it’s calculated by summing squared market shares of firms competing in a certain market.

The study compares the volatilities of the core-satellite portfolios to various benchmarks and mean-variance optimized portfolios. The study finds no dominant portfolio optimization strategy. (Methling & Nitzsh, 2019a)

Methling and Nitzsh have conducted research challenging the core-satellite approach in thematic investing. The study tries to provide a solution to the issue that thematic and conventional ETF portfolios are separately optimized in the bi-criterion framework. To solve the multi-objective optimization problem the study utilizes a tri-criterion portfolio optimization model as a framework. The tri-criterion framework has three objectives that are optimized in relation to each other with the two being the same as in the bi-criterion model basing on theory presented by Markowitz, and the third dimension maximizing the proportion of capital allocated to theme investing. The study shows that the bi-criterion core framework has inefficiencies regarding portfolio sizes and correlations between conventional (core) and thematic (satellite) portfolios. The less thematic stocks are picked and the lower the correlation is, the greater the inefficiencies. As the researchers assumed, the optimization of core and satellite portfolios separately leads to dominated criterion vectors. Methling and Nitzsh discuss that strong market correlation has a weakening effect on potential yield benefits of the tri-criterion model. The researchers project that as the thematic ETF space evolves and produces more specific thematic ETFs, the correlation between core and satellite portfolios gradually weakens growing yields in the future having a positive impact when portfolios are optimized based on the tri-criterion model. The study presents a framework for portfolio optimization in an efficient surface formed by the three dimensions of the tri-criterion model providing alternative optimization method for investors with interests besides the traditional risk and return. The researchers raise the issue of the lack of studies in the field of thematic investing and calls for more academic studies to be conducted. (Methling & Nitzsh, 2019b)

2.6 Fees and expenses of ETF classes

In the recent decade's ETFs have proven to be a disruptive innovation in the financial space. Issuers have ever since the launch of the investment vehicle tried to differentiate their products in any way possible. The main tool for differentiation is expenses, which have helped to push the expense ratios as low as 0,02 % in benefit of investors. The expense ratio is the most important expense factor in ETFs, as it indicates the percentage of the ETFs assets that are used to manage the ETF. The expense ratio hence lowers the returns investors get from the ETF. (Navone & Nocera, 2016) As Hougan points out, the expense ratio doesn't cover the full story

of ETF expenses. Tracking error is measured by calculating the difference of returns of an index and ETF, on average, over one year. According to Hougan, the more ***niche*** an ETF is, the more weight tracking difference should have when making an investment decision. (Hougan, 2014)

Exchange-traded funds can be categorized like Ben-David et al. into four different categories arranged by average fees from low to high: broad-index ETFs, smart beta ETFs, sector ETFs, and thematic ETFs. Broad-index ETFs that track index or benchmark are not highly differentiated compared to other ETF products. Broad-index ETFs typical characteristics are low volatility and low expenses. Smart beta ETFs are based on one or more factors based on which investment decisions are made in the fund. Smart beta ETFs can for example invest only in low volatility or high dividend yield. These ETF products aim to capture beta returns, exposure to the market, and alpha returns over a broad-based index (Meziani, 2016). Smart beta ETFs can be characterized with medium-to-low expenses and by differentiation level they are between broad-index ETFs and setor ETFs. Sector ETFs invest in a certain sector for instance technology, healthcare, or financials. Sector ETFs as reported by Ben-David et al. on average have higher fees than smart beta ETFs and are more differentiated. Finally, the ETF class with the highest fees and the highest level of differentiation; the thematic ETFs that are characterized by high expenses and high volatility. Thematic ETFs invest in certain themes or concepts and offer niche exposure to investors. (Ben-David et al., 2021)

In the study conducted by Ben-David et al., the results indicate that cash flows to broader ETFs are sensitive to fees, but specialized ETF cash flows are sensitive to past performance. (Ben-David et al., 2021) This indicates that less knowledgeable investors tend to invest in the more specialized ETFs with good past performance while careful, more weathered practitioners invest into broader ETFs with low expenses. Other costs to investors can be caused by the bid-ask spread. Bid price is the price associated with selling and ask price with buying. ETFs with lower trading volumes often have larger bid-ask spreads that can cause extra expenses for investors.

2.7 Creation / Redemption process

It is commonly thought that ETFs that trade on low volumes or have a little number of assets under management are illiquid. This can be easily understood since ETFs are in many ways similar to stocks and ETFs often hold stocks in a portfolio. Unlike stocks, ETFs are created and

destroyed according to demand and therefore are not illiquid even when trading on low volumes. (Hill et al., 2015)

The creation and redemption occur between an ETF fund manager and authorized participant or AP. APs are often brokerages or market makers that are authorized by the issuer of the ETF to take part in the creation and redemption process of ETFs. ETF managers publish a "creation basket" daily which is a list of securities equaling the ETF portfolio. The intrinsic value of the ETF comes from the trading prices of the securities in the creation basket. The AP then purchases all the securities listed by the ETF manager in the same weights as in the creation basket. The AP then delivers the securities at the end of the day to the ETF manager and gets in exchange the same value of ETF shares. The common size of the exchange is 50 000 ETF shares. Redemption is the same process but the AP exchanges ETF shares with the ETF fund manager for the underlying assets in the ETFs portfolio. The basket of securities the AP receives from the exchange is called the "redemption basket". (Hill et al., 2015) The continuous creation / redemption mechanism is one of the most essential features of the ETFs differentiating them from other investment vehicles. This process allows the ETFs to track the underlying asset prices so closely and ensures that the liquidity of an ETF is not a proxy of trading volume or assets under management. In imbalances of ETF shares supply and demand, balance is restored by APs that create or destroy ETF shares and benefit from arbitrage position in the process. (J.P. Morgan, 2015)

The ETF arbitrage mechanism explained should ensure that the price of an ETF is closely tied to the net asset value of the underlying assets. Delcoure & Zhong found in their study that the price of an ETF can deviate significantly from the net asset value of the underlying assets. (Delcoure & Zhong, 2007) Problems with the arbitrage mechanism can arise when ETF holdings are diversified across global exchanges when synchronized buying's may not necessarily be possible. Also, the assumption that AP's would always have standard lots worthy of holdings in storage can be questioned.

3 Theoretical background

3.1 Modern portfolio theory

Contemporary finance is founded on the modern portfolio theory which is also the foundation of quantitative finance. (Chen, 2016) Modern portfolio theory bases on the idea that a rational

investor maximizes return on a specific risk level thus choosing portfolios in the efficient frontier. The model makes the following assumptions: investors are risk-averse, and the investor makes a portfolio pick based on mean-variance efficiency. This means that the portfolio minimizes the variance of its expected return on a certain expected return level and maximizes the expected return on a certain variance level. Portfolio diversification aims to mitigate the idiosyncratic risk that is strongly present with a portfolio of highly correlated assets. For riskier investments, investors demand higher returns.

3.2 Beta

Beta is a measure of risk used to determine the risk of an asset or portfolio of assets compared to the broader market. Beta estimates systematic risk of an asset or portfolio compared to the volatility of a market or comparison index. The beta of the broader market is 1 and beta can be thought of as a multiplier or reactivity to market changes and therefore as a measure of systematic risk. If the average market prices fall by 2 %, an asset with a beta of 1,5 can be expected to fall in price by 3 %. Beta can also be negative implicating that the asset correlates negatively to the market. Riskier assets carry higher betas and generally perform better compared to markets on bull markets but worse on bear markets. (Levinson, 2006) Meaningful results using beta are reliant on the correct selection of benchmark index.

$$\beta = \frac{cov(r_a, r_m)}{var(r_m)}$$

where:

r_a =*Returns of asset or portfolio*

r_m=*Market returns*

$cov(r_a, r_m) = Covariance\ between\ asset\ and\ market$

$var(r_m) = Variance\ of\ market$

Equation 1. Beta.

3.3 Capital Asset Pricing Model

The capital asset pricing model developed by William Sharpe (1964), John Litner (1965), and Treynor (1961) is widely used and offers a simple way to measure the relation of risk and expected return. Previously touched upon, beta plays a salient role in the equation of CAPM.

The CAPM gives as result a demand of return from the market since it's calculated by multiplying assets beta with market-rate over risk-free return and the risk-free, market baseline rate added to the result. (Chen 2016)

$$R_a = R_f + \beta_a(R_m - R_f)$$

where:

R_f =*Risk-free rate*

β_a =*Asset beta*

R_m =*Market return*

Equation 2. Capital asset pricing model.

CAPM presents the extension of risk return. CAPM has faced critique for the dominant influence of one factor to the result of the equation. For instance, Ross presented Arbitrage pricing theory that recognizes that there can be multiple factors or themes affecting asset prices. (Ross, 1976)

This thesis uses CAPM based Sharpe ratio, Treynor ratio, and Jensen's alpha as risk-adjusted measures. These are all CAPM based measures with Sharpe ratio comparing return over risk-free rate to volatility, Treynor ratio the same as Sharpe ratio but the comparison is made to systematic risk, and Jensen's alpha which compares the portfolios realized yield to CAPM expected yield. (Sharpe, Alexander & Bailey, 1999) CAPM is widely used in finance and finance academic literature making it a commonly known easily approachable framework for the comparison of risky securities.

3.4 Performance measures

This thesis uses a set of traditional risk-adjusted performance measures; Sharpe ratio, Jensen's alpha, and Treynor ratio. The main deficiency of the measures is their retrospective nature. While they can provide valuable information of risk-adjusted rewards provided by assets and portfolios of the past, they are incapable of making predictions of the future.

3.4.1 Sharpe ratio

Sharpe ratio is one of the most well-known measurements in finance and it's used to establish return over risk-free rate per unit of risk. Sharpe ratio by William Sharpe is an alternative for Markowitz's equation presented in the article "Portfolio Selection" in 1952 (Markowitz,

1952). In Sharpe Ratio portfolio return is subtracted by risk-free rate such as US Treasury bonds. The return over risk-free rate is then divided by portfolio standard deviation.

$$SR_i = \frac{R_p - R_f}{\sigma_i}$$

where:

$R_p = Portfolio\ return$

$R_f = Risk - free\ rate$

$\sigma_i = Standard\ deviation\ of\ portfolio's\ excess\ return$

Equation 3. Sharpe ratio.

3.4.2 Jensen's alpha

Jensen's alpha is a formulation developed to capture the alpha or above-market returns. Alpha gives a result; positive or negative, that exhibits the deviation of return compared to the best guess given by the CAPM. Jensen's alpha gives an idea if an asset or portfolio is delivering adequate returns to the risk it possesses. (Jensen, 1968; Knight & Sachell, 2002; Chen, 2020)

$$\boldsymbol{alpha = R_i - R_f + \beta\, x\, (R_m - R_f)}$$

where:

R_i =*Portfolio return*

R_f =*Risk-free rate*

$R_m = Market\ return$

$\beta = Portfolio\ beta$

Equation 4. Jensen's alpha.

3.4.3 Treynor ratio

Treynor ratio describes the return over the risk-free rate of an asset or portfolio to the volatility of the asset or portfolio. The similarities to Sharpe ratio are obvious but while Sharpe compares returns over risk-free rate to standard deviation, Treynor ratio compares them to beta. The difference is perhaps best explained as Knight et al.: "Sharpe ratio is a measure for a unit per risk and Treynor ratio measures reward to assets or portfolios systematic risk and the risk of investing." As Treynor ratio uses beta the index chosen for the calculation of beta must be selected correctly. (Treynor, 1965; Knight et al., 2002; Kenton,2020)

$$Treynor\ ratio = \frac{r_{p-r_f}}{\beta_p}$$

where:
$r_p = Portfolio\ return$
$r_f = Risk - free\ rate$
$\beta_p = Portfolio\ beta$

Equation 5. Treynor ratio.

3.5 Portfolio weighting method

Value-based portfolio weighing strategies have been long used. Value weighted strategies are based on capital asset pricing model and efficient market hypothesis which rely on mean-variance optimization. The efficient market hypothesis Fama (1970) expects that all information available has already been considered in the market prices and it's therefore impossible to generate long-term alpha. (Fama, 1970; Downey, 2021) Malkiel makes a point that investors are bound to make mistakes sometimes and demonstrate the irrational behavior of some market participants. (Malkiel, 2003) Since the 1970s there have been numerous alternative portfolio formation and implementation strategies that have managed to beat the market. (Arnott, Hsu & Moore, 2005; Dheeriya et al., 2019) Arnott et al. form a portfolio based on other size metrics than market cap and present that the portfolio beats the market while Dheeriya et al. form an equally weighted portfolio based on a theme that manages to beat the market. (Arnott et al., 2005; Dheeriya et al, 2019) Malladi & Fabozzi find in their study that equal-weighted portfolio weighting beats 14 different strategies including value-weighted and many alternative beta strategies. (Malladi & Fabozzi, 2017) Equal-weighted portfolio has also been validated by DeMiguel (2009) that argue that the time frame needed for an optimally diversified portfolio to deliver returns is much longer than the time frames often used in academic literature. (DeMiguel, 2009). Dye and Growth make a case for value-weighted strategy by comparing value-weighted and optimized portfolios in their research. Capital allocations in the optimized portfolio are made based on an investors risk aversion coefficient. If the investor is very risk averse, the algorithm allocates capital strongly to smaller volatility stocks offering a less risky portfolio along the efficient frontier. In the study value-weighted portfolio offer on average the less volatile option and deliver on average better returns than the optimized portfolios. (Dye & Growth, 2000) Ehm, Laudenbach and Weber study an alternative weighting method in which allocations are made based on volatility. They find in their study that investors have a habit of allocating

security weights without consideration of volatility. The researchers aim to offer a less biased way of portfolio weighting than the traditional portfolio weighting methods by utilizing volatility in weight allocation. (Ehm, Laudenbach & Weber, 2017) Baxter discusses about the drawbacks of thematic ETFs and names equal weighting and concentration on a few securities as major ones. In the text Baxter discusses that equal weighting in an ETF can lead to large ownerships in smaller companies in the ETFs portfolio causing liquidity problems. When the ETF take a smaller company into their portfolio the stocks receive an immediate boost but once they end up dropping the stock from the portfolio the stock takes a dive and hurts the ETF. (Baxter, 2021)

Behavioral finances show that investors have besides monetary values, other objectives, and drivers in investing. Mean-variance portfolio optimization is therefore not the chosen portfolio weighing strategy in this thesis. This thesis experiments with theme-based portfolio formation with ETFs and sees the results stack to the growing evidence of market beating performance of theme-based investing.

3.6 Classification of ETFs

In this thesis, ETFs are classified into two classes based on the funds' investment goals. The categorization to thematic and sectoral ETFs caused the following changes to the thesis data sample: iShares MSCI Europe Small-Cap ETF (IEUS), VanEck Vectors Israel ETF (ISRA), and WBI BullBear Value 3000 ETF (WBIF) were dropped from the thesis since according to the funds' websites, the ETFs are not focused on technology, telecommunications, semiconductors, or other relevant sector for the thesis.

In this thesis, ETFs are classified into two classes based on the funds' expense ratio in line with Ben-David et al (Ben-David et al., 2021). First is broader ETFs that track broader sectoral indexes which are in this thesis referred to as "sectoral ETFs". Second, this thesis focuses on more specialized ETFs focused on certain themes or trends referred to as "thematic ETFs".

3.7 Choosing of the ETFs

A popular thematic ETF provider Global X categorizes disruptive technology ETFs to be in the field of big data, mobility, digital content, fintech, connectivity, and robotics. Big data consists of machine and deep learning, cybersecurity, quantum computing, and cloud and edge computing. The mobility category contains autonomous- and electric vehicles. Digital content augmented and virtual reality. FinTech mobile payments, peer-to-peer lending, crowdfunding, and blockchain. Connectivity digital infrastructure, next-generation networking (5G), emerging markets internet, internet of things, and space and satellite communications. Finally, robotics includes the fields of artificial intelligence (AI) and automation, 3D printing, and drones. (Global X, 2020)

Alive equity ETFs were chosen with ETF Databases ETF screener tools and price quotes are gathered from Thomson Reuters datastream. ETFs that got into this thesis were filtered through the following criteria. The investment vehicle must be an exchange-traded fund. ETFs' inception date had to be before the first of January 2015 to fit the chosen timeframe. Only equity ETFs were qualified except for smart beta, leveraged, and inverse ETFs. ETFs had to be on technology, telecommunications, broad-technology, broad-telecommunications, video games, fintech, or AI and robotics sector. After checking of the ETFs' investment goals, a pool of 34 ETFs was found that fit the criteria.

From the 34 ETFs, thematic and sectoral ETFs were separated to find the answer to the research question, "Do thematic ETFs deliver higher returns compared to sectoral ETFs". ETFs were divided to thematic ETFs and sectoral ETFs based on their investment strategy and goals described in the fund's websites. Tables 1 and 2 provide descriptions of the ETFs. ETFs classified as sectoral invested based on a sector classification such as GIGS, ICB, or Standard and Poor's sector classification. The thematic ETFs aimed to benefit from the rise of a long-term trend and invested cross-sectoral to investments seen to yield from the trend. Now the study has its final research material that consists of 34 ETFs: 12 thematic ETFs and 22 sectoral ETFs.

Ticker	Description	Tracked index
ARKK	Invests in securities internationally based on theme disruptive innovation	No index tracked
ARKW	Invests in securities internationally based on theme next generation internet	No index tracked
BJK	Invests in gaming from sports betting and casinos to gaming equipment	MVIS® Global Gaming Index
EMQQ	Investments include search engines, online gaming, and e-payment systems	Leading internet and ecommerce companies in emerging markets index
FDN	Tracking the largest US companies by cap and trading volume in the internet industry	Dow Jones Internet Composite IndexSM
HACK	Invests in companies providing cyber security solutions	Prime Cyber Defense Index
KWEB	China-based publicly traded companies focused on internet	China internet and internet-related sectors
NXTG	Invests in 5G and next generation digital cellular technology companies	Indxx 5G & NextG Thematic Index SM
PNQI	CTA categorized internet and internet related companies	Nasdaq CTA Internet IndexSM
ROBO	Invests in global robotics and automation companies	ROBO Global® Robotics and Automation Index
SKYY	Companies involved in the cloud computing industry	ISE CTA Cloud Computing™ Index
SOCL	Tracks index focused globally in social media companies	Solactive Social Media Total Return Index

Table 1. Descriptions of the thematic ETFs.

Table 1 describing thematic ETFs the following abbreviation is used: CTA (Consumer Technology Association). In table 2 describing the sectoral ETFs chosen into the study, the following abbreviations are used. GICS (Global Industry Classification Standard) is an industry classification standard that separates companies into following sectors: energy, materials, industrials, consumer discretionary, consumer staples, health care, financials, information technology, communication services, utilities, and real estate. (MSCI, 2021) ICB (Industry Classification Benchmark) by FTSE Russell is divided into 11 industries, 20 super sectors, 45 sectors, and 173 subsectors. (FTSE Russell, 2021)

Ticker	Description	Tracked index
CQQQ	China A-shares and China B-shares in the information technology sector	FTSE China Incl A 25% Technology Capped Index
FCOM	Tracks performance of the United States communication services sector	MSCI USA IMI Communication Services 25/50 Index
FTEC	Tracks performance of the United States information technology sector	MSCI USA IMI Information Technology Index
IGM	Technology sector and select technology-related companies	U.S.-traded stocks expanded tech sector
IGN	Telecom equipment, data networking, and wireless equipment companies	North American multimedia and networking technology sectors
IGV	Software, home entertainment, and interactive media	North American expanded tech-software sector
IXN	GICS classified information technology stocks in the S&P Global 1200	S&P Global 1200 information technology Index
IXP	GICS classified communication services stocks in the S&P Global 1200	S&P Global 1200 communication services Index
IYW	Electronics, software and hardware, and informational technology	Market-cap weighted US technology companies index
IYZ	Telephone and internet products, services, and technologies	US telecommunications sector index
PSCT	US small cap information technology companies	S&P SmallCap 600® Capped Information Technology Index
QTEC	ICB classified technology stocks listed on Nasdaq	NASDAQ-100 Index
RYT	Track performance of information technology stocks in S&P 500	S&P 500® Equal Weight Information Technology Index
SMH	Semiconductor production and equipment companies in the United States	MVIS® US Listed Semiconductor 10% Capped Index
SOXX	Companies involved in the semiconductors sector	PHLX Semiconductor Sector IndexSM
VGT	Information technology focused on software, consulting, and hardware	Market-cap weighted US information technology index
VOX	New GICS (after 2018) classified communication services	Market-cap weighted US communication services index
XLK	Tracks the technology sector of the S&P 500 Index	Technology Select Sector Index
XNTK	Holds an equally weighted portfolio of large-cap technology companies	NYSE Technology Index
XSD	GICS classified semiconductor sector companies in the S&P Total Market Index	S&P® Semiconductor Select IndustryTM Index
XSW	GICS classified software & services companies	S&P® Software & Services Select Industry® Index
XTL	GICS classified telecommunications services companies	S&P®Telecom Select Industry Index

Table 2. Descriptions of sectoral ETFs.

Sector funds diversify broadly over the ETFs sector of focus often having holdings of large-cap companies with small allocations offering a well-diversified portfolio. Thematic funds on the other hand can invest cross-sectoral based on a theme and aim to capture the upside of a trend. Sector ETFs are less focused and more diversified and therefore usually offer lower expense ratios. (Dheeriya et al., 2019; Liu, 2020)

3.7.1 Overview of the ETFs

Investment market, and asset-class sizes according to the ETF database described below in tables 3 and 4. There are different standards for market capitalization limits and the thesis uses the following: large-cap 10-200 billion USD (United States dollars), mid-cap 2-10 billion USD, small-cap 300 million to 2 billion USD, and micro-cap 50-300 million USD. (Seth, S., 2020) Many of the ETFs are classified by asset class size as multi-cap meaning that the market capitalization of the ETFs holdings varies across the market-cap classes. The chosen ETFs offer quite diverse selection of ETF issuer with 14 different issuers ETFs in the thesis.

Ticker	ETF Name	Investment market	Asset class size
ARKK	ARK Innovation ETF	United States	Multi-Cap
ARKW	ARK Next Generation Internet ETF	United States	Large-Cap
BJK	VanEck Vectors Gaming ETF	Developed Markets	Multi-Cap
EMQQ	Emerging Markets Internet & Ecommerce ETF	Emerging Markets	Multi-Cap
FDN	First Trust Dow Jones Internet Index	United States	Large-Cap
HACK	ETFMG Prime Cyber Security ETF	United States	Multi-Cap
KWEB	KraneShares CSI China Internet ETF	China	Multi-Cap
NXTG	First Trust Indxx NextG ETF	Developed Markets	Large-Cap
PNQI	Invesco NASDAQ Internet ETF	Developed Markets	Large-Cap
ROBO	ROBO Global Robotics and Automation Index ETF	Developed Markets	Multi-Cap
SKYY	First Trust ISE Cloud Computing Index Fund	United States	Multi-Cap
SOCL	Global X Social Media Index ETF	Global	Large-Cap

Table 3 Thematic ETFs investment focus. ETF Database.

Illustrated in the table above, five of the thematic ETFs invest in the United States while seven of the ETFs are considered multi-cap; invest cross capitalizations and five large-cap. Of the 12 thematic ETFs four invest broadly in the developed markets, one to emerging markets, one globally, and one has a focus on China.

Ticker	ETF Name	Investment market	Asset class size
CQQQ	Invesco China Technology ETF	China	Large-Cap
FCOM	Fidelity MSCI Communication Services Index ETF	United States	Large-Cap
FTEC	Fidelity MSCI Information Technology Index ETF	United States	Large-Cap
IGM	iShares Expanded Tech Sector ETF	United States	Large-Cap
IGN	iShares North American Tech-Multimedia Networking ETF	United States	Multi-Cap
IGV	iShares Expanded Tech-Software Sector ETF	United States	Large-Cap
IXN	iShares Global Tech ETF	United States	Large-Cap
IXP	iShares Global Comm Services ETF	Developed Markets	Large-Cap
IYW	iShares U.S. Technology ETF	United States	Large-Cap
IYZ	iShares U.S. Telecommunications ETF	United States	Multi-Cap
PSCT	Invesco S&P SmallCap Information Technology ETF	United States	Micro-Cap
QTEC	First Trust NASDAQ-100 Technology Sector	United States	Large-Cap
RYT	Invesco S&P 500® Equal Weight Technology ETF	United States	Multi-Cap
SMH	VanEck Vectors Semiconductor ETF	Developed Markets	Large-Cap
SOXX	iShares PHLX Semiconductor ETF	United States	Large-Cap
VGT	Vanguard Information Technology ETF	United States	Large-Cap
VOX	Vanguard Communication Services ETF	United States	Large-Cap
XLK	Technology Select Sector SPDR Fund	United States	Large-Cap
XNTK	NYSE Technology ETF	United States	Large-Cap
XSD	SPDR S&P Semiconductor ETF	United States	Multi-Cap
XSW	SPDR S&P Software & Services ETF	United States	Multi-Cap
XTL	SPDR S&P Telecom ETF	United States	Multi-Cap

Table 4. Sector ETFs investment focus. ETF Database.

For the thesis, 22 sectoral ETFs were chosen based on a focus on technology and separated from thematic ETFs by investment goals. Almost all of the sectoral ETFs invest in the United States and many have a focus on large-cap assets. Three of the ETFs have a different investment market two investing in developed markets and one to China. Six of the ETFs are multi-cap investing to assets in different capitalization classes and one unlike any other in the whole dataset invests in micro-cap companies. The dataset is focused mainly on the United States large-cap assets hence the comparison index was chosen to be the S & P 500 Composite.

3.8 Expense ratios

Expense ratio is one of the most important factors to consider when investing in an ETF and the first thing most investors look at when investing in ETFs. (Hougan, 2014) It reflects all the costs of an ETF and has a straight effect on returns. Expense ratio covers ETFs operating expenses and includes for instance management, distribution, and marketing costs.

The average expense ratio of an ETF is according to Morningstar Investment Research was 0,44 % in 2008. (Pilon, 2008) In comparison the average expense ratio of the ETFs chosen for the study is 0,53 %.

Ticker	ETF Name	Expense ratio
ARKK	ARK Innovation ETF	0.75
ARKW	ARK Next Generation Internet ETF	0.79
BJK	VanEck Vectors Gaming ETF	0.66
EMQQ	Emerging Markets Internet & Ecommerce ETF	0.86
FDN	First Trust Dow Jones Internet Index	0.52
HACK	ETFMG Prime Cyber Security ETF	0.60
KWEB	KraneShares CSI China Internet ETF	0.73
NXTG	First Trust Indxx NextG ETF	0.70
PNQI	Invesco NASDAQ Internet ETF	0.60
ROBO	ROBO Global Robotics and Automation Index ETF	0.95
SKYY	First Trust ISE Cloud Computing Index Fund	0.60
SOCL	Global X Social Media Index ETF	0.65

Table 5. Thematic ETF expense ratios. ETF Database.

Expense ratio is the amount of assets allocated into the operating and other costs of the ETF. Commonly actively managed ETFs have higher expense ratio than passively managed. ETFs with higher expense ratios give in a way a promise of higher annual returns since the fund's managers have more budget for analyzing and picking securities. In reality expense ratio is mainly just a tool of differentiation between ETFs. (Ben-David et al., 2021) The average expense ratio of the thematic ETFs chosen into this thesis is 0,70 %. As can be seen from table 5, two thematic ETFs with the highest annual returns, ARK Innovation ETF (ARKK) and ARK Next Generation Internet ETF (ARKW) have expense ratios of 0,75 % and 0,79 %. In their case higher expense ratios have yielded high annual returns. On the other hand, the ROBO Global Robotics and Automation Index ETF (ROBO) has the highest expense ratio of all the ETFs but rewarded investors with 15,46 %.

Ticker	ETF Name	Expense ratio
CQQQ	Invesco China Technology ETF	0.70
FCOM	Fidelity MSCI Communication Services Index ETF	0.08
FTEC	Fidelity MSCI Information Technology Index ETF	0.08
IGM	iShares Expanded Tech Sector ETF	0.46
IGN	iShares North American Tech-Multimedia Networking ETF	0.46
IGV	iShares Expanded Tech-Software Sector ETF	0.46
IXN	iShares Global Tech ETF	0.46
IXP	iShares Global Comm Services ETF	0.46
IYW	iShares U.S. Technology ETF	0.43
IYZ	iShares U.S. Telecommunications ETF	0.42
PSCT	Invesco S&P SmallCap Information Technology ETF	0.29
QTEC	First Trust NASDAQ-100 Technology Sector	0.57
RYT	Invesco S&P 500® Equal Weight Technology ETF	0.4
SMH	VanEck Vectors Semiconductor ETF	0.35
SOXX	iShares PHLX Semiconductor ETF	0.46
VGT	Vanguard Information Technology ETF	0.1
VOX	Vanguard Communication Services ETF	0.1
XLK	Technology Select Sector SPDR Fund	0.12
XNTK	NYSE Technology ETF	0.35
XSD	SPDR S&P Semiconductor ETF	0.35
XSW	SPDR S&P Software & Services ETF	0.35
XTL	SPDR S&P Telecom ETF	0.35

Table 6. Sectoral ETFs expense ratios. ETF Database.

Sectoral ETFs were separated in this thesis from thematic ETFs by investment goals described in table 1 and 2. The average expense ratio of the sectoral ETFs is 0,35 % compared to the thematic ETFs 0,70 %. Most of the sectoral ETFs are passively managed and are index or sector tracking. Of the sectoral ETFs VanEck Vectors Semiconductor ETF (SMH) has the best annual returns, iShares PHLX Semiconductor ETF (SOXX) second, and SPDR S&P Semiconductor ETF (XSD) third. All the three best performed sectoral ETFs have focus on semiconductors. SMH and XSD have 0,35 % expense ratio equal to the category average 0,35 %. SOXX has a little higher compared to the two 0,46 % Fidelity has issued both of the ETFs with the lowest expense ratios Fidelity MSCI Communication Services Index ETF (FCOM) and Fidelity MSCI Information Technology Index ETF (FTEC). These ETFs have very different returns with FCOMs low 9,34 % and FTECs 22,00 % which is one of the highest annual returns in the category.

3.9 Risk-free rate

This thesis focuses on ETFs listed in the United States and therefore U.S 3-month treasury bill is used as a risk-free rate. Treasury bills are short-term debt with under 1-year maturity backed by the United States government. Bonds, notes, and bills are all U.S. government debt, but the difference is the maturity of the debt. Treasury bills are zero-coupon bonds implying that coupon is not paid. In figure 1 the rate fluctuations of the 3-month treasury bill are illustrated from the start of 2015 to the end of 2020.

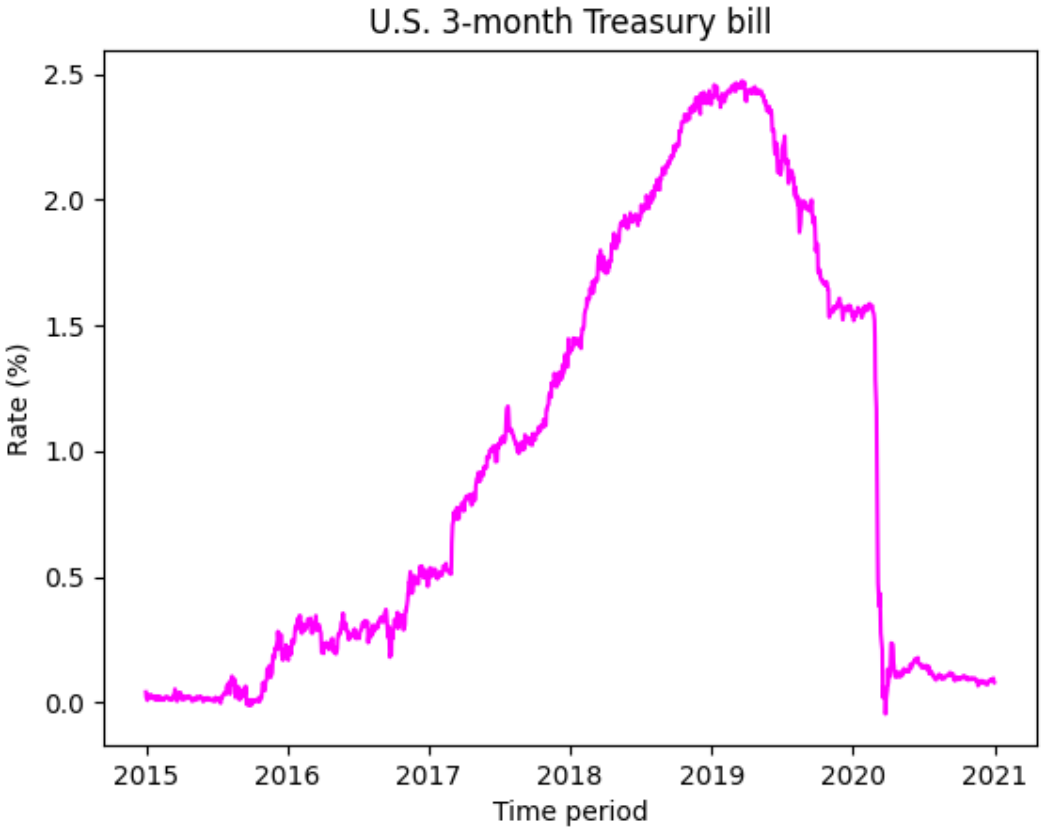

Figure 4. United States 3-month treasury bill rate. Thomson Reuter Datastream.

Since 2015 the 3-month T-bill grew steadily for few years. A significant drop took place in early 2020. In March 2020, the markets reacted to the spread of COVID-19 to the western countries. Usually, in the time of crisis, investors turn to traditional safe-haven assets such as gold and U.S. government bonds. As He, Nagel & Song (2020) and Cheng, Wessel & Younger (2020) point out, in the COVID-19 crisis the bond prices went controversially down and suffered from a lack of demand. (He, Nagel & Song, 2020; Cheng, Wessel & Younger, 2020) In previous crises, U.S treasury bonds have expressed safe-haven status with negative beta and thus gaining price while the markets go down (He, Krishnamurthy & Milbradt, 2019). In March

2020 the realization came of the magnitude of damage COVID-19 would have on the global economy and investors rushed out of U.S government bonds in efforts to cover loss positions or to get cash to buy equities at low price. This caused high illiquidity and vast spreads in U.S debt markets playing a part in causing the drop of U.S treasury bill prices. Other factors that played a role according to Cheng et al. were leveraged positions in government debt, and regulations from the 2008 financial crisis. After the federal reserve intervened with purchases helping to make the market more liquid and with temporary deregulations, the spreads narrowed again, and the government debt market gained liquidity. (Cheng et al., 2020)

3.10 Market index

The market index chosen for this thesis is the Standard & Poor's 500 Composite index (S&P 500). ETFs chosen for this thesis are all U.S listed and mainly invest in the United States. To that end, the Standard & Poor's 500 index is the most relevant for the study as it tracks the 500 largest publicly traded companies in the United States. S & P 500 was launched in 1923 and tracked 90 companies in 1926. Soon in 1929, the index was stretched to track the performance of 500 companies. The index is weighted by market capitalization. (Kenton, 2020; Britannica, 2019) S&P 500 index was chosen as it gives a comparison to the whole US-market as many of the ETFs already follow a sector index. Block and French point out that comparing equally weighted portfolio to a value-weighted index might yield suboptimal results and therefore raise questions about the comparison index chosen for this thesis. (Block & French, 2002) At the same time the equally weighted portfolios formed in this thesis base on ETFs that themselves are necessarily not equally weighted. For a thematic ETF portfolio which has a strong focus on large cap securities in the United States, the S&P 500 index provides adequate match.

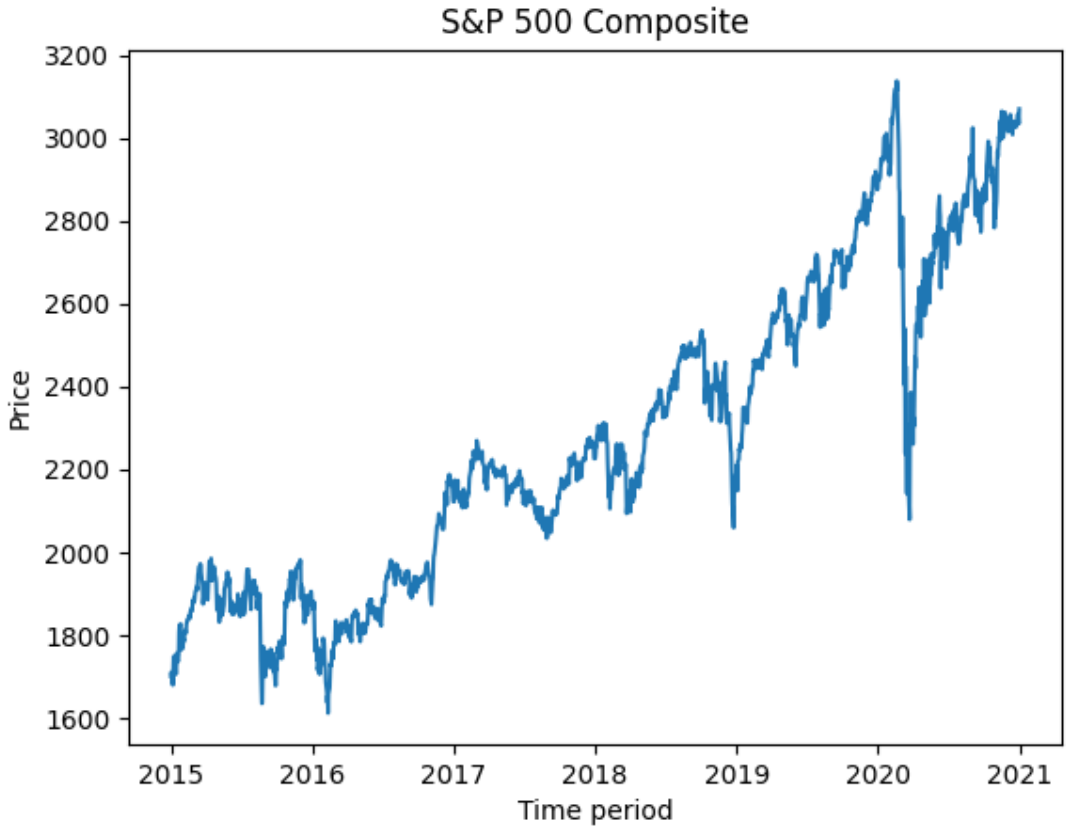

Figure 5. Standard & Poor's 500 composite index. Thomson Reuter Datastream.

The S&P 500 index grew steadily from 2015 along with the market with minor corrections. In the early 2020 the S&P 500 index dropped in under a month from over 3100 to around 2100. As explained in the risk-free rate part of this thesis, it was a cause of markets coming in terms with the effects COVID-19 would have on the global economy. Soon after the S&P 500 continued to climb to record heights. The rise can be explained by a strong bull market and raise in technology stocks as the S & P 500 is strongly weighted on the technology sector.

The S & P 500 was chosen as the comparison index because it offers the best equivalent for the dataset. All of the ETFs are listed in the United States and most of the ETFs that trickled through the filter to the study invest in the United States and are focused on large-cap assets. Also as mentioned the S&P 500 is weighted heavily on the technology sector providing one more reason for the choosing of the comparison index.

4. Research methodology

4.1 Data and methodology

This thesis is conducted using a quantitative research method and the timeframe of the thesis is 2015-2020. All calculations and figures were done with python programming language. Fund data used was provided by Thomson Reuters datastream. Daily frequency data and adjusted closing prices were utilized. Adjusted closing price include any changes made to the closing price including adaptations like dividends or stock splits. To avoid survivorship bias also dead ETFs fitting the study criteria were originally included as described in the section (3.7 Choosing of ETFs) but later dropped due to the bias they would have themselves caused. There are 34 exchange-traded funds chosen for the thesis, of which 12 are thematic and 22 are sectoral. The ETFs are compared by annualized returns and volatilities, and three risk-adjusted metrics: Sharpe ratio, Treynor's index, and Jensen's alpha.

Following (Dehaariya et al.) an equally weighted portfolio of 12 thematic ETFs and 22 sectoral ETFs were constructed for 2015-2020. (Dehaariya et al., 2019)

5. Empirical results

This section presents and visualizes the main findings of the study. The first section covers the annualized returns and annualized volatilities of the ETFs. The second section presents the risk-adjusted measures of the ETFs and both sections end with the construction of equally weighted portfolios.

5.1 Returns and volatilities

In the tables below the annualized returns and volatilities are presented for the thematic-, sectoral, and for the equally weighted portfolios constructed from the categories. In table 9 annual return and -volatility statistics are shown for the Standard and Poor's 500 Composite index.

Ticker	ETF Name	Average annualized returns	Volatility p.a.
ARKK	ARK Innovation ETF	35.45 %	29.24 %
ARKW	ARK Next Generation Internet ETF	38.73 %	27.97 %
BJK	VanEck Vectors Gaming ETF	3.34 %	24.94 %
EMQQ	Emerging Markets Internet & Ecommerce ETF	18.75 %	25.80 %
FDN	First Trust Dow Jones Internet Index	22.99 %	22.60 %
HACK	ETFMG Prime Cyber Security ETF	13.81 %	22.22 %
KWEB	KraneShares CSI China Internet ETF	15.35 %	28.80 %
NXTG	First Trust Indxx NextG ETF	10.41 %	19.67 %
PNQI	Invesco NASDAQ Internet ETF	22.63 %	22.32 %
ROBO	ROBO Global Robotics and Automation Index ETF	15.46 %	21.08 %
SKYY	First Trust ISE Cloud Computing Index Fund	22.26 %	20.87 %
SOCL	Global X Social Media Index ETF	22.80 %	23.53 %

Table 7. Thematic ETFs annualized returns and volatilities.

The best performed ETFs in the timeframe are both issued by ARK Investment management. The first ETF is ARK Innovation ETF (ARKK) with a 35,45 % annualized return and the second is ARK Next Generation Internet ETF (ARKW) with a 38,73 % annualized return. With the high returns comes high volatility as both of these ETFs are at the top three most volatile in the thematic ETFs and have a portion of the returns to thank for the success of Tesla. From the start of the timeframe, Tesla has delivered a cumulative return of 1568 % and an annualized return of 58,51 %. ARKK has 10,54 % of its holdings in Tesla while ARKW has 10,35 %. The second-biggest holding of both ETFs is weighted around 6 % relying quite heavily on one stock. Of the 12 thematic ETFs, only one failed to beat the S&P 500. There has been a strong bull market especially for technology stocks which shows highly in the results.

Ticker	ETF Name	Average annualized returns	Volatility p.a.
CQQQ	Invesco China Technology ETF	15.51 %	27.36 %
FCOM	Fidelity MSCI Communication Services Index ETF	9.34 %	19.49 %
FTEC	Fidelity MSCI Information Technology Index ETF	22.00 %	22.65 %
IGM	iShares Expanded Tech Sector ETF	22.82 %	21.96 %
IGN	iShares North American Tech-Multimedia Networking ETF	8.20 %	22.03 %
IGV	iShares Expanded Tech-Software Sector ETF	25.01 %	23.19 %
IXN	iShares Global Tech ETF	21.15 %	22.34 %
IXP	iShares Global Comm Services ETF	3.58 %	17.17 %
IYW	iShares U.S. Technology ETF	21.77 %	22.82 %
IYZ	iShares U.S. Telecommunications ETF	0.53 %	19.58 %
PSCT	Invesco S&P SmallCap Information Technology ETF	16.02 %	23.29 %
QTEC	First Trust NASDAQ-100 Technology Sector	21.11 %	23.66 %
RYT	Invesco S&P 500® Equal Weight Technology ETF	18.68 %	22.09 %
SMH	VanEck Vectors Semiconductor ETF	25.99 %	27.30 %
SOXX	iShares PHLX Semiconductor ETF	26.42 %	27.99 %
VGT	Vanguard Information Technology ETF	22.54 %	22.44 %
VOX	Vanguard Communication Services ETF	6.00 %	19.42 %
XLK	Technology Select Sector SPDR Fund	21.04 %	22.53 %
XNTK	NYSE Technology ETF	18.56 %	25.48 %
XSD	SPDR S&P Semiconductor ETF	27.44 %	28.58 %
XSW	SPDR S&P Software & Services ETF	21.63 %	21.85 %
XTL	SPDR S&P Telecom ETF	6.60 %	20.72 %

Table 8. Sectoral ETFs annualized returns and volatilities.

SPDR S&P Semiconductor ETF (XSD) has been the best sectoral ETF in the timeframe with a 27,44 % annualized return. XSD tracks the benchmark of semiconductor manufacturers. Its holdings are quite well diversified with the biggest asset weighting covering 4,51 % of all assets. The second and third-best performing sectoral ETFs also specialize in semiconductors: iShares PHLX Semiconductor ETF (SOXX) and VanEck Vectors Semiconductor ETF (SMH). SOXX invests in large-cap companies and has over 90 % of its holdings invested in the United States. While SMH bases on the performance of the 25 largest semiconductor producers in the United States it's still regarded as an investor in developed markets. The largest holding in the SMH portfolio is Taiwan Semiconductor Manufacturing Co which covers a very significant, 13 % of SMHs' assets. Fourth and fifth-best performed ETFs iShares Expanded Tech-Software Sector ETF (IGV) and iShares Expanded Tech Sector ETF (IGM) are both from the same issuer IGV investing in tech-software sector and IGM to technology sector. The sixth best performed sectoral ETF, Vanguard Information Technology ETF (VGT) and seventh best Fidelity MSCI

Information Technology Index ETF (FTEC) both track MSCI USA IMI Information Technology Index. Therefore, both have similar holdings with over 19 % weighting in Apple and over 15 % weighting in Microsoft relying heavily on the two.

Name	Average annualized returns	Volatility p.a.
Thematic ETF portfolio	20.16 %	24.09 %
Sectoral ETF portfolio	17.36 %	22.91 %
All ETFs	18.35 %	23.32 %
S & P 500	10.34 %	20.08 %

Table 9. Portfolio annualized returns and volatilities.

Average annualized returns and annual volatilities give mostly expected results based on the performance of the thematic and sectoral ETFs shown in tables 7 and 8. Thematic ETFs are the most volatile and have delivered the best returns. Sectoral ETFs are a bit less volatile and lose to thematic ETFs in returns about three percentage points. The portfolio constructed of both thematic and sectoral ETFs manage to beat the benchmark index quite comfortably with 18,35% annualized return compared to the S&P 500s 10,34%.

5.2 Risk adjusted returns

This thesis compares the performance of thematic ETFs, sectoral ETFs, and benchmark index S&P 500. This section presents calculations of beta, Sharpe ratio, Jensen's alpha, and Treynor ratio for each ETF, ETF portfolios, and compares the results with the S&P 500. 3-month treasury bill has been used as a risk-free rate. Risk-adjusted returns of the ETFs are presented in the tables below visualized by category.

Ticker	ETF Name	Beta	Sharpe	Alpha	Treynor
ARKK	ARK Innovation ETF	0.9918	1.1796	0.2519	0.3478
ARKW	ARK Next Generation Internet ETF	0.9477	1.3504	0.2889	0.3986
BJK	VanEck Vectors Gaming ETF	0.7589	0.0954	-0.0474	0.0313
EMQQ	Emerging Markets Internet & Ecommerce ETF	0.7908	0.6895	0.1038	0.225
FDN	First Trust Dow Jones Internet Index	0.8852	0.9751	0.1373	0.2489
HACK	ETFMG Prime Cyber Security ETF	0.8046	0.5783	0.0531	0.1597
KWEB	KraneShares CSI China Internet ETF	0.7828	0.4997	0.0705	0.1839
NXTG	First Trust Indxx NextG ETF	0.6868	0.4806	0.0301	0.1377
PNQI	Invesco NASDAQ Internet ETF	0.8234	0.971	0.1396	0.2633
ROBO	ROBO Global Robotics and Automation Index ETF	0.8316	0.6882	0.067	0.1744
SKYY	First Trust ISE Cloud Computing Index Fund	0.833	1.021	0.1349	0.2558
SOCL	Global X Social Media Index ETF	0.7983	0.9282	0.1435	0.2736

Table 10. Risk measures for thematic ETFs.

The best-performed ETF of thematic ETFs by every metric is the ARK Next Generation Internet ETF (ARKW). The same results applied in the previous section where ARKW proved to be the best thematic ETF by annual returns. The second-best ETF was from the same ETF provider, ARK Innovation ETF. By annualized returns, the fourth-best thematic ETF was Global X Social Media Index ETF (SOCL), by Sharpe ratio, it's only the sixth best but by alpha and Treynor it's ranked the third. Quite a strong indicator of success in this dataset is beta; ETFs with high beta – strong correlation to the S&P 500 have in majority of the cases done well and those with low beta have performed poorly.

Often Sharpe ratio over one can be perceived as good or acceptable by investors. Of the 12 thematic ETFs, only three have a Sharpe ratio over 1 in the timeframe: ARK Next Generation Internet ETF (ARKW), ARK Innovation ETF (ARKK), and First Trust ISE Cloud Computing Index Fund (SKYY). Results from Jensen's alpha seem better for the ETFs. Every thematic ETF apart from VanEck Vectors Gaming ETF (BJK) managed to deliver alpha returns.

Ticker	ETF Name	Beta	Sharpe	Alpha	Treynor
CQQQ	Invesco China Technology ETF	0.765	0.5319	0.0738	0.1902
FCOM	Fidelity MSCI Communication Services Index ETF	0.7267	0.43	0.0157	0.1153
FTEC	Fidelity MSCI Information Technology Index ETF	0.9745	0.9293	0.1191	0.216
IGM	iShares Expanded Tech Sector ETF	0.934	0.9955	0.131	0.2341
IGN	iShares North American Tech-Multimedia Networking ETF	0.8303	0.3289	-0.0054	0.0873
IGV	iShares Expanded Tech-Software Sector ETF	0.9053	1.0371	0.1556	0.2656
IXN	iShares Global Tech ETF	0.956	0.9041	0.1123	0.2113
IXP	iShares Global Comm Services ETF	0.6509	0.1531	-0.0348	0.0404
IYW	iShares U.S. Technology ETF	0.9691	0.9119	0.1172	0.2148
IYZ	iShares U.S. Telecommunications ETF	0.7209	-0.0219	-0.0719	-0.0059
PSCT	Invesco S&P SmallCap Information Technology ETF	0.8976	0.6468	0.0665	0.1678
QTEC	First Trust NASDAQ-100 Technology Sector	0.9751	0.852	0.1101	0.2067
RYT	Invesco S&P 500® Equal Weight Technology ETF	0.9555	0.8021	0.0876	0.1854
SMH	VanEck Vectors Semiconductor ETF	1.0366	0.9168	0.1531	0.2415
SOXX	iShares PHLX Semiconductor ETF	1.074	0.9096	0.1539	0.2371
VGT	Vanguard Information Technology ETF	0.9651	0.9618	0.1253	0.2237
VOX	Vanguard Communication Services ETF	0.7449	0.2598	-0.0194	0.0678
XLK	Technology Select Sector SPDR Fund	0.9724	0.8915	0.1096	0.2065
XNTK	NYSE Technology ETF	0.9631	0.6907	0.0857	0.1827
XSD	SPDR S&P Semiconductor ETF	1.0818	0.9267	0.1634	0.2448
XSW	SPDR S&P Software & Services ETF	0.8421	0.946	0.1277	0.2454
XTL	SPDR S&P Telecom ETF	0.7822	0.2727	-0.0169	0.0722

Table 11. Risk measures for sectoral ETFs.

Sectoral ETFs offer quite a different ranking with risk-adjusted measures than by annualized returns. The three semiconductor ETFs: SPDR S&P Semiconductor ETF (XSD), iShares PHLX Semiconductor ETF (SOXX), VanEck Vectors Semiconductor ETF (SMH) were the three best performing ETFs by annualized returns. The three semiconductors-focused ETFs have also the highest volatilities and betas with Invesco China Technology ETF (CQQQ) dropping them out of top five by Sharpe ratio. By alpha, XSD is the best performing sectoral ETF and SOXX claims the third spot. SOXX performed poorly by Sharpe- and Treynor ratio due to the high volatility and beta. SOXX has had relatively high total risk measured by Sharpe ratio and systematic risk as indicated by Treynor ratio.

With the reward for systematic risk measuring Treynor ratio iShares Expanded Tech-Software Sector ETF (IGV) performs the best followed by the semiconductor ETFs. Only IGV reaches a Sharpe ratio of one.

Name	Beta	Sharpe	Alpha	Treynor
Thematic ETF portfolio	0.8279	0.7881	0.1144	0.225
Sectoral ETF portfolio	0.8965	0.6944	0.08	0.175
All ETFs	0.8723	0.7275	0.0921	0.1927
S & P 500	1	0.467	0	0.0938

Table 12. Risk measures for portfolios.

Portfolios of the ETF classes and portfolio including all of the ETFs chosen for this thesis have been constructed and illustrated in table 12. As the thematic ETFs beat the sectoral ETFs and index by annualized return and volatility, so do they by risk adjusted measures. Thematic and sectoral ETFs beat the comparison index by every measure and as can be expected accordingly, so does the portfolio of all of the ETFs.

6. Summary and conclusions

This study aims to find evidence from the recent past if the thematic ETFs outperform sectoral ETFs and if they can deliver over market returns. There has been little research into the subject as thematic ETFs are relatively new and for now lack the track record needed to conduct larger studies. To give investors the best view possible of the subject at this time, the thesis timeframe was set out to start in 2015. This had a major impact on the sample size of the study since most of the thematic ETFs in today's exchanges are only couple years old. This also provided an

academic gap for the study since the amount of academic literature on thematic ETFs remains very light.

6.1 Research findings

The empirical part of the thesis was conducted as quantitative research on 34 different ETFs chosen from ETF database and Thomson Reuters datastream. Once the ETFs had been chosen, daily frequency data was exported from the datastream to excel workbooks and then analyzed with python. Main python packages and libraries used for data cleaning, manipulation, and visualization were pandas, numpy, matplotlib, and scipy. Returns, volatilities, and risk adjusted measures were then calculated for the ETFs. Rationalized in the section 3.5, this thesis used equal weighting method for portfolio construction. The risk-free rate chosen for the thesis was U.S 3-month treasury bill. As illustrated in figure 4, risk-free rate has changed quite significantly in the thesis timeframe having a major effect on the calculated results.

This thesis was based on a main research question which was then specified into three sub research questions. The main research question of the thesis was "Do thematic ETFs deliver higher returns compared to sectoral ETFs?". The sub research questions were "Do disruptive technology thematic ETFs beat the Standard & Poor's 500 index from 2015 to 2020?". "Does equally weighted disruptive technology ETF portfolio deliver alpha returns?", and "Does higher expense ratio result to higher returns?". The field of thematic ETFs is very new which made choosing equal number of ETFs across categories impossible while maintaining sample size of tens of ETFs.

Do thematic ETFs deliver higher returns compared to sectoral ETFs?

To answer the main research question of the thesis, thematic ETFs did manage to beat sectoral ETFs by almost three percentage points. Thematic ETF portfolio had annualized return of 20,16 % but with 24,09 % volatility while sectoral ETFs had 17,36 % annualized returns with 22,91 % volatility. The data sample has 22 sectoral ETFs and 12 thematic ETFs giving a vaster view of the sectoral than thematic ETFs. Only one disruptive technology ETF got beaten by the S&P 500 while six of the 22 sectoral ETFs didn't manage to beat the comparison index. In this thesis thematic ETFs had on average higher expense ratio of 0,70 % compared to the sectoral ETFs average 0,35 and in this case it seems to have slightly rewarded the investors. With the higher

expense ratio taken into account in the annualized returns, the results could have looked somewhat different.

Do disruptive technology thematic ETFs beat the Standard & Poor's 500 index from 2015 to 2020?

In the time period of 2015-2020 disruptive technology and technology ETFs have been a good investment and have generated alpha returns constantly beating the market. As presented in the section 5.1 of the thesis, the best performed ETFs have relied heavily on Teslas performance so it will be interesting to see if they can continue to deliver high returns in the coming years. Of the 24 thematic ETFs only six failed to beat the market by annualized returns in the time period. The higher returns are naturally paired with higher volatility compared to the index. The thematic ETF portfolio performed better than the S&P 500 based on Sharpe ratio, Jensen's alpha, and Treynor ratio.

Does equally weighted disruptive technology ETF portfolio deliver alpha returns?

As seen with individual thematic ETFs, most of them beat the S&P 500 in the chosen timeframe. The equally weighted portfolio of thematic ETFs also manages to beat the market index quite comfortably providing a 17,38 % annual return. The sectoral ETF equally weighted portfolio have returns very similar to the thematic ETF portfolio giving a 17,13 % annualized return. The only portfolio not beating the market is the dead ETF portfolio with only 6,25 % return. The equally weighted portfolio constructed of thematic-, sectoral, and dead ETFs deliver 15,76 % annualized return which is enough to beat the S&P 500 index with little over 10 % return. The study would have yielded very different results with alternative weighting methods and larger proportion of the thesis sample consisting of dead ETFs.

Does higher expense ratio result to higher returns?

The comparison of thematic ETF and sectoral ETFs is in this thesis more of a look if higher expense ratio is a good promise of higher returns or not. Thematic ETFs and sectoral ETFs were separated in this study based on ETF class illustration by Ben-David et al. The researchers show that coming to the start of 2015 broad-index ETFs have, on average, expense ratio of sub 0,1 %, smart-beta ETFs around 0,25 %, sector ETFs 0,4 %, and thematic ETFs somewhere

between 0,7 to 0,8 %. Surprisingly, the sectoral ETF portfolio has almost the same annual returns and volatilities as the thematic ETF portfolio. The sectoral ETF portfolio gave 17,13 % annual return losing only 25 percentage points to the thematic ETF portfolio. In line with thematic ETFs of the top four sectoral ETFs by annual returns, three had a weighting of over 10 % in one asset. Thematic ETFs present new competition in the ETF space and findings in this thesis suggests that investors are better of with investing in lower expense ratio ETFs with broad focus. Higher expense ratio is not a good promise of higher returns as illustrated below in figure 7.

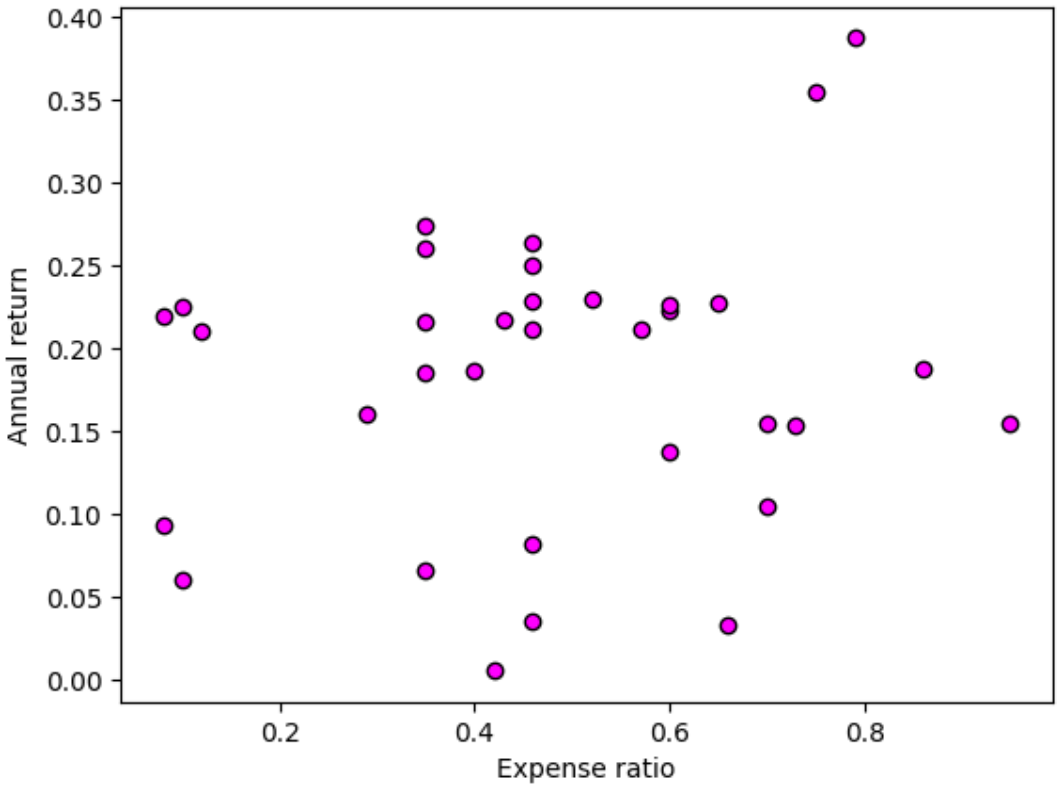

Figure 6. Scatterplot of ETF expense ratios and annual returns.

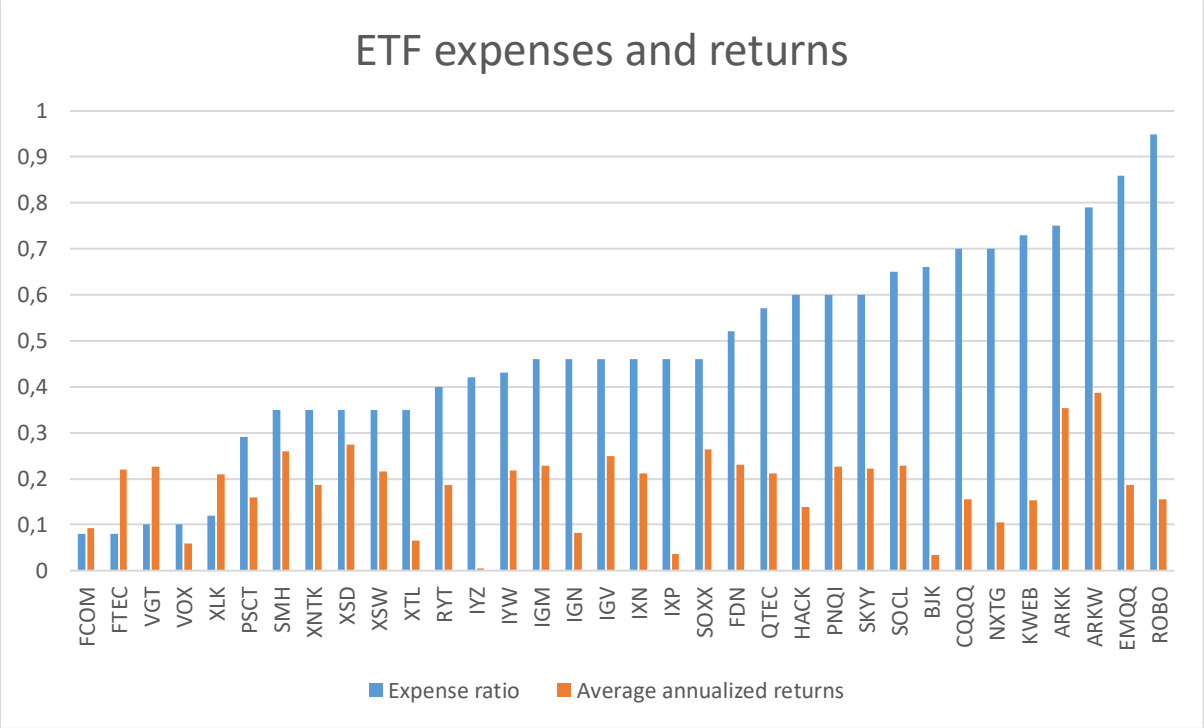

Figure 7. ETF expense ratios and annual returns sorted by expense ratio. Excel.

From figure 7 it can be seen that even with very little expense ratio it has been possible to get over 20 % annualized returns from the timeframe while with over 0,7 % expense ratio annualized returns have with one ETF been close to zero. Conversely two ETFs with around 0,8 expense ratio have managed to deliver the best returns of the sample. Figure 8 illustrates the individual expense ratios and annualized returns of the ETFs.

6.2 Conclusions

The aim of this thesis was to compare the performance of disruptive technology thematic ETFs and disruptive technology sectoral ETFs from the start of 2015 to the end of 2020. The study shows that thematic ETFs managed to beat both sectoral ETFs and the comparison index in the timeframe. The subject was very interesting to conduct a research upon since the thematic ETF space is very new and constantly growing. The relevancy of the subject is proven by the rapidly growing interest into thematic investing and thematic ETFs. The thematic ETF field has only developed in recent years and most of the more concentrated and heavily focused ETFs have appeared after 2015 that could provide deeper differences in returns and volatilities in the two ETF classes. It could provide interesting insight to compare volatilities of newer and older

thematic ETFs. The thesis would have provided very different results with equal amount of thematic, sectoral ETFs. Also, dead ETFs would provide a survivorship bias free view into the field of thematic ETFs. The little number of thematic ETFs incepted before the start of 2015 affected this thesis greatly. The original scheme for the study was to include dead ETFs. All of the technology focused dead ETFs would have been categorized sectoral based on investment goals and were therefore dropped from the study.

The ETFs chosen were separated into thematic and sectoral ETFs based on the fund's investment objectives. Interestingly, while Morningstar Investment Research reports that all ETFs have around 0,44 % average expense ratio, the 12 thematic ETFs have an average expense ratio of 0,70 % and sectoral ETFs' average expense ratio is 0,35 %. The category averages end up on the opposite sides of the average expense ratio of all ETFs giving further evidence to the illustration by Ben-David et al. with much larger data sample. (Ben-David et al., 2021) Figures 6 and 7 show expense ratios and annualized returns of the ETFs in form of a scatter plot and a composite bar chart. The figures present that expense ratio is not necessarily a good promise of returns. While ARKW has given 38,73 % annualized return in the timeframe for quite high 0,79 % expense ratio, ROBO has only managed a 15,46 % return for even higher 0,95 expense ratio %. FCOM and FTEC on the other hand have the lowest expense ratios 0,08 % in the data sample but FCOM loses to the benchmark index with 9,34 % annualized return but FTEC delivers 22,00 % annualized return clearly beating the S&P 500.

Thematic ETFs have raised discussions about strong weightings on certain stocks. The best-performed thematic ETFs by annualized returns ARKW and ARKK, both have portfolios biggest weighting in Tesla. In the timeframe, Tesla has 58,51 % annualized return lifting both of the ARK Investment Management ETFs overall returns significantly. The yields are not free either, the two being the most volatile ETFs in the dataset. All but one thematic ETF managed to beat the comparison index in the data frame. It gives a strong indication that the technology sector as a whole has performed tremendously in the studied time frame. The three best sectoral ETFs by annualized returns all invest in semiconductors. XSD by State Street has 100 % of its capital invested in the US and it is the sectoral ETF with the highest returns. Also, it is surprisingly well-diversified with the highest weighting in the portfolio being around 4 % while having the most holdings out of the three semiconductor ETFs, 42. SOXX had the second-highest returns of sectoral ETFs and a strong focus on the United States with over 90 % of its assets invested in the country. It's a more concentrated ETF with the largest holdings covering over

17 % of its portfolio. The third-best performed sectoral ETF SMH announces on its website that its investment focus is on the United States, but the ETF database still classifies it as a developed market investing ETF. It has almost 15 % of its portfolio in Taiwan Semiconductor Manufacturing Co., Ltd. And the top two holdings cover over 23 % of the ETFs portfolio. 16 of the 22 sectoral ETFs beat the S&P 500 in the timeframe.

The thesis used three risk-adjusted measures to compare the ETFs: Sharpe ratio, Jensen's alpha, and Treynor ratio. ARKW was the best and ARKK the second-best ETF by all three measures. In the timeframe with this data sample, beta was quite a good indicator of success indicating a strong bull market. The high returns moreover imply superior performance in the technology sector. Only three thematic ETFs had higher Sharpe ratio than one that is often used as an indicator of acceptable return in relation to risk. Both of the ARK Investment Management ETFs have a Sharpe of over one. Also, all but one of the 12 thematic ETFs have positive Jensen's alpha. Of the sectoral ETF categorys best-performing ETFs, not one is in the top five in Sharpe ratio comparison meaning that the semiconductor ETFs have had high volatilities compared to the other sectoral ETFs. Only one sectoral ETF, IGV has a Sharpe ratio over one. All portfolios, thematic ETF, sectoral ETF, and all ETF portfolio beat the S&P 500 index in the timeframe.

To answer the main research question thematic ETFs did beat the sectoral ETFs in the chosen timeframe. Disruptive technology thematic ETFs also managed to beat the comparison index and the broader sectoral ETFs beat the comparison index by some margin. In the thesis timeframe from the start of 2015 to the end of 2020 equally weighted disruptive technology ETF portfolio delivered alpha or above-market returns underlining the superior performance of the technology sector in recent years. The results if a higher expense ratio leads to higher returns are ambiguous. While thematic ETFs with a higher average expense ratio managed to beat the sectoral ETFs, some of the higher expense ratio ETFs performed poorly and very low expense ratio ETFs exceptionally.

The time and length constraints affected the depth of the thesis while the required track record limited the number of ETFs that could be taken into the study. The study consisted only of ETFs listed in the United States and it would have been interesting to compare disruptive technology ETFs across markets. As thematic ETFs are new in the ETF space, the amount of dis-

ruptive technology ETFs with inception date before 2015 was extremely restricted. As the popularity and the number of thematic ETFs will be likely to raise in the future, also the amount of research is bound to grow in the process. Thematic ETFs offer interesting ways of diversification but paired with higher volatility. While they may have some drawbacks, at their best thematic ETFs can in the future offer investing niches that haven't previously been thought, utilized, or that have been out of the reach of an individual investor.

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