Blockchain Technology & Volatility of Stock Returns
A Quantitative Study that Examines Blockchain Technology’s Impact on Volatility in Swedish Stocks

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Umeå, Sweden, 2020-05-28
Sincerely,

Kajsa Andersson  
Anna Styf
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Abstract

Blockchain technology has received tremendous attention during the last decade. Huge investments incentives have been made into Blockchain technology and companies worldwide are adapting the new modern innovation. Advocates for Blockchain technology claims that the safe and transparent distributed decentralized ledger has the potential to transform entire industries. One of the biggest operational risks for financial institutions is risks associated with cyber security and cybercrimes. It is argued that Blockchain technology should reduce possibilities for cyber-attacks, increase transparency, and reduce risk. No previous research has been found to confirm this research proposition with perspective to stock return. Still, there remain uncertainties regarding how Blockchain technology affects individual businesses, operational activities and stock behaviours. This research gap is aimed to be partly bridged with this thesis in a Swedish setting.

The primary purpose with this study is therefore to study if the introduction of Blockchain technology in Swedish corporations have an impact of stock return volatility. The longitudinal research methodology of this thesis is designed to satisfy a deductive, quantitative research design, with objectivist ontological assumptions and epistemological positivist approach to generate axiological value-free results. Multiple Linear Regressions and Panel data regression have been performed as well as t-tests to test two hypotheses with regard to systematic risk and total risk as measurements for historical volatility of returns.

The primary findings show a non-significant slight reduction for total risk of stock return, and a slight increase in the systematic risk of stock return. Using mathematical set theory one can argue that the unsystematic risk of stock return decreases. This has proven to be in line with previous theoretical research suggestions which states that operational risk should be reduced. However, the effects observed through the statistical procedures are quite small. Thus, this could indicate that investors’ perceptions of Blockchain technology are still associated with negative issues.

Financial theories such as asymmetry of information, adverse selection, signalling, risk-return fundamentals and behavioural aspects of finance are applied to describe the results, together with previous research, to use the theoretical framework in a coherent way. More research is emphasized to further explore this phenomenon, in order to draw generalizable, significant conclusions though different geographical contexts and markets.

Keywords: Blockchain technology, Systematic risk, Total risk, Volatility of stock returns
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Definitions

Blockchain Technology: A distributed centralized public ledger which is a record keeping technology.

Blocks: Digital information is stored into blocks in the blockchain.


Node: Point in a network or diagram at which lines or pathways intersect or branch.

Ledger: A book or computer file, which record and totalling economic transactions for financial accounts.

Mining: Refers to the process of verifying and adding new information to the block.

Peer-to-peer Network: A network of connected nodes, where every node must be able to act as both a server and a client of data.

Hash code: A code which is a unique identifier to certain information.

Distributed ledger: A database that is accessible and shared across different stakeholders with characteristics of consensus.
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1. Introduction

This chapter will start with an introduction to the background of Blockchain technology, volatility and financial risk, leading to this research problematization. Academic and practical motivations will be discussed to motivate a research gap. The purpose of this study and our research question will then be presented. Furthermore, the choice of subject, delimitations, theoretical and practical contributions will be described.

1.1 Problem Background

One of the megatrends in the modern world is digitalization and the technical disruption is changing the society more than ever before. The technical capabilities increase exponentially, and the continuous productivity gains is providing complex new innovations and solutions. Blockchain technologies and cryptocurrencies have received tremendous amount of attention during the past years. The Blockchain technology, as a currency, was first invented by the claimed Japanese, secret and pseudonymous Satoshi Nakamoto, who developed and implemented the first Blockchain ledger and deployed the first decentralized cryptocurrency in 2008, called Bitcoin (Nakamoto, 2008, p. 1). The years after were a turbulent time. The traditional financial system lived in the aftermath of the Financial subprime-mortgage crisis in 2008, and trust in authorities and financial institutions was challenged. Excluding third party financial intermediary and personally manage transactions with Blockchain technology, has perhaps never been so appealing.

Today, Blockchain as a cryptocurrency forms an entirely new class of assets. It has picked up momentum and received attention from various stakeholders worldwide. In this thesis, focus will be directed towards the Blockchain technology rather than cryptocurrencies. Thus, giving attention to the underlying technology, for example, Bitcoin and Ethereum. This is an important distinction to make from the beginning, since price movements of cryptocurrencies has proven to be volatile, while the underlying Blockchain technology is argued to be quite the opposite and decreasing risk (Anoop & Anandaro, 2019, p. 449). According to Treleaven et al. (2017, p. 15) Blockchain is transparent because all transactions can be traced. This should make the system safer since risks of manipulation should be reduced, and thereby also risk of fraudulent behaviors. Treleaven et al. (2017, pp. 15 & 16) further states that because of distributed open source protocols, Blockchain technology does not need a third party to carry out transactions. It is also transparent because when a party in the network is making, for example, a transaction, it needs to be independently verified. This reduces the risk of manipulation because when a party has made a transaction it cannot be changed.

Blockchain refers to a decentralized distributed ledger, that is open and available to all interested parties. Information is stored into blocks, which contains details of the data, a hash-value, and a hash to the previous block in the distributed chain. The primary purpose of Blockchain technology is to exclude third-party intermediaries, such as financial institutions, and increase information transparency to all participants. When a new actor enters the Blockchain network, one receives a full copy of the entire Blockchain, and this provides consensus throughout the distributed ledger. It is difficult to change the records that is already in the Blockchain. However, anyone has the ability to add new layers to the blocks. The Blockchain technology in itself will further be elaborated in the theoretical framework, see chapter three.
The World Economic Forum (2018, p. 8), predicts that 10 percent of the global gross domestic product (GDP) will be stored in Blockchain technology by the year 2025. Further, the research bureau Gartner forecasts that by the year 2030 it will generate approximately $3 trillion in business value (Granetto et al., 2017). The Blockchain technology is argued to be a revolutionary computing paradigm as a decentralized information technology (Swan, 2015, p. 92). PwC conducted a qualitative study among 600 people in decision-making positions, from fifteen regions globally, and found that 84 percent are actively working with Blockchain technology (Olsson, 2018). Blockchain has large potential within supply chains, whereas complex tracking systems can be used to increase trust, cooperation and transparency as one track a products path from production to consumer and making supply chains more efficient (Queiroz & Wamba, 2019, p. 70).

The financial industry has given much attention to Blockchain. Hassani et al. (2018, p. 258) states that huge Blockchain incentives has been made globally by, for example, BNP Paribas, The Bank of America, The Agricultural Bank of China, Goldman Sachs, Bank of England and Santander Bank. Blockchain can also be used in financial sectors as a platform for trading. This indicates a massive interest, and the technology in itself has a multi trillion-dollar value. Yet, the identity of secret and pseudonymous Satoshi Nakamoto, remains a mystery.

It has become increasingly important for companies to act with regard to sustainability, with regard to social, environmental and governance issues (ESG). In a study from 2015, evidence from more than 2000 empirical studies among ESG and financial performance was aggregated. The findings show that 90 percent of the studies found a non-negative relationship between ESG and financial performance, and the majority of the studies indicates that a positive ESG impact on financial performance appears stable over time (Friede et al., 2015, p. 210). Applying sustainability to the Blockchain technology setting, it could be argued that the Blockchain technology increases transparency, safety and inclusiveness. Thus, apply another dimension to the term sustainability. Blockchain technology is further used for environmental purposes, such as reducing global emissions in the shipping industry as the technology applied in incentives for the inclusion of renewables in energy networks among others (Mulligan, 2020). Given better sustainability practices though incorporation of Blockchain technology, it could be argued that financial performance could increase. This is another dimension to Blockchain technology.

Lack of empirical evidence and knowledge for new technologies, such as Blockchain can cause uncertainties, skepticism and trust issues for new systems (Ying et al., 2018, p. 1). Some researchers argue that more empirical evidence is needed to be able to provide guidance of how to implement Blockchain technology in various fields and business models. Because of the possibility that manipulative behaviors and frauds should be lower with Blockchain technology, operational risk should be reduced (Hull, 2018, p. 625).

1.2 Problematization & Research Gap
Blockchain technology could be argued to be a disruptive technology according to (Frizzo-Barker, 2020, p. 2), which refers to how a technical innovation changes global markets, and how market leaders fail to be in forefront if not adapting to this new innovation. This is in line with Hassani et al. (2018, p. 256), who further argues that the Blockchain is disruptive to the banking industry. Lakhani & Lansiti (2017, pp. 118–127), rather argues that the Blockchain technology is foundational, as the technology has the potential to create new innovative foundations for both social- and economical systems.
Although, several barriers such as regulation, societal, technological and organizational have to be conquered.

Previous research has also shown that innovations have a significant impact in stock behaviors. As Blockchain technology could be argued to be a disruptive innovation, it should have an impact to the stock price behaviors and volatility. Adjei & Adjei (2016, p. 580) finds that innovative firms who continuously innovates have an increase of market share as a result. Blundell et al. (1999, p. 550) finds that firms with higher market share benefits more from innovation. The authors emphasize on the competitive marketing advantages by high market share firms, which helps the dominant companies to market their new innovations. Gilbert and Newbery (1982, p. 524) shows that present R&D monopolists, maintain their position by and raising barriers for competitors by innovating more. Further, the authors find a statistically significant positive correlation between innovative stocks and market value (Blundell et al., 1999, p. 548). Thus, being innovative seems to have a positive effect for both market leaders who want to maintain position and for the firm who seeks to increase their market value.

Financial risks refer to the probability that the actual return of an investment will be lower than the expected return. Operational risks include both internal and external events that can occur in operating activities (Hull, 2018, p. 517). The internal events are things that the company can control such as computer systems while the external events are things that cannot be controlled such as political regulations. According to Kocianski (2018), nearly all banks are experimenting with Blockchain technology through collaboration with, for example, external fintech companies or developing own solutions with the purpose to increase operational efficiency and cost savings. According to Bruno & Gift (2019, p. 20) the risks associated with the uncertainty of Blockchain technology can be reduced if, for example, the companies implement good internal processes, utilize experts, demand research and learn the system well. Akkizidis & Bouchereau (2005, p. 329) argues that the key issue in operational risk is transparency in risk strategies. Given increased transparency, efficiency, safety and inclusiveness provided by the Blockchain technology, implementing it in firms’ operational activities should decrease operational risk.

In contrast, Jensen (1993, cited in Adjei and Adjei, 2016, p. 572), finds that investments in innovations can increase the risk of the firm. However, due to the assumption that Blockchain technology is transparent, efficient and sustainable could argue that the operational risk should decrease as the technology operates in the long-term perspective as a contributor to sustainability. Thus, the risk implications of Blockchain in firms remains uncertain. If companies face less risk in their businesses and daily operational activities, listed stocks should be less volatile.

However, to the authors' best of knowledge, no previous research has been conducted to research Blockchain’s relationship and impact to stock volatility which is a found research gap in the financial literature. Volatility is defined as the mean-variance price movements. Riskier stocks face higher volatility and the less risky stocks face lower volatility. Based on the risk-return fundamental assumptions by Markowitz (1952) and the Modern Portfolio Theory, the rational investor would prefer the security with less risk given the same expected return, compared to the riskier security. Volatility in this thesis will be defined as systematic risk of stock return (Beta), and as standard deviation for the total risk of stock return.
Previous studies have mostly researched volatility in relationship to Blockchain technology in the shape of cryptocurrencies. Guandong et al. (2017, p. 6), explores the Blockchain technology as a currency, and aims to predict Bitcoin volatility, whereas the volatility behavior compared to the USD is expected to be continuously unpredictable. The authors find that the Bitcoin price movements tend to be random and being unaffected by traditional financial market movements. Frizzo-baker et al. (2020) have made a systematic literature review from Business literature between 2014 - 2018. In total, 155 papers have been reviewed. Their findings show that research in four years has increased rapidly, and highlights the major advantages and challenges, indicating a major interest from the academic society towards this new technology. Frizzo-baker et al. (2020, p. 10) states volatility as risk, and that challenges remain a concern, especially in the form of a Blockchain technology as a currency. Throughout their paper, the term volatility is only mentioned twice. Risks, such as scalability, reliability, security, and lack of universal standards etc., can all influence crashes and spikes in the cryptocurrency market. The authors also state that the perceived versus the actual value of this new asset class is debated. It is further argued that future research directives, could explore how leaders act to mitigate uncertainty and volatility of Blockchain technologies and that more research of the Blockchain technology and volatility is needed (Frizzo-baker et al., 2020, p. 11). This supports our research gap.

Xu et al. (2019) have conducted a systematic literature review, collecting in total 119 articles from fields of business and economics. In their review, the term volatility is only mentioned once with regard to Blockchain technology as a currency “... at first, the extremely high volatility of bitcoin and the attitudes of many countries toward its complexity” (Xu et al., 2019, p. 1). This is also emphasized to highlight the research gap which will partly be fulfilled in this thesis. Conducting a clustering analysis, the authors find five themes of Blockchain technology research such as fintech revolution, sharing economy, economic benefit, blockchain technology and initial coin offerings. Future research directions for Blockchain has emphasized the importance of understanding the effects of Blockchain technology for individual businesses and applications of the organizational structure. This supports the need for research in companies using the Blockchain technology.

Blockchain technology is a relatively new concept with almost unlimited possibilities. If companies or institutions are aware of the advantages with Blockchain, why have not companies and institutions already implemented the technology? Ying et al. (2017, p. 1) describe that one of the reasons could be that firms do not yet have concrete reason to implement it or make use of the technology in their businesses. The theoretical discussions about Blockchain technology is comprehensive, but there is a lack of evidence from empirical studies (Ying et al., 2017, p. 1). Another problem with new technologies could be issue of trust. If clients or corporations do not trust the system, then the implementation might not be as profitable or useful as it could be. It is therefore important that companies adapt and introduce new systems to clients, so that stakeholders are aware about the benefits the technology can bring.

According to Swan (2015, p. 1), there are three different types of Blockchain technologies; Blockchain 1.0, Blockchain 2.0 and Blockchain 3.0. The first one relates to Blockchain as a cryptocurrency, the second one refers to Blockchain as contracts, and the third one refers to Blockchain in justice applications. As mentioned before the majority of the previous studies refer to Blockchain technology, as a cryptocurrency, and few
studies focus on other aspects of the technology. In this study, all types of Blockchain technology will be included in the sample, as we aim to research the impact of the technology. Previous studies have also researched how Blockchain technology function in different contexts. However, no study has focused on Swedish companies and how Blockchain technology affects the stock volatility. Further, if Blockchain technology is as transparent, safe and immutable as it claims to be, then stock return volatility should decline as operational risk decreases in firms. Thus, there should be a change in volatility before and after the Blockchain technology is introduced in Swedish companies. This is the research proposition of this thesis.

1.3 Purpose and Research Question
The primary purpose of this study is to research if the introduction of Blockchain technology in Swedish companies will impact their stock return volatility. The secondary purpose is to contribute to the academic society, gain new knowledge and to provide a first analysis of the relationship between Blockchain technology and stock return volatility. Thus, to partly fulfil a research gap in the financial literature. The chosen research period is the years between 2010 and 2019, and the aim is to draw valid and reliable conclusions from statistical tests. The following research question will be studied:

*Does the introduction of Blockchain technology impact the volatility in Swedish stocks?*

1.4 Delimitations
In this study, some delimitations have been made in order to conduct a credible study within the given time frame of this thesis.

The first delimitation is that this study will only look at Swedish listed companies in OMX Stockholm PI. This is to have a relatively good sample size and also to facilitate the data gathering. Sweden has been chosen as the geographic area due to the fact that no previous studies have been conducted with regard to Blockchain technology and volatility on Swedish stocks.

A second delimitation is that the study will only investigate a period of 10 years, ranging between 2010 and 2019. This number have been chosen because Blockchain technology is a relatively new concept and the period is expected to cover both before and after introduction of Blockchain technology, to be able to investigate if there is a change in volatility. It would be desirable to research a longer time period. However, the 10 years are judged to be enough to provide a reliable result.

Third, this research is limited to the standard deviation of stock return as the measurement for the total risk, and to the Beta of stock return for the systematic risk in order to capture the historical volatility through time-series. Other measurements, such as GARCH, ARCH and EWMA could have been preferable to include to, broaden the spectrum and to provide further knowledge and analysis. Due to time limitation and the stated research question the standard deviation and historical beta is argued well suited.

1.5 Choice of Subject & Preunderstandings
The choice of subject is based on the curiosity of new technologies combined with the interest of financial markets. The emergence of new technologies is rapidly increasing and creates new opportunities for different stakeholders. The interest of studying volatility in stock returns after introduction of Blockchain technology, arose from
previous studies' discussions about how open, transparent and secure Blockchain technology is and the fact that previous studies also highlights an uncertainty of the risk implications in the stocks. Since no previous study have been conducted with regard to stock risk and Blockchain technology in firms, we aim to bridge this gap. The choice of subject is argued to be suitable for a Master’s Thesis.

Preunderstanding is important to consider as it can affect the research process and result negatively, if not the authors are well aware of its impact. The authors are both reading the Master’s Programme in Finance at Umeå School of Business, Economics and Statistics and should therefore have good knowledge when it comes to how financial markets work and also when it comes to financial terms, concepts and theories. To remain objective throughout this research process, this study will be quantitative and take a quantitative approach.

1.6 Theoretical and Practical Contributions
The primary audience is considered to be anyone interested in Blockchain technologies, stock markets and investments. If there is an incentive that incorporating Blockchain technologies in business models and practices would impact volatility in stock returns, that would have implications for both businesses and investors. Previous studies have been conducted in different areas regarding Blockchain technology, but no previous study have been investigating this specific research question. This study can therefore both contribute to the academic field of research regarding risk and new innovations, such as in fields of Blockchain technology, but also contribute to practical implications, such as making investors more informed about how risk and Blockchain technology could interact with each other in the Swedish stock market.
2. Scientific Method

The second chapter describes the scientific research process & research philosophy with regard to epistemological, ontological, and axiological assumptions. The research approach and design will be described. Further, we will provide a discussion upon source criticism and describe the literature review. Lastly, we will elaborate on ethical and societal considerations.

2.1 Research Philosophy

When conducting scientific research, it is important to reflect upon the knowledge development within a field. That refers to one's research philosophy which tend to form social scientific research. The research philosophy refers to assumptions and beliefs which are present during the whole process (Saunders et al., 2016, p. 124). These assumptions refer to stances within human knowledge and different perspectives with regard to reality. Personal values tend to influence the research process. Fundamental assumptions are important to regard in order to develop coherent research, and constitute credible research choices (Saunders et al., 2016, p. 125). By becoming familiar with research philosophies in business research, authors have reflected upon their own beliefs and assumptions. Saunders et al. (2016, p. 125) argue that active choices regarding the research method should be informed and justified. The research process is reflexive and operates on both theoretical and empirical levels.

2.2 Ontology

Ontology regards social reality and whether its objective or subjective to the researcher (Collis & Hussey, 2014, p. 46). There are two main segments within ontology, and these refer to objectivism and subjectivism. According to objectivism, one reality exists, and that reality is objective to the researcher. Subjectivism, in contrast, view several realities as present and coexistent since they are created as social constructions by humans (Collis & Hussey, 2014, p. 46). The objective reality views the world as real and universal, with a perspective to order and independency, often applied in natural science. The reality is argued external to the researcher and embraces realism, as of studied objects. Actors of phenomenon are existing independently whether research them, or even are aware of them. Thus, all phenomena coexist in the same universe independently within the positivistic assumption (Saunders et al., 2016, p. 128). The subjective reality rather views the world as socially constructed and dependent by the actors within it. According to this view, multiple realities could exist (Saunders et al., 2016, p. 129). The subjectivism embraces the nominalism and argues that social researched phenomena are constructed and changeable (Saunders et al., 2016, p. 130). Further, Bryman et al. (2018, p. 5) states that ontological considerations refers to the nature of the social phenomenon.

Secondary markets have been constructed by humans to engage in financial activities, which could be argued to be a social construction by humans. One could argue that, for example, price movements in stocks are dependent on Behavioral Finance factors and decision-making by humans. However, the activities in the studied stock market will be existing whether we research them or not. We take the stance towards the positivist view and that the reality is universal. Actual price fluctuations in the researched companies are not somehow interpreted by this research. In this study, the goal is to remain objective and therefore a positivist approach is best suited to avoid misunderstandings and
misinterpretations of the study’s results. This research will accordingly follow the approach of objectivity.

2.3 Epistemology
Epistemology regards the nature of knowledge, and what true and trustworthy knowledge is. Assumptions regarding epistemology can also be objective or subjective. In the objective approach, social scientists tend to care about facts, numbers and if phenomenon’s can be observed with law like generalizations. In contrast, the subjective approach to epistemology regards narratives, opinions, with specific contexts and motives (Saunders et al., 2016, p. 129). In a positivist approach, true and valid knowledge arises from observable observations, and the researchers should have an objective stance and distance to the researched phenomenon (Collis & Hussey, 2014, p. 47). According to interpretivism the distance between the researched phenomenon and the researcher should be limited, valid knowledge is subjective (Collis & Hussey, 2014, p. 47). In this study, the authors want to keep a distance to the researched phenomenon, and they want to find valid knowledge only through objectively analyzed data results. This study is therefore based upon positivism, with the aim to increase the generalizability, validity and reliability of the study and the epistemological assumption refers to positivism and true knowledge.

2.4 Axiology
Axiology regards personal values in social scientific research, and if results are to be value-free or value-laden. According to the positivism approach, the researchers should be independent from the studied phenomenon and therefore, results should also be value-free. The opposite applies to interpretivism, where the results are value-laden because of the influences and involvement of the researchers in the study (Collis & Hussey, 2014, p. 47; Saunders et al. 2009, p. 119). Despite education within the Business Administration and Finance, the field of Blockchain technology has not been encountered before, and this research process is thus entered with a neutral stance. Neither of the authors have made intentional investment decisions in Blockchain technologies, in, for example cryptocurrencies. Encounters has only been through media and news, regarding for example, Bitcoin price fluctuations. Without previous experience and neutral opinions, the aim is that personal values will not influence this study. As previously mentioned, this study will take a positivist approach and the results of this study will become as value-free as possible.

2.5 Research Approach
In social scientific business research, deductive and inductive studies are usually distinguished. In a deductive research study, the purpose is to test already existing models and theories by empirical observations (Collis & Hussey, 2014, p. 7). Hypothesis should logically be drawn from already existing theories. If the hypothesis is correct then the result would be expected (Woo et al., 2017, p. 256). Thus, deductive research is built on logical reasoning.

In an inductive research, the aim is instead to observe and make empirical observations to create new theories and models. In this approach the researcher strives to find patterns in the observable variables to draw some new conclusions to build new theories (Woo et al., 2017, p. 257). It also exists a third approach called abduction. This approach tries to make explanations and create theories regarding phenomenon (Woo et al., 2017, p. 257). Deduction and induction are two types of research approaches that are traditionally
related to either positivism or interpretivism, and thereby also to quantitative respective qualitative studies. In this study, the aim is to test already existing theories through hypotheses and use a deductive positivistic research design, see Figure 1.

Figure 1. The deductive approach.

2.5.1 The Role of Theory
Theory is defined by Bacharach (1989) as system of constructs, or concepts, and propositions which are the relationship between those constructs that collectively presents a coherent, logical and systematic explanation of a phenomenon of interest within boundary conditions and some assumptions. Theories explain why things happen, rather than making predictions or descriptions. They are used to generalize knowledge and help us understand why observed regularities occur, help us to predict unobserved relationships and give guidelines to the research, in accurate directions for a specific academic field. The elements of the social scientific theory include assumptions among space, values and time, referred to as boundaries. The boundaries capture the variables and constructs, which is the concept used to explain a phenomenon (Ghauri & Grönhaug, 2010, pp. 36-37).

In this thesis, theory and previous studies give guidelines to research and the research question is developed through a research gap spotted in literature. The presented hypotheses are based on theoretical constructs and a proposition, see part 3.13. The constructs should have measurable representatives; variables. These variables can be dependent, independent, moderating or mediating. The observatory, or the empirical plane of the research is where the variables are measured and operationalized.

In this thesis, dependent and independent variables will be used, as well as control variables. The dependent variable is presumed to be affected by another, and the independent variable are hypothesized to influence others. The control variable is used to control the causation, and if the independent variable and the dependent variable together can cause the relationship and not another variable. Relationships among the theoretical constructs, are stated as propositions and indicate a cause- and effect relationship. Our hypotheses are derived from the research proposition, with background in previous studies. The theoretical propositions are tested by examining the hypotheses, which is the empirical formulation. Deduction, as explained, emphasizes testing logical reasoning from already existing theories. Thus, evaluating the theory and give further implications to the academic society. This thesis applies the quantitative approach to the principal orientation to the role of theory.

2.6 Research Method & Design
Based on the above-mentioned philosophical framework this study will take on a positivist and deductive approach, as in testing existing theory and analyzing data through statistical measures using a quantitative approach (Collis & Hussey, 2014, p. 52). According to Morgan (2007, p. 70) it is almost impossible to adopt a completely deductive or inductive approach. In reality, the process is not unilaterally, but rather moving back and forth between the theory and data (Morgan, 2007, pp. 70-71). Quantitative and qualitative research methods are not mutually exclusive, although these
tends to have traditional streams in social scientific business research. Data collections can be quantified but the analysis qualitative, or data could be qualitative but the analyses quantitative. Therefore, a more abductive approach with a combination between quantitative and qualitative method could be more reasonable, but because the authors did not choose a pragmatic paradigm and due to a limited time frame, a traditional quantitative method will be used. The method was also chosen to simplify for the reader and to make the study’s philosophical framework as clear as possible. Given this, methods for sampling, collecting data and perform empirical analysis will be made through a cause-and effect traditional research design, with characteristics of structure and numerical data. Figure 2 illustrates different ways of how to conduct research.

![Figure 2. The Research Onion](image)

Source: Saunders et al., Business Research for Business Students (2016).

Given our perceptual orientations and fundamental assumptions we believe that this research method should well employ this study within this field. In conclusion, this study will be quantitative, following a deductive theory testing approach, with an objective ontological view of reality with an epistemological positivism in order to gain true and valid knowledge. Axiological assumptions imply a value-free result on this study with numerical data and statistical procedures.

### 2.7 Literature Search & Source Criticism

In this study, two search engines have primarily been used, Business Source Premier and Google Scholar. Business source premier was accessible via Umeå University’s web page. It was first and foremost the later engine that was utilized to collect peer reviewed articles. Thus, secondary sources are used to support our literature review and the theoretical framework. Since most sources are peer reviewed, and many sources found from its origin authors, the chosen literature is considered credible and reliable. The
keywords that were mostly used when searching for relevant articles were, for example: *blockchain, blockchain technology, cryptocurrencies, financial markets, volatility, stock movements, operational risk*.

To find relevant knowledge and previous studies regarding the chosen topic, a systematic literature search was selected. The systematic literature review is commonly used to make an extensive search in a specific research field, in order to classify the sources in categories according to relevance. Then give a step-to-step description on derived conclusions, decisions taken, and the method used in the searching. The purpose with a systematic literature review is to gain knowledge within previous research in the field, learn about different theoretical and methodological approaches to research, and develop an analytical framework as well as interpret results in order to draw new conclusions or find a research gap. When conducting a literature search, one could find information about how previous studies approached the same subject and also what methodologies the studies have used (Collis & Hussey, 2014, p. 76).

The systematic literature review commonly uses a positivistic approach, in line with this research, and a quantitative focus where the theory informs the search. Secondary data sources provide information which has been collected for various purposes. Consequently, the time period, author and reliability have been evaluated in this study, as suggested by Ghauri & Grönhaug (2010, p. 91). There are several advantages with collecting secondary data for literature review and previous research. First, it provides a very broad base from where conclusions’ can be drawn, where the researcher herself can evaluate the reliability of others work and take her moral responsibility. Second, data only needs to be located, utilized and the verification process of the needed sources is rapid. Secondary data also allows international research and is collected by experts using rigorous methods. Third, suitable research methods can be suggested and consulted with secondary data can provide lots of inspiration. Churchill (1992, cited in Ghauri & Grönhaug 2010, p. 94) argues that nevertheless research design, one should start by using secondary data, and if necessary, proceed to primary data.

### 2.7.1 Literature Review

In order to make the systematic literature review as comprehensive yet as targeted as possible, careful reflections of the literature review was made from the beginning. This search strategy included choices of online databases and search engines, search terms, intended phrases to use, searching parameters and criteria for selecting specific scientific articles as suggested by Saunders et al. (2016, p. 90). The defined research parameters refer to:

**Language of Publication:** Swedish & English  
**Geographical Area:** Global Research  
**Publication Period:** As recent as possible, although original sources and publications has been prioritized  
**Subject Area:** Finance, Computer Science  
**Business sector:** Finance, Logistics, Health, IoT  
**Literature type:** Referred secondary material, peer-reviewed scientific journals and books

Further, used material has been referenced fully, with date of publication, authors, title of article and journal, page number, volume and part number of the journal issue. The
majority of accessed engines have a paid subscription from Umeå University and is therefore considered trustworthy and encouraged to use. Saunders et al. (2016, p. 108) states that a systematic review is a process for analysis, evaluation of contribution, and reviewing literature using a comprehensive, planned strategy. Review questions which aims to explore what have previously been researched was formulated in order to make a literature review and generate a comprehensive list of relevant research articles and studies. First, title and abstract are reviewed, for those not excluded, full text is read. Data is then classified into constituent part and key points are collected. Then data extraction is used to form, explore and integrate the findings in relation to the specific research questions.

2.8 Ethical Considerations & Societal Considerations

Ethical issues are important to take into consideration since moral values underlie the study’s code of conduct (Collis & Hussey, 2014, p. 30). These considerations typically refer to ensure the consent and safety of the research phenomenon. There are several different ethical issues that researchers need to regard when conducting research. Bell & Bryman (2007, p. 71) describe principles that researchers must consider referring to privacy, anonymity, misrepresentation, deception, honesty and transparency. The researcher faces a moral responsibility when conducting research activities. Ethics refers to values and moral principles. As companies become more aware, and the increasing debate on social responsibility issues, together with environmental factors and consumer wellness, it has become increasingly important to consider ethics. Otherwise, research might not be credible or lose its respect (Ghauri & Grönhaug, 2010, p. 20). The research has significant impact and if wrongly conducted, the researcher could face charges. It is further necessary to consider moral principles early on in the research process. Ghauri & Grönhaug (2010, p. 22) further argues that reporting results honestly and objectively is the most important aspect of ethics. Providing misleading result is ethically wrong. Ethical considerations, such as constraints upon research measurements and technologies have been reflected upon and moral judgements about the research procedures have been made. To the authors’ best knowledge, the results and the research procedures could not imply conflict, harm or negative implications for any involved part. In this study, no human participants will be included, and therefore some of the stated principles are of less importance, such as anonymity and harm to participants. Societal considerations refer to interests of individuals, groups or society. In general, these involve interventions in financial mechanisms. Further, it involves socio-economic implications with regard to, for example, governance and regulations. Secondary information has been gathered through companies’ annual reports researching if Blockchain technologies are used, and when they were introduced. Thus, a Yes/No answer is searched for and in a specific point in time of introduction, leaving very little room for interpretations.

The focus will be targeted to transparency, honesty and actions towards misrepresentation, because these are of relevance to ensure the generalizability, validity and reliability of the results. The authors have tried to describe all different research steps, and procedures as detailed as possible in order to increase transparency. Methods, procedures and instruments are presented to the reader, so that they can make their own judgement upon the reliability of the findings, which is in line with Ghauri & Grönhaugs suggestions (2010, p. 23). This subject is not considered controversial and has no direct dangerous impact. The results will be objectively presented and analyzed based on previous theories to avoid misrepresentations but at the same time provide a discussion
with roots in financial literature. Intersubjective and clear communication is throughout the thesis embraced. However, some disclaimers could be made due to peer-pressure to the quantitative research design since it is the most common method to use for statistical testing and regression analysis with binomial distribution. More comprehensive research could have been conducted regarding research paradigms to make more extensive choices. However, scientific choices are considered to reflect the study well.

Further, the Umeå School of Business, Economics & Statistic’s ethical code of conduct has been regarded and reflected upon throughout this research process.
3. Theoretical Framework

This third chapter will be divided into three parts. First, previous research linked to the field of Blockchain technology and its application in various industries is introduced. Second, financial concepts and academic theories are described. Third, volatility measurements for this thesis is presented, in order to argue for method choices and derive the research proposition. Lastly, this chapter ends with a model with the purpose to provide the reader with an overview of the theoretical framework.

3.1. The Origin of Blockchain

Blockchain technology refers to a distributed ledger with the purpose to exclude third-party intermediaries, such as financial institutions or regulation bodies. Blockchain technology has potential in many different contexts and areas, such as in medicine, logistics, education, employment and in law (Treleaven et al., 2017, p. 17). Blockchain technology is a safe and transparent system that uses nodes and cryptographic to store information. The first Blockchain technology innovation was originally intended to time stamp digital documents in 1991, with the purpose to make it impossible to backdate or tampering with documents as they passed the server (Haber & Stornetta, 1991). No other document then the original, could be stamped with date and time, making it impossible to change even one bit of the document without making the whole change apparent and visible. Thus, without any reliance to the medium characteristics where the data appears. This could be compared to a notary, with a structure very similar to today's modern Blockchain technology with both linking and hash functions (Haber & Stornetta, 1991, pp. 3-5). Haber & Stornetta were the pioneers within the field, and what started as a timestamping problem, is now transforming entire industries worldwide.

The pseudonymous Satoshi Nakamoto published a paper in 2008 called “Bitcoin: A Peer to Peer Electronic Cash System”. He, or She, or them, managed to create a financial system which ensured the integrity of transactions, and excluded centralizing roles of financial intermediaries through adopting Haber and Stornettas algorithm, and previous academic writings with several other ideas regarding, for example, William Fellers work on probability theory, and Tim May's crypto-anarchy (Nakamoto, 2008, p. 11). Nakamoto addresses the problems of double-spending in digital currencies, and claim a solution using a peer-to-peer network. Double spending means that digital money can be spent more than once. It refers to the risk, that a holder makes a copy of a digital token, and while retaining the original, sends it to another party (Frankenfield, 2019). Further, Nakamoto (2008, p. 8) creates an electronic system based on cryptographic proof, allowing direct transactions between two parties without a trusted financial intermediary. Through the structured simplicity, robustness is achieved. The design of Bitcoin is further public, free of one owner, has an open source code and everyone can participate. Claiming increased transparency compared to the traditional financial system, yet with anonymity as a user. The Blockchain technology in Bitcoin is a public distributed ledger, which holds records of all transactions that have ever been executed in the ledger. The Blockchain is constantly growing and adding new blocks every ten minutes to store the most recent transactions. The key innovation of the Blockchain is the trust less decentralized transactions (Swan, 2015, p. 10).

Today, 12 years later, the Blockchain technology has been implemented in various fields, and the development has increased rapidly. Simply explained, records of information are
stored into blocks. Thus, a block contains a bunch of records. These blocks of information are then linked to each other, see Figure 3.

Figure 3. Illustration of Blockchain. Source: Murray (2018). Reuters Graphics.

Each block has a hash value (soon to be described), and another hash value to the previous block in the chain. Let us say that we are going to record a trade between Anna & Kajsa, the transaction is recorded with digital signatures from both women, and details of their transaction. The nodes in the network then checks the details of the record to make sure it is valid, safe and sound, and then the network accepts the record and adds it to a block. Multiple blocks are then added to a chain linked with the hash value in a chronological order. The distributed network makes constant checks so that all copies, available to the user of the Blockchain are the same (Murray, 2018). Further, Swan (2015, p. 11) describes the Blockchain as a giant accounting system in form of a spreadsheet for registering all assets and transactions globally.

3.2. Computational Technology Related to Blockchain Technology

3.2.1. Peer-to-Peer Network
In the previous section, describing the Blockchain technology requires the usage of some specific terms that we will explore briefly. In the field of computer communication, a node refers to either an endpoint or a branching in a network. Each active node can receive and send data. In a distributed system, which is a computer network without a central control unit, a node refers to a computer unit that runs peer-to-peer software (Schollmeier, 2002, pp. 1-2). The peer-to-peer network is a network of connected nodes, where every node must be able to act as both a server and a client of data. This implies that each computer does not have a specific role and can take on any role. This contrasts with a more traditional model, where one or several nodes act as a client, and one central node acts as the server, which is called the client-server model, see Figure 4 (Schollmeier, 2002, pp. 1-2)
According to Dinh et al. (2018, p. 1367), there are two types of Blockchains; private and public. In public Blockchains, nodes have open access and no membership is required to enter the system. The opposite applies for private Blockchains, where all nodes need a membership if they want to participate in the system (Dinh et al., 2018, p. 1367). Blockchains are to a great degree created to protect information integrity.

3.2.2 Hashing & Cryptography

When describing the Blockchain technology and encryption, one uses the principles of hash functions and hash values. Hashing refers to running an algorithm over a content file which could be a document, a video, a gif or a genome file. The outcome is a hash string of alphanumeric characters, that cannot be back-computed to its original file before the algorithm was executed (Swan, 2015, p. 39). An algorithm is defined as a finite sequence, i.e. set of operations with the characteristics of definiteness, effectiveness, output and input used to solve a specific task (Janlert and Wiberg, 2000, p. 22). Further, the hash string serves as a private and unique identifier to the original file. If the content file for some reason needs to be reconfirmed, the same algorithm is executed with the file as input, if nothing in the file has changed, the same hash signature as previously will be generated. This means that any new input into the original file will generate a new hash (Murray, 2018). The hash, for example a 64-character string, or a 32-byte character can look like this: a948904f2f0f479b8f8197694b30184b0d2ed1c1cd2a1ec0fb85d299a192a447, any hash string generated will always have the same length. The example string above is “hello world” converted into a hash- string. Thus, it would be visible in the generated hash if someone would try to make changes. Swan (2015, p. 39) states that the hash string is short enough to be included into the Blockchain transaction.

3.3. Different Definitions of Blockchain Technology

Melanie Swan, founder of the institute of Blockchain technology divides the technology into classifications of three. The first one refers to Blockchain technology as the deployment of currency, and in applications related to digital transfers, payment mechanisms and cash. The second one refers to financial contracts, where the Blockchain technology is used to a larger and more advanced extent, rather than simple cash
applications, such as smart contracts, bonds, mortgage, futures, stocks and wraps around all financial applications and the economic market. The third one refers to fields of applications beyond currency, markets and finance, which could especially be in governance, health care, culture and art as well as supply chain management and literature (Swan, 2015, p. 9).

3.3.1 Blockchain 1.0 Blockchain Technology as Currency
Blockchain 1.0 refers to Blockchain technology as a currency. In the general structure, digital cryptocurrency builds on three layers, the Blockchain, the protocol and the currency. Swan argues that Blockchain as a cryptocurrency is better than electronic cards, such as Visa or MasterCard, since it allows us to do what we have not thought of.

The first layer; the underlying technology, is the transparent transaction records ledger. That is the database, which is shared and monitored by everyone, owned and controlled by no one, and updated by mining. The middle layer of Blockchain as a currency is the software system that transfers money over the ledger, in other words the bitcoin protocol and client. The third layer is the currency itself, for example, Bitcoin, Ripple, Peer coin, Litecoin etc. (Swan, 2015, p. 1). Large players that today accepts Blockchain technology as a money transferring currency are for example Microsoft, Amazon, Burger King, Twitch and Norwegian Air just to mention a few. Over 80 000 merchants accept Bitcoin as a payment (Larissa, 2016, pp. 84-85). Annop & Amandaro (2019, p. 457), have studied the volatility spill over in crypto markets using a multivariate GARCH model and wavelet analysis. Their findings indicate that cryptocurrencies return in its various forms, such as Ripple, Ethereum and Litecoin, are moderately correlated in the short run. Evidence towards moderately volatility spill over and these are further caused by shocks in Bitcoin prices and other exogenous events. Guandong et al. (2017, p. 6), explores the Blockchain technology as a currency and aims to predict Bitcoin volatility, whereas the volatility behaviour compared to the USD is expected to be continuously unpredictable. The authors find that the Bitcoin price movements tend to be random and being unaffected by traditional financial movements.

3.3.2 Blockchain 2.0 Blockchain Technology as Contracts
Blockchain 2.0 refers to Blockchain technology as contracts. According to Swan (2015) Blockchain 2.0 does not only cover cash transactions and decentralization payments, it rather refers to more extensive financial market applications. Blockchain 2.0 can also, unlike Blockchain 1.0, transfer assets of different kinds such as stocks, bonds and futures (Swan, 2015, pp. ix & 9). Swan further states that Blockchain 2.0 is under development and has yet no clear classification. Blockchain businesses are constantly working to interfere traditional banking and financial markets though cryptocurrencies applications, and traditional banking is making efforts to adjust. For example, one of the largest banks in Sweden, SEB, has made efforts to the Blockchain technology by collaborating with the venture capital backed Ripple, and now applies their Blockchain technology for foreign transactions in the bank. Blockchain 2.0 slowly reinvents financial services through innovations in financial markets and economies (Swan, 2015, p. 11). The functionality through decentralized ledgers could be used to confirm, register and transfer all properties and manner of contracts, for example mutual funds, derivatives, business certificates, voter registrations, notarized documents, as well as intangible assets such as copyrights and patents (Swan, 2015, p. 10).
3.3.3 Blockchain 3.0 Blockchain Technology as Justice Applications Beyond
Blockchain 3.0 refers to Blockchain technology in justice applications, and applies beyond financial markets, currencies and economies. It focuses on government, health, art and culture, but also on medical science (Swan, 2015, p. ix). As stated, Blockchain technology has the potential to transform and reinvent payment systems, financial services and monetary markets, but the modern technology also offers similar reconfiguration possibilities to various industries. Swan argues that Blockchain technology is a new paradigm for effectively organizing activity on a great scale, and that perhaps all modes of human activity could be coordinated (Swan, 2015, p. 29). The Blockchain technology is applicable where a distributed, sequential and public data storage (Swan, 2015, p. 68). For example, Blockchain could facilitate the predictive task automation in big data, be used as a freedom of speech mechanism and digital identity verification (Swan, 2015, pp. 31-36). However, this thesis will primarily focus on Blockchain technology and its applications in finance and will not further elaborate on possible fields for development. According to Carson et al. (2018), twenty-five governments are actively running Blockchain pilots with start-ups.

3.4 Disruptive Technology
Christensen (1997) published the theory of Disruptive Technology in the book “The investors dilemma”. The highly entrepreneurial term refers to superior attributes by an innovation, that oversees old processes, whereas the old products, processes or strategies lose its forefront. To early adopters, usually smaller companies, the advantages of the innovation seems immediately obvious. This explains how successful companies, which might dominate their industry, can fail because of disruptive technology. The disruptive innovation develops to meet the future needs of consumers, and thus, creates the future needs of the consumer. Hassani et al. (2016, p. 270) concludes in a time where adjustments to innovations could determine a company’s survival in a competitive market, Blockchain technology is here to stay. Blockchain technology has been argued to be a disruptive technology, as it changes the nature of organizations in a global environment (Frizzo-Barker et al., 2020, p. 2). Disruptive innovations cannot be ignored, and large companies have to monitor niche-markets in order to stay informed and identify potentially disruptive innovations.

However, not everyone agrees. Lakhani & Lansiti (2017, pp. 118–127) argues that if there is to be a Blockchain revolution, many barriers such as organizational, regulation, societal and even technological have to fall. The authors further argue that Blockchain technology is not a disruptive technology, but rather a foundational technology, which means that the Blockchain has the potential to create new foundations for both social and economic systems. As the disruptive technology, could attack original business models, take over firms quickly, and provide lower-cost solutions, the new Blockchain technology paradigm is not argued to have that capacity according to the business professors. However, Lakhani & Lansiti (2017, pp. 118–127), do share the Blockchain enthusiasm and recognise its impact for society, although they argue that the Blockchain technology transformation will happen gradually, take time and that true changes could be many years away.

According to Skarzynski & Gibson (2008, p. 128) radical innovation is something that can change the customer’s behaviour and expectations, change the core of competitive advantage or change the economy of an industry. If one or more of these changes are fulfilled, then it is a radical innovation. The word radical can often be related to something
risky and negative because people relate it to, for example, speculative and uncertain investments. Skarzynski, & Gibson (2008, p. 131) argues that the risk often increases when companies innovate, or enters, totally new areas but it does not mean that all radical innovations are all bad. An idea can be radical, but it can be based or build on well studied grounds and the risk can therefore be reduced. Since Blockchain technology is argued to be both a functional and disruptive technology, it could further be argued to be of radical innovation. At first glimpse, the disruptive innovations in its early niche market, is not considered advantageous or profitable. However, with maturity, the innovations can have superior impact on performance and impact stock behaviours. The disruptive innovations tend to often become market leaders. Thus, investing in those could be profitable.

3.4.1. The Fifth Disruptive Computing Paradigm

The modern world changes rapidly and the Internet has revolutionized the world as we know it. Swan (2015, p. 11) states that one way of understanding the present is through computing paradigms as the arising of one new paradigm per decade. The first, in 1970s, referred to a mainframe paradigm which is where the computational power resides in the first computers before commercialisation. Then the second, in 1980s, refers to the personal computer which became available for private users. The third paradigm refers to the Internet in the 1990s, which has significantly changed our society, human activity and business. The most recent paradigm refers to mobile units and social networking in the 2000s. The next paradigm could according to Swan, be the connected world of computing, relying on cryptographic and Blockchain technology, as the connected world could rely on Blockchain for multi-devices such as IoT-sensors (Internet of Things), smart-, cars, homes and cities, self-tracking devices and laptops through effective allocation. This research orients through Swans fifth computing paradigm and explores potential impact of businesses.

3.5. Blockchain Technology in Banking & Finance

In the banking and financial markets, Blockchain technology is a very attractive system. Nearly all banks are experimenting with Blockchain technology in collaboration with, for example, external fintech companies or developing own solutions with the purpose to increase operational efficiency and cost saving (Kocianski, 2018). However, regulatory framework and governance is needed to further develop the adjustment for banks of the Blockchain technology. Although, the evidence towards benefits of implementing Blockchain technology in banking has different perspectives.

Hassani et al. (2018) present what is argued to be the most comprehensive review to date of the impact of Blockchain technology in banking. Yet, the term volatility in this review is only mentioned once in this review as well “…suggests a ‘stable coin’ which is basically a digital token that will have low price volatility as a result of being pegged to some underlying fiat currency…” (Hassani et al., 2018, p. 266). This is emphasized to highlight the research gap for this thesis. The authors provide descriptions upon the challenges and opportunities with Blockchain in banking. Hassani et al. (2018, p. 269) argues that while some view the technology to be threatening to traditional business models, and some view it as the next revolution, others view the technology as overhyped. The authors further highlight the opportunities for Blockchain technology in banking as improved KYC (Know your customer) processes, with regard to new regulations against money laundering, improved transaction speeds, enhanced security, cost reductions and transparency (Hassani et al., 2018, pp. 259-265). Further, challenges among Blockchain
technology refers to standardization requirements and costs, legislations and regulations, security, scalability and currency stability (Hassani et al., 2018, pp. 265-268).

The global banking industry has given lots of attention to Blockchain and further follows some evidence on the ongoing implementations. For example, 50 Blockchain-patents have been filed for by The Bank of America. The French BNP Paribas has for order processing tested Blockchain technology on currency funds. HSBC recently executed live trade finance transaction using R3’s Blockchain platform for agriculture conglomerate Cargill and International food. Several companies, such as IBM, Commerzbank, Bank of Montreal, Caixabank and UBS are collaborating and working on ‘Batvia’ which is a global trade platform used for greater efficiency and transparency while transferring goods and money based on a Blockchain technology. The Agricultural Bank of China has used Blockchain technology for loan of 300 000 USD and in Israel, Bank Hapoalim has integrated Blockchain technology to their database of customer- information (Hassani et al., 2018, p. 258). Further, 80 % of Japanese banking industry has partnered with Ripple for international transactions. Goldman Sachs is claimed to use internal funds for trading of Bitcoin for their clients. In the middle east Blockchain technology has been used in check-insurance system by the National Bank of Dubai. The UK also adjusts and adopts to the disruptive technology as Santander Bank also partnered with Ripple for international transactions, and the Bank of England has made a proposal for facilitating money transfers and payments by using Blockchain technology integrated in Real-time gross settlement systems (Hassani et al., 2018, p. 258).

Governments have played a major role in the development of Blockchain. In 2013, many countries, such as Iceland, Ecuador, Bangladesh, Vietnam, banned the Blockchain technology as a cryptocurrency completely, and thus limited development and Blockchain solutions within those countries. China banned institutions of dealing with virtual cryptocurrencies. Further, countries such as Germany, Thailand, France, Korea have viewed Bitcoin unfavourably (Swan, 2015, p. 7). Since 2013, as stated before, lots have changed and the huge actors within banking industry is today working hard for the advantages from the Blockchain technology. Despite various efforts across the globe, Carson et al. (2018) argues that the banking industry is not yet ready for everything that Blockchain technology has to offer and that the technology in banking is yet immature.

3.6. The Blockchain in Supply Management
According to Morkunas et al. (2019, p. 295) there is much discussion about how Blockchain technology can be used in the financial sectors and less about how it can be used in organisations to create value. Blockchain can be used in any business that have an intermediary that communicates between two parties, for example, between a seller and a buyer. Morkunas et al. (2019, p. 296) further state that Blockchain technology can challenge the current business models and find new ways of value creation. Today, there is little information and guidance regarding different types of Blockchain technologies, and how it can affect the business models. According to Morkunas et al. (2019, p. 296) one can easily find sources that claims that Blockchain technologies can disrupt business activities. Blockchain technology is introduced in many contexts such as in real estate, clinical trials and in open manufacturing but it is also implemented to prevent fraudulent behaviours. Blockchain technology is also useful in supply chains because with this technology it can make the transactions more efficient and easier to track (Queiroz & Wamba, 2019, p. 70). If companies adapt Blockchain technology in their supply chains the customer trust can increase, because Blockchain technology can allow them to follow
a product during the whole process (Queiroz & Wamba, 2019, p. 70). Blockchain technology related to supply chain will not be further discussed. However, it is regarded important to mention since the value creation in operational activities, due to Blockchain advantages, is present in all industries and especially in logistics companies.

3.7. Blockchain and Implications for Trust in Cybersecurity
According to Kshetri (2018, p. 88) Blockchain technology can be of use to increase security for cyber threats. In an article written by Bruno & Gift (2019, p. 20) it is discussed how Blockchain and cryptocurrencies can be utilized in a safe way in businesses without increasing the risk of, for example, cyber-attacks, criminal activity, regulatory violations, and financial losses. The discussions regarding different risks might frighten people from implementing the system in their businesses, despite the advantages that this system also brings. Bruno & Gift (2019, p. 20) claims that the businesses have to evaluate all risks that Blockchain technology might bring to be able to manage the risks. To manage the risks, businesses can, for instance, make sure that they have good internal operational processes, that they learn the system and demand research and utilize experts. This causes that risks with this technology decrease. According to Bruno & Gift (2019, p. 22) there are still some twists that are still not solved regarding Blockchain technology and cryptocurrencies.

Even if there is a lot of information written on implications with Blockchain technology there is a lack of empirical evidence that inform companies about how Blockchain technology can be used in the organisations. Companies could therefore wait for others to test the system. Ying et al. (2018, p. 1) provided empirical evidence when they investigated the block-based e-commercial platform, used to benefit employees, that Hainan Airlines (HNA) group successfully had implemented. The study shows that Blockchain can allow companies to make their own cryptocurrency to secure transactions (Ying et al., 2018, p. 3). It also contributes to better protection of sensitive information because the system integrates and verifies all parts without them leaving out sensitive information. Finally, the case study also shows that Blockchain technology decreases the centralized risk because it is a system that does not need an intermediary to make trustful transactions between two parts (Ying et al., 2018, p. 3).

3.8 Limitations to Blockchain Technology and Challenges
Despite the many argued advantages with Blockchain technology, the technology and various implementations faces many challenges. In global supply chain management, various countries and institutions, regulations and law operate in a complex environment together. Bringing Blockchain technology into this international global supply chain system could be very difficult since important parties need to be brought together (Kshetri, 2018, p. 88). Another challenge to the Blockchain technology in various fields is that it has no regulation and is “lawless” which raises questions. How does one operate without laws in such a huge mechanism? Blockchain requires technological abilities, and internet connections are of great importance, the Blockchain technology cannot be considered ecological, and as it could be argued to be unavailable for less developed countries. Marr (2017), states that before the banking industry can explore the full benefits of Blockchain technology, one has to overcome safety requirements for data and privacy laws. This combined with the many questions regarding regulations, oversight authorities and the scalability to manage the huge data sets. In the development of future Blockchain implementations, this will be important to consider. Higginson et al. (2019)
also state that regulations is a necessity in order for companies to have certainty of the status of the various forms of implementations of the Blockchain, and investor protection.

Another limitation to Blockchain technology is quality assurance in auditing and accounting. There still remains uncertainty on how to treat Blockchain technology as an asset, with no clear accounting standards according to PwC and one must therefore apply a principle-based approach (Leopold & Vollman, 2019, p. 1). Blockchain technology is still a new and complex technology. If a psychological dimension is added to Blockchain, one could argue that the things that are unknown and new could be frightening for stakeholders. It could be the case that companies are unsure of how stakeholders would react to the news of introducing Blockchain technology in the cooperation’s. This could be an incentive to be careful. First, companies would want to be certain that the technology is really safe. Further challenges regard cyber-attacks, although they are argued to almost be impossible. If the human error is present, no information system can be argued to be 100 % secure (Piscini & Kehoe, 2017, p. 11).

3.9 Advantages of Blockchain Technology
To conclude this section, Blockchain technology as a disruptive technology, and the fifth disruptive computing paradigm provides tremendous advantages for various industries and has the potential to change the world. The major advantages refer to the decentralized technology with increased transparency, entering the centralized scale. Primarily, Blockchain technology is a way to store data. Swan (2015, p. 94) argues that the Blockchain technology is the embedded economic layer that the Internet never had, which do not need trust, and emphasizes on possible governance decentralized and personalized services that could be offered. Any digital document could be extracted and prove the existence of an asset in any time. Further, Blockchain technology is a public layer for registration, available to all who wants to participate worldwide. Seven billion intelligent agents could, according to Swan, be coordinated (2015, p. 94). Ying et al. (2018, p. 3) state that Blockchain technology contributes to better information security. It also reduces the centralized risk since the system does not need an intermediary. Kshetri (2018, p. 88) states that Blockchain technology can be of use to increase the security regarding cyber threats and reduce the uncertainties when it comes to trust. Blockchain technology is also useful in supply chains to easier track and increase efficiency (Queiroz & Wamba, 2019, p. 70).

Blockchain technology could be a new tool to effectively organize and model human activity on a great scale (Swan, 2015, p. 29). Lakhani & Lansiti (2017, pp. 118–127) argue that the Blockchain technology is fundamental and has the potential to create new foundations for both social and economic systems. Hassani et al. (2018, pp. 259-265) argues for the many benefits in banking, such as improved KYC processes, transaction speeds, enhanced security, transparency, new regulations against money laundering and cost reductions. Kocianski (2018) also argues for cost savings and increased operational efficiency. The Blockchain technology is applicable where a distributed, sequential and public data storage is needed (Swan, 2015, p. 68). For example, Blockchain could facilitate the predictive task automation in big data, be used as a freedom of speech mechanism and digital identity verification (Swan, 2015, pp. 31-36).
3.10. Financial Risk Management

3.10.1 Asymmetric Information
Information asymmetry can, for example, occur in a situation where two parties are going to make a trade, where one of the parties has access to more information than the other, which causes the information deficient person to make a different decision than if he had access to the same information. Almost all transactions involve some information asymmetry (Ruan, 2019, p. 167). Usually, it is the seller who possesses the information benefit, but all constellations are possible. An imbalance of power is created in the transaction because of the asymmetric information, which in worst case scenario can cause market failure. Information asymmetry plays within a knowledge dimension, which is a non-economic behaviour applied to any economic trade. In a healthy market economy, the growing information asymmetry, also known as information failure, is desirable. Modigliani & Miller (1958), stated that a firm's financial structure does not affect valuation, was challenged as the acknowledgement of information asymmetry between companies shed light of the importance of aligning stakeholders’ interest with those of managers (Garmaise & Natividad, 2010). A large proportion of research has been conducted in field of accounting with regard to information asymmetry as the corporate information has to transfer from the enterprise to stakeholders who need the information for decision making. It could be the case that investors do not have access to the information of Blockchain technology, then it would be difficult to make informed decisions.

3.10.2 Adverse Selection
Asymmetry of information can cause Adverse selection which refers to a case of exploited information asymmetry. In other words, information asymmetry applied to a service or product. In contrast, the symmetric information would relate to a situation where all the involved parties have the same knowledge of available information. The concept was first founded in Akerlof’s “The market for "lemons": quality uncertainty and the market mechanism” in the 1970s. Akerlof (1970) describes how the car industry has information asymmetry, and how average pricing of products tend to increase, no matter the quality of the product, resulting in that a good quality product, due to adverse selection has to lower its price. Thus, adverse selection is in a negotiation where one party has information which the other party do not have. If one seller has an information advantage, the buyer who lacks the information is put at a disadvantage, thus an unfavourable trade. For example, a corporation would be more eager to issue equity if they knew that the stock is overvalued, as buyers can end up losing money through buying the overvalued shares as a real example of adverse selection.

3.10.3 The Principal-Agent Problem
The Principal-Agent Problem, also known as the Agency dilemma or the Agency problem, refers to information asymmetry and adverse selection where one party, referred to as the agent, can make decisions on behalf of the other party, referred to as the principal. Thus, the Agency dilemma, in contrast to information asymmetry and adverse selection, emphasises the decisions impact on the less fortunate party. The Principal-Agent problem typically refers to situations where agents are motivated to take actions with their best in mind, which is usually in contrary to the best of the principals. Taking the above-mentioned example, the agent would be the managers of the company and the principal the shareholder (Eisenhardt, 1989 p. 58).
3.10.4 Moral Hazard
Moral hazard arises from asymmetric information which can exist between parties in the market. For example, if part A in a contract has more information than the other part B, then part A might act upon the behalf of part B. This causes that part A might be willing to take on more risk, because part A does not have to stand for the costs which may arise from the riskier business, since part B also is charged (Hull, 2018, p. 61). Moral hazard emphasises the risk that one party does not enter a negotiation, a transaction or a contract, with correct details or faithful intentions. In finance, it is common to relate Moral hazard to insurance companies. For example, the insurance company could be unaware of the intentions of the policyholder, and an insurance could contribute to a more riskful behaviour of the policyholder (Hull, 2018, p. 61). This is because someone else, in this case the insurance company, have to bear the cost if a policyholder conducts risky activities. In this chapter, Blockchain technology has been discussed and presented as a very safe and transparent system, but challenges and limitations have also been highlighted. Blockchain technology could reduce asymmetry of information though ensuring transparency.

3.10.5 Signalling Theory
Signalling Theory is about sending out a message to another part. One example of this could, for example, be that managers increase dividends. An increased dividend is a signal that the company is doing well and can afford to pay a higher dividend in the future (Berk & DeMarzo, 2017 p. 655). According to Bhattacharya (1979) shareholders do not possess the same information as managers. The asymmetric information can make investors more sensitive towards changes in dividend policy, due to a positive relationship between the dividend policy and level of asymmetric information (Dionne & Ouederni, 2011 p. 188). Investors can therefore only base their investment decisions on disclosed and communicated information. The Signalling Theory was first founded by Michael Spence in 1973, who observed knowledge gaps between corporations and future recruitments. An employer can only see the observable attributes or characteristics of a job seeker, and not the actual marginal product that the job seeker will generate if he will be hired (Spence, 1973, p. 357). The employer can therefore only base his judgement on what he can observe. Spence (1973, p. 357) further states that some attributes can change, such as, education while some are less changeable, such as, gender. Spence called the more unchangeable attributes for indices and the changeable for signals. After hiring a person, the employer gets the true picture of an individual’s capacity and it contribute to new characteristics of job seekers and also as a basis for the wages (Spence, 1973, p. .358). It is the confronted indices and signals that becomes the basis for the salary. Screening is a way of dealing with Moral Hazard and Adverse selection because screening regards to looking beyond the obvious, to find the true and correct information (Stiglitz, 1975, p. 284).

Given all the huge possibilities and advantages with Blockchain technology in businesses, investors should view the communication of the usage of technology as a positive signal. This theory is therefore of interest in this study as a background to how different information or decisions can generate positive or negative signals to the investors, and how these signals can change an investor’s decision. Thus, stakeholder’s perception of Blockchain technology is important since it causes changes in trading activity in the market.
3.10.6 Behavioural Aspects of Finance

One of the most classical theories in finance is The Efficient Market Hypothesis (EMH). This theory states that prices of securities, reflects all available information on the market. EMH states that the correct price in the markets arise as investors compete to find arbitrage possibilities (Ritter, 2003). This theory has received a lot of criticism, and new theories have emerged such as Behavioural Finance to explain price changes. There are different factors that can impact the decision of an investor. The efficient market hypothesis states that all markets are rational but agrees to some extent that investors are irrational. Behavioural aspects of Finance consider markets to be informationally inefficient (Ritter 2003, p. 430). Behavioural Finance is also based on other research areas than just finance, such as, psychology, anthropology and sociology (Mishkin et al., 2018, p. 143). According to Ricciardi & Simon (2000) the Behavioural Finance theories include different themes such as the theory of cognitive dissonance, the theory of regret and the theory of prospect. Behavioural Finance theories has been defined and interpreted differently by different scholars and research areas (Ricciardi & Simon, 2000, p. 2). According to Ritter (2003, p. 429) the Behavioural Finance field is divided into two blocks and these consist of the limitation to arbitrage and cognitive psychology. The first one is about financial inefficiency and it refers to when arbitrage is, or is not, effective. The second one relates to how people think and, apart from other financial theories, this theory takes psychological research into consideration.

Previous psychological research has found that people make systematic errors when they think or act. Previous experience and too much overconfidence can be two things that affects people’s decision making (Ritter 2003). When investors become to overconfident, they tend to miss information that can be of importance in making a good investment decision (Jaiswal & Kamil, 2012, p. 12). Investors could be influenced by different factors and therefore not draw logical conclusions from available information. Another cognitive bias worth mentioning is conservatism. According to Ritter (2003, p. 432), people tend to adopt slowly to changes because they are anchored to how it used to be and that this often leads to an underreaction in short-term, but in long-term, investors instead tend to overreact to changes. In this study, the theory of Behavioural Finance will be used to explain why investors do not always act rational. If the investors were informed about the use of Blockchain technology and all its advantages then the stock price could increase, and the volatility would be reduced. But if this study shows the opposite and contradicts normal rational conclusions, this theory might be used to explain investors irrational behaviours. Blockchain technology is a relatively new concept and therefore one might suspect that investors have not anchored it yet, which can be explained by the cognitive bias, conservatism.

3.11 Risk Implications for Blockchain Technologies

Since previous research has highlighted the uncertainty of how risk could be affected by Blockchain technology and innovations, this part aims to elaborate on different financial risks which could be influenced.

3.11.1 Credit Risk

Credit risk is the risk of default in a counterparty, and it is one of the largest risks that financial institutions, or financial intermediaries, have to face when their clients cannot meet their financial obligations (Hull, 2018, p. 42). This risk is therefore one of the risks that need to be regulated to ensure that institutions and companies have large enough capital buffers to protect themselves against unexpected losses. The Basel committee
introduced capital requirements to prevent credit risks in 1988 Basel accord (Hull, 2018, p. 373). Credit rating agencies that can be used to evaluate credit risk. These agencies provide information regarding the credit quality of a security. If a security of a company gets a rating of AAA, the security has a very little chance of default (Hull, 2018, p. 19). There are two types of credit risks defined by the Fundamental Review of the Trading Book (FRTB), these are credit spread risk and jump-to-default risk (Hull, 2018, p. 425). Credit spread risk, is the risk that the market value will change because of changes in the credit spread. The jump-to-default risk is the risk that the companies will default. According to Beier et al. (2010, p. 5) a well functioned IT-system can reduce or avoid the counterparty risk. This is because a well functioned IT-system can help risk managers to quickly calculate and identify the future appearance of counterparty risks. In this study, Blockchain technology will be analysed to see if the risk will be reduced and if the volatility decreases in the stocks. If Blockchain technology transfers transactions immediately, both parts in an agreement can be sure that the transaction will be transferred in a safe and secure way. The risk of default should therefore be limited and so the credit risk using Blockchain technology.

3.11.2 Market Risk
Market risk is inherent systematic risk which affects the overall market. These risks appears most frequently in the trading operation of the banks and it is the risk that the value of the financial instruments will decline (Hull, 2018, p. 42). These risks refer to politics, currency risks, cyclically risks etc. Unsystematic risks can be diversified, as these risks can be identified according to Brealey et al. (2017, p. 176). Market risk on the other hand, is the risk that is unknown and unpredictable, and it does not matter how many various financial instruments investors include in their portfolios, or which hedging strategies they use. One will always be exposed to market risk (Brealey, 2017, p. 176). In this study, market risk is included as a risk that Blockchain technology cannot reduce. Even if Blockchain technology is supposed to be safe and transparent, which might lead to a reduction of credit risk, liquidity risk and operational risk, the market risk will still be there to potentially threaten the investors’ portfolios.

3.11.3 Operational Risk
Operational risk can, according to Hull (2018, p. 517), be defined in slightly different ways. It can be defined as any risks that may arise from operational activities. Operational risks may also include a broader definition such as risks that may arise when companies choose to develop new products or decide to enter new markets (Hull, 2018, p. 517). Operational risk can both include internal risk and external risk. Internal risks are those risks that are related to the operations and that the companies can control, such as, computer systems etc. External risks are risks that arise from incidents, such as natural disasters and political regulations that the companies cannot control or influence. Hull (2018, p. 517) claims that regulators prefer to define operational risk as both internal and external risks. The Basel Committee on Banking Supervision has defined operational risk as “The risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events.” (Basel Committee, 2001; Hull, 2018, p. 517). According to Akkizidis & Bouchereau (2005, p. 329), the key issue in operational risk is transparency in risk methodologies. Blockchain technology is a computerised system. People, or internal and external processes, cannot change a transaction without anyone’s knowledge, as it would be visible in the hash-string. If Blockchain is a system that is safe, secure and transparent, then operational risk should be reduced.
3.11.4 Liquidity Risk

Liquidity risk refers to the risk of not having enough liquid capital, so that one cannot pay its current obligations (Hull, 2018, p. 537). According to Hull (2018, p. 385) this risk arises because banks use short-term funding to finance long-term needs. It is important that financial institutions have enough liquidity and thus conduct worst-case-scenario calculations and stress tests, to make sure that they can meet capital requirements. To ensure that banks have enough liquidity more regulations have been introduced such as the Basel III accord. Basel III requires the banks to make sure that they have enough liquidity to cover both the liquidity coverage ratio (LCR) and the Net Stable Funding Ratio (NSFR). The two ratios are both required to be above 100% to ensure the liquidity (Hull, 2018, pp. 386-387). If the operational risk, described in the previous section, is reduced when Blockchain technology is introduced, then the liquidity risk should also reduce. This is because the operational risk includes internal and external risks.

3.12 Volatility of Stock Returns

3.12.1 Modern Portfolio Theory

In 1952, Harry Markowitz first introduced the Modern Portfolio Theory. The concept states that an asset’s risk and return cannot be assessed in itself, but rather how it is a contribution to a portfolio of assets determination of overall risk and return. It is further a proposition for pricing, and how rational value-maximizing investors should optimize their portfolio through diversification. Markowitz (1952, p. 77) argues that a large variance of the return is less desirable.

Modern Portfolio Theory, or so-called mean-variance analysis, assembles a portfolio for a given level of risk, such that one maximizes the expected return. In other words, the work founded the idea that holding various assets in a portfolio is less risky than just owning one asset; the importance of diversification is the key insight (Markowitz, 1952, p. 77). The financial theory assumes that given the same expected return of two portfolios of assets, the investor chooses the portfolio with less risk, in other words; the rational investor is risk averse. Thus, if the investor takes on more risk, one would want to be compensated through a higher expected return on the investment. This implies that if the investor wants higher return, the investor must also take higher risk. The fundamentals of Markowitz’s theory describe how the expected return is maximized for a given risk level and that the investor would choose the highest expected return given the lowest possible risk exposure. Markowitz (1952, pp. 80-81) uses the mean variance of the portfolio as the measurement of risk and argues that investment returns can be represented by normal distribution, which has faced critique today. Nevertheless, in the 1990s Markowitz received the Nobel prize in economy for his work and the modern portfolio theory and it has today become a crucial component in most management practices (The Nobel Prize, 2020).

Diversification is a form of risk management strategy to reduce risk in finance. Common practices of risk diversification refer to include various investments in a portfolio so that the assets correlation is not aligned. The purpose of the diversified portfolio is that negative performances in single stock will balance the positive performance of other single stocks in the portfolio, and thus strive to smooth out unsystematic risk. Portfolio diversification can be done through industries, asset classes, geographical areas etc. (Hull, 2015, p. 17). Private investors are often recommended to be diverse in their investment decisions though buying indices. Diversification or Hedging strategies, is two broad
procedures within Risk management. The well diversified portfolio across markets
provides protection against specific market volatility. Investments in a portfolio made in
the same industry is thus less diverse than investments in a portfolio from various
industries (Markowitz, 1952, p. 79). However, in the short run the diversification could
mitigate performance.

In order to research the Blockchain and its effect to volatility, two hypotheses have been
stated, one researching the total risk and one researching the systematic risk. One part of
the total risk can be diversified to reduce the unsystematic risk, but it also includes
systematic risk that cannot be diversified. It could therefore be of interest to know if a
potential risk change could be diversified.

3.12.2 Standard Deviation & Total Risk
Standard deviation is a statistical measurement used in finance as an indicator to historical
volatility in securities. Using historical volatility and standard deviation is the most
common measurement which shows a security’s past performance, although there are
various ways for calculating different forms of volatility (Hull, 2018, p. 213). By taking
the square root of a security’s variance, one calculates standard deviation. It is the
dispersion of a datasets return, relative to its mean, that is measured by the standard
deviation. It is usually a useful measurement when evaluating investments in the same
asset class. An investment with a large standard deviation is argued to have a high
volatility, and correspondingly the investment with a narrow standard deviation is argued
to have less of volatility. The standard deviation is often used as a total risk measurement,
including both systematic and unsystematic risk.

\[ s = \sqrt{\frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n - 1}} \]  

(3.1)

Where:
- \( s \) = Standard deviation
- \( x_i \) = The \( i \)th value of the observation
- \( \bar{x} \) = The mean value of daily returns
- \( n \) = Number of total observations

Thus, an investment’s inherent risk is compared to its expected return and shows historic
price swings. Hull (2018, p. 213) states that a variable’s volatility is defined as the
standard deviation of the return, expressed with continuous compounding. First, one
calculates the returns. Second, the variance for each observation is calculated by
subtracting the observation value from the mean and square the number, and then
summarize the results, and divide by the number of observations subtracting one. Third,
one calculated the square root and finds the standard deviation. The standard deviation
gives analysts a risk-assessment of more long-term and thus, all above mentioned,
indicates the total risk. The standard deviation is used in this research to satisfy the stated
research question through one of the soon to be stated hypothesis. Since Markowitz
(1952, p. 77) argues variance is less desirable, standard large deviation, and thus volatility
of total risk, would be less desirable to the risk averse value-maximizing investor.
3.12.3 Beta & Systematic Risk

Total risk includes both unsystematic and systematic risk. The unsystematic risk refers to risks that are typical for a specific company or industry. It is risks that are possible to reduce through risk management strategies such as diversification. The systematic risk is a risk that is inherent in the market, also referred to as market risk as stated before. These are risks that influence most enterprises and the overall market, no matter the industry.

Systematic risks include interest risk, political risks, epidemics or natural disasters, and major changes, for example The Great Recession. Systematic risk can be measured with Beta ($\beta$); which measures the sensitivity of an investment to the market return. Beta is thus measured against a capitalization weighted market. The Beta of an investment is calculated by dividing the covariance between the market return and the stock return with the variance of the market. Beta is a part of the Capital Asset Pricing Model (CAPM), soon to be described, that is used to measure an asset expected return (Amihud & Mendelson, 1989, p. 479).

The covariance measures how securities move together, while the variance refers to how securities moves relative to the calculated mean. If we calculate historical Betas for stock returns, and the Beta ($\beta$) is equal to 1, the market return is correlated with the stock return. If Beta is above 1, the volatility of stock return is greater than the market volatility, and if less than 1, the volatility of stock return is less than the market volatility.

$$
\beta = \left( \frac{Cov(ri, rm)}{Var(rm)} \right) \tag{3.2}
$$

Where:

$\beta$ = Beta (Systematic Risk)

Cov = Covariance

$ri$ = Stock Return of Investment

$rm$ = Stock Return of the Market

Var = Variance

Systematic risk is something that investors take into consideration and something that they want to be compensated for, in the form of a required expected return (Hull 2018, p. 9). The systematic risk, historical Betas for stock return, and the standard deviation for total risk, is used in this research to satisfy the stated research question through hypothesis. If a relationship is found between volatility of stock return and the introduction of Blockchain technology, it could be interesting to know if it is subject to diversification and could provide incentives for investment strategies. Therefore, both systematic- and total risk of stock return are researched.

3.12.4 Capital Asset Pricing Model (CAPM)

Sharpe (1964), developed the Markowitz theorem upon risk-return and diversification through a simplified and extended model called the Capital Asset Pricing Model (CAPM). This model describes the relationship between expected return and systematic risk, particular for stocks. One can use this model to calculate the expected return as:
\[ E(r_i) = r_f + \beta_i[E(r_m) - r_f] \]  

Where:

\( E(r_i) \) = Expected return for investment i  
\( r_f \) = Risk-free rate  
\( \beta_i \) = Beta for investment i  
\( E(r_m) \) = The market's expected return

If \( \beta = 0 \) then the expected return is equal to the risk-free rate (\( R_f \)) and there is no systematic risk. If \( \beta = 1 \) then the expected return is equal to \( E(R_M) \) and the systematic risk is the same as the market portfolio \( (M) \) (Hull, 2018, p. 9). The CAPM model explores which part of the total risk of an asset that cannot be diversified, and a risk premium will be added by the market. All these theories, Markowitz, Modern portfolio theory and the CAPM model are also based upon some assumptions. First, there are endless lending opportunities and that risk-free interest rates exist. One separates between the financial market and the production sector. The capital market is assumed perfect, according to Modigliani & Miller (1958), meaning that no transaction costs exist, nor taxes and no arbitrage opportunities. Hence, the market is efficient. Investors are risk averse, rational value maximizing and the returns can be normally distributed. However, the perfect capital market is perhaps only existing in theory which implies that the CAPM model has some flaws. Although, the model is widely used throughout finance as a pricing model for risky assets and generating expected return. The purpose of CAPM is to compare a stock’s expected return to whether the stock is fairly valued with regard to its time-value of money and risk level.

### 3.12.5 Volatility

Volatility defined as price movements with regard to a standard deviation can either be calculated or estimated. One typically separates between conditional volatility with regard to time series, and the unconditional volatility who does not take yesterday’s volatility in consideration. Further, volatility can, according to Hull (2018, p. 213), be defined as the standard deviation (\( \sigma \)) of stocks or variables return, if compounding return is used.

Based on the fundamental assumptions by Markowitz, the rational investor would prefer the security with less volatility given the same expected return, compared to a riskier security. Hull (2018, p. 216) states that people may believe that new information entering the market often leads to changes in stock prices and thereby also volatility. However, this is not true according to what researchers have found. In a study made by Roll (1984, cited in Hull, 2018, p. 216) nothing indicated that important news regarding the weather, affected the price of the orange juice futures, in a further extent than normally. Hull (2018, p. 216) draws the conclusion that it is not new information that causes volatility, it is rather the trading itself. Volatility can be classified into historical volatility, implied volatility and asymmetric volatility.

### 3.12.6 Historical Volatility & Implied Volatility

Historical volatility is used in most risk strategies to give risk evaluations for the present, and risk estimations for the future. Preferably, the stock returns historic volatility is somewhat in line with the market. If the volatility of the stock return is greater than the market, one faces higher risks to lose, but also larger possibilities for abnormal capital gains. If the volatility is less than the market volatility, one risk to miss out on returns. In contrast, the implied volatility is the forecast of a security’s price movement. This metric
looks to the future and is commonly used by option traders to calculate probabilities (Hull, 2018, p. 215). According to Hull (2018, p. 215) the implied volatility gives the price of the option when it is included in the Black-Scholes-Merton Model. The implied volatility is not observable in the model because it constitutes the price of the underlying asset. However, since this research is delimited to price movements within stocks, implied volatility will not be further developed.

3.12.7 Asymmetric Volatility
Asymmetric volatility refers to volatility of a given security in comparison to market volatility. The theory states that if the market is declining, then the given security tends to be more volatile than it would be if the market would be still or rising. Volatility increases and reacts more to the trading of bad information than to trading of good information. As human investment decision affects the stock prices, this might not be surprising as most people persist negativity bias (Bratslavsky et al., 2001, p. 362). The asymmetric volatility phenomenon describes that in a declining equity market, the tendency of market volatility is higher than in a growing market (Knight & Satchell. 2017, p. 52).

This research has a time frame from 2010, which is a period after the financial crisis until the end of 2019, before the financial consequences of the Covid-19 Pandemic hit the Swedish economy. This period is characterised by long-term growth, whereas the OMX30 Stockholm had a growth rate of 49.72 % and OMXSPI a growth rate of 80.77 % for a 10-year time period (Thomson Reuters Eikon, 2020). This implies that the volatility measured though price movements within this period of time can be somewhat skewed compared to if the same research would be conducted in a time period with stagnancy, or in a declining market context due to the phenomenon of information asymmetry.

3.13 Summary of Theoretical Framework
The theoretical framework began with an explanation of Blockchain technology and its applications in various areas. Thereafter, the framework described different financial theories and risks associated with Blockchain. Lastly, the framework described volatility of stock returns, measured through Standard deviation (Total risk) and Beta (Systematic risk) but also some other ways to interpret the concept volatility. Figure 5 visualizes the theoretical framework in order to provide a brief overview of the different parts.
3.13 Research Proposition & Hypothesis

From previous research, the theoretical framework and the attributes of Blockchain, the research proposition of this thesis follows in line with a theory testing approach. Previous studies have shown that using Blockchain technology increases transparency, security, auditability and decreases conflicts of interest. The Blockchain technology could be considered a disruptive technology and should have an impact on stock price behaviours. Since previous studies have highlighted huge investments incentives by various industries, the interest for Blockchain is expected to continuously grow. Companies using Blockchain technology could be argued to be more sustainable in a long-term perspective, and previous research has shown that being sustainable could decrease risk and increase financial performance. Previous research has also argued for the need of future research which explores the effects of Blockchain technology to volatility, and for the importance of understanding Blockchain technology’s implication for organizational structures and individual businesses. If companies face less risk in their activities, the volatility of their stock return should be impacted.

To the authors best of knowledge, no previous research has explored this research proposition in a Swedish context, and this report aim to bridge this gap. This leads to the following two stated hypotheses:

**Hypothesis 1**

\[ H_0: \text{There is no relationship between Blockchain technology and the Systematic risk} \]

\[ H_a: \text{There is a relationship between Blockchain technology and the Systematic risk} \]

**Hypothesis 2**

\[ H_0: \text{There is no relationship between Blockchain technology and the Total risk} \]

\[ H_a: \text{There is a relationship between Blockchain technology and the Total risk} \]
4. Practical Method

This fourth chapter will present the practical methodology. It will also explain the statistical procedures such as test-method and chosen variables. The purpose with this chapter is to give a background to how the research will be conducted.

4.1. Data Collection & Sample Size

The purpose with this study is to research if the introduction of Blockchain technology in Swedish listed companies impacts volatility. All Swedish listed companies will therefore be the study's population. The OMX Stockholm PI is an index which includes all companies on the Swedish stock market. The procedure for collecting information regarding the use of Blockchain was done manually as no common database includes information about Blockchain technology, and there are no requirements for companies to include Blockchain information in their annual reports. In order to gather this information, different websites were used to gather information whether these companies use Blockchain technologies or not, and when this technology was first introduced within the companies. The words that were used to search for information on the web were the company’s name and Blockchain technology, for example, SEB and Blockchain technology. The exact introduction date was very difficult to find because no webpage gave that exact information, therefore the Blockchain introduction has been collected on a yearly basis. This has further consequence throughout this thesis as all variables have been used in regressions on a yearly basis to be consistent with the Blockchain data. As Blockchain technology is a relatively new concept, few companies have implemented the technology in their operations. First, companies in the Stockholm OMX 30 was researched if they used Blockchain technology or not, and then the OMX Stockholm PI. Companies have been researched manually though this “keywords” strategy and sorted by volume from largest market cap to smallest. It was possible to identify 20 companies in total due to the limited disclosure of information, see Appendix 1 The dataset resulted in 88 observations in total. As the volume of the companies decreased, so did the usage of Blockchain observations in the companies. This results in a quite limited sample size. Given that this sample should represent the population and a single country, Sweden, the sample size is argued to be large enough.

Arithmetic Returns Daily

\[ R_t = \left( \frac{P_t - P_{t-1}}{P_{t-1}} \right) \]  

Where:

- \( R_t \) = Daily Stock Return
- \( P_t \) = Today’s Closing Price
- \( P_{t-1} \) = Yesterday’s Closing Price

Daily prices have, for the chosen companies, been downloaded from Eikon, Thomson Reuters, due to a ten-year period from 2010 - 2019, and the closing prices have been used to calculate the arithmetic daily returns. Hull (2018, p. 214) states that using the arithmetic return is almost exactly the same as the returns calculated with logged daily prices. Using the proportional change in a variable during a day, calculated with standard deviation is, according to Hull (2018, p. 214), the most usually used calculations of volatility in risk
management. Given the closing price, the dividend accumulation effect should be included in the return and cause a drop in the closing price, the day the dividend is paid. Thus, the effect on a particular day of the dividend payment is ignored, as it compensates all other daily return.

**Standard Deviation Daily**

\[ s = \sqrt{\frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1}} \]  

(4.2)

Where:

- \( s \) = Standard deviation
- \( x_i \) = The \( i \)th value of the observation
- \( \bar{x} \) = The mean value of daily returns
- \( n \) = Number of total observations.

The daily standard deviation has been calculated through Microsoft Excel using the stated formula for a sample using the historical daily returns for the companies.

**Daily Stock Return Variance**

\[ s^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1} \]  

(4.3)

Where:

- \( s^2 \) = Variance
- \( x_i \) = The \( i \)th value of the observation
- \( \bar{x} \) = The mean value of daily returns
- \( n \) = Number of total observations

Daily returns have been used to calculate the daily variance. All calculations in this method have been made through Microsoft Excel. The daily variance has been used to calculate the annual variance using 252 business days as suggested by Hull (2018, p. 215). The process of finding the annual standard deviation is stated below.

**Annual Variance**

\[ \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n - 1} \times 252 = \text{Annual Variance} \]  

(4.4)

**Annual Standard Deviation**

\[ \text{Annual Standard Deviation} = \sqrt{\text{Annual Variance}} \]  

(4.5)

Historical Betas have been downloaded through a time-series request in Eikon, Thomson Reuters, on a yearly basis for all companies. In addition, two Betas were missing, and to minimize the effect we decided to set them to 1. Market capitalization has also been downloaded, as well as the Return on Asset in Eikon, Thomson Reuters. All companies did not report their figures in the income statements and the balance sheets in Swedish
SEK, but also in US dollars and Euro. Historical exchange rates have been gathered through Forex Bank, and the figures in US and Euro have been recalculated with the exchange rate annually for each year at the 31th of December, which is the same date of the reported figures in Eikon. Research and development expenditures have primarily been gathered through the income statement in Eikon, Thomson Reuters, but also though Refinitiv and companies’ annual reports. When this information was gathered a binary dummy variable was made, representing the years before (0) and after the introduction of Blockchain technology (1). In order to view a potential significant impact of the Blockchain introduction on systematic risk and total risk, the same amount of time before as after has been researched. This has limited our observations further as most companies using Blockchain technology has implemented it during the latest part of the 2000s. For example, Investor AB, a Swedish investment company introduced their Blockchain in 2015. For fair distribution, data has been collected from 2010, five years before, until the end 2019, five years after. The year that the Blockchain technology is introduced is coded as a (1). This dummy variable was made in the data program STATA.

4.2 Time Perspective
The time frame that this study will investigate is the period between 2010 and 2019. This period has been selected in order to analyze the volatility before and after the introduction of Blockchain. According to the chosen sample, Blockchain technology was first introduced in 2015 and in order to make a comparison before and after introduction we chose to have the same number of years before, as after, the year of introduction. This will therefore be a longitudinal study, as Saunders et al. (2009, p. 155) describe is a study that can be used to investigate a longer period of time. If only a certain time would have been studied, it would instead be called a cross-sectional study (Saunders et al., 2009, p. 155).

4.3 Sources of Research Errors
Biases and errors can occur in all research and needs to be taken into consideration as it can affect the study's results and credibility. The probability of error increases in qualitative surveys because such studies are based on the fact that individuals are being honest and answers truthfully and to all questions (Byström & Byström, pp. 358-359). In this study, no survey will be performed but some errors can occur during the data gathering of variables, based on the absence of observations in Eikon, Thomson Reuters. Some errors can also occur during the manual research collection of whether companies in OMX Stockholm PI used Blockchain technology, due to the lack of information reported by the companies. This may result in the exclusion of certain companies that use Blockchain technology, if they have not clearly informed the stakeholders about the usage of this technology.

In quantitative research with hypothesis testing, errors can occur in the interpretation of the result and taking the wrong decision in the hypothesis rejection/acceptance referred to type I and II errors. Type I occurs if the researcher accepts the alternative hypothesis and rejects a true null hypothesis and type II occur if the researcher rejects the alternative hypotheses and accepts a false null hypothesis (Moore et al., 2011, p. 382). As these errors are related to one another, the decrease of one will increase the other. In order to avoid these errors, the regression results will be interpreted carefully with caution.

Coverage errors refers to that the frame and target population does not correspond. In this study, the population is all companies in the Stockholm OMX PI. However, due to manual
research method for the Blockchain technology entering several annual reports for each year. Most companies have been researched, but not all of them due to time limitation of this research. By sorting on volume and adding the R&D expenditures to the equation the authors hoped to have captured the companies using Blockchain technology. However, it is still possible that there are companies using Blockchain technology that is not included in the sample, referring to potential under coverage. This is an incentive for development and for future research.

In a few companies, some of the chosen variables were missing. This can make the data skewed and cause an incorrect result. To avoid a distorted selection, the data was checked. This was done by analyzing, heteroskedasticity, descriptive statistics, scatterplots and correlation. These tests are described more in-depth in chapter 5. Given that this dataset has been gathered manually, and all sources researched thoroughly, it is argued that this dataset has a high credibility.

4.4 Variables
In chapter 3, two hypotheses were stated and to investigate these hypotheses, two regression models needs to be performed. To investigate the first hypothesis, we need a dependent variable that will represent the systematic risk and the variable that will represent this will be Beta. The dependent variable in the first regression model will therefore be Beta. To investigate the second hypothesis, we need a dependent variable that represent the total risk and we will therefore use the standard deviation as the dependent variable in the second regression model. To investigate if the risk is reduced after introduction of Blockchain technology, a dummy variable will be created, and this will represent the independent variable in both hypotheses. Some control variables will also be included in the two regression models and these are; Market Capitalization, Branch, R&D expenses and Return on Assets (ROA). These different variables were chosen because previous studies have shown that these are variables that have an impact on volatility. More information regarding each variable will be discussed during the following sections where the dependent variable will be presented first and then followed by the independent variables and control variables.

4.4.1 Dependent Variables
A dependent variable is a variable that is affected by different independent variables (Collis & Hussey, 2014, p. 204). The aim with this study is to investigate if Blockchain technology will have an impact on the volatility and the dependent variable will therefore be volatility. To investigate volatility two multiple linear regressions will be performed and there are also two hypotheses that will be tested. The first hypothesis will test if Blockchain technology has an impact on systematic risk and in this regression the dependent variable will be the historical Beta. These Betas were collected from Eikon, Thomson Reuters, but two Betas were missing. Beta can be calculated on many different ways and in this study the missing Betas were therefore set to 1. If Beta is equal to 1 then the stock moves in line with the market and the risk is thereby naturalized. The Beta was logged in this study since the Beta variable was not normally distributed. To deal with this issue, the variable can be logged to make the variable more systematically distributed and to be able to use the variable in the regression, and to fulfill the assumption of normal distribution.

The second hypothesis will test if Blockchain technology have an impact on the total risk and in this regression the dependent variable will be the standard deviation. The standard
deviation can be used to measure the risk and volatility because it is a calculation of how the prices differ from the average prices. A very volatile stock has a very high standard deviation and the opposite applies for stocks with low volatility. The standard deviation has been calculated on a yearly basis.

4.4.2 Independent Variable, Dummy
An independent variable is a variable that affects the values of a dependent variable (Collis & Hussey, 2014, p. 204). In this study one independent variable will be included to investigate whether the dependent variable will be affected. The independent variable that will be included in the two multiple linear regressions is a dummy variable that represents the years after introduction of Blockchain technology. A dummy variable is a variable that can either take the value 0 or 1, depending on what it should investigate. In this case the years after the introduction of Blockchain technology will take the value 1 and the years before introduction will take the value of 0. This dummy variable can thereafter be used in a regression to investigate whether it exist a statistically significant relationship between the introduction of Blockchain technology and the volatility. To check for further variables that could impact the volatility some control variables were included in the regressions. These variables will be presented in the following sections.

4.4.3 Control Variables
Control variables are variables that control the effect of other variables that may affect the dependent variable. In this study four control variables have been included and these are Market Capitalization, ROA, Branch and R&D expenditures. These control variables have been included because they are variables that are trusted/known to influence the dependent variable.

4.4.3.1 Market Capitalization
To measure size, the market capitalization has been collected from each company. The market capitalization could be found in Eikon, Thomson Reuters, and it was calculated as number of common shares multiplied by the price in the end of the year. The market capitalization was collected form Eikon and the companies had different currencies, such as, MUSD, MEUR and MSEK. In this study, MSEK was chosen as the currency and the currencies USD and EUR were therefore converted into SEK.

4.4.3.2 Return on Assets (ROA)
According to Nilsson et al. (2013, p. 138) profitability can be measured in many different ways and one way is to divide the profit with the losses. In this study, ROA will be used as a measure of a company's profitability. ROA was collected from Eikon, Thomson Reuters, and according to the database it was calculated as the income after taxes divided by average total assets. Companies want a high ROA but to generate it, companies have to be competitive (Brealey et al., 2017, p. 744). This measure is included in the regression to see if a higher or lower profit affect the volatility.

4.4.3.3 Branch
Branch is another control variable that will be included in the regression to see if it affects the dependent variable. The data includes companies from six different industries named: Industry, Finance, Technology, Raw materials, Consumer-cyclical and Communication. It is important to control for this variable because different industries might have more or less impact on the volatility. To be able to measure this, a dummy variable was made for each branch.
4.4.3.4. R&D Expenditures

Research and Development (R&D) expenses is argued to capture the investment incentives for implementing developments among Blockchain technology, thus this variable might affect the volatility of the stock. This variable was therefore included in the regression and it has been retrieved for most companies from the Income statement in Eikon, Thomson Reuters. The income statement typically records two R&D figures, the Research & Development Expense, and the Supplemental Research & Development Expense. Both of these figures have been checked, and in the majority of companies these correspond to one another but in some cases, there were only an expense for the Supplemental Research & Development figure. Due to consistency matters, the number from the Supplemental Research & Development expense was recorded in all companies. The Supplemental Research & Development Expense represents all expenses that companies spend on R&D of new services and products to remain a competitive advantage on the market. It is also specified that the R&D Supplemental includes the “...Software development costs for software and programming companies...” which is argued to be as close to an official recording of at least some proportion of the investments in Blockchain technology as we can get (Eikon Thomson Reuters, 2020).

For the companies that are recognized to use Blockchain but lacks information of the R&D expenses in the income statement in Eikon Thomson Reuters, the database Retriever was used to research annual reports. However, not all of them has reported R&D expenses. This control variable is believed to be a good predictor and therefore important to include and find the data. Because of lacking numbers, the authors have made a proxy for the expenditures in order to gather the data, where figures for: “Capitalized development expenditures and software”, “Direct research and development expenses”, “Capitalized expenses for development”, “Capitalized expenditure for computer software”, and “Costs for development” has been included in the R&D proxy. Mixing numbers for the R&D expenses from the income statement through Eikon Thomson Reuters, with figures from the annual reports could create bias in the variable, however this is believed to be a necessary adjustment. Although the figures from the capitalized expenses for software and development might capture the incentive for the Blockchain development better, these will likely tend to be smaller as they exclude figures that otherwise would be included in the whole R&D expense.

4.5. Multiple Linear Regression

To test if volatility is impacted after introduction of Blockchain technology a Multiple Linear Regression will be used. A regression can be used to test if there is a relationship between two or more variables (Moore et al., 2011, p. 573). In this study, more than one independent variable will be included, and a multiple regression can therefore be used. According to Collis & Hussey (2014, p. 283), a regression analysis can also be performed when independent variables are quantitative. As mentioned in the previous sections, the independent variables that will be used are dummy variables representing the year before and after introduction of Blockchain technology. Control variables will also be included as explanatory variables to see if they affect the dependent variable and those are, Market capitalization, Branch, R&D expenses and ROA. To investigate if the independent variables and control variables affect the dependent variable volatility, the following regression model, retrieved from Moore et al. (2011, p. 591) will be used:
\[ Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_n x_n + \epsilon_i \]  
(4.6)

for \( i = 1, 2, \ldots, n \).

**Where:**
- \( Y_i \): Dependent variable
- \( \beta_0 \): Intercept
- \( \beta_1, \beta_2, \beta_3 \): Coefficients
- \( x_1, x_2, x_n \): Explanatory Variables
- \( \epsilon_i \): Error term

The Error term is independent and normally distributed with mean 0 and standard deviation (\( \sigma \)) (Moore et al., 2011, p. 591).

This aim with this study is to investigate two hypotheses and therefore two regression models need to be performed. Regression 1 will be used to answer the first hypothesis regarding if introduction of Blockchain technology will impact the systematic risk. Regression 2 will be used to answer the second hypothesis regarding if Blockchain technology will impact the total risk. The two regressions are stated and defined in the following sections.

### 4.5.1. Regression 1 for Systematic Risk

\[ Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \epsilon_i \]  
(4.7)

**Where:**
- \( Y_i \): Historical Beta
- \( \beta_0 \): Intercept
- \( x_1 \): Dummy_Blockchain
- \( x_2 \): Market Capitalization
- \( x_3 \): R&D expenses
- \( x_4 \): ROA
- \( x_5 \): Branch
- \( \epsilon_i \): Error term

### 4.5.2. Regression 2 for Total Risk

\[ Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \epsilon_i \]  
(4.8)

**Where:**
- \( Y_i \): Standard deviation
- \( \beta_0 \): Intercept
- \( x_1 \): Dummy_Blockchain
- \( x_2 \): Market Capitalization
- \( x_3 \): R&D expenses
- \( x_4 \): ROA
- \( x_5 \): Branch
- \( \epsilon_i \): Error term
4.6. Method Criticism
Chapter 4 will end with some method criticism that we, to some extent, have already touched upon. First, in order to ensure no under coverage in the population the purpose was to research all companies in the Stockholm OMX PI. Although, due to the time frame of this research, and the manual “keywords” strategy for the data gathering, entering and researching all annual reports of all companies from 2010-2019, was not possible.

When collecting the Blockchain information, some companies have just disclosed one or a few sentences in their annual reports about using the technology. Often stating that they are using and seeking to develop their AI, Blockchain, Big Data, Machine learning processes etc. This creates further uncertainty to which degree the companies have implemented the Blockchain technology as it is not elaborated upon further in annual reports. Of course, some companies, for example Volvo, SEB and ABB have more descriptive elaborations on how the technology is used but far from all of the companies. More information should have been disclosed to stakeholders in order to evaluate to what degree the technology is incorporated and for what purposes. In order to explore this uncertainty, one could have mixed a quantitative research with qualitative interviews which could be a suggestion for future research if one wishes to repeat this study. Since this research method just uses a binary variable for the Blockchain technology, it is believed that even if the companies have disclosed the usage of Blockchain, even if just in a few sentences, it is regarded as enough.

A further criticism is the usage of secondary data. Saunders et al. (2016, p. 332) argue that secondary data may be costly, unsuitable and collected for a purpose that does not match the research purpose. Indeed, as the Eikon, Thomson Reuters, has a license paid by Umeå University, it would create difficulties replicating this study without the access to the numbers in Eikon, Thomson Reuters. One can simply not control the authenticness and process of the data collection by the database. This critique is impossible to avoid and conducting this research without secondary data, in this time frame would be impossible. However, Grönhaug et al. (2010, p. 94) argue for several advantages with collecting secondary data, as it allows the researcher to evaluate the reliability of others’ work, take moral responsibility and using secondary data provides a broad base for conclusions to be drawn. Further, secondary sources allow global research and material developed by experts. Secondary sources also enhance a rapid data collection process as the data only needs to be located, verified and utilized. Considering the drawbacks and the advantages with secondary data, all sources have been carefully evaluated and deemed trustworthy.

As a proxy used for the R&D expenditures, this variable will face some inconsistency in its data collection. This is further a critique for the practical methodology. The risk for human errors is also consistent throughout this research process, referring to human mistakes in measurements and calculations. This risk has been coped with through carefully double checking all calculations by both authors. Further, there could be other variables better suited as control variables, for example growth, since stock volatility can significantly change from year to year depending on the company’s growth level.

The time perspective of this research begins in 2010, a time in the aftermath of the financial crisis in 2008. Due to the general growth in the Swedish market during this time period, the general volatility could be lower as implied by the concept of asymmetric volatility (Knight & Satchell, 2017, p. 52). The market condition should be taken into
consideration when evaluating the findings, and the results. Thus, if the study would be replicated in a different time period, it is no guarantee that the results would be the same under different market conditions. This could have influenced in the financial performance and volatility of the companies in the Swedish market. However, no conclusions of the full effect can be drawn but it is regarded as worthy to mention.

Lastly, we would like to highlight a potential currency issue of this research. Figures for the market capitalization and the R&D expense was gathered from Eikon annually, reporting date the 31th of December. Figures are reported in different currencies, SEK, US-dollar and Euro. In order to conduct the study in the same currency, the numbers were recalculated to SEK using the exchange rate the 31th of December since the figures were reported then. However, it could be the case that converting the currency on one specific day does not capture the real values, as these could be calculated several days before the release of the annual reports. The historical exchange rate for each day when these numbers are reported is impossible to know. It is believed that using the historical exchange rate the 31th of December is the most accurate day to re-calculate. However, this creates potential inaccuracy in the reflection of Swedish converted numbers which implies that one can question the validity of the numbers. Another thing that can be criticized is that the inflation rate has not been taken into consideration.
5. Results

This fifth chapter will analyse the results. The chapter begins with descriptive statistics and thereafter the results from the multiple linear regressions and the panel data regressions will be presented. The chapter ends with an analysis of the results from the t-tests.

5.1 Descriptive Statistics

Descriptive statistics is used in order to observe different groups and phenomena in data. This is done by, for example, studying the spread, mean and standard deviation between different variables (Byström & Byström, 2011, p. 66). Data needs to be normally distributed, as in statistic inference, it is often a requirement for credible results, and to be able to conduct regressions with the underlying fundamental assumption of normal distributed data. Thus, the process began with an analysis of the data by using descriptive statistics, skewness and kurtosis tests for normality, scatter plots and a correlation matrix. The findings of the raw data analysis showed some problems with normal distribution due to skewness and kurtosis in the data set, mainly for the continuous variables Market Capitalization and Beta, see Appendix 2. This is not entirely unexpected due to the narrow data set. Doornik-Hansen tests were also performed to check for univariate and multivariate normality, see Appendix 3. In order to deal with skewness and kurtosis, the natural logarithmic value of these variables was calculated. The logarithmic value transformation is a widely used method in statistics for dealing with skewness (Robbins, 2012). This solved the problem of non-normal distribution. Both tests, skewness and kurtosis tests for normality, and Doornik-Hansen, implied that the logged variables reduced skewness and kurtosis in the dataset. Thus, the logarithmic values were kept throughout the practical method. In the descriptive statistics, see Table 1, one can observe that the standard deviation in general is quite low and the mean for the R&Dln and MarketCapln is rather high. The minimum value for the R&D expenditure is due to an outlier, which could be eliminated, but it is argued to be crucial for the study as the number of companies needs to be the same after as before Blockchain introduction.

Table 1. Descriptive Statistics for Continuous Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Observations</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>BetaLn</td>
<td>88</td>
<td>-0.111</td>
<td>0.480</td>
<td>-1.897</td>
<td>0.673</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>88</td>
<td>0.305</td>
<td>0.167</td>
<td>0.131</td>
<td>1.150</td>
</tr>
<tr>
<td>R&amp;Dln</td>
<td>88</td>
<td>19.688</td>
<td>2.978</td>
<td>0.000</td>
<td>24.692</td>
</tr>
<tr>
<td>MarketCapln</td>
<td>88</td>
<td>24.720</td>
<td>1.838</td>
<td>18.776</td>
<td>27.052</td>
</tr>
<tr>
<td>ROA</td>
<td>88</td>
<td>0.063</td>
<td>0.132</td>
<td>-0.381</td>
<td>0.752</td>
</tr>
</tbody>
</table>

Then a frequency table where performed to analyse the independent variable, which is the Dummy_Blockchain. The table showed, not surprisingly, a distribution of 44 companies before respectively after the introduction of the Blockchain technology, see Table 2.
Table 2. Frequency Table of Dummy_Blockchain

<table>
<thead>
<tr>
<th>Dummy_Blockchain</th>
<th>Freq.</th>
<th>Percent</th>
<th>Cum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>44</td>
<td>50,00</td>
<td>50,00</td>
</tr>
<tr>
<td>1</td>
<td>44</td>
<td>50,00</td>
<td>100,00</td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
<td>100,00</td>
<td></td>
</tr>
</tbody>
</table>

A frequency table was also performed to analyse the dummy variable Branch. Branch is represented by a dummy variable including 6 different branches. Table 3 below, shows how many observations that belong to respective branch. These refers to the coding of: Industry 1=Communication, 2=Finance, 3= Industry, 4=Consumer-cyclical, 5=Raw materials and 6 =Technology. As stated in the table, the collected data includes 10 observations from the branch communication, 24 observation within the branch finance, 16 within industry, 6 within consumer-cyclical, 12 within Raw materials and 20 observation within technology. Thus, our research method is limited to these branches.

Table 3. Frequency Table of Branch

<table>
<thead>
<tr>
<th>Branch</th>
<th>Freq.</th>
<th>Percent</th>
<th>Cum.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>11,36</td>
<td>11,36</td>
</tr>
<tr>
<td>2</td>
<td>24</td>
<td>27,27</td>
<td>38,64</td>
</tr>
<tr>
<td>3</td>
<td>16</td>
<td>18,18</td>
<td>56,82</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>6,82</td>
<td>63,64</td>
</tr>
<tr>
<td>5</td>
<td>12</td>
<td>13,64</td>
<td>77,27</td>
</tr>
<tr>
<td>6</td>
<td>20</td>
<td>22,73</td>
<td>100,00</td>
</tr>
<tr>
<td>Total</td>
<td>88</td>
<td>100,00</td>
<td></td>
</tr>
</tbody>
</table>

5.1.1 Plot Residuals Fitted
A scatterplot can plot the residuals on the vertical line against the independent variables on the horizontal line. If the plots are randomly spread around the x-axis, y=0 then a linear regression can be used. If a pattern can be found in the plots, such as in the form of a U, then a linear regression would not be the best model to use. The scatter plots made describes how the data tends to be more normally distributed after the natural logarithm was used. However, one could still question the normality distribution, see Appendix 4 for plots. In order to research it further, the average mean of the residuals was calculated through a frequency table. This shows that the average mean is -2.24e-09, which is very close to zero. Given this, the assumptions for a regression is argued to be fulfilled.

5.1.2 Multicollinearity
A multiple logistic regression contains more than one independent variable and if these correlate with each other, multicollinearity can occur. This may affect the result of the regression negatively because the results may be inaccurate (Moore et al., 2011, p. 610). Multicollinearity can be difficult to detect if many explanatory variables are included in the regression. In this study, one independent variable and 9 control variables will be included in the model and it is therefore important to test for multicollinearity. According to Moore et al. (2011, p. 610), many statistical programs calculate something called the
Variance Inflation Factor (VIF). If VIF is greater than 10 then it is most likely that multicollinearity exists between the explanatory variables. Multicollinearity also exists if the correlation between two independent variables are higher than 0.8 (Studenmund, 2014, p. 272). The VIF-test, see Appendix 5, gives a value below 10 which indicates that it does not exist any multicollinearity between the different control variables and the independent variable.

5.1.3 Correlation
Correlation is about examining whether there is a strong or weak relationship between the different selected variables (Byström & Byström, 2013, p. 222). It measures the strength and direction of two quantitative variables in a linear relationship (Moore et al., 2011, p. 93). The correlation can only take on a value between -1 and 1 and if the correlation is 0, there is almost no linear relationship (Moore et al., 2011, p. 95). If the correlation is -1 or 1, the linear relationship is very high and the different dots in a scatterplot lies along a straight line. If the correlation is -1 it indicates a strong negative linear relationship between two quantitative variables and if it is +1 then it is a strong positive linear relationship. In Table 4, the correlation between the dependent variable, independent and the control variables are stated. A correlation matrix was made including all the variables in order to ensure that the correlations of the control variables were low. The results of this matrix show values around 0 which means that there is almost no correlation between the variables. Some values are positively correlated such as the coefficient for standard deviation and MarketCapIn and others are negatively correlated such as the coefficient for Betaln and Dummy_Blockchain. To conclude, there is almost no correlation between the variables which means that there is almost no linear relationship between the dependent variable, independent variable and control variables.

Table 4. *Correlation Matrix for All Variables*

<table>
<thead>
<tr>
<th></th>
<th>Standard deviation</th>
<th>Dummy_Betarn</th>
<th>Blockchain</th>
<th>Company</th>
<th>R&amp;Dln</th>
<th>MarketCapIn</th>
<th>ROA</th>
<th>Year1</th>
<th>Industry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Betarn</td>
<td>1</td>
<td>-0.386</td>
<td>-0.008</td>
<td>-0.271</td>
<td>0.126</td>
<td>0.372</td>
<td>-0.051</td>
<td>0.026</td>
<td>-0.026</td>
</tr>
<tr>
<td>Standard deviation</td>
<td>0.008</td>
<td>1</td>
<td>0.197</td>
<td>0.000</td>
<td>0.011</td>
<td>0.006</td>
<td>0.232</td>
<td>0.000</td>
<td>0.408</td>
</tr>
<tr>
<td>Dummy_Betarn</td>
<td>-0.386</td>
<td>-0.008</td>
<td>0.000</td>
<td>0.000</td>
<td>0.043</td>
<td>0.026</td>
<td>-0.051</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Company</td>
<td>-0.271</td>
<td>0.197</td>
<td>0.000</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>-0.172</td>
<td>0.020</td>
<td>0.000</td>
</tr>
<tr>
<td>R&amp;Dln</td>
<td>0.126</td>
<td>0.197</td>
<td>0.111</td>
<td>-0.351</td>
<td>1</td>
<td>1</td>
<td>-0.044</td>
<td>0.004</td>
<td>0.000</td>
</tr>
<tr>
<td>MarketCapIn</td>
<td>0.372</td>
<td>0.000</td>
<td>0.006</td>
<td>-0.589</td>
<td>0.424</td>
<td>1</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>ROA</td>
<td>-0.051</td>
<td>0.232</td>
<td>-0.195</td>
<td>0.060</td>
<td>-0.049</td>
<td>-0.044</td>
<td>1</td>
<td>0.020</td>
<td>0.000</td>
</tr>
<tr>
<td>Year1</td>
<td>0.026</td>
<td>-0.027</td>
<td>0.809</td>
<td>0.000</td>
<td>0.043</td>
<td>0.026</td>
<td>0.078</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>Industry</td>
<td>-0.026</td>
<td>0.408</td>
<td>0.000</td>
<td>0.261</td>
<td>0.088</td>
<td>-0.172</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
</tbody>
</table>

5.2 Level of Significance
In order to know when the null hypothesis can be rejected a level of significance need to be stated. In this study a level of significance has been set to 5 percent which means that if the P-value is less than this then the null hypotheses can be rejected. A P-value is the probability of getting the same value of the test statistic as the one that was actually observable (Moore et al., 2011, p. 356). The smaller the P-value is the stronger the odds are against the null hypothesis.
According to Collis & Hussey (2014, p. 255) a significant level of 5 percent is common when it comes to research in business and management but when it comes to research in health and safety it is usually preferred to have a lower significance level. This is because the significance level states how much of type 1 and type 2 errors that is accepted (Collis & Hussey, 2014, p. 255).

5.3 Test of Heteroskedasticity
Heteroskedasticity is a test to see whether there is an unevenly distributed spread between different variables in the data sample. In a linear regression, the data is assumed to be homoscedastic, which means that the dependent and independent variables have the same distribution and variance (Djupsjöbacka, 2017). Heteroskedasticity can occur if the sample includes observations with very large differences between the highest and lowest variable value. In other words, if the residuals of a regression do not have a constant variance, one can claim Heteroscedasticity. The chance of heteroskedasticity increases in time series because the variable values can change much between, for example, different years. A Breusch-pagan test can be used to investigate if heteroskedasticity exist in the data (Djupsjöbacka, 2017). In this thesis, two Breusch-pagan tests were performed, one for each dependent variable, see Appendix 6. The Breusch-pagan test including the standard deviation gave a chi2 of 63,86 and a P-value of 0,000 which means that the null hypothesis can be rejected, there is heteroskedasticity. The Breusch-pagan test including the Betaln, gave a chi2 of 14,17 and a P-value 0,0002 which also indicate that heteroskedasticity exists. In order to manage the heteroscedasticity, regressions can be displayed with robust standard errors. The regression in this study will therefore include robust standard errors.

5.4 Hausman Test
Hausman tests were also performed to test whether it existed unobservable heteroscedasticity in the data sample. This test investigates the null hypothesis that states that the test prefers random effects against the alternative hypothesis that states that the test prefer fixed effects (Hausman, 1978). The Hausman tests were performed in STATA and the test, performed for the model of Betaln, gave a Chi2 of 0,57 and a P-value of 0,9666, see Appendix 7a. The P-value is not significant, and the null hypothesis can therefore not be rejected. This means that the model for the Betaln prefer random effects. The Hausman test for the standard deviation gave a Chi2 of 4,46 and a P-value of 0,3476, see Appendix 7b. This P-value is not significant either, on a 5 percent significance level. The model for the standard deviation does therefore also prefer to have random effects instead of fixed effects. Due to this test and the Breusch-pagan test, stated in the previous section, the Panel data regressions in this study will include both robust and random effects.

5.5. Regression Results
To study the relationship between the dependent and continuous variables, a multiple linear regression was used with robust standard error. The first regression was performed with Betaln as the dependent variable, see Table 5. The regression gave a R-square of 0,1422 which can be considered rather low because the R-square indicates how well the variables; control variables and the independent variable, can explain the dependent variable in the regression (Moore et al., 2011, p. 105-106). The result did not give any significant P-values except for the MarketCapln. This is due to the fact that the continuous variables had P-values below the significant level of 5 percent. The coefficient of the
Dummy_Blockchain, R&Dln, and ROA is negatively related to the Betaln. This indicates that the systematic risk slightly decreased after the introduction of Blockchain technology.

Table 5. Regression with Robust - Betaln

<table>
<thead>
<tr>
<th>Cohenent</th>
<th>Coefficient</th>
<th>Robust Standard Error</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dummy_Blockchain</td>
<td>−0,048</td>
<td>0,159</td>
<td>−0,30</td>
<td>0,762</td>
</tr>
<tr>
<td>R&amp;Dln</td>
<td>−0,070</td>
<td>0,019</td>
<td>−0,38</td>
<td>0,704</td>
</tr>
<tr>
<td>MarkCapln</td>
<td>0,102</td>
<td>0,042</td>
<td>2,41</td>
<td>0,018</td>
</tr>
<tr>
<td>ROA</td>
<td>−0,156</td>
<td>0,502</td>
<td>−0,31</td>
<td>0,756</td>
</tr>
<tr>
<td>Yearl</td>
<td>0,012</td>
<td>0,045</td>
<td>0,26</td>
<td>0,798</td>
</tr>
<tr>
<td>Industry</td>
<td>0,005</td>
<td>0,034</td>
<td>0,16</td>
<td>0,874</td>
</tr>
<tr>
<td>_cons</td>
<td>−2,468</td>
<td>0,926</td>
<td>−2,67</td>
<td>0,009</td>
</tr>
</tbody>
</table>

In the second regression, the standard deviation was selected as the dependent variable, see Table 6. The R-square for this regression was 0,4812 which is much higher than the R-square for Betaln. This regression can therefore explain the dependent variable much better than what the regression for Betaln could. The P-values that are significant are the P-value for the MarketCapln and the one for the Industry. The P-values for the others are not significant and therefore no statistically significant conclusion can be drawn from these results. In this regression, the coefficients are all positively related to the standard deviation except for the MarketCapln. This indicates that the total risk increases after introduction of Blockchain technology.

Table 6. Regression with Robust - Standard deviation

<table>
<thead>
<tr>
<th>Cohenent</th>
<th>Coefficient</th>
<th>Robust Standard Error</th>
<th>T-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dummy_Blockchain</td>
<td>0,008</td>
<td>0,042</td>
<td>0,20</td>
<td>0,840</td>
</tr>
<tr>
<td>R&amp;Dln</td>
<td>0,003</td>
<td>0,002</td>
<td>1,28</td>
<td>0,206</td>
</tr>
<tr>
<td>MarkCapln</td>
<td>−0,049</td>
<td>0,009</td>
<td>−5,63</td>
<td>0,000</td>
</tr>
<tr>
<td>ROA</td>
<td>0,266</td>
<td>0,282</td>
<td>0,94</td>
<td>0,348</td>
</tr>
<tr>
<td>Yearl</td>
<td>0,000</td>
<td>0,013</td>
<td>0,02</td>
<td>0,998</td>
</tr>
<tr>
<td>Industry</td>
<td>0,028</td>
<td>0,009</td>
<td>3,19</td>
<td>0,002</td>
</tr>
<tr>
<td>_cons</td>
<td>1,346</td>
<td>0,219</td>
<td>6,13</td>
<td>0,000</td>
</tr>
</tbody>
</table>

5.5.1 Random-Effects GLS Regression using Panel Data

Two panel data regressions were made for each dependent variable. The first regression including the standard deviation gave an R-square of 0,4775 which is quite high. The panel regression, for the standard deviation, gave significant P-values for the variables MarketCapln and ROA because the stated P-values are below 5 percent, see Table 7. All coefficients are positive except for the MarketCapln which means that there is a positive relationship between the continuous variables and the Standard deviation (Total risk). No statistically significant conclusion can be drawn regarding if the introduction of Blockchain technology impacts the Total risk, but if it would have been significant the
total risk would have increased after the introduction of Blockchain technology. This is because the coefficients for the Dummy_Blockchain is slightly positive.

Table 7. Panel data regression with robust and random effects - Standard deviation

<table>
<thead>
<tr>
<th>Standard deviation</th>
<th>Coefficient</th>
<th>Robust Standard Error</th>
<th>Z-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dummy_Blockchain</td>
<td>0.006</td>
<td>0.013</td>
<td>0.48</td>
<td>0.632</td>
</tr>
<tr>
<td>R&amp;DIn</td>
<td>0.000</td>
<td>0.003</td>
<td>0.12</td>
<td>0.908</td>
</tr>
<tr>
<td>MarketCapIn</td>
<td>-0.035</td>
<td>0.011</td>
<td>-3.23</td>
<td>0.001</td>
</tr>
<tr>
<td>ROA</td>
<td>0.214</td>
<td>0.052</td>
<td>4.08</td>
<td>0.000</td>
</tr>
<tr>
<td>Industry</td>
<td>0.026</td>
<td>0.018</td>
<td>1.45</td>
<td>0.148</td>
</tr>
<tr>
<td>_cons</td>
<td>1.053</td>
<td>0.277</td>
<td>3.81</td>
<td>0.000</td>
</tr>
</tbody>
</table>

In Table 8, the result for the dependent variable, Betaln (Systematic risk), is presented. The R-square for this model is 0.1393 and it is less than the R-square for the model of the Standard deviation (Total risk), presented above. The P-values in this panel regression are also not significant, except for the MarketCapIn. This is due to the fact that all variables have P-values below the significant level of 5%. The second stated null hypothesis, in chapter 2, can therefore not be rejected. This means that there is no relationship between the introduction of Blockchain technology and the volatility. If the results would have been significant, the Systematic risk would have decreased after introduction of Blockchain technology because the coefficient for the Dummy_Blockchain is negative.

Table 8. Panel data regression with robust and random effects - Betaln

<table>
<thead>
<tr>
<th>Betaln</th>
<th>Coefficient</th>
<th>Robust Standard Error</th>
<th>Z-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dummy_Blockchain</td>
<td>-0.010</td>
<td>0.096</td>
<td>-0.10</td>
<td>0.918</td>
</tr>
<tr>
<td>R&amp;DIn</td>
<td>-0.010</td>
<td>0.009</td>
<td>-1.13</td>
<td>0.257</td>
</tr>
<tr>
<td>MarketCapIn</td>
<td>0.097</td>
<td>0.045</td>
<td>2.33</td>
<td>0.020</td>
</tr>
<tr>
<td>ROA</td>
<td>-0.013</td>
<td>0.141</td>
<td>-0.07</td>
<td>0.944</td>
</tr>
<tr>
<td>Industry</td>
<td>0.012</td>
<td>0.055</td>
<td>0.22</td>
<td>0.828</td>
</tr>
<tr>
<td>_cons</td>
<td>-2.320</td>
<td>0.872</td>
<td>-2.65</td>
<td>0.008</td>
</tr>
</tbody>
</table>

Further, this regression shows that the control variables in general explain the effects to the dependent variables better than the independent variable that represents the introduction of Blockchain technology. The results of the regression also indicate that the effect is larger for bigger firms than for smaller ones. This does not change the previous conclusions for the regression. However, the P-values show a non-significant result given the 5 % significant level. The panel variable however is unbalanced according to the statistics, which shows that the panel data is not giving any new insights. The effect on the dependent variable is larger for the control variables than the independent variable and to test the effect on only the independent variable, t-tests were performed, which is stated in the following section.
5.6 Two-sample T-test with Equal Variances

A t-test is a hypothesis-test that test whether there is a difference between two normal distributed populations with unknown standard deviations (Moore et al., 2011, p. 420). These tests were conducted in order to evaluate the means of the two population groups, the first group included the dummy for Blockchain, and the standard deviation and the second group involved the natural logarithm for Beta, and the dummy variable for Blockchain. These tests were conducted in order to exclude the control variables which, according to the regression and panel regression, affects the dependent variables more than the variable for the Blockchain introduction.

Table 9. Two-sample t-test with equal variances for the Betaln

<table>
<thead>
<tr>
<th>Group</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Err.</th>
<th>Std. Dev.</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>44</td>
<td>-0.1070613</td>
<td>0.0656701</td>
<td>0.4356063</td>
<td>-0.2394977 to 0.0253751</td>
</tr>
<tr>
<td>1</td>
<td>44</td>
<td>-0.1149613</td>
<td>0.0792099</td>
<td>0.5254191</td>
<td>-0.274673 to 0.044811</td>
</tr>
<tr>
<td>combined</td>
<td>88</td>
<td>-0.1109961</td>
<td>0.0511512</td>
<td>0.4798412</td>
<td>-0.2126648 to 0.0093275</td>
</tr>
<tr>
<td>diff</td>
<td></td>
<td>0.0028697</td>
<td>0.102892</td>
<td>-0.1966729</td>
<td>0.2124123</td>
</tr>
</tbody>
</table>

\[ \text{diff} = \text{mean(0)} - \text{mean(1)} \quad t = 0.0765 \]

Ho: diff = 0

degrees of freedom = 86

Ha: diff < 0

Ha: diff != 0

Ha: diff > 0

Fr(T < t) = 0.5304

Fr(|Z| > |t|) = 0.9392

Fr(T > t) = 0.4696

The t-test for the logged Beta gave a high value on the t-value of 0.0765, see Table 9. This indicates that the null hypothesis cannot be rejected because the P-value is higher than the chosen significance level of 5%. The null hypothesis states that the mean of two groups are equal. The P-value is higher than the chosen significance level, which means that there is no difference between the mean values. However, if we go into detail and observe the coefficients, we can observe that systematic risk increases slightly between the range of the min and max values.

The t-test for the Betaln indicated a slight increase regarding the mean values. Before the introduction of Blockchain technology the average value of the mean was approximately -0.107 and after introduction of Blockchain the average mean was approximately -0.115, see Table 9. The average Beta value mean is negative due to the logarithmic adjustment. If one calculates the natural logarithm of a value between 0 to 1, one gets a negative output, so the value is not unexpected or strange. The -0.115 is slightly smaller than -0.107.
The $t$-test for the total risk gave a low value on the $t$-value of 0.1472. This indicates that the null hypothesis cannot be rejected, because the P-value is higher than the chosen significance level of 5%. The null hypothesis states that the mean of two groups are equal. The P-value is higher than the chosen significance level, which means that there is no difference between the mean values. However, if we go into detail and observe the coefficients, we can observe that total risk decreased slightly between the range of the min and max values. Before the introduction of Blockchain technology the average value of the mean was 0.308 and after introduction of Blockchain the average mean was 0.303, which is slightly smaller, see Table 10.
6. Analysis & Discussion

This sixth chapter will analyze the results and provide a discussion with regard to the theoretical framework, financial theories and previous findings. The discussion will include one theoretical part and one statistical part.

6.1. Analysis for Statistical Procedures

This research has been conducted as a longitudinal thesis with Multiple Linear Regressions and a Panel study. The p-values from the performed tests were not significantly different from zero. From the results, no statistically significant conclusions could therefore be drawn from the regressions. However, the findings from the regressions also show that the effect is larger for big firms compared to small ones. This finding would be in line with Blundell et al. (1999, p. 550) which also find that the companies with a higher market share benefits from more innovation, perhaps due to the competitive market advantages for larger companies. However, this finding is not generalizable to the whole population even if the result was significant, due to the fact that only one small cap company was included in the sample.

The t-tests were then performed because the control variables in the regressions had higher effect on the dependent variable, than the independent variables own effect. To exclude this effect, t-tests were performed to only test the change in the independent variable. The conclusions that can be drawn from the t-tests are that the total risk in stock returns slightly decreased after the introduction of Blockchain technology, and that the systematic risk in stock returns slightly increased after introduction of Blockchain technology, both within max and min values, observing the mean coefficients. However, this is not significant given the chosen level of significance and the null hypothesis can therefore not be rejected.

Unsystematic risks refer to risks that can be identified and reduced through diversification. These risks refer to, for example, liquidity risk, legal risk and business risks, in other words, operational risks. Hull (2018, p. 515) states that cyber-risks is an increasingly important form of operational risk and that for example banks, needs to adapt sophisticated computer systems in order to protect themselves. Stakeholders and personnel have to be continuously educated which is in line with Bruno & Gift (2019, p. 20) who argues that risk associated with Blockchain technology can be reduced by implementing good internal processes and being educated with the system. Previous research has stated that Blockchain technology increases protection trough transparency. Hull (2018, p. 516) further states that operational risk is the most important risk to consider according to many regulators. It has been argued for an academic research gap in financial literature with perspective to IT.

The Total risk (Standard deviation) could mathematically be called a set, which contains of two subsets with unknown proportions; Systematic risk (Beta) and Unsystematic risk. The research evidence from the t-test shows that if the subset of systematic risk increase, and the set of total risk decrease, the subset of unsystematic risk must decrease above the proportion of which the systematic risk increases in order for the total risk as a set to decrease. This implies that the largest effect to any subset is to the unsystematic risk. The subset of systematic risk increases with +0.0078697 and the set of total risk decreases with -0.0052742. Using simple mathematics, the subset of unsystematic risk must
decrease with -0.0131439 with is the largest change, which is an interesting yet non-significant finding. Given that we view the theory of risk with perspective to mathematical theory of sets.

However, the effect of the changes is known but not the full proportion of the unsystematic risk to the total risk, and its related value in the gathered sample is unknown. Hull (2018, p. 516-517) states that operational risks are more difficult to manage and quantify compared to other risks and that the definition of operational risk might be too broad since it includes economic factors, entering new markets and last but not least, developing new products. The biggest operational risk issue is cyber risk (Hull, 2018, p. 637) and the protection is argued to be increased by previous literature, see Kshetri (2018, p. 88), Ying et al. (2018, p. 3) & Treleaven (2017, p. 15).

Given the t-tests and defining unsystematic risk as the operational risk for a company and using mathematical theory of sets, our non-significant results show that largest effect of reduction is to operational risk by introducing Blockchain technology in companies. This is in line with our research proposition, and previous financial literature which argues that risks should be reduced with Blockchain technology. These findings are thus in line with Hulls (2018, p. 625) suggestions that the operational risk should decrease using Blockchain technology.

We faced some issues with normality distribution which was an essential problem to solve in order to accept the underlying assumptions for a regression. Although, this was solved using the logarithmic values and calculating residual means, adjustments have still been made that could influence the outcome. Measuring the total risk of stock return using the simple standard deviation as a measurement, might not capture the whole picture of total risk. It could also be the case that using the arithmetic return, instead of geometric returns, could bias the standard deviation, although it is stated to use in risk evaluations by Hull (2018, p. 215).

It has been stated that no clear framework exists in accounting for how to treat the Blockchain technology as an asset, which we have partly observed during the practical method in this thesis (Leopold & Vollmann, 2019, p. 1). It remains uncertain where the Blockchain technology information has been disclosed in the financial sheets but is believed to be a part of companies disclosed software expenses, as an R&D expense in the income statement or/and as an intangible asset. This is lifted in the statistical analysis, since as the uncertainty where investments for Blockchain technology is recorded, could affect the R&D proxy as a control variable which could influence the accuracy of the results. Nevertheless, regression results are non-significant.

6.2. Theoretical Analysis of Findings

6.2.1 Diversification & Investments
Given that the non-significant total risk slightly decreased, this would imply that the company’s stock returns is slightly less volatile after the Blockchain technology was introduced in the companies. Less volatile stocks would be an investment preference for the rational investor who, according to Markowitz Modern Portfolio Theorem (1952), chooses the less risky investment alternative.

If the rational value-maximizing investor would like to make investment decisions based
upon Blockchain technology and volatility, this research can only provide a non-significant result for reduction of stock return volatility defined as standard deviation in the Swedish market. The art of diversification often involves investments spread across different assets, markets, regions according to Hull (2015, p. 17). It could therefore be the case that the slight risk reduction in total risk is overviewed by only investing in the Swedish market, compared to a more well diverse portfolio. Investments in a portfolio made in the same industry is less diverse than investments in a portfolio from various industries (Markowitz, 1952, p. 79).

6.2.2 Information Asymmetry, Adverse Selection & Investors’ Perceptions

Bitcoin is a very volatile investment (Guandong et al., 2017, p. 6). It could therefore be difficult for the public to view the usage of Blockchain technology as a safer investment, since common perceptions of Blockchain technology often refers to cryptocurrencies and especially Bitcoin.

The technology and the cryptocurrency is often wrongly interpreted to always be the same, and we argue for the clear distinction between Blockchain technology and cryptocurrencies, in order to convince the market that the Blockchain technology in firm operations could beneficial, a safer investment and reduce total risk, as shown by this research. The term Blockchain may still be associated with negative issues, which could explain the fact that the observed effects are yet rather small.

The information regarding Blockchain disclosure in annual reports is somewhat uninformative, as we have touched upon in the methodological criticism. The communication of the usage of Blockchain technology is not clear in the information provided. This raises the concern that Blockchain technology could be viewed as frightening by the market and investors. It could be questioned if it is an active choice by companies to not disclose the information. In today's society, cybercrimes are present, and this could contribute to less trust or/and increased skepticism to new digital solutions (Ying et al., 2018, p. 2). Could firms be worried that investors would react negatively to the information of Blockchain technology?

No universal standards for recording crypto assets exists according to Leopold & Vollman (2019, p. 1). No broad cross-geographical method, or definition on how to record Blockchain technology has been encountered. We have mentioned this in the statistical analysis, but it is also of value to mention for the theoretical analysis. This is something that clearly could affect how the Blockchain technology is disclosed, and perhaps why it is not disclosed clearly enough, which is partly observed in this thesis practical method and data gathering. This shows that information asymmetry is present in the Blockchain field because the communication to the market upon the technology is limited. It seems that companies have more information than investors. One of the market fundamentals build on the fact that prices should reflect all information on the market. In order to make optimal decisions, investors need to have access to all information. Corporate information has to be transferred to the stakeholders, from the enterprise, in order for them to make informed decisions regarding investments. Thus, the shareholder’s perceptions are essential for this research, and stakeholders are perhaps still unaware of the potential advantages among the Blockchain technology.

With this research, we emphasize, and argue for the need of new regulations and a clear framework for treating the Blockchain technology with regard to accounting purposes,
which could help enable the communication and disclosure to investors and reduce information asymmetry which is partly observed in this research process. Haber (2018), one of the original founders of the Blockchain who solved the timestamping problem, is now working on a project in order to bring cryptographic verifiability to the audit and financial reporting of all sorts of business records.

6.2.3 Signaling Theory & Behavioral Finance Aspects

Signaling the usage of Blockchain to the market seems to be done carefully, as it is still uncertain how investors react. Together with a more mature market, and the increased awareness of the advantages of Blockchain, using the technology could give positive signals to stakeholders, and not disclosing the information regarding Blockchain could be argued to be a disadvantage.

This study showed that the risk was slightly reduced after introduction of Blockchain technology with regard to standard deviations in t-tests. This could be treated as a positive signal to risk adverse investors that are less willing to take unnecessary risks, since firm’s shares will be less volatile. The signal might be less positive to investors that would like higher returns thus, higher risks. However, as Blockchain technology is argued to be a disruptive technology with major development potential, this would highlight the general growth and revenue potential for businesses using the Blockchain technology and attract even the less risk averse investor but who prefer to receive higher returns. Given the potential unawareness, a market immaturity, the technology could wrongly be viewed as a risky investment. If investors know that Blockchain technology reduce risk in the company's shares, then the rational investor would invest in those shares.

To explain why investors do not invest in these shares might also be because of rationality and that investors are influenced by other factors which Behavioral aspects of Finance could explain. According to Jaiswal & Kamil (2012, p. 12), different factors can affect the investors behaviors. Too much overconfidence can be one factor that can contribute to less good investment decisions. Hull (2018, p. 216) states that it’s not new information entering the market which causes volatility, but rather the trading itself. As it is believed that information has perhaps not yet reached the market, and not yet been acted upon, could be an explanation to the non-significant results for stock return volatility.

6.2.4 Blockchain Technology, Volatility & Previous Studies

Ying et al. (2018, p.1) describe how firms are waiting for others to test new innovations. This makes sense since no enterprise wants to be the first one to fail. Higginson et al. (2019) also question whether any financial institution will be willing to lead and creating innovation. It could be the case when the market is waiting for others to take the lead implementing Blockchain technology. However, as there are many incentives for implementing Blockchain in finance and other various industries, this is not believed to be the case (Hassani et al., 2018, p. 258).

It has been shown that the Blockchain technology has major advantages according to Swan (2015), Hassani et al. (2018) and Ying et al. (2018). As Blockchain technology has major development possibilities, and could, according to predictions by the World Economic Forum (2018, p. 8), store 10 % of the global gross domestic product by year 2025, this indicates extensive growth potential. Companies should be proud of being in the forefront and using the modern technology, and inform shareholders about their innovative, modern, and transparent solutions.
These findings are not in line with Jensen (1993, cited in Adjei and Adjei, 2016, p. 572), who finds that the investments in R&D expenditure could increase the firm's risk, interpreted as business risks. Skarzynski & Gibson (2008, p. 131) find that innovations often increase risk, and this could partly be in line with this research findings since the systematic risk increases.

However, the results of this research, although they could be argued to be vague, supports the research proposition as the volatility decreases after the Blockchain technology was introduced. This result also supports Ying et al. (2018, p. 3) who stated that centralized risks are reduced, and Kshetri (2018, p. 88) who finds that Blockchain technology increase trust, security and reduces uncertainty. This applied to the financial risk-return fundamentals, should imply that the operational risk also should decrease. Furthermore, the claimed advantages with Blockchain technology such as increased transparency, according to Treleaven et al. (2017, p. 15), and its effect to operational risk could be argued to be confirmed by this research as the argumentation builds upon the effect of the advantages to risk and thus volatility. The result also supports Bruno & Gift’s (2019, p. 20) argumentation that risk associated with Blockchain technology can be reduced by implementing good internal processes and be well-familiar with the system.

Risks associated with the concepts of Moral Hazard are likely to be reduced, as there is no third-party that could be held morally responsible for the risks taken with the insurance of the third party. However, one could question how Moral Hazard still could be applied to large financial institutions using Blockchain technology. It is likely that potential bailouts by government could still occur, no matter if the financial institutions are using Blockchain technology in their operational activities or not.

To conclude this analysis, we believe that the perceptions of the shareholders’ matter to a great degree in order to explain the results of this research. Given the theoretical research proposition, operational risk should be reduced when introducing Blockchain technology in companies which is showed in our non-significant results. On the other hand, it could still be the case that Blockchain technology is associated with negative issues, and that the market, in practice, is not yet mature for this research proposition which could explain the rather small effects.

Lastly, we would like to emphasize that more research in this area is necessary to be able to draw more generalized, statistically significant, reliable and valid conclusions. We would like to end this discussion by raising the question whether the technology is used for inclusiveness, openness and decentralization with a purpose of excluding third parties and regulations, should end up being implemented in huge centralized institutions. Could it be the case that using the Blockchain technology for centralized purposes will discard Blockchain’s original purpose?
7. Conclusion

This last chapter will conclude this research, summarize the findings and revisit the research question. Concluding comments on how this research meets the research purpose, research gap and the theoretical and practical contribution will follow. Future research directives will be suggested in order to give more solid theoretical contribution to the academic society.

7.1 Research Question

The presentation of the study's empirical findings and the results in chapter 5, together with the analysis is chapter 6, have the objective purpose to answer the stated research question, as follows:

“Does Blockchain technology impact the volatility in Swedish stocks?”

This research has followed a quantitative deductive theory testing approach with an ontological view of an objective reality. The nature of knowledge follows epistemological positivism with the objective to gain valid and true knowledge. Through statistical transparent procedures, and the axiological underlying assumptions, this result should be free of value. Two hypotheses were developed in order to satisfy the research question, one for the total risk of the stock return and one for the systematic risk of the stock return. Thus, this research builds on the financial risk-return fundamentals. The hypotheses were aimed to be answered with multiple regressions, panel data regressions and later with t-tests. The findings show that the control variable in the regression takes over the effect for the small changes in systematic risk of stock return and in the total risk of the stock return. The findings also show that the effect is larger for big firms compared to small ones. However, the results from the multiple regression and the panel data was not significant. The findings from the t-test indicate that there is a slight increase in systematic risk on stock return and a slight reduction in the total risk of the stock return. Thus, to answer the research question, the findings indicate that the introduction of Blockchain technology does slightly impact the volatility in Swedish stock returns in the Stockholm OMX PI Index.

7.2 Fulfilment of Research Gap, Contribution and Purpose

The purpose with this study is to research whether the introduction of Blockchain technology have an impact on the volatility of return in Swedish stocks. Thus, the purpose of this research is argued to be fulfilled. The discussion and analysis in chapter 6, could explain the results, and further explain why the results are not significant and the effects quite small. The theoretical framework is used through the deductive approach to test the relationship, that is to satisfy the research gap observed in previous research and financial literature.

The majority of previous studies have researched volatility with perspective to Blockchain technology in form of cryptocurrencies. Studies have examined and tried to predict the price movements and found that, for example, Bitcoin prices tend to be unaffected by traditional financial movements and continuously unpredictable. Thus, cryptocurrencies tend to be very volatile. The literature review has highlighted the drawbacks of Blockchain technology, and its advantages of increasing transparency, cost
efficiency and reducing risks. However, to the authors best knowledge, no previous study has researched the Blockchain technology with its effect to stock return volatility. This is the stated research gap in this study, which is now argued to be partly fulfilled with a perspective to the Swedish stock market. Although, it is necessary to emphasize that more empirical research is needed to draw statistically significant conclusions. This research provides a new knowledge regarding the effect to stock return volatility, by incorporating Blockchain technology into businesses.

Given that this research’s time perspective is partly characterized by growth, after the financial crisis in 2008 and before the 2020’s Covid-19 Pandemic, the volatility could be lower in this time period due to the phenomenon of asymmetric volatility. It is difficult to state how much this could affect the results, but we would like to emphasize that it could be the case, and that the result could be different in another period of time.

We hope to contribute to the academic society with this research. Observing the results gives incentives for further research. It would be really interesting to research this phenomenon in a few years to see if the results then could be significant and further reduce risk. The results of this research could confirm the previous findings in literature that supports the advantages of Blockchain. Thus, the research findings are in line, although vaguely, with the stated research proposition. This research shows how stock volatility is impacted by introducing Blockchain technology in companies and contributes to the academic field regarding risk and new innovations.

The practical contribution is especially with an investment perspective, to managers and to investors. As the volatility, defined as standard deviation of stock return, slightly decreases when the Blockchain technology is introduced, this would give investment incentives. Investors who prefers lower risk can invest in companies using Blockchain technology. It is also of significance to businesses, as incorporating Blockchain technology in operational activities increase their transparency and reduces their risks. Reduced operational risk is considered positive for any firm. This thesis also serves its purpose by making investors, managers, or scholars further informed about how Blockchain technology and risk interact on the Swedish stock market.

7.3 Future Research Directives
Throughout the research process we have encountered some suggestions for future research. It could be interesting combining this research with a qualitative approach in order to provide more in-depth analysis on how the Blockchain technology is actually used in the companies, and to what degree. This could also increase the validity of the research phenomenon as this study just research the introduction of Blockchain technology with a binary independent variable, through regressions and t-tests. Perhaps it could be the case that firms that have integrated the Blockchain technology to a higher degree into its core business, faces lower operational risk than those who have not. Given the lack of general disclosure of information regarding Blockchain technology, in annual reports, this could be solved with qualitative interviews.

This study has researched if there is a relationship between the introduction of Blockchain technology and stock volatility with a deductive theory testing approach. However, it is not researched why this is, and an inductive study could identify the underlying reasons, which for now, is argued to be the related advantages of Blockchain technology. Without further research, one can only state based upon this research that there is a relationship.
It would be very interesting to conduct in-depth qualitative interviews with investors to research behavioral aspects of this field, such as rational reactions and investor perceptions of the Blockchain technology. If investors are frightened, the risk should increase. This could provide further knowledge upon the maturity of the market, the information received and the rationality of investment decisions.

The results from the regressions are not significant despite a believed solid argumentation for the research proposition, with roots in the financial literature. Therefore, it would be interesting to research how markets at the time perceive Blockchain technology, as the attitude towards Blockchain technology and the unawareness of the advantages could explain the results of this thesis further.

It is believed to be beneficial to replicate this research in another geographical setting in order to draw more valid and general conclusions. Although, this is not believed to be the case, it could be that the Blockchain introduction has a slight impact on volatility defined as systematic risk, only in Sweden and not in general. Nothing can be stated for other geographical settings, or markets, and the general research proposition should be tested in various environments in order to draw more definite, general and valid conclusions.

It could also be of interest to apply various statistical measures to observe the stock return volatility, for example the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) or the Exponentially Weighted Moving Average Model (EWMA), or other models that could fit the research proposition. Using different methodological approaches, and statistical procedures for observing the phenomenon could increase the credibility. It is the majority of different research that becomes science.

Furthermore, it could be advantageous to exclude the companies who just have disclosed Blockchain information for one year (two-year sample), in order to receive further accuracy in the results. It would also be good to replicate this study in the future, when the Blockchain technology has been implemented to a greater extent in companies and as the market matures and knows how to react as well as value the information of Blockchain technology. In order to generalize the results, companies who uses Blockchain technology needs to be included in the sample for a longer time period, and perhaps a period of different market conditions in order to observe the volatility of stock volatility in relationship to Blockchain technology.

7.4 Social and Ethical implications
The non-significant findings of the study still have the potential for various implications both for businesses and investors. First, more research is needed to confirm this research proposition, and more studies is needed to support the non-significant relationship. If further developed and confirmed, this potential finding of this study affects the society through its application areas. Businesses who want to be cost efficient, transparent and decrease their risks could incorporate Blockchain technology in their business activities. The risk-averse value- maximizing investor, will prefer less risky, and more sustainable companies to invest in. Thus, adding Blockchain technology could have positive implications for a stakeholder perspective and for a corporate perspective, which could create value through both views. The Blockchain technology could enable digital assets, and information withdrawing from any point in time. Since the economy is heavily dependent upon financial regulations, intermediaries and third parties, the rising of Blockchain technology could question the position of banks and financial institutions.
The information exchange using Blockchain could ensure the safety of two parties and exclude today's traditional trusted authorities. If investors do not trust the financial system, and seek argued better solutions for managing activities, this could as a consequence cause major effects to the economy and change traditional finance practices. However, one should remember that Blockchain technology is still new and has many challenges to concur before being able to make great deeds in the large scale. Although, Blockchain technology is argued to be transparent it still has limitations. What characterizes crises is that they are often unpredictable. It could be questioned if the technology has been around long enough to claim its security advantages. What are unknown risks, or flaws, regarding Blockchain technology remains unknown until they are discovered, which could take some time.

As with all modern new technology, ethical implications are important to discuss. Since Blockchain technology is primarily a way to store and protect distributed information. The technology could be used to make information hidden or secret. In some cases, sensitive information needs to be public, reviewed and reacted to, in order to take steps forward as a society. Therefore, it is important to discuss which purposes Blockchain technology should be used for. Another perspective to this, is that the financial institutions enables security through large responsibility in the society, monitoring services, and acts under regulations such as Basel or Mifid II. It could be argued that efforts made to decrease fraudulent unethical behavior though better regulation and requirements. The Blockchain technology promises great implication, and one of the ethical implications regards to how this promise can actually be met. It is questioned whether the technology can deliver what it promises. Without a third financial intermediary to carry out, for example large transactions, there is a risk that these transactions can be pursued as a result of fear or force, with no one to evaluate bargain power or violent forces, which is to a large extent an ethical implication of Blockchain. The shadow banking sector stands without regulation, similarly to Blockchain technology, and concerns have been made that risks increase, and that the growth of the shadow banking sector could threaten financial stability.
8. Truth Criteria

This section will describe the thesis’ perceived transparency, consistency, coherency, comparability, accuracy, completeness and relevance. Three common measurements are used to evaluate the research: validity, reliability and generalizability. These three truth criteria are important to take into consideration since they are crucial for the research overall credibility.

8.1 Validity

Validity regards whether the method used actually measure what the researcher wants to measure, and if the outcome accurately reflects the studied phenomenon (Collis and Hussey, 2014, p. 53). Validity thus say something about the chosen measurement. There are different forms of validity, and forms of validity considered most important for this research will further be discussed.

First, construct validity is defined as “the extent to which an operationalization measures the concept which it purports to measure” (Zaltman et al., 1977, p. 44, cited in Ghauri & Grønhaug, 2010, p. 81), and can be accessed in various ways and is crucial for meaningful and interpretable research findings. Hypothetical construct is a form of construct validity that is used when a phenomenon cannot be visibly observable to the researcher. In this case the researcher has to make sure that the construct can be highly motivated and that it can explain the findings of the research. In this study, the data has been analyzed with statistical tests and the observable phenomenon is of visible character. Construct validity is often related to qualitative studies where observations of, for example, motivation can be studied. In this study, a quantitative study has been conducted and this concept is therefore of less importance to further discuss. A deeper discussion will instead be performed regarding the following concepts face validity, internal validity and external validity.

Face validity ensures that the test is measuring what is intended (Collis and Hussey, 2014, p. 53). This form of validity informs us weather the measurement seems reasonable (Ghauri & Grønhaug, 2010, p. 81). This implies whether it in a subjective way capture what it is intended to capture. In this thesis, face validity has been evaluated through questioning the accuracy of our statistical measurement and variables. Thus, the face validity of this thesis could be questioned as there are no accounting standards for recording cryptographic assets. Consequently, it could be the case that the R&D proxy, one of our control variables, do not capture the investment into Blockchain technology in every observation. However, due to the available disclosed information, we argue that this is the most valid result that we are able to find during this point in time.

Internal validity refers to the extent one can infer a causational relationship between variables (Ghauri & Grønhaug, 2010, p. 83). Causation is not necessarily indicated by correlation, or if other factors influence the potential relationship. This is particularly important in this research, that a potential relationship between Blockchain technology and stock volatility is caused between the two variables. Applied to the practical method and statistical procedures, several control variables are used to deal with this matter. In this research the internal validity is low due to our non-significant results. Without further research of this phenomenon, we cannot state anything about the internal causation. This emphasizes for future research to explain the relationships more in-depth and strive for statistically significant results, which excludes the possibility of randomness.
Last, but not least, *External Validity* relates to which extent the research findings can be generalized to another setting, as well as across contexts. In order for this thesis to provide theoretical implications or practical contributions the research method needs external validity. The findings of this quantitative research need to be intersubjective and relationships consistent. In order to ensure the external validity, one could replicate the research and if the same results are shown, one can argue for external validity (Ghauri & Grönhaug, 2010, p. 84). The external validity should be relatively high because transparency has been important and communicated throughout the research process. In order to further claim external validity this research phenomenon has to be researched further.

### 8.2 Reliability

Reliability measures the stability of the measurement (Ghauri & Grönhaug, 2010, p. 78). The difference between validity and reliability is that reliability measures the accuracy of the measurement, and not if the study measures what it is intended to measure. Reliability is related to replication because if the measurement is accurate, then the study would provide the same results if it were to be re-made (Collis & Hussey, 2014, p. 53). In studies with a positivistic approach the reliability is often higher and therefore more trustworthy, compared to studies with an interpretivist approach. The reliability should be quite high in this study, due to the sought transparency but also due to a quantitative approach where statistical tests have been performed.

### 8.3 Generalizability

Generalizability or transferability regards to what extent the result can be applied to a larger population or in other situations (Collis & Hussey, 2014, p. 54). Generalizability is similar to the external validity presented in section 8.1. To increase the chance of generalization one must think about the sample size. The bigger the sample size is, the better it can represent and be generalized to the chosen population (Collis & Hussey, 2014, p. 198). In quantitative studies, one common way to generalize is to draw conclusions from a sample to a larger population through, for example, statistical tests. In this study, the sample is collected from Nasdaq, OMX Stockholm PI, and it includes at least 20 Swedish companies. This, given a time period of five years, represents 88 observations which is argued to be enough due to the limited Swedish research setting, and the fact that Blockchain technology is still quite new. Most Swedish listed companies are researched however not all of them, although a small dataset was still considered to be enough in order to generalize the potential results. However, these were not significant for Sweden. Since the results are non-significant one cannot make further conclusions or generalize them. However, we would like to argue that the research proposition could be generalized globally, but in order to draw statistically significant conclusions in other settings more research and replication is needed.
8. Reference list


Leopold, R., & Vollmann, P. (2019). In depth A look at current financial reporting issues. [Information paper] Online: PwC. https://www.pwc.com/gx/en/audit-


Queiroz, M. M., & Wanba, S. F. (2019). Blockchain adoption challenges in supply chain:


Appendix

Appendix 1 - List of Companies

Companies
ABB
Investor AB
Nordea Bank Abp
SEB
Skanska AB
Nokia Oyj
Fingerprint Cards
Boliden
Volvo
Telia Company
Catena Media PLC
Stora Enso
Ericsson
Lucara Dimond Corp
TradeDoubler
Collector
LeoVegas
Fenix Outdoor International
TietoEVRY Oyj
ÄF Pöyry
Appendix 2 - Skewness & Kurtosis tests for normality

a) Skewness & Kurtosis Test for Normality, Not Logged

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Pr(Skewness)</th>
<th>Pr(Kurtosis)</th>
<th>adj chi2(2)</th>
<th>Prob&gt;chi2</th>
</tr>
</thead>
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<tr>
<td>Beta</td>
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<td>0.8416</td>
<td>0.6415</td>
<td>0.26</td>
<td>0.8795</td>
</tr>
<tr>
<td>Standardde-n</td>
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<td>0.0000</td>
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<td>0.0000</td>
</tr>
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<td>0.4745</td>
<td>10.07</td>
<td>0.0065</td>
</tr>
<tr>
<td>ROA</td>
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<td>0.0000</td>
<td>51.27</td>
<td>0.0000</td>
</tr>
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</table>

b) Skewness & Kurtosis Test for Normality, Logged

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Pr(Skewness)</th>
<th>Pr(Kurtosis)</th>
<th>adj chi2(2)</th>
<th>Prob&gt;chi2</th>
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<td>0.0000</td>
<td>0.0000</td>
<td>46.81</td>
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</tr>
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<td>0.0003</td>
<td>0.1857</td>
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<td>0.0023</td>
</tr>
<tr>
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<td>0.0000</td>
<td>51.27</td>
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</table>
Appendix 3 - Tests for normality, Doornik-Hansen

a) Doornik - Hansen before logged values

Test for univariate normality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pr(Skewness)</th>
<th>Pr(Kurtosis)</th>
<th>adj chi²(2)</th>
<th>Prob&gt;chi²</th>
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<tbody>
<tr>
<td>Standarddev-n</td>
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<td>0.0000</td>
</tr>
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<td>Beta</td>
<td>0.8416</td>
<td>0.6415</td>
<td>0.26</td>
<td>0.8795</td>
</tr>
</tbody>
</table>

Test for multivariate normality

Doornik-Hansen  
\[ \chi^2(10) = 853.986 \quad \text{Prob}>\chi^2 = 0.0000 \]

b) Doornik - Hansen after logged values

Test for univariate normality

<table>
<thead>
<tr>
<th>Variable</th>
<th>Pr(Skewness)</th>
<th>Pr(Kurtosis)</th>
<th>adj chi²(2)</th>
<th>Prob&gt;chi²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standarddev-n</td>
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<tr>
<td>Betalog</td>
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<td>0.0020</td>
<td>22.99</td>
<td>0.0000</td>
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</tbody>
</table>

Test for multivariate normality

Doornik-Hansen  
\[ \chi^2(10) = 698.459 \quad \text{Prob}>\chi^2 = 0.0000 \]
Appendix 4 - Scatter Plots

a) Scatter Plot, Logged Variables

b) Scatter Plot, Not Logged
Appendix 5 - VIF test

<table>
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<tr>
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</table>

Mean VIF       | 1.79 |
Appendix 6 – Breusch-pagan tests

a) Breusch-pagan Betaln

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

H₀: Constant variance
Variables: fitted values of Betalog

\[
\text{chi2}(1) = 14.14 \\
\text{Prob > chi2} = 0.0002
\]

b) Breusch-pagan Standard deviation

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

H₀: Constant variance
Variables: fitted values of Standarddeviation

\[
\text{chi2}(1) = 63.86 \\
\text{Prob > chi2} = 0.0000
\]
Appendix 7 - Hausman tests

a) Hausman test Betaln

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>(b)</th>
<th>(B)</th>
<th>(b-B)</th>
<th>sqrt(diag(V_b-V_B))</th>
<th>S.E.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>fe</td>
<td>re</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>.0179972</td>
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</tbody>
</table>

b = consistent under Ho and Ha; obtained from xtregr
B = inconsistent under Ha, efficient under Ho; obtained from xtregr

Test: Ho: difference in coefficients not systematic

\[ \text{chi2}(4) = (b-B)'[\text{diag}(V_{b-V_B})^{-1}] (b-B) \]
\[ = 0.57 \]
\[ \text{Prob}>\text{chi2} = 0.9666 \]

b) Hausman test Standard deviation

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>(b)</th>
<th>(B)</th>
<th>(b-B)</th>
<th>sqrt(diag(V_b-V_B))</th>
<th>S.E.</th>
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</thead>
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</tbody>
</table>

b = consistent under Ho and Ha; obtained from xtregr
B = inconsistent under Ha, efficient under Ho; obtained from xtregr

Test: Ho: difference in coefficients not systematic

\[ \text{chi2}(4) = (b-B)'[\text{diag}(V_{b-V_B})^{-1}] (b-B) \]
\[ = 4.46 \]
\[ \text{Prob}>\text{chi2} = 0.3476 \]

(V_{b-V_B} is not positive definite)