**DOKUZ EYLÜL UNIVERSITY**

**GRADUATE SCHOOL OF SOCIAL SCIENCES**

**DEPARTMENT OF BUSINESS ADMINISTRATION (ENGLISH)**

**BUSINESS ADMINISTRATION (ENGLISH) PROGRAM**

**MASTER'S THESIS**

# HERDING BEHAVIOR IN CRYPTOCURRENCY MARKETS DURING CORONAVIRUS PANDEMIC

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**THESIS APPROVAL**

## DECLARATION

I hereby declare that this master's thesis titled as "Herding Behavior in Cryptocurrency Markets During Coronavirus Pandemic" has been written by myself in accordance with the academic rules and ethical conduct. I also declare that all materials benefited in this thesis consist of the mentioned resources in the reference list. I verify all these with my honour.

23/01/2023

Arda Sağlam

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**ABSTRACT**

**Master's Thesis**

**Herding Behavior in Cryptocurrency Markets During Coronavirus Pandemic**

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**Business Administration (English) Program**

**The concept of money, which we use for many goods and services today, is evolving towards the concept of blockchain and cryptocurrency with the innovations in digitalization. Cryptocurrencies have many advantages in terms of time and cost compared to traditional finance methods. The value of money is highly influenced not only by internal factors in the markets, but also by external factors such as wars and pandemics. In particular, coronavirus pandemic, which is still ongoing as of 2022, has a significant impact on both the lives of individuals and economic indicators in countries.**

**With the introduction of the concept of behavioral finance, it has been argued that individuals exhibit irrational behavior towards the use of money. These behaviors lead to the formation of different biases according to different scenarios. In particular, herding behavior, which is seen as one of the social factors, is known to have a significant impact on the decision-making process of investors.**

**In this study, herding behavior in cryptocurrency markets during the coronavirus pandemic was analyzed by employing cross-sectional absolute deviation (CSAD) technique. The study covers the daily closing prices of ten cryptocurrencies with 66.8% total market capitalization and CCi30 index proxy for the market portfolio. The data covers the period from September 11, 2018, to September 11, 2021.**

**The findings of the study support the herding behavior in cryptocurrency markets for the whole period. However, when we divide the period into two sub-periods such as before the coronavirus pandemic and during the coronavirus pandemic, we observe that herding behavior emerges especially during the coronavirus pandemic period.**

**Keywords: Cryptocurrency, Blockchain, Herding Behavior, Coronavirus.**

# ÖZET

**Yüksek Lisans Tezi**

**Koronavirüs Salgını Sırasında Kripto Para Piyasalarındaki Sürü Davranışı**

**Arda SAĞLAM**

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**İngilizce İşletme Anabilim Dalı**

**İngilizce İşletme Yönetimi**

**Günümüzde birçok mal ve hizmet için kullandığımız para kavramı, dijitalleşmenin getirdiği yeniliklerle beraber blokzincir ve kripto para kavramına doğru evrilmektedir. Kripto paralar, geleneksel finans yöntemlerine kıyasla zaman ve maliyet açısından oldukça iyi bir avantaja sahiptir. Paranın değeri, sadece piyasalardaki iç faktörlerden değil, aynı zamanda savaşlar ve salgınlar gibi dış faktörlerden de oldukça etkilenmektedir. Özellikle de 2022 itibariyle, günümüzde hala etkisini sürdüren koronavirüs pandemisi hem bireylerin hayatını hem de ülkelerdeki ekonomik göstergeleri önemli ölçüde etkilemektedir.**

**Davranışsal finans kavramının ortaya atılması ile beraber, bireylerin paranın kullanımına yönelik irrasyonel davranışlar sergilediği ileri sürülmüştür. Bu davranışlar, farklı senaryolara göre farklı önyargılar oluşmasına sebep olmaktadır. Özellikle de sosyal faktörlerden biri olarak görülen sürü davranışının, yatırımcıların karar verme aşamalarına önemli ölçüde etki ettiği bilinmektedir.**

**Bu çalışmada koronavirüs salgını sırasında kripto para piyasalarındaki sürü davranışı incelenmiştir. Çalışmada yatay kesit mutlak sapma modeli (CSAD) kullanılmıştır. Veriler, kripto para piyasası değerinin %66,8'lik dilimine sahip on kripto paranın günlük kapanış değerleri ve market portföyü olarak ele alınan CCi30 endeksini kapsamaktadır. Verilerin aralığı, 11 Eylül 2018'den, 11 Eylül 2021 dönemine kadar olan süreyi kapsamaktadır.**

**Çalışmanın bulguları, yatırımcıların, kripto para piyasalarında sürü davranışı gösterdiğini destekler niteliktedir. Sürü davranışındaki periyotlar arasındaki farkı gözlemlemek için, model, koronavirüs pandemisi öncesi ve koronavirüs pandemisi boyunca olmak üzere tekrar iki ayrı dönemde test edilmiştir. Periyotlardaki farklar gözlemlendiğinde, sürü davranışının koronavirüs pandemi döneminde ortaya çıktığı ileri sürülmüştür.**

**Anahtar Kelimeler: Kripto Para, Blokzincir, Sürü Davranışı, Koronavirüs.**

**HERDING BEHAVIOR IN CRYPTOCURRENCY MARKETS DURING CORONAVIRUS PANDEMIC**

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**ABBREVIATIONS**

| | |
|---|---|
| **BRICS** | Brazil, Russia, India, China, South Africa |
| **BTC** | Bitcoin |
| **COVID-19** | Coronavirus |
| **CCi30** | Cryptocurrency 30 Index |
| **CPI** | Consumer Price Index |
| **CPU** | Central Process Unit |
| **CRIX** | Royalton's Cryptocurrency Index |
| **CSAD** | Cross-Sectional Absolute Deviation |
| **CSSD** | Cross-Sectional Standard Deviation |
| **ETH** | Ethereum |
| **FBI** | Federal Bureau Investigation |
| **FINCEN** | The Financial Crimes Enforcement Network |
| **GDP** | Gross Domestic Product |
| **P2P** | Peer-to-peer |
| **RBI** | Reserve Bank of India |
| **RMB** | Official Currency of People's Republic of China |
| **SHA** | Secure Hash Algorithm |
| **S&P** | Standard & Poor's |
| **TOR** | The Onion Router |
| **US** | United States |
| **USD** | United States Dollar |
| **USDT** | Tether |
| **VAT** | Value Added Tax |

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## INTRODUCTION

From the past to the present, people have used assets for the goods and services that they bought. When the concept of "Money" had not yet been invented, goods and services were exchanged for other goods and services, and this was called the barter system. In trade, the trading of goods, such as cotton and wheat, was one of the most used assets. Over the years, with the changes in the economic policies of countries and the development of trade systems, the barter system was replaced by payment in silver coins and gold, and then this process left itself to the concept of "Money". As of the 21st century, with the development in technological infrastructures and systems, innovative payment methods such as credit cards, debit cards, mobile payment systems have now entered people's lives in terms of banking and financing. In addition, with the changes in technological infrastructures, financial costs started to decrease and with the emergence of cryptocurrencies, the concept of payment methods took a new course.

Cryptocurrencies have many features that are different from traditional finance methods. These currencies, unlike other commodities such as gold and silver, have no tangible properties and therefore cannot be physically held. Similarly, with the cryptographically encrypted codes, these assets cannot be imitated in any way, so situations such as counterfeit of gold or money cannot be similarly exhibited on cryptocurrencies. From another perspective, cryptocurrencies offer anonymity, protecting personal information. Moreover, with the peer-to-peer (P2P) system, money transfers can take place without the need for any third party.

The use of money is affected by economic indicators such as inflation, production conditions, foreign exchange rates and exchange prices over the years. In addition, throughout human history, economic indicators have been significantly affected also by external factors such as wars and epidemics. Today, similarly, the coronavirus pandemic (Covid-19) has put humanity in a different dimension both in terms of health and economically. The mandatory isolation methods applied in this pandemic, and it caused the production lines in countries to stop for a while, which led to a decline in terms of production outputs. Moreover, trade activities in countries

slowed down. This issue led to decreasing growth rates, and high inflation in most countries of the world.

In traditional finance methods, it is suggested that individuals always make their decisions for maximum benefit. However, just as economic indicators affect individuals' investment decisions, some irrational behaviors also change the investors' decision-making process for their investments. This idea has evolved in a different direction which is also stated as behavioral finance. In this theory, it has been argued that irrational behavior of individuals emerges with different concepts due to their risk factors. When the concept of behavioral finance is considered, the extent of irrational behavior has been examined especially in the "Herding Behavior" concept.

The aim of this thesis is to measure herding behavior in cryptocurrencies throughout the Covid-19 pandemic. The thesis covers Binance daily data for the 18-months period before and 18-months period after March 11, 2020, which is the declaration of coronavirus as a pandemic. Herding behavior, which has been previously mostly studied in stock markets, is examined here in a different market which can be stated as cryptocurrency markets. Therefore, this thesis will provide a new perspective to the literature by examining the relationship between cryptocurrencies and herding behavior during the Covid-19 period.

The thesis is divided into three parts, with a conclusion. Chapter 1 includes conceptual explanations about cryptocurrencies and their status. In addition, the situations regarding the Covid-19 pandemic, which affects many economic factors, were briefly mentioned. In the Chapter 2 of the thesis, information on what behavioral finance is and how it emerged was discussed and important biases in behavioral finance were mentioned. In the rest of the same section, the literature that is directly related to herding behavior is analyzed. In Chapter 3, data, methodology and empirical results were discussed with a conclusion of the thesis.

# CHAPTER ONE
# THE EVOLUTION TO BLOCKCHAIN AND EFFECT OF CORONAVIRUS PANDEMIC

In this section, conceptual details about cryptocurrencies and the effect of Covid-19 in the world were discussed. First, the transformation of the concept of money, which has changed over the years throughout human history, and its current form were analyzed. Afterwards, it was briefly described about the differences of cryptocurrencies from other technological-based money concepts and information about the functions of cryptocurrencies. With that, the differences of cryptocurrencies from traditional finance methods, their advantages and disadvantages, and the legal regulations of cryptocurrencies. On the other hand, the pandemics that have affected the human condition since history and the current situation of the Covid-19, which continues to affect today, were briefly mentioned. In addition, the current situation is supported with data to understand the impact of Covid-19 on the world market.

## 1.1. TRANSFORMATION OF THE CONCEPT OF MONEY

The asset with purchasing power used in the trade of goods and services and in the payment of debt is called money (Cecchetti, et al. 2006: 24). From the past to the present, money initially emerged as a barter for the trade of goods and has now transformed into a completely intangible form. Over the years, the use of money has become more widespread. Ensuring the trade of objects such as copper, cotton, wheat, which are used in trade, with money based on gold and silver has increased the usability of money. With the economic policies of countries over the years, the increase in the value of the scarce assets between the 15th and 18th centuries made gold even more interesting. The mercantilist thought, which gradually increased especially in Europe, where wealth is defined by the possession of precious metals, increased the competition based on gold and silver (Peker, 2015: 2-3). However, in the 17th century, due to the thefts against jewelry stores that started in England, the jewelry masters delivered their goods to the mint in London, to protect their gold and other valuable items from theft. With the confiscation of gold by the King of England,

Charles I, the trust in the king at that time was decreased. Upon this situation, the "Goldsmiths", who were the jewelry family of that period, took the gold of other jewelry stores and gave them paper as collateral, thus keeping the jewelry stores' gold (Erol, 2006: 13). Afterwards, the fiat money which is built on trust and signed by the governments we use today, were created by printing machines. Most of the western countries, on the other hand, introduced their fiat currencies towards the end of the 17th century.

In the 19th century, with the increase in the use of silver in metal money systems, the use of silver became widespread. In that barren environment, both domestic and foreign markets were affected considerably, and a limitation was applied to silver supply due to protecting the value of silver coins. In addition, the ease of imitation of silver coins and their low-cost production for counterfeiting led to the success gold (Redish, 1990: 803-805). For this reason, the use of silver coins has been replaced by gold, which is the basis of the gold standard system. At the same time, David Ricardo, who put forward the comparative advantage theory, also played a leading role in laying the foundations for the gold standard. According to David Ricardo's thesis, it has been suggested that in order for the gold standard to function effectively, countries' banks and coins must be tied according to the gold in the market (Cecco, 1991: 325). Before exactly 100 years passed, the World War I and the Great Depression in the United States of America in 1929 showed its global effect and revealed that the gold standard was an impractical policy. Countries stopped using the gold standard for a while, especially to adjust the economic balance after the war. On the contrary, high inflation situations occurred in countries that increased their money supply with the usage of the gold standard. 25 years later, with the outbreak of World War II, the gold standard became completely unusable. Because the gold standard is no longer a viable method, nations met at the Bretton Woods conference in 1944 to create a new monetary system. According to the new system, other countries' currency would be linked to a key currency that can be used worldwide and can be used in almost every country. Other national currencies would be tied at a fixed rate to the key currency, which is valid almost everywhere. The United States' dollar (USD) was assumed as the key currency role, given the post-war economic conditions and at the same time the predominance of gold reserves in the treasury. By the new standard, 35

USD is now tied to 1 ounce of gold, and currencies of other countries will find a direct equivalent in dollars (Hall and Tavlas, 2013: 344-345). However, in 30 years, the United States' holding 1 ounce of gold for 35 dollars, significantly shaken the domestic market conditions (Irwin, 2013: 30-37). As the demand for gold increased day by day, the US administration realized that the gold equivalent of the dollars circulating around the world could not be paid, President Nixon dismissed the convertibility of the dollar to gold. Thus, this event called the Nixon Shock, laid the foundations of the process of exporting its national fiat currencies to other countries without gold.

Today, with technological advances, new products are emerging in almost all areas. In terms of banking and finance, important inventions such as credit and debit cards, mobile payment options, and Quick Response codes for people have emerged. In the process that has passed since the Nixon shock, it has been shifting towards the realization of payment methods directly from virtual environments without cash or other valuable papers. As financial transformations progress, payment methods have become easier and less costly. From this point of view, fast and low-cost payment methods offered by digital payment methods are candidates to be an alternative payment method.

### 1.1.1. Digital Currency

Conceptually, digital currencies are completely intangible products that are based on a payment method that exists entirely in an electronic environment, not like paper money or coins. These are representations of papers and coins in the accounts of individuals or institutions. These assets, which facilitate money transfers under the financial services, were vital for transactions on many online websites. Digital currencies other than crypto assets are usually monitored and controlled by a centralized control. The first examples of this concept were handled by DigiCash in the early 1990s. DigiCash provided fast and reliable transfers between users. At the same time, thanks to the "Blind Signature" algorithm, it provided anonymity to its users by ensuring complete confidentiality between individuals. With this algorithm, it is prevented from being monitored by any government or third party along with public and private key encryptions. Although today it appears to be a technology like

cryptocurrencies, these digital assets are differentiated from crypto assets in terms of having centralized control mechanisms (Çarkacıoğlu, 2016: 7). Although it seems to be an innovative practice, the DigiCash initiative failed to progress and went bankrupt in 1999 and in 2002, and all the assets of the company were sold (Pitta, 1999: 390-392). For the main reason of this situation, it is argued that it occurred because of not being able to use the opportunities correctly at that time (Elfring and Hulsink, 2003: 418).

### 1.1.2. Cryptocurrency

Cryptocurrency is digital virtual currency used with cryptography or encryption method to secure the transactions. Unlike traditional methods of finance, cryptocurrency has a decentralized feature, but it still allows individuals to pay for goods and services (Farell, 2015: 2). These currencies do not carry their value in grams as other precious commodities do such as gold, silver, and oil. Parallel to this situation, cryptocurrencies do not qualify as a document equivalent to gold anywhere. Since it is not a tangible object, it cannot be imitated in the technological environment, which makes cryptocurrencies safe. It is suggested that cryptocurrencies basically have 6 properties (Lansky, 2018: 19) such as:

- The transaction can be applied by the owner of the transaction.
- Transactions can be proven by cryptographic methods.
- If two other transactions for encryption ownership are given at the same time, only one of them will be performed by the system.
- The system does not need any central authority.
- In case a new cryptocurrency is created, the ownership of the new units is defined by the system.
- The system provides an overview of cryptocurrency units and their ownership in the system.

## 1.2. HISTORY OF CRYPTOCURRENCY

The first steps of the cryptocurrency concept were suggested by Wei Dai (1998), a study named "B-Money" based on a distributed cash system. In this study, two important protocols for the operation of the B-Money system were discussed by Dai. According to the first protocol in the published study, it has been suggested that the proof-of-work function must be presented to the phenomenon of money creation to occur. The second protocol deals with the situations that occur according to the actions taken by the users. According to this protocol, users show their transactions to the "servers" owned by other participants to verify the account transactions they publish. In the transaction process, the server performing the transaction confirms that the money supply is not inflated in any transaction, and then if it does not contain malicious intent, the server confirms the transactions. In case of irregularity in the transactions made where occurred in a server, that server is removed from the system. In the same year as the B-Money study, a mechanism was designed by Nick Szabo (2008) which is referred as "Bit Gold", a digital currency without a centralized structure was established. This work, which remains only with theoretical knowledge, has not turned into any practical system in history. In the Bit Gold study by Szabo, it was mentioned that the users can perform the proof of work function by performing their transactions in a cryptographic manner. The reusable proof of work system, which could be a further model of the proof of work system, was introduced by Hal Finney (2004). In the version of the mentioned reusable proof of work system, the proof of work method was designed as part of the HashCash model.

The first decentralized cryptocurrency, Bitcoin, emerging as a working system beyond theory, was introduced in 2009 by a person named "Satoshi Nakamoto". This new cryptocurrency, founded by Nakamoto, is entirely based on a P2P electronic cash system. On January 3, 2009, the first known starting block, "Genesis", was created by Nakamoto and the foundation of the Bitcoin network was established. On the day the Bitcoin software came out, Hal Finney, who previously introduced the reusable proof of work system, started the first crypto trade by buying 10 Bitcoins from Nakamoto (Peterson, 2014). Exactly 1 year after the system's appearance, it was claimed that the

first commercial transaction known in the corporate field was Laszlo Hanyecz's purchase of pizza from two Papa Johns with 10,000 Bitcoin (Kharpal, 2018: 1).

Due to its "proof of work" and "anonymity" feature, the use of Bitcoin in the black market reached record levels in 2011 and started to be used in illegal works. In February 2011, the black market, known as Silk Road, reached a transaction volume of 9.9 million Bitcoin, in other words, a volume of $ 214 million at that time (Böhme et al., 2015: 223). Ross William Ulbricht, the known founder of the "Silkroad" system, was caught by Federal Bureu Investigation (FBI) in October 2013 due to illegal transactions such as drugs and illegal arms trade. With this operation, the FBI seized 30,000 Bitcoins, and the Bitcoins received from the operation were sold with the blind auction (Böhme et al., 2015: 224).

While Bitcoin was traded at an average of $ 0.3 in 2011, this value jumped to $ 850 in February 2014 (Webster, 2021). Another cryptocurrency under the name "Litecoin" was created in the same year as the prices suddenly took shape and increased according to the demand. This cryptocurrency, which is different from the “Secure Hash Algorithm (SHA)-256” system, existed using the scrypt hashing algorithm. Due to the growing interest in cryptocurrencies, The Financial Crimes Enforcement Network (FinCEN) has legally classified the people who deal with and trade Bitcoin mining by establishing regulatory requirements against cryptocurrencies (Financial Crimes Enforcement, 2013: 1-3). However, not every country looks at the use of cryptocurrencies in the same way. In December 2013, a statement made by People's Bank of China, which announced that transactions with Bitcoin were banned within the borders of China (Kelion, 2013).

The demand for cryptocurrencies increased in 2017 and 1,335 cryptocurrencies were created at that time. With the highest market capitalization and the absence of any errors from the system over the years, the price of Bitcoin, which was traded at $ 3,500 in the middle of 2017, reached to $ 19,700 in 2017 December (Procházka, 2018: 178). On the other hand, the high value of Bitcoin also reflected losses due to theft. According to a report in 2018, it was alleged that cryptocurrencies worth $ 761 million were lost because of theft (Chavez-Dreyfuss, 2019).

By 2022, Bitcoin had become the most popular cryptocurrency in the market. On the other hand, with the popularization of the cryptocurrency market, investors are

also showing interest in alternative coins. With their own decentralized control mechanisms and public account registration, cryptocurrencies are gradually becoming the focus of investments. In addition, although alternative coins such as Ethereum, Ripple, Cardano, etc. still exist, the most popular cryptocurrency is seen as Bitcoin with the highest capitalization in the market as of 2022.

## 1.3. THE FUNCTIONING OF CRYPTOCURRENCIES

Cryptocurrencies have some differences compared to other virtual currencies in terms of origin and functioning. They have a privileged method to encrypt various messages according to a certain system that includes the science of cryptology. In addition, for the system to work, it must be processed on the base of the blockchain, and proof of work must be approved.

### 1.3.1. Cryptology

With the digitalization of the world, new problems have emerged with the technological innovations in the field of finance. As an example of this situation, the biggest threats are again realized from the digital environment. Especially with internet banking, identity theft is becoming the most important issue. To prevent this situation, cryptology science can prevent technology-based theft.

The concept of cryptology is divided into two within itself. First, cryptography handles the case of writing encrypted text in itself. Secondly, cryptanalysis; It is called the ability to decrypt or analyze. These algorithms, on the other hand, emerge from a purely mathematical function. In this field, it is known as the "Rotor Machine" technique used by the "Enigma" machine, especially during World War II. The most important feature of this encoding is that the encryptions change dynamically (see Figure 1). For example, the first letters can represent a password and the second letters can represent another password (Kruh and Deavours, 2002: 6).

**Figure 1:** The Logic of Cryptology

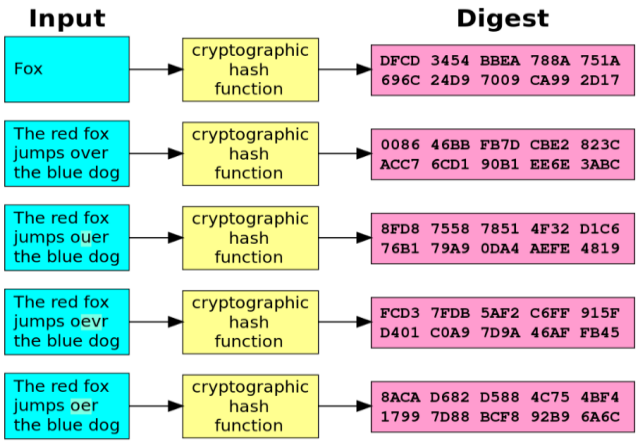
| | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| CONTACT: | 1 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 |
| INPUT: | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z |
| STATOR: | J | W | U | L | C | M | N | O | H | P | Q | Z | Y | X | I | R | A | D | K | E | G | V | B | T | S | F |
| ROTOR 1: | L | P | G | S | Z | M | H | A | E | O | Q | K | V | X | R | F | Y | B | U | T | N | I | C | J | D | W |
| ROTOR 2: | S | L | V | G | B | T | F | X | J | Q | O | H | E | W | I | R | Z | Y | A | M | K | P | C | N | D | U |
| ROTOR 3: | C | J | G | D | P | S | H | K | T | U | R | A | W | Z | X | F | M | Y | N | Q | O | B | V | L | I | E |
| REVERSE: | I | M | E | T | C | F | G | R | A | Y | S | Q | B | Z | X | W | L | H | K | P | V | U | P | O | J | N |

Source: Kruh and Deavours (2002). The commercial Enigma: Beginnings of machine cryptography. Cryptologia, 26(1), 10.

### 1.3.2. Cryptography Hash Functions

Hash functions in cryptos are an algorithm that maps random data to a dimensional data array. These algorithms are a one-sided function, it is not possible to reverse, in other words, no results can be produced from hash functions without decrypting it. The same input data in hash functions gives the same result. Parallel to this situation, different inputs also have different results (see Figure 2). Mostly, the size of the hash functions is smaller than the size of the input data. The hash functions used make it difficult to read a message using encryption instead of directly sending it (Altıner, 2017: 132). With this encryption, the anonymity of the data is ensured, and other people will not be able to access this message.

**Figure 2:** Hash Algorithm in Cryptography




Source: Wikipedia. Retrieved 2022, March 15 from https://en.wikipedia.org/wiki/Cryptographic_hash_function.

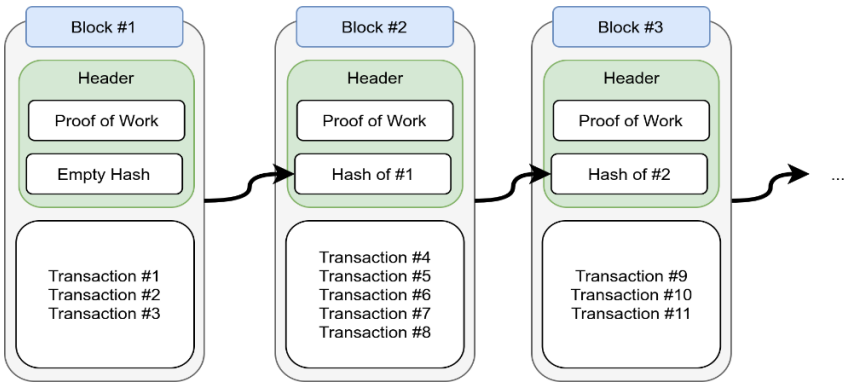
Verification of message integrity is the basis of a secure crypto transaction. With the use of hash functions, it will be defined whether there is any change in the message before and after the operation to be performed, thanks to these functions. In this way, potential malicious changes in the transaction will be detected.

The number of keyless cryptographic hash functions used in cryptology is more than 30 today. As of April 2021, many cryptocurrencies such as Bitcoin, which is the most traded with a market volume of nearly 1 trillion dollars, are using the SHA-256 encryption method for the accuracy of their transactions (Gültekin, 2017: 103). Thanks to this encryption method, a process to be performed will turn into a string consisting of 256 consecutive 0 and 1. With this transaction, the content and message of the transaction will be hidden.

### 1.3.3. Blockchain System

Blockchain is a digital ledger in which cryptographic transactions called "blocks" are recorded, and blocks of records grow cumulatively (Treleaven et al. 2017: 15). Basically, each block contains the hash function and transaction data of the previous block (see Figure 3). Thanks to these blocks, which have been formed since their foundation, the data in the block in any division will be preserved. Because to change the data in any block, the data in the entire block that comes after that block must also be changed.

**Figure 3:** The Functioning of Blockchain System




Source: Thoma, 2021. Retrieved 2022, March 15 from https://medium.com/coinmonks/the-blockchain-473aac352e5.

Multiple transactions can be involved in the formation of any block in a blockchain system. In a transaction performed by person X with person Y, a hash function summarized message is delivered to users connected to the common network. In this way, a decentralized ledger can be used publicly to a P2P network. With the users that are connected to this network, the transactions performed are evaluated and these messages are copied to the registry and shared with other users. After these operations, the data to be added to the blocks are stored simultaneously on the computers of all users in the common network. In case of a problem in any user's network during transactions, the data to be processed in the blocks will be taken from the computers of other users in the common network, and the transactions will be protected. With this method, the system will continue without any transaction loss.

An Intentional malicious change in the blockchain can be detected by the system itself. In particular, the modification of data to be processed in the block will not be verified by other users connected to the public network. With this distributed, decentralized structure, the source of the malicious data exchange transaction will be revealed by the system and that source will be removed by the system.

### 1.3.4. Proof of Work

Proof of work is cryptographic proof that a prover can prove to other connected people to the public network to achieve a goal as a result of certain accounts (Houben and Snyers, 2018: 18-19). Miners can connect to the common network, and they can earn a certain number of rewards within the blockchain with the works they have proven. Each work intensity within the block is not equal, each process has different difficulties. If a solution is found less than the difficulty value for a job specified by the system, the user will prove the work and share the proof of work done to other users. When other users in the public network confirm and approve the transaction, the work is added to the blocks and becomes a part of the block chain.

Proof of work does not take place within the same period for every computer. Some basic functions affect problem solving issues in order to be able to solve different difficulty levels. Such as;

- The calculations depend on the central process unit (CPU) where the processors of the devices used are running. Whether the CPU used is strong or weak will significantly affect the proof-of-work process.
- Any job on the devices used that may affect latency or bandwidth will change the time of the process.
- Hardware components, any delay that will affect the memory performance of the devices will affect the time of the job.

Today, the cryptocurrency with the most transaction volume, namely, Bitcoin uses the HashCash method (Ma et al., 2018: 6). The HashCash method accelerates the process by reducing spammy data. With this proof of work method used, blocks are created in the system and proven transactions are added to these blocks.

### 1.3.5. Transaction Confirmation

When a person who will make a transaction starts the transaction, he / she acquires a unique secret key and private key. Private keys are known only to the owner of the transaction and can be seen as a unique digital identity (Sönmez, 2014: 9). At the same time, with the private key, the user can observe and control transactions between accounts. On the other hand, the public key has been cryptographically altered by the private key. Since this public key also contains the digital signature of the private key, it can also reflect the ownership of the user. To make transactions easier, the public address is used based on the public key. Because public keys consist of long numbers, the use of the public address is seen as a way of shortening the public key. For a cryptocurrency transaction based on a P2P system, users initiate the transaction process by showing each other their public addresses.

The first basic element for transactions made in cryptocurrencies is that the transaction to be made is not more than the current value. If the transaction is more than the value of the available inputs, the transaction is canceled automatically. In transactions where inputs and outputs are acceptable, the action to be performed is spread among the users in the common network. Each transaction's result reaches another user within seconds and checks the digital signatures of the transactions. Users

connected to the public network verify the transactions they have received. Any bad manipulation will be prevented by processing the transactions made into blocks.

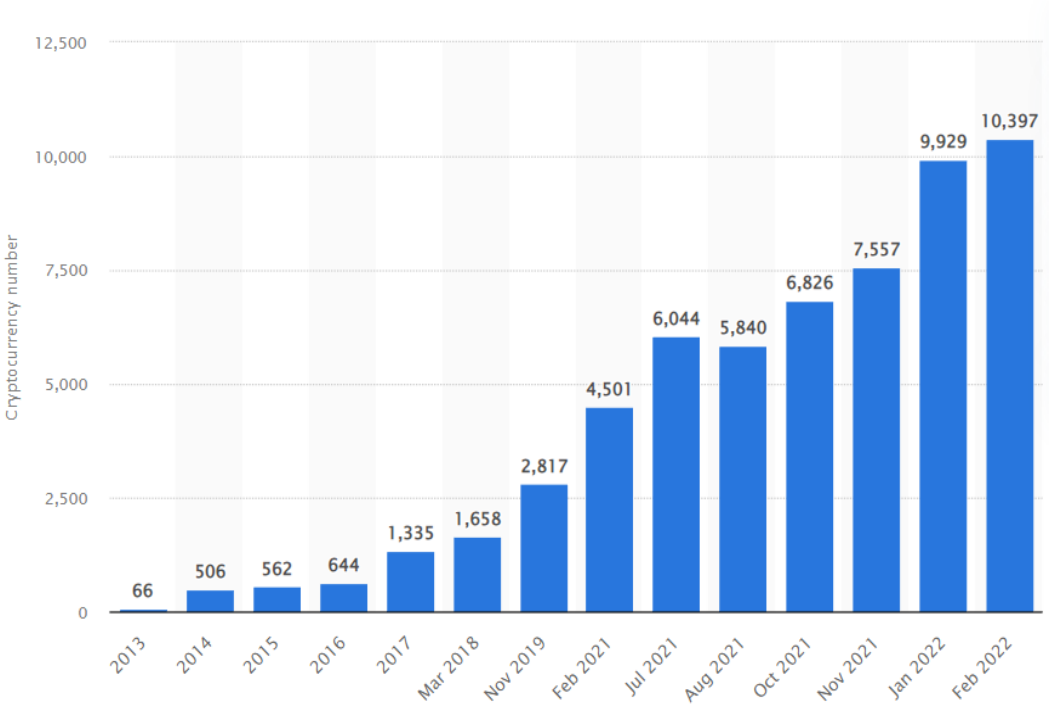
Transactions between cryptocurrencies are entered into the system within seconds, but transactions are not approved immediately. Transactions are confirmed because the transactions received from the common network are seen and recorded in blocks by crypto miners in a distributed manner from end to end (Kasahara and Kawahara, 2016: 4). There is no charge for transactions made via P2P. However, some cryptocurrencies registered on the blockchain can receive commissions to reduce transactions to a period that allows instant identification. Although the person performing the transaction needs the internet to be able to execute the transaction, the recipient does not need to be connected to the internet in any way. Because, thanks to the recording of the transactions made in the blocks, the amount of the transaction made to the account of the buyer will be visible in the blocks and in the buyer's account.

Transaction approval is seen as a healthy method for cryptocurrencies but the time delay in its approval may reveal the "double spending" problem (Çarkacıoğlu, 2016: 40). A person who will initiate the transaction does not cause any problems with a digitally signed transaction to be performed through his public address. On the other hand, if a person tries to make a transaction while the balance is less than the value of the transaction, the system will reject the transaction, and no issues will arise. However, a user can open a transaction of current value in two different places and reveal double spending by spending all his assets more than once. For this reason, when the transaction is initiated, it is important for the transactions to be carried out, that the buyer should observe the transaction in a strictly approved manner.

## 1.4. TOP 3 CRYPTOCURRENCIES BY MARKET CAPITALISATION

With the interest in cryptocurrencies, there are a total of 10,397 cryptocurrencies as of February 2022, within 14 years from the launch of Bitcoin (see Figure 4). Although Bitcoin continues to be known as the most popular cryptocurrency today, there are also different cryptocurrencies that have emerged with different projects in the market and exist as an alternative to Bitcoin. These cryptocurrencies, known as alternative coins / Altcoins, also receive a lot of support from investors.

**Figure 4:** Number of Cryptocurrencies in the Market by Years




Source: Statista. Retrieved 2022, March 23 from https://www.statista.com/statistics/863917/number-crypto-coins-tokens/.

In 2021, Tesla Inc. created a significant institutional demand for cryptocurrencies by investing worth of 1.5 billion USD in Bitcoin (Taskinsoy, 2021: 13). In addition, the importance of cryptocurrencies is increasing day by day with the consideration of cryptocurrencies as a part of Morgan Stanley's customers' portfolios, and the positive statements made by Mastercard and PayPal companies regarding cryptocurrencies (Olga, 2021). Together with the increasing corporate demand for cryptocurrencies, the total market volume in October 2022 reached almost 1 trillion USD. Despite the emergence of alternative cryptocurrencies, currently the most popular cryptocurrency is Bitcoin in the first place with a market capitalization of more than 370 billion USD (see Table 1).

**Table 1:** List of Top 3 Cryptocurrencies (01 October 2022)

| Rank | Name | Symbol | Market Capitalization | Price Per Unit | Circulating Supply |
|---|---|---|---|---|---|
| 1 | Bitcoin | BTC | $370,142,714,486.89 | $19,312.09 | 19.166.368 BTC |
| 2 | Ethereum | ETH | $160,822,630,102.86 | $1,311.64 | 122.611.453 ETH |
| 3 | Tether | USDT | $67,952,350,803.33 | $1.00 | 67.949.424.452 USDT |

Source: Coinmarketcap. Retrieved 2022, October 10 from https://coinmarketcap.com /historical/20221001/.

### 1.4.1. Bitcoin

Previous studies have guided every technological advancement in history. In terms of Bitcoin, as we mentioned in the history of cryptocurrencies, Dai's B-Cash and Szabo's BitGold studies played a role in the formation of the basic logic of cryptocurrencies. Along with these studies, the beginning of cryptocurrencies was initiated with an article "Bitcoin: A Peer-to-Peer Electronic Cash System" by a person whose nickname is known as "Satoshi Nakamoto" in November 2008. In 2009, the Bitcoin network was created and the first block, the "Genesis" block, was processed into the block chain.

Transactions that are completely based on trust and encoded with cryptographic encryption can be performed without the need for any third party (Nakamoto, 2008: 2). This system, which works as a P2P, enables the identification of any transaction, and subjects the transactions to a chain with parties' electronic signature. The public keys of the users are required for the transactions to be carried out, and the users can give commands with the secret key they have to perform the transactions. For the system to work, the following situations occur:

- A new transaction is sent to all ends on the server.
- Each node collects the new transaction in the block.
- The transaction received by the end tries to find a proof of work so that it can be performed.
- The first node that can find proof of work sends its own solution to all ends.
- When a result that can be accepted by each end is found, the correctness of the solution is completed.
- After the process of the transaction is completed, the transaction is recorded in the new block with the hashes in the previous block.

Since the year it was established, Bitcoin has existed without the need for any institution till today. The symbol of Bitcoin, which is abbreviated as BTC, is defined as ₿. Its maximum supply is limited to 21 million Bitcoin, and its mining is decreasingly growing day by day. Bitcoin can be processed as an 8-digit number after the first 0 within its own unit, in other words, a transaction can be performed with 0.00000001 Bitcoin. This smallest unit is known as "Satoshi" (Çarkacıoğlu, 2016: 11). Bitcoin does not have any discouraging transaction processes such as long waiting times and commission charges as in bank transfers used in traditional financial methods. Due to its decentralized nature, Bitcoin can perform all kinds of transactions from P2P at any time of the day. Anonymity is ensured for the parties as the transactions are carried out with electronic wallet addresses. As of October 2022, there are 19.166.368 BTC in circulation (see Table 1).

### 1.4.2. Ethereum

Ethereum (ETH) was created in 2013 by software developer Vitalik Buterin. It is a public, decentralized crypto operating system with its open source and smart contract feature. With the fall of Ripple in 2018, it is traded as the second most popular cryptocurrency in the crypto market. As of October 1, 2022, the total market capitalization has exceeded 160 billion dollars (see Table 1).

A cryptocurrency called "Ether" is used to record transactions made by users in Ethereum. This cryptocurrency is traded as an ETH code, it is also used in cases such as gas payments and calculation fees (Vujičić et al., 2018: 4-6). Unlike other

cryptocurrencies, Ether does not have a limited supply. Like other cryptocurrencies, transactions with Ether are carried out on a block chain protected by cryptographic encryption. As with the Bitcoin system, it is highly protected against data exchanges between blockchains. Each transaction made contains the hash properties of the previous block. Therefore, to change the data in any block, all subsequent blocks must also be changed. Although it has similar features to Bitcoin, Ethereum users can continue to see transactions in their accounts through "State Transition" functions. In addition, while the transaction fees used for Ethereum are equal to $ 0.33, if the same transaction fees are made with Bitcoin, it is equivalent to $ 23 (Kyle, 2017). Similarly, it takes 10 minutes for Bitcoin to confirm and reflect transactions made to blocks. However, the same process with the Ethereum system can be completed in less than 1 minute (Prabath, 2017).

### 1.4.3. Tether

Tether (USDT) is a digital currency, a stablecoin, produced by Tether Limited with the goal of creating a stable value, exactly equivalent to the USD. This cryptocurrency, which was first established in 2014, would create a kind of digital dollar, allowing investors to easily fix their money with a stable currency with a fixed value. Tether, which still maintains a stable existence today, is completely shaped according to the price of the USD. Technically, Tether, which also includes Omni protocols, is backed via Bitcoin (Valdeolmillos et al. 2019: 157). This feature creates an off-chain scalability for this digital currency. Tether, which maintains its existence to protect against fluctuations in the market in general, corresponds to $ 1 today. Tether, which has gone through controversial processes, is operated in partnership with Bitfinex crypto exchange. Previously, the Tether currency stated that it supported 100 percent of its total circulation in the market with its own reserves. However, in 2019, Tether lawyers claimed that 74 percent of the circulation was reserve backed (Nikhilesh, 2019).

## 1.5. DIFFERENCES OF CRYPTOCURRENCIES FROM TRADITIONAL FINANCE

Cryptocurrencies are traded independently from a centralized structure by their assets. For this reason, contrary to traditional finance methods, it cannot be controlled by any authority. With its decentralized feature, many cryptocurrencies can be seen as a P2P transaction system without requiring any third party. The power of these transactions is based on the processing power of the participants in the common network. At the same time, cryptocurrencies exist without any political or economic power behind them. Due to the smart contracts in use, it takes a more advantageous role in the cost and time offered by traditional finance methods. The differences of cryptocurrencies from today's traditional finance methods are listed in detail as advantages and disadvantages in general.

### 1.5.1. Advantages of Cryptocurrencies

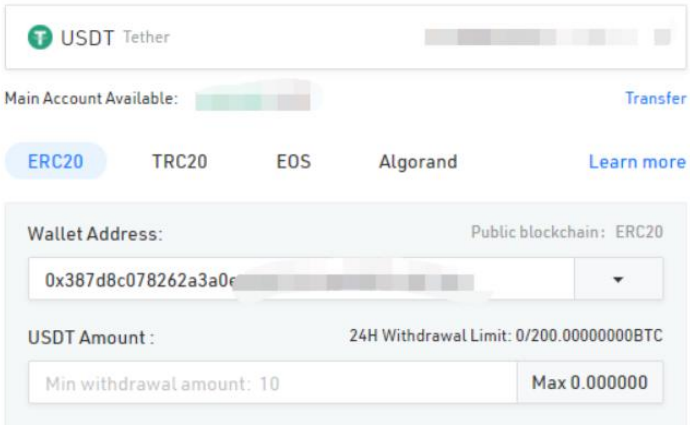
In the use of cryptocurrencies, privacy protections are built into their own codes. Through the blockchain system, people perform their transactions and record them in the system without revealing their own or others' identities (Saxena et al., 2014: 135). Similarly, since it will not be possible to access any private keys with the transaction processes made through the public key, there will be no threat to the users. Unless users explicitly reveal the addresses of their crypto wallets, nobody will be able to track transactions. In addition, people who do not have a private key will not be able to perform any transaction in a similar way and the user will not be able to see the balance in the wallet.

The use of cryptocurrencies compared to traditional banking methods makes the processes in a very short time. While the payments sent to foreign accounts via banks have the possibility to reach a couple of days to be reflected on other accounts, transactions on blockchains will be processed within minutes. At the same time, with the fact that the transactions made with crypto are based on a P2P basis, transactions can be carried out without the approval of any third party (Bunjaku et al., 2017: 37).

Payments to be sent to overseas accounts can be made easily within minutes using mobile phones or computers without the need for any physical card (see Figure 5).

A similar advantage mentioned in the process section stands out in terms of cost. As stated, payments made with cryptocurrencies will be cheaper and faster due to the absence of a third party in a transaction between the parties (Bunjaku et al., 2017: 36). In the case of that issue, the use of cryptocurrencies shows itself as a very advantageous transaction.

**Figure 5:** Transaction via Kucoin with Ethereum Blockchain




Source: Kucoin. Retrieved 2022, March 8 from https://kucoin.zendesk.com/hc/article_attachments/900006791406/mceclip3.png.

In the use of fiat currencies, due to any change in purchasing power, the country using that currency changes the value of their own fiat currency by reducing their interest rates or money supply. Because of central authorities, fiat currency changes in value against other countries' currencies because of government interventions, resulting in inflation or deflation. From this point of view, cryptocurrencies with limited supply cannot be managed by any person or institution, due to their P2P features, without being bound by any authority. Therefore, in such a system, the values of many cryptocurrencies with limited money supply cannot be manipulated, in other words, they will not be in an inflationary attitude (Alpago, 2018: 421).

### 1.5.2. Disadvantages of Cryptocurrencies

A reason that may pose a potential disadvantage can be claimed as the 51% threat (Bradbury, 2013: 6). It will occur if more than 50% of the hash rate in the blockchain where cryptocurrencies operate is captured by individuals or people with the same purposes and disrupts the functioning of the network. Due to the decentralized nature of the block chain system, anyone in the world has access to participate in this network. However, if a person or people seizes a possible 50% control, they can stop adding new blocks to the block chain, remove old processed blocks from the chain, reject other people's transactions and have the opportunity to double spend.

In a fully digitalized market, potential hacking threats are likely to be one of the major obstacles in cybersecurity situations. Handling more than 70% of Bitcoin transactions in the world by 2014, Mt. Gox crypto exchange will be the best example of this. It has been announced by the managers that some problems have occurred in company activities due to security since February 2014. The company announced in February 2014 that they suspended their Bitcoin commercial activities and temporarily suspended their services (Dougherty, 2014). It has been stated that 850,000 Bitcoins belonging to customers are lost in the market. In the statement made by the company, it was claimed that the problem arose due to the suspicious transaction. Exactly 10 days after this statement, the company made another press release due to security problems and continued to suspend the transactions. During this period, in the monthly period from January 2014 to April 2014, Bitcoin lost almost 50% of its value.

The most important disadvantage of individual Bitcoin wallets appears due to anonymity that result from any illegal activities. "The Onion Router" (TOR) technology pioneers this issue, especially in order to achieve this anonymity in the internet environment. Developed in the early 2000s, this technology enables users to isolate their information and location. TOR technology is a platform that can be accessed through the Tor browser (Yardımcıoğlu and Şerbetçi, 2018: 180). Because of this feature, it will be possible to perform illegal transactions by protecting the identity of individuals by accessing the Dark Web, which cannot be accessed through standard web browsers, by people who are prone to illegal activities. The Dark Web platform, on the other hand, can offer some illegal services. These; it may consist of services

such as the sale of illegal weapons, drug trafficking, hacking, and selling of stolen credit cards (He et al., 2019: 77).

With the use of digital signature on the basis of the Bitcoin system, a secure process is provided for the transactions. In a transaction made with Bitcoin, the party receiving the transaction first checks the digital signature of the other party, and if the signature is valid, the transaction is approved and written to the system. As mentioned in the previous sections, there were two main elements at the basis of this digital signature; public key and private key. It was mentioned that it is not possible to access the code of private keys in any way by using public keys. For this reason, it is very important that secret keys consist of only one code and that it is stored. Sharing private keys with other people or obtaining them by third party applications poses a very potential risk (Çarkacıoğlu, 2016: 23). Another person who can access the private key will have the ability to control the transactions belonging to that wallet.

As the demands for cryptocurrencies increase, there is a lot of movement in their prices. The situation was also observed in Bitcoin, which had the highest market also in 2021. Intraday price volatility from January 2021 to March 2021 nearly reached 20% levels on some days (see Figure 6). From this point of view, investors who face high volatility risk may experience losses due to their investments in cryptocurrencies.

**Figure 6:** Price Range of Bitcoin, 2021 January to 2021 April


Source: Binance. Retrieved 2022, June 11 from https://www.binance.com/tr/trade/BTC_USDT.

There is a two-state inflation effect for cryptocurrencies. Although the effect of inflation in the previous section showed a positive atmosphere for the market, this situation may turn in the opposite direction in the future. The biggest problem for this situation arises from the amount of supply, which was discussed as an advantage in the previous section. In terms of market volume, Bitcoin constitutes the highest volume as of 2022 (see Table 1). It is also firmly stated that the maximum supply of Bitcoin will be 21 million. From this point of view, if the high amount of demand in the market cannot be met from the supply side, it may affect the prices of products that are priced with Bitcoin. Therefore, in such a market, cryptocurrencies can gain momentum in a deflationary direction (Çarkacıoğlu, 2016: 64).

## 1.6. LEGAL STATUS OF CRYPTOCURRENCIES

The development of cryptocurrency markets pushes countries to keep up with innovations. With the cryptocurrency markets gaining importance in the market day by day, it has been inevitable for countries to make regulations for cryptocurrencies. Countries make different approaches against the situation that cryptocurrencies can surpass traditional banking methods due to their low cost and fast payment issues.

From a regional point of view, the European Union has evaluated the use of Bitcoin on different issues over the years regarding legal regulations regarding taxation. It is stated that in 2014, the status of value added tax (VAT) on Bitcoin is not valid as the conversion between fiat currency and VAT. However, expenditures for goods and services made with Bitcoin are subject to a value added tax pursuant to the legislation (Library of Congress, 2014: 8).

In 2014, Bitcoin was described as a decentralized convertible "virtual currency" by the European central bank. Although the classification of Bitcoin by the European central bank seems to be a positive situation, during the same period, the European Banking Authority made recommendations for not trading Bitcoin and its derivatives, virtual currencies, unless a legal regulation is made (European Banking Authority, 2014: 23-25).

In 2015, the Court of Justice of the European Union argued that Bitcoin should be exempted from taxation, so Bitcoin should be treated as a means of payment rather

than a good (Solodan, 2019: 67). One of the most important steps taken for the use of cryptocurrencies in the institutional field was reported by the European Commission in 2020 through a proposal. With cryptocurrencies, which were previously referred to as legislation in the European Union market, as financial instruments, a pilot regime was proposed for market structures that want to trade with cryptocurrencies. This new pilot regime offers some exemptions from existing rules in place, allowing organizations to test their processes using blockchains.

Corporate companies in the North America region, especially in Canada, that transact with virtual money, must register to the Financial Transactions and Reports Analysis Center of Canada (2021: 18). During the transactions, it is required to keep records of the cryptocurrencies transacted. However, on the other hand, in 2018, the Bank of Montreal stated that cryptocurrency transactions of individuals with credit or debit cards will be prohibited (Majumder et al. 2019: 131). From this point of view, although cryptocurrency transactions have a legal visibility in the country, the banning by banks reduces the usage areas of cryptocurrencies.

In the United States, the first classification for cryptocurrencies came in 2013. With the statement made by the Ministry of Treasury, Bitcoin is described as a convertible virtual currency. Companies that deal with cryptocurrencies institutionally have to register to the Financial Crimes Enforcement Network (Blanco, 2018: 2-3). Due to the anonymity feature offered by cryptocurrencies, institutions are required to implement anti-money laundering software programs in order to prevent commercial transactions from being used in illegal activities. In addition to this, submitting regular reports to FinCEN is obligated by recording the transactions made.

In Asian countries, there have been many regulations regarding cryptocurrencies. The Indian Government stated well-known cryptocurrencies such as Bitcoin and Tether as neither legal nor illegal in 2018. (Singh and Singh, 2018: 116). Following this statement, it was announced that the same year, the Reserve Bank of India (RBI) prohibited transactions for the purchase and sale of cryptocurrencies. With the increase in demand and transaction volume for cryptocurrencies, in 2020, the Supreme Court of India restrictive implementations on cryptocurrencies imposed by RBI were canceled (Malik and Bandyopadhyay, 2021: 45).

In the People's Republic of China, Bitcoin transactions, in particular, were banned by financial institutions in 2013. The first restrictive step towards cryptocurrencies was taken by the People's Bank of China by banning Bitcoin transactions (Van Alstyne, 2014: 30-32). People's Republic of China, which holds a strict attitude towards cryptocurrencies, banned virtual currency transaction platforms and initial coin offering platforms in 2018 in accordance with the regulations for crypto money platforms (Library of Congress, 2018: 106).

Although there is an uneven attitude in the world markets for cryptocurrencies, some countries have a very conservative behavior towards cryptocurrencies. Especially in Algeria and Morocco, it is completely forbidden to use cryptocurrencies in any transaction, to make a commercial transaction and to be held by individuals or institutions. Institutions and individuals will be punished for any violation of these rules as required by law (Global Legal Research Center, 2018: 5).

In Turkey, there were no legal statements for cryptocurrencies until 2013. According to a press briefing made by the Banking Regulation and Supervision Agency of Turkey in 2013, Bitcoin was not considered as any electronic currency under the law due to its control mechanism and supervision issues which are decentralized. That is why Bitcoin was not seen as a legal payment in Turkey. In addition, Bitcoin was not considered as a currency due to the fact that the parties are not known in transactions using Bitcoin, the market pricing is extremely variable, and digital wallets can be stolen (BDDK, 2013).

In 2021, Central Bank of The Republic of Turkey announced new regulations in terms of use of cryptocurrencies. It was stated that cryptocurrencies cannot be used directly or indirectly for the payments of goods and services. Also, creating a business model that involves the use of cryptocurrencies for payment services is not allowed. With that, payment, and electronic money institutions such as banks or e-money issuers, are not allowed to act as intermediaries for platforms that offer services related to cryptocurrencies (Central Bank of The Republic of Turkey, 2021).

## 1.7. THE EFFECT OF CORONAVIRUS

Since early 2020, the Covid-19 pandemic, which continues to have an impact today, has been affecting both individuals and financial markets. During the period when the number of patients were high, mandatory isolation practices of countries were one of the steps to protect the health of individuals. In addition, in the following period, precautions were taken to ensure that not only civilians but also employees adapted to the mandatory home isolation process. For this reason, some small and medium-sized enterprises could not continue their business activities due to the mandatory isolation at home and production lines stopped for a while. During the Covid-19 period, people sought liquidity, and this created an inactivity in the market. Besides with that issue, inevitably many businesses will be affected by the illiquid market (Baig et al., 2021). Similarly, in the Covid-19 era, in order to better understand any herding behavior on cryptocurrencies, it would be essential to understand the impact of Covid-19 on the world.

### 1.7.1. Brief History of Pandemics

Pandemics have continued at different years throughout human history. Some factors such as changes in climate conditions, migrations and wars have led to the existence of certain diseases and their global spread. Diseases such as Plague of Justinian, Black Death, Smallpox and Spanish Flu have caused the death of many people globally.

The Plague of Justinian is known as the first plague outbreak of pandemic proportions. It is suggested that this disease was first spread by ships coming from Egypt. During periods of intensive grain transportation, rodents such as rats and fleas fed on this grain and increased their population (Silver, 2012: 214-215). Therefore, with the increase in the population of rodents, the spread of the disease accelerated considerably.

The worst of the pandemics, the Black Death, which is also known as the Bubonic Plague, had a major impact in Europe in 1347. The contagiousness of this disease was affected by rodents such as rats. With that issue, rodents play an important role in the spread of the disease. Once a person is infected, the disease causes severe

infections in the lymph nodes of individuals. The Black Death virus was estimated to have killed around 60% of the 14th century Venice population (Slack, 1988: 434).

Another large-scale epidemic is called Smallpox. This virus causes fever, vomiting and affects the existence of pus-filled blisters all over the body. The contagiousness of the disease can be easily passed from person to person. Moreover, the virus can also spread through some of the patient's belongings such as clothes. It is thought that this virus caused around 300 million people's death by the 2000's (Manela, 2011: 251).

One of the first cases of Spanish Flu emerged in 1918. It is known that the results of World War I triggered the spread of this virus. High fever and nosebleeds are the most well-known symptoms of the disease. This virus, which has the one of the highest number of cases, is known to result in approximately 100 million people's death (Aassve et al., 2020: 840).

### 1.7.2. Coronavirus Pandemic

Covid-19 was first reported in the Wuhan region of China in late 2019. Before it was declared as a pandemic, Covid-19 was unofficially named Wuhan virus in 2019 (Masters-Waage et al., 2020: 2). In the early stages of the Covid-19, there was no diagnosis of its infectiousness, so it was not known whether it was transmitted by factors other than human factors. It has been known for years that there are different variations of the coronavirus in the world.

The symptoms of coronavirus include sore throats, coughing, fever and respiratory tract infections. Moreover, this virus can lead to kidney failure and even death. In order to minimize the contagiousness of the virus, certain basic hygiene precautions must be implemented. Foremost among these precautions, wearing a face mask in public places is very effective against Covid-19 (Wang et al., 2021: 8-9). On the other hand, it is recommended to pay attention to hand hygiene after coughing and sneezing.

**Table 2:** Total Cases and Deaths During Covid-19 by Regions

| | Total Cases | | Total Deaths | |
|---|---|---|---|---|
| **Regions** | **March 11, 2021** | **March 11, 2022** | **March 11, 2021** | **March 11, 2022** |
| **World** | 118,996,920 | 455,678,653 | 2,737,141 | 6,066,319 |
| **Europe** | 36,201,164 | 165,749,102 | 876,931 | 1,769,124 |
| **North America** | 33,832,439 | 93,878,965 | 771,363 | 1,396,546 |
| **South America** | 18,985,070 | 55,068,194 | 572,578 | 1,266,824 |
| **Asia** | 25,918,599 | 125,400,248 | 408,149 | 1,374,745 |

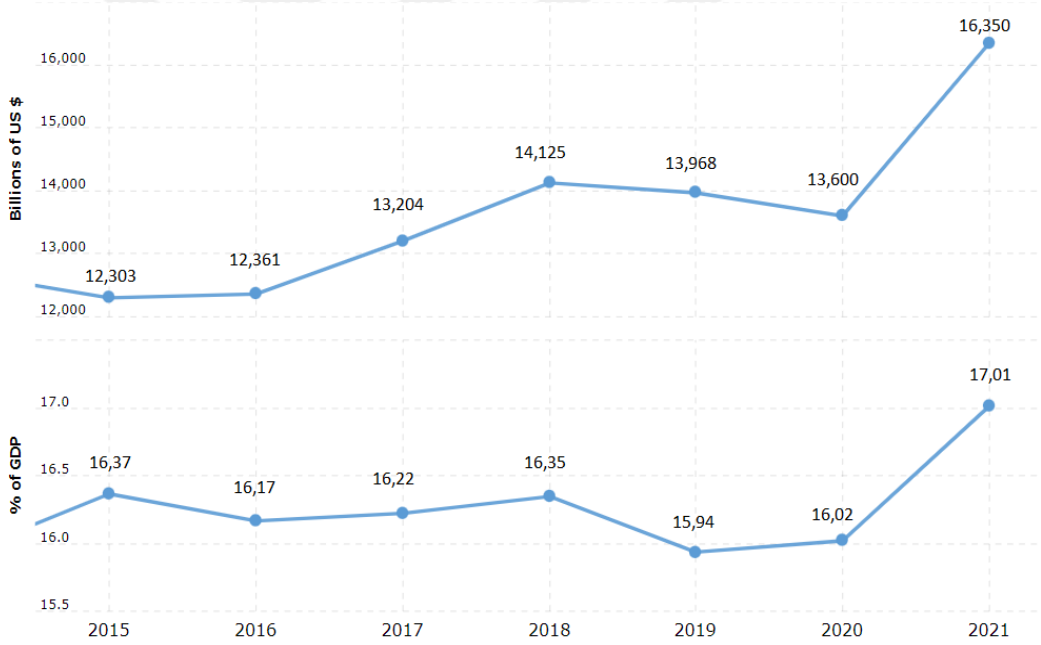
Source: Our World in Data. Retrieved 2022, November 6 from https://ourworldind-ata.org/explorers/coronavirus-data-explorer.

The impact of the Covid-19 pandemic on individuals reveals a frightening picture in terms of number of cases. (see Table 2). Exactly 1 year after the World Health Organization declared March 11, 2020, as a pandemic, more than 118 million of the world's population has been diagnosed with the Covid-19. Interestingly, the number of cases in Asia is lower than in Europe and North America. Although the medical supplies in some Asian countries are not the same as in Europe in terms of medical quality, the fact that the number of cases is lower in Asian countries can be explained by the implementation of quarantine conditions (Deshwal, 2020: 439). With the easing of pandemic precautions, the total number of Covid-19 cases exceeds 455 million by 2022. In other words, this number has increased 3.83 times compared to last year.

### 1.7.3. Economic Effect of Coronavirus Pandemic

Covid-19 outbreak has also shown its effects on the economic indicators of countries. Home isolation practices at the beginning of the pandemic period have significantly affected production lines. In addition, with the inactivity in foreign trade activities, the inflation problem is triggered in many developed and developing countries. In addition to rising inflation values, growth indicators in many countries have also shown a negative trend. In summary, examining this section under the effect of Covid-19 on manufacturing output, inflation and gross domestic product in countries will help us understand the impact of Covid-19.

**Figure 7:** World Manufacturing Output by Years




Source: Macrotrends. Retrieved 2022, November 6 from https://www.macrotrends.net/countries/WLD/world/manufacturing-output.

The impact of the changes in production lines during the Covid-19 pandemic was felt around the world (see Figure 7). Manufacturing output values have shown a continuous growth between 2015 and 2018. In addition, the ratio of manufacturing output to gross domestic product (GDP) was above 16%. However, when it is considered in 2019 and 2020, there has been a decline in manufacturing output values which is more than 500 billion USD. Although the ratio of manufacturing output to GDP in 2020 is higher than in 2019, in numerical terms, there is a difference of 368 billion USD. With the mandatory isolation of the labor force, this situation affects most sectors in waves. Labor-intensive sectors have been the most affected. With the triggering of this situation, the cost increase in commercial activities is triggered. Similarly, the disruption of import activities will also create a change in product inputs (Maliszewska, 2020: 14). In parallel with this information, when looking at 2021, an increase of more than 2.5 billion USD in manufacturing output is observed compared to last year. In the Covid-19 period, the fact that the isolation rules were not used as strictly as before in the precautions enabled companies to return to their activities.

**Table 3:** Consumer Price Index (CPI) of Countries by Years (%)

| Countries | 2018 | 2019 | 2020 | 2021 | 2022 December |
|---|---|---|---|---|---|
| **Argentina** | 47.6 | 53.8 | 36.1 | 50.9 | 95 |
| **Brazil** | 3.7 | 4.3 | 4.5 | 10.1 | 6 |
| **China** | 1.9 | 4.5 | -0.3 | 1.8 | 2.7 |
| **France** | 1.9 | 1.6 | -0.2 | 3.3 | 6.3 |
| **Germany** | 1.7 | 1.5 | -0.7 | 5.7 | 10.2 |
| **India** | 2.5 | 6.7 | 4.9 | 6.3 | 6.4 |
| **Russia** | 4.3 | 3 | 4.9 | 8.4 | 12.5 |
| **Spain** | 1.2 | 0.8 | -0.5 | 6.5 | 7.7 |
| **Turkey** | 20.3 | 11.8 | 14.6 | 36.1 | 73.5 |
| **United Kingdom** | 2.1 | 1.3 | 0.6 | 5.4 | 11.3 |
| **United States** | 1.9 | 2.1 | 1.5 | 7.4 | 6.4 |

Source: IMF. Retrieved 2022, December 2 from https://www.imf.org/external/datamapper/PCPIPCH@WEO/OEMDC/ADVEC/WEOWORLD.

Considering the production in 2019 and 2020, it can be seen that the supply side for manufacturing will not be met in the same way compared to previous years. As the production lines stopped at the beginning of the pandemic period, there was a decrease in overall production. For this reason, existing products will meet the demand side. In the meantime, it will be likely that there will be a demand pressure on the products (Okorie et al., 2020: 2). With this in mind, the consumer price index (CPI) of the countries in 2021 and 2022 has increased considerably compared to the previous years (see Table 3). Although Turkey and Argentina had CPI above 70%, some other developed and developing countries had also seen values in the double digits.

**Table 4:** Gross Domestic Product Growth Rate by Countries (%)

| **Countries** | **2018** | **2019** | **2020** | **2021** |
|---|---|---|---|---|
| **Argentina** | -2.6 | -2 | -9.9 | 10.24 |
| **Brazil** | 1.8 | 1.2 | -3.9 | 4.6 |
| **China** | 6.8 | 6 | 2.2 | 8.1 |
| **France** | 1.8 | 1.9 | -7.9 | 6.8 |
| **Germany** | 1 | 1.1 | -3.7 | 2.6 |
| **India** | 6.5 | 3.7 | -6.6 | 8.7 |
| **Russia** | 2.8 | 2.2 | -2.7 | 4.7 |
| **Spain** | 2.3 | 2.1 | -10.8 | 5.1 |
| **Turkey** | 3 | 0.8 | 1.9 | 11.4 |
| **United Kingdom** | 1.7 | 1.7 | -9.3 | 7.4 |
| **United States** | 2.9 | 2.3 | -3.4 | 5.7 |

Source: IMF. Retrieved 2022, November 6 from https://www.imf.org/external/datamapper/NGDP_RPCH@WEO/OEMDC/ADVEC/WEOWORLD.

One of the changes in economic indicators caused by Covid-19 can be observed on GDP. (see Table 4). Between 2018 and 2019, GDP of developed and developing countries increased, except for Argentina. However, when looking at GDP growth for 2020, it can be seen, many countries are experiencing very serious problems in terms of growth. The possible reasons for this issue can be understood with the inefficient utilization of the labor force and the deterioration of import-export balances (Tan et al., 2022: 15). On the other hand, considering China and Turkey, these countries nevertheless had a positive GDP at the end of the year. Looking at 2021, although the pandemic period continues, there is a significant difference in growth values compared to the previous year. Since the beginning of the Covid-19 pandemic, the regular activity of the workforce has positively affected all countries.

In summary, this global pandemic has caused many impacts on people. On the other hand, the precautions taken against the disease also affected some economic indicators because of restricting the labor force. Considering these reasons, many indicators that we are used to during the Covid-19 period may have changed. The fact that the research covering the Covid-19 period, will offer a new perspective in literature.

# CHAPTER TWO
# THE CONCEPT OF BEHAVIORAL FINANCE

In this section, we provided information on what behavioral finance is and the effects of behavioral finance on individuals and financial investments. We examined the idea of prospect theory, which is the important point of all these concepts. Some biases, which are examples of behavioral finance, have been emphasized. In terms of the scope of the research, explanations about the concept of herding behavior were made and then the literature related to the research was examined in this section.

## 2.1. BEHAVIORAL FINANCE

Individuals are thought to always make decisions that will bring maximum utility in their decisions. The best thesis to summarize this situation is the “Expected Utility Theory”, first mentioned by Daniel Bernoulli in 1738 and later developed by Neumann and Morgenstern in 1944 (Davis et al., 1998: 171-172). The preferred outcomes that a person favors over unknown alternatives are modeled mathematically by expected utility theory, which is employed in economics. It is based on the concept that a utility function, which gives a "utility" to each potential consequence of a decision, can adequately reflect an individual's decision-making. The total of the utilities of each potential outcome, weighted by the likelihood that each scenario would occur, is used to determine the expected utility of a decision. The idea makes the hypothesis that people are logical and maximize their expected utility while making decisions. By weighing the chances and benefits of all potential outcomes, people will select the choice with the highest projected utility.

Bernoulli developed a formulation for a solution to the “St. Petersburg Paradox (also known as St. Petersburg Game)” which revealed a deficiency in decision-making process. (Davis et al., 1998: 172). In short, this paradox is caused by a problem in expected value calculation. The game is a coin toss, and the rules are very simple. If it lands heads, the game is over. When viewed in the light of these rules, a person will earn 2 dollars in case of no heads on the first toss, 4 dollars in case of two no tails, and 8 dollars in case of three no tails, which will continue perpetually. From this point of

view, the "Expected Value" calculation comes into play to calculate how much people should pay for this game with traditional methods. In this context, expected value calculation:

- $\left(\frac{1}{2}\ x\ \$2\right) + \left(\frac{1}{4}\ x\ \$4\right) + \left(\frac{1}{8}\ x\ \$8\right) + \cdots = \$1\ +\ \$1\ +\ \$1\ +\ \$1\ + \cdots\ = \infty$

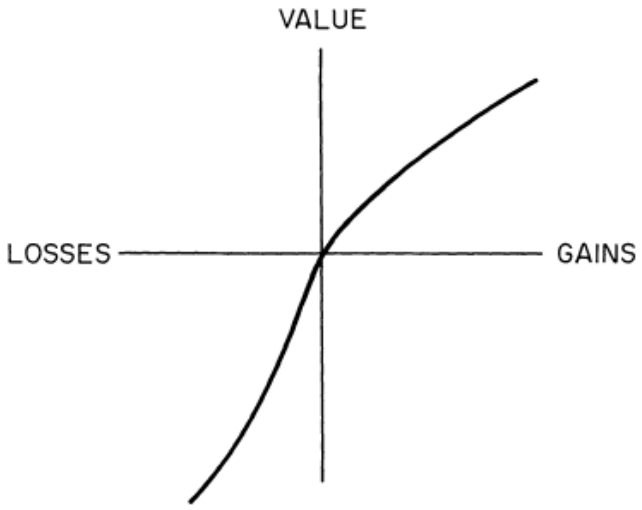
From this point of view, Bernoulli argued that such evaluations would yield an infinite result with the expected value method, so it should be evaluated in another way as he suggested the expected utility. In essence, Bernoulli suggested that the solution should be measured in terms of the value of monetary results and justified the logarithmic function as a workable idealization due to its characteristic of rapidly declining nominal utilities which was stated also with “Marginal Utility” in the following years.

In traditional financial markets another aspect came forward with the “Efficient Market Hypothesis”. This hypothesis suggests that available information must be accurately priced for assets to be meaningfully effective (Fama, 1970: 413). Based on this view, investors in the market will make rational decisions, leading to the correct pricing of assets. Similarly, this hypothesis argues that investors make investment decisions from rational perspectives in order to maximize their profits. Thus, investors calculate their possible expectations with their analysis and make their choices according to the benefit situation.

Traditional financial methods assume that individuals make decisions based on maximum utility. Although traditional theoretical modeling provided a solution to the situation in which individuals with rational mindsets achieved the optimum equilibrium, it could not provide an answer to some of irrational behaviors that occurred (Kahneman and Tversky, 1979: 263). Due to that issue, a behavioral theory which is called "Prospect Theory" was introduced to explain the perceptions of people under the risks and uncertainty. This theory was developed by Daniel Kahneman and Amos Tversky (1979) to being an explanation of irrational decisions that given by people. The theory was also an alternative method of the traditional aspects, which suppose that people are rational who constantly aim to maximize expected value.

One of the most important points of prospect theory is the concept of "Reference Point". Moreover, it also introduces the "Loss Aversion" bias based on value function (see Figure 8). According to that concept, it has been argued that even if people are rational in their long-term decisions, they are more likely to act in loss situations (Tversky and Kahneman, 1991: 1039). Similarly, decisions can appear from a reference point where potential outcomes are evaluated. For example, if a person has $200 in his or her pocket, an extra gain of $50 may be seen as less valuable than a loss of $50.

**Figure 8:** Value Function of Loss Aversion




Source: Loss aversion in riskless choice: A reference-dependent model. Tversky and Kahneman, 1991: 1040

In a different way, it has been suggested that investors give different weights in different scenarios and probability levels according to their earnings and losses according to their current portfolio (Tversky and Kahneman, 1992: 298). In other words, it is predicted that there is a different importance between the perceived risk factor of the investors and the expected risk factors. According to that research, it has been observed that investors pay more attention to the perceived risk factor. In this way, contrary to the efficient market hypothesis, investors do not always invest rationally and in parallel with the right information, thus they are following a behavioral process. As a result, it was reflected that it is possible for human psychology

to display an irrational attitude in decision-making processes which can result in a behavioral bias.

Investors can ignore their own opinions and imitate the decisions of other investors while making their decisions especially in the capital markets (Banerjee, 1992: 816). For this reason, market pricing will not reflect the truth, so a bubble pricing can occur. Similarly, the set of information in the market will be shaped by the behavior created by imitation, not by investors' own ideas. As mentioned, investors' decisions must be visible to other investors in order to create imitations in market pricing.

Rabin and Thaler (2001: 224-227) argue that the expected utility theory is far from explaining most risk situations and that some interpretations of the theory by its users are misleading. The authors argue that it is the change in wealth or welfare status of individuals that matters, rather than the state of values in a decision. From this perspective, the value of wealth at any point in time may reflect wealth status for one individual, but not the same wealth status and sentiment for another individual.

In behavioral finance theory, one of the important effects is stated as "Endowment Effect". It was first explained conceptually by Richard Thaler in 1980. This effect is a phenomenon that describes the fact that people value objects that they own more than other objects that they do not own (Thaler, 1980: 44). Although both products have the same value in terms of cost, their pricing differs for individuals.

One of the most well-known experiments exemplifying the endowment effect was conducted by Kahneman et al. in 1990. In the experiment, the first group was given a coffee mug and told that they could immediately exchange it for a chocolate bar. The second group was given chocolate first and told that they could exchange it for a mug. The third group was asked to choose either the mug or the chocolate. The results of the experiment suggested that, even though mugs and chocolates cost nearly the same, individuals felt more possessive towards coffee mugs and were therefore less likely to exchange them (Kahneman et al., 1990: 1341-1342).

## 2.2. BEHAVIORAL BIASES

Individuals always try to choose the maximum efficient choices for the decisions they make. However, in some cases, individuals may exhibit irrational behavior. Biases appear when individuals do not have a strong feeling in terms of correlation between the frequency of events and their ease of recall (Thaler, 1987: 116). Assumptions about events may be made in an irrational manner due to behavioral bias, which is defined as regular patterns of judgmental divergence from the norm or reason. These irrational judgments cause different reactions in individuals in different scenarios and concepts. The concepts that have a significant impact on behavioral biases are reviewed in this section as follows.

### 2.2.1. Overconfidence

The concept of overconfidence can be described as people having more confidence in the information they hear and believing in this situation in line with their existing knowledge and experience (Bektur and Atasaygın, 2017: 49). From a financial perspective, this can be defined as investors relying more on the probability that their expectations will be realized than in the normal case. However, if the problem of overconfidence poses a costly problem for investors, it is an intriguing question why such a bias is still used in the market. Possibly, it is argued that this issue occurred because overconfidence had created an advantage in human history, supported by different features such as bluffing (Johnson and Fowler, 2011: 2).

According to Ackert and Deaves (2009: 110-112), there are three different types of overconfidence concepts. First, when people exhibit overconfidence bias, it can be defined as a kind of "Better-than-average" effect. In other words, people think that their knowledge and abilities are above average compared to other people. In a study by Svenson (1981: 146), it was stated that people think themselves to be more skilled and less risky person than other members of the groups they are in.

Secondly, another strain came forward under the concept of "Illusion of control". This bias occurs when people believe that they have control over any situation that will objectively occur. For example, in the case of a lucky roll of the

dice, it occurs when people believe that they can control the outcome of the roll at that moment.

Lastly, a bias that is one of the strains of overconfidence is seen as "Excessive optimism". This bias is an optimistic attitude of individuals towards the likelihood of an event or situation occurring in a desirable or undesirable way. A related study can be exemplified by a study conducted by Baker and Emery (1993: 445-449) on newlywed couples. As a result of the experiments, it was concluded that even though the newly married couples had information about divorce, they were more confident that their marriage would continue in a better way than in an average case.

From an investor's perspective, overconfidence can have a significant impact on the actions that individuals take in subsequent periods. In particular, early successful investments may affect individuals' irrational behavior in their decisions. One of the experiments for this concept was provided by Pikulina et al. (2017: 17-20), who argue that overinvestment occurs when individuals exhibit overconfidence. In parallel to this issue, individuals exhibit irrational behavior by showing their overconfidence in their own knowledge towards their investments at the same time.

### 2.2.2. Confirmation Bias

Confirmation bias is an irrational behavior that allows individuals to seek out, evaluate, and remember data in a manner that supports their preexisting views and attitudes. This phenomenon did not emerge in a unitary way, but rather, that is a feature of the complex process of hypothesis development (Klayman, 1995: 413).

By filtering information that conflicts with their beliefs and giving information that supports those beliefs disproportionate weight, people may be affected by this type of cognitive bias. This type of bias can influence how individuals assess the evidence. People may be more inclined to accept information that confirms their preexisting ideas and to reject information that contradicts with their idea when presented. This may cause people to only perceive what people want to see and become unable to assess new information objectively.

In finance, this bias can lead individuals to behave irrationally towards their investments. In particular, if an investor has a strong belief in a particular stock and

only assigns information according to their own opinion for the favorable decision, that investor is likely to be negatively affected by this bias. In a study based on individuals' decisions on the stock market, it was examined whether individuals exhibit confirmation bias (Park et al., 2010: 14-21). According to the study, investors' trading performance was measured by analyzing the information on the message boards for stocks. As a result of the study, it is argued that investors are influenced by message boards, and they reflected confirmation bias. It's critical to maintain objectivity and be open to evaluate a variety of viewpoints and data in order to prevent confirmation bias in finance. Seeking the counsel of people with various viewpoints can also be beneficial since it can assist to reveal biases and give a more balanced perspective.

### 2.2.3. Representative Bias

Representative bias is a behavioral bias that occurs when people make a judgment based on preconceived ideas about a particular phenomenon or event. Such irrational behavior can lead to unfair inferences about events or individuals. According to Tversky and Kahneman (1974: 1124), this irrational behavior is evaluated according to whether state A represents state B. To better illustrate this, Tversky and Kahneman, in the same study, gave the following example: Let us consider a person. This person is both meticulous, modest, and dignified. The same person also has attributes of a doctor, pilot, farmer, and salesman. On what conditions do people evaluate the likelihood of this person being in one of these professions and in what order do they rank them? Moreover, the research conducted on behavioral biases has shown that people rank occupations in exactly the same way according to likelihood and similarity. This kind of approach to this bias leads to serious errors because similarity or representativeness is not affected by the various factors that should influence probability judgments.

When people judge a situation or a person based on their own preconception ideas rather than the available facts, this is referred to as representational bias, which is a sort of cognitive bias. In many different circumstances, this bias has the potential to cause severe consequences by influencing people to make poor assessments and decisions. For instance, representational bias can cause people to wrongly judge

someone based on their ethnicity, gender, or other personal traits in the justice system. This may result in unfair treatment or even false convictions (Cunneen, 2006: 329). Representational bias can result in discrimination and unfair opportunities for particular groups of persons at the workplace.

In finance, representation bias can occur in various ways. One example is; when investors place too much ensure on their own personal experiences and preferences, they can ignore important information that contradicts their beliefs. Moreover, an investor who has had success with a particular stock in the past may continue to invest in that stock even when there are clear signs that it is no longer a good investment. According to Irshad et al. (2016: 26), in line with the aforementioned situation, it has been argued that investors make their decisions based on their past performance. This kind of bias can lead the investor to make poor investment decisions that ultimately result in financial loss. Another study for financial markets was analyzed by Chen et al. (2007: 448) for this bias and they argued that investors exhibit a representative bias.

Being conscious of our own preconceived notions and actively considering the rational factors are two ways to avoid representational bias. It can be accomplished by looking for information from a range of sources, also by being receptive to fresh concepts and viewpoints. Additionally, it can be beneficial to attempt to be fair and impartial when thinking about how the conclusions and decisions might affect various other variables.

### 2.2.4. Mental Accounting

A behavioral finance term known as mental accounting describes how people organize and keep track of personal financial activities (Thaler, 1999: 183). It covers the cognitive factors that people employ to determine the worth and potential uses of their money as well as how to divide it up between various desires and needs.

The component of mental accounting is the fact that people commonly perceive different financial sources as unique from one another and assign them various valuations and meanings. People may give different levels of importance to each of these sources of income, such as treating salary as distinct from savings or investments.

People could view money that they received as a gift differently than money that they had to work hard for. In a study conducted by Kahneman and Tversky (1984: 347), questions were asked whether individuals showed any mental accounting bias. First, they were told that they had a $10 theater ticket and then they lost the ticket. When the subjects were asked if they would pay $10 again to buy the same ticket, 46% answered as yes and 54% answered as no. Then, following the same logic in another scenario, they were told that they had lost $10 when they arrived at the theater and asked if they would pay $10 for the ticket at the theater. Interestingly, 88% of the participants agreed to pay, while 12% did not.

The way that people classify their expenses and divide their money among various purposes is another crucial part of mental accounting. People frequently have a variety of financial objectives, such as saving for retirement, minimizing debt, or putting money aside for a down payment on a house. Additionally, they can spend much money in a variety of areas, including needs, luxury, and unexpected costs. By using mental accounting, people may choose how much money to put toward each of these objectives and categories as well as the most effective manner to spend resources to get there.

A study related to that bias was conducted by Thaler and Shafir (2006: 699-702) on whether individuals view their past expenditures as investment-oriented or expenditure-oriented. In this study, the behavior of individuals was observed after the purchase of an asset, their participation, and their behavior after the loss of that asset. According to the results of the study, while individuals view the assets they purchase as an "investment" in the case of purchase and participation, they view the purchase of the same asset as a "cost" in the case of loss.

In general, mental accounting is a psychological idea that can significantly affect people's ability to make financial decisions and maintain their financial well-being. The ability to comprehend and control mental accounting can be crucial to long-term success.

### 2.2.5. Anchoring Effect

In most cases, individuals make a guess from a starting point that they set for themselves in order to make the final decision. The beginning of this estimation may have occurred due to a formulaic error (Tversky and Kahneman, 1974: 1128). When people give their decisions very heavily on the first piece of information they are given, it is known as the anchor effect which is a cognitive bias. People are prone to being overly influenced by the first piece of information they are given, even if it is unreliable or irrelevant, which can result in distorted judgments and bad decision-making. For instance, picture yourself looking for a new car and having the choice between Car X and Car Y. Car Y is more affordable than Car X. You might think that Car X is the better car without any additional information because it is more expensive. However, you might reconsider your choice if you conduct some investigation and discover that the Car Y has better quality and superior features. In this instance, even though it was unreliable information, the initial cost of the Car X worked as an anchor, affecting your estimation of the car's value.

Our decision-making can be significantly impacted by anchoring, which can be challenging to overcome. One explanation is that information that contradicts our initial views is less likely to be found by our brains than information that reinforces them. In parallel to this issue, Cho et al. (2017: 125) measured the decision-making process of individuals using visual analytics systems and argued that individuals exhibit irrational behavior that shows an anchoring effect.

In a study by Brewer and Chapman (2002: 67-75), manipulation was applied considering the basic anchoring effects of individuals. As a result of the experiments, they found that individuals' basic anchoring effects are more fragile in the absence of the traditional biases.

In conclusion, the effect of anchoring can be dangerous, because it might cause people to base their decisions on inaccurate or insufficient information. It is critical to be conscious of this bias and make an effort to take into account all relevant details while making judgments, as opposed to placing an undue emphasis on the first piece of information we are given.

### 2.2.6. Gambler’s Fallacy

The concept of the gambler's fallacy is stated as when individuals assume that the probability of the next event is higher or lower based on the actual outcomes of previous events (Oppenheimer and Monin, 2009: 326). When the odds are consistently against them, people may assume that the next event will occur in their favor.

To give an example of this concept, coin toss will be an effective item. Suppose that a person flipped a coin five times and all five times it came up heads. When that coin flipped sixth time, people might think that, given the previous events, it is more likely to come up heads this time. But in reality, there will always be a 50% chance that the same coin will come up heads on the sixth time. That can be described as a behavioral bias occurring in the mind of people due to the synthesis of past events (Roney et al., 2003: 1).

The gambler's fallacy can lead to dangerous situations for individuals in the decision-making process. When logical reasoning is ignored, investments will have bad consequences. Investing in a stock based solely on recent stock performance can be an indication of faulty judgment. In order to make more profitable decisions in the future and to make rational decisions, not only the realization of the recent chain of events, but also the chain of events such as factors for the company and external factors in the market should be taken into consideration. In a study that was conducted by Burns and Corpus (2004: 179-182), the probability of people to continue the series for non-random processes was examined. According to the study, it was found that when individuals were implied that a process was not random, they were more likely to continue the same chain series. From this perspective, the gambler's fallacy revealed that people have different orientations in random or non-random series of events.

Another study (Suetens and Tyran, 2012: 16-17) was conducted by observing the numbers selected according to the results of lotto draws. The research groups were evaluated under the male and female sample categorization and their betting behavior on the numbers drawn in the previous week lotto results was assessed. Interestingly, while irrational behavior was found for male participants, no significant result was found for female participants in terms of bias. Accordingly, betting on the previous week's numbers by male individuals indicates that they do not bet on the same numbers for the following week.

In short, the gambler's fallacy, which is an irrational attitude, is a behavioral bias that can lead individuals to make poor decisions. The reoccurrence of any event under the same conditions will occur independently of the previous probabilities. Looking at the decisions to be made from a logical framework and proceeding with an evidence-based method will yield better results. Analyzing the formation of results through internal and external factors by acting independently of investors' prejudices will lead to a more efficient process.

### 2.2.7. Loss Aversion

According to Tversky and Kahneman (1991: 1039), the reaction of individuals to a different factor that will lead to a negative disadvantage will have a greater impact than a different factor that will lead to a positive advantage. In other words, the impact of a loss will be greater than gains. In a situation where individuals exhibit loss aversion can lead to poor investment decisions. Moreover, the fear of losing out on investments can prevent potential future gains.

Loss aversion may lead individuals to follow a riskier process when making investment decisions. For example, as a result of investing in risky stocks, individuals may still hold on to their shares despite being in a losing position. In particular, they are likely to follow a path that is independent of the risk assessments they have built up in the hope of recouping lost investments. In a study conducted by Bouteska and Regaieg (2018: 451), the quarterly performance of companies was analyzed. As a result of the research, it was claimed that the loss aversion bias in companies causes a negative economic performance of companies.

In contrast, loss aversion is a strong factor that can affect people's choices and actions in a variety of situations. This bias, which takes "Prospect Theory" as a reference that we explained in the beginning of this chapter, offers a different perspective compared to traditional finance. Businesses, decision-makers, and people who are seeking to act in their own best interests can all benefit by truly understanding the concept of loss aversion.

### 2.2.8. Herding

Herding behavior is the implementation of society's decisions by considering the decisions of others or society rather than making their own decisions in the face of a situation or phenomenon (Baddeley, 2010: 282). Considering herding behavior as a basis; there may be two elements for investors to act together (Bikhchandani and Sharma, 2000: 281). First of all, the movement in a possible herding behavior may be due to the fact that asset prices in the market are formed in the presence of accurate information. An asset affected by a change in technological, managerial, environmental, or political factors may be perceived by investors in similar ways and subject to a high purchase or a high sale. In such a scenario, the value of the mentioned asset will be priced in line with market conditions that will result in spurious herding behavior. Another factor may arise when investors decide by looking at the change in prices in the market, without any rational exchange of information. In such a scenario, the assets in question may not be priced in line with the information in the market. Moreover, with investors ignoring key information, it will inevitably become a true herding behavior. For this reason, examining herding under two main titles as " Spurious Herding" and "True Herding" will create a more concrete perception about herding behavior.

#### 2.2.8.1. Spurious Herding

Given the basis of herding behavior, it would not be correct to say that this behavior is always made by irrational decisions. If there is not enough information for investment instruments in a market, or if investors have low reliability of information about that investment instrument, it may seem rational to imitate other investors according to some characteristics of investors. Similarly, if decision-making factors affect the right decision-making mechanism due to informational difficulties, they may be affected by investors with different characteristics (Bikhchandani and Sharma, 2000: 281). In line with the ideas mentioned, three basic factors that cause rational herding behavior are mentioned such as information-based herding behavior, compensation-based herding behavior and reputation-based herding behavior.

Informational based herding is a type of behavior that occurs due to the convergence of investor beliefs to general beliefs. Regardless of the information received by the investors, regardless of what the information received, the behavior of the investors should be determined by the general behavior of the market. If this effect is more dominant than personal information, it emerges with an informational frame and informational exclusion occurs (Devenow and Welch, 1996: 605). Also, the investors do not have the personal information of those who invested before them, they only consider the actions of the investors.

The existence of compensation-based herding behavior is also related with the framework of agency theory (Altay, 2008: 32). In the presence of more than one representative in the relationship, the criterion used to determine the wage may be the relative status of the proxies' performances with each other. When the principal is considered as the fund owner or owners, and the agent as the fund managers, herding behavior can occur when the remuneration of a fund manager becomes a function of the performance of other fund managers. In the presence of these conditions, another element of information that will be affected by fund managers in the investment decision-making process was received by other fund managers, whose performances will be based on. One of the biggest reasons behind the emergence of compensation-based herding behavior is that fund managers' performance is compared to other fund managers. This type of herding behavior continues as a fund manager's remuneration becomes a function of the performance of other fund managers. In this way, it will be inevitable to follow high-performance fund managers one after another. Fund managers will mimic each other's decisions and minimize performance risks (Bikhchandi and Sharma, 2000: 291).

The uncertainty of fund managers' ability to obtain and evaluate asset prices can result in mimicking the decision of a successful fund manager. The uncertainty in this matter causes the information set to be used by fund managers in investment decisions to vary according to the characteristics of the first investor. In a market, the signs that talented fund managers will use to make investment decisions will be valid information for asset prices. On the other hand, the signals to be used by low-skilled fund managers can be considered as noises in asset pricing. In such a market, if fund managers are unsure of their abilities, they will rely on the decision of a talented

investor, rather than making a different investment decision from the first investor (Scharfstein and Stein, 1990: 478). Fund managers prefer to follow the initial investor, even if their personal information reveals the opposite. As a result of this approach, personal information or noise is left aside and herding behavior emerges by imitating the decisions of the first investor.

#### 2.2.8.2. True Herding

The efficient market hypothesis suggests that investors exhibit rational behavior throughout the investment process, creating a benefit maximization by investing within the available information in the market while making investment decisions (Fama, 1970: 414). In addition, any situation in the market that takes an irrational shape or investors make irrational decisions is seen as a temporary situation and is ignored, and in the long run, it suggests that the market will return to its normal position. On the other side with the consideration of behavioral finance, investors may ignore their own thoughts and behave irrationally due to social pressure and differing consensus, which does not stem from rational knowledge. Thus, prices in the markets may not reflect the truth, so market prices may be located at a point far from their real value. Also, it is suggested that the factors that cause irrational behavior that especially affect investment activities consist of three main headings; heuristic simplification, self-deception, and social interaction (Kahn, 2004: 17). The first element, heuristic simplification, emerges when investors act intuitively, ignoring the basic elements. Similarly, it has been suggested that investing in a well-known stock, regardless of its performance, represents a more reliable situation for investors (Demir and Songur, 2011: 140). The second element, self-deception, consists of individuals' success and failure situations based on their own ideas. While a profit-making investment based on superficial information is seen as the knowledge of the individual, a loss-making investment can be imposed on a bad luck factor. With the last element, social interaction, individuals can be influenced by each other and reveal herding behavior.

## 2.3. LITERATURE REVIEW

In this section, we have mentioned the literature on herding behavior throughout the study. The effect of herding behavior on financial markets were examined in developed, emerging and frontier markets. Then, herding behavior in cryptocurrencies were discussed and a perspective was presented.

### 2.3.1. Herding Behavior in Financial Markets

The status of the markets is important in order to understand herding behavior. In particular, herding behavior will be more likely to occur in emerging markets than in developed markets (Degirmen et al., 2012: 145). It was argued that the likelihood of false cascades increases, especially when emerging economies are considered to have low quality information. Also, to see the differences in other market structures, frontier markets can also be added to this perception. From this perspective, analyzing financial markets as developed, emerging and frontier markets will create a clearer impression of herding behavior. Secondly, to understand the market dynamics in terms of herding behavior, external factors also were considered in this section.

#### 2.3.1.1. Developed Markets

Chang et al. (2000) examined the herding behavior for the US, Hong Kong, South Korea, Taiwan, and Japan stock markets during periods of intense price volatility by employing cross sectional absolute deviation (CSAD) method. As the result of the study, they did not identify any meaningful herding behavior for the developed market; USA, Japan, and Hong Kong. On the other hand, for South Korea and Taiwan stock markets, which are considered as developing markets, herding behavior was detected during extreme market movements.

In addition, another study was conducted by Chang et al. (2020). They studied herding spillovers between cross sectoral markets in the Covid-19 pandemic with fossil fuel and renewable energy resources. It was observed that a herding spillover was observed especially during the period when oil returns were low in the US.

Similarly, in addition to the open economy features of developed economies, having more information transparency compared to other markets may cause effective information in the market to be more visible. Therefore, capturing herding behavior in such an environment may be more difficult with a single model. With that issue, Vieira, and Pereira (2015) used two different methods to understand whether investor's sentiment affects herding behavior in the Portuguese market. First, herding behavior was measured with the cross-sectional standard deviation (CSSD) method, but not any significant result was obtained. Later, they tested herding behavior using a method created by Patterson and Sharma (2007) on the basis of Bayes theorem, based on the trading of shares by investors, and found the result meaningful. As a result, it may be necessary to use more than one model to understand herding behavior in developed markets.

Hachicha (2010) analyzed herding behavior using by Hwang and Salmon (2007) method and cross-sectional dispersions of trade volumes in the Toronto stock exchange. The statement is saying that the relationship between herding behavior and returns is unstable because of the impact of extreme negative returns. Also, according to the research, the herding behavior for investors includes three main components. The first one is stationary herding, which occurs regardless of the conditions in the market. Another dimension is intentional herding, which is based on investors' expectations about the overall market. Last one is feedback herding, which is influenced by previous instances of herding behavior (Hachicha, 2010:17).

Clements et al. (2017) tested US Dow Jones stocks with using Granger causality for in a search of herding behavior. They found evidence of herding behavior among the stocks in Dow Jones during major market events such as the subprime mortgage and debt crisis. (Clements et al., 2017: 190).

A different region, Central and Southeastern Europe, was analyzed by Filip et al. (2015), using a different method, CSAD, in order to better understand the extent of the mortgage crisis as an external element. They argued that the pre-crisis and post-crisis periods were different in investor behavior, and especially after the 2008 crisis, statistically, herding activities showed more significant results in the markets.

For Spain’s stock market, Blasco et al. (2012: 323) examined herding behavior using the model of Patterson and Sharma (2006), and they suggested that presence of

herding intensity is significantly related with volatility. On the other hand, Caparrelli et al. (2004) studied the Italian stock market to detect herding behavior. They used several models for their methodology. The results showed that only CSSD model revealed the existence of herding behavior especially in extreme market conditions.

In a different study, Litimi (2017) studied the French market to identify herding behavior. The study consisted of CSAD model which includes trading volumes of stocks. The sample was taken between 2000-2016 that includes 232 companies. According to the research, herding behavior was seen especially in crisis periods. But they also stated that the herding behavior did not influence all over the sectors in the stock market. Moreover, they found that the factors that cause investors to engage in collective herding behavior vary by sector. The study's findings also suggested that there was a relationship between herding and market volatility (Litimi, 2017: 17).

Lastly, Economou et al. (2018) studied the stock market of USA, United Kingdom, and Germany to reveal herding behavior. They examined the influence of investor fear which is based on volatility indices of aforementioned countries on herding behavior. The results showed that fear significantly affects herding and evidence for herding in the United Kingdom during certain sub-periods was detected.

#### 2.3.1.2. Emerging Markets

In order to comprehend the characteristics of emerging markets, it will be very important to grasp the conditions of BRICS (Brazil, Russia, India, China, South Africa) economies. Various studies have been conducted within the scope of literature on this concept. Especially in the Indian market, Bhaduri and Mahapatra (2013: 15) suggested that both large- and small-scale enterprises have herding behavior.

On the other hand, according to Sardjoe (2012), there is no evidence for herding behavior in the Russian market. Moreover, it has been suggested that periods of excessive market volatility were similarly not caused by any herding behavior.

Looking at the effects of herding behavior in financial markets, various studies have been conducted on Asian economies. A study in which all companies in the China Stock Market and Accounting Research Database source were taken as a sample by Chen et al. (2003) and suggested the existence of herding behavior in the Chinese

market. Moreover, the authors discussed the A and B class shares in the Chinese capital market separately. Class A shares were considered as shares bought and sold by Chinese citizens for RMB currency at the time, while Class B shares were described as stocks traded by individuals living overseas or by foreign investors. As a result of the research, they argued that the systematic risk in B class stocks is at higher levels. Therefore, it was claimed that investors made irrational decisions in the Chinese capital market in 1996 and 2002, which led to herding behavior.

In addition, an irrational attitude in the Chinese economy has been observed in emerging economies in Asia by Munkh-Ulzii et al. (2018). They analyzed herding behavior in the Chinese and Taiwanese capital markets using the CSAD method. Similar to the previous one, while A-class stocks show a weaker effect on herding behavior, B-class shares and the shares in Taiwan stock exchange continue to exhibit herding behavior at certain periods.

Wu et al. (2020) conducted a study on herd behavior in Chinese markets during Covid-19 pandemic. In this study, they examined Shenzhen and Shanghai stocks for Chinese markets. It was observed that there was a herding especially during the periods when the Shenzhen stocks were extremely low volatile. One of the studies in the Asian region was conducted for Hong Kong markets. Wen et al. (2022: 10-11) used the Hang Seng index for the Hong Kong market and showed that in the post-pandemic period, the market revealed herding.

From another point of view, it was argued that the methods used in research also have different effects on herding behavior rather than market differences by Luu and Luong, (2020: 155). They examined the emerging market characteristics of Vietnam and the Taiwanese stock markets with the frontier market characteristics. It will be more possible to understand the differences between economies better and to understand the characteristics of herding behavior with the use of both CSAD and state space methods. In particular, the fact that the period covers the influenza epidemic allows us to comprehend the characteristics of the period we deal with in our study. As a result of the study, it has been suggested that developing markets are more prone to herding behavior, and the methods used catch the herding behavior easier or more difficult.

Considering a different market, Dhall and Singh (2020: 386-387) found anti-herding behavior for Indian markets in the before Covid-19 pandemic period. On the other hand, when the post-pandemic period is analyzed, they found that there was herding in bull market periods.

Özkan and Yavuzaslan (2022: 164-166) stated that some of Borsa Istanbul indices showed a herding behavior in the bull and bear market during the Covid-19 pandemic period. Şahin (2021: 48) suggested that the Covid-19 pandemic period has a negative impact on investors' perception of investment outcomes in Turkey. In addition, there is not any significant effect in terms of mediator role of pandemic period on investment behavior and outcomes. Similarly, Erdogan (2021: 366), using daily data on Borsa Istanbul stocks, observed that investors exhibit irrational behaviors while they are making investment decisions during Covid-19 period.

#### 2.3.1.3. Frontier Markets

The most important features that distinguish Frontier markets from developing markets are that they reflect a less liquid capital. Although they are seen as riskier markets compared to developed markets, they are still included in the "investment grade" status by credit rating agencies. Looking at the Tunisian market with Frontier status, investors are more likely to apply market tendencies rather than their decisions according to Elkhaldi and Abelfatteh (2014: 1). In that study by using the state space model, it has been suggested that there is herding behavior in the Tunisian market, especially during periods of high volatility.

Similarly, looking at the Amman financial market, it was suggested that the interest in stocks proceeds independently of the risk and return of the market by Ramadan (2015: 192). In the research conducted using the Free Float Share Weighted Index, it was stated that there were 100 companies registered in Amman. The research, covering the data between 2000 and 2014, was examined by CSAD method. As a result, stock pricing of companies in the Amman financial market which is stated as frontier market according to S&P is an example of herding behavior.

According to Berisha and Pavlovska (2015: 39), although herding behavior is also expected in frontier markets, covering the three Baltic countries; no herding

behavior has been detected in Estonia, Latvia and Lithuania. Moreover, it has not been observed that the future expectations of the investors affect the market conditions in any term. However, it has been suggested that activities in the US market have an effect on the movement in these three countries. Therefore, from this point of view, although markets have different internal dynamics, the effects of external factors may also lead to differences in herding behavior.

Factors affecting herding behavior in financial markets may also be caused by external factors rather than the nature of the domestic market. This situation has become an even more important factor, especially in the world where the global economy is effective. Demir and Solakoglu (2016) observed four Middle Eastern countries; Bahrein, Kuwait, Oman and Qatar in their study. In addition, they investigated the impact of external factors on regression equations by addressing the mortgage crisis, the Syrian civil war, the Egypt coup, and price changes in oil. By using the state space model, they found Kuwait and Qatar markets were affected by herding behavior. More specifically the Kuwait market; the mortgage crisis, the Syrian civil war and the exogenous factors in the Egypt coup caused investors to exhibit irrational herding behavior. On the other hand, they found that the changes in stock prices depend on the oil prices, except for rational information.

### 2.3.2. Herding Behavior in Cryptocurrencies

In the previous section, many studies related to herding behavior in financial markets, especially for developed, emerging and frontier markets, were mentioned. In this section, we examined cryptocurrencies. When looking at these assets, it can be seen that cryptocurrencies are not fully mature compared to financial markets. Examining the herding behavior for cryptocurrencies will bring more comprehensive results on these assets. We considered cryptocurrencies as a whole, in order to understand whether there is a comprehensive herding behavior. Afterwards, whether Bitcoin, which is very popular in 2022, affects the crypto market by itself, and further, the impact of external factors on this market were discussed in this section.

In the study proposed by Calderón (2018: 23-25), 100 leading cryptocurrencies were considered to measure herding behavior towards cryptocurrencies. In addition to

CSAD model, which is a frequently mentioned static model in financial markets, and Markow Regime Switching model representing a dynamic model used to examine whether the herding behavior existed in an asymmetric situation. According to this study, while no herding behavior was detected in static modeling, it was suggested that herding behavior was present in dynamic model.

Bouri et al. (2018:6) found a significant result for anti-herding behavior by implementing static CSAD equation for 14 leading cryptocurrencies. In contrast, for the same period, Leclair (2018: 14) found strong evidence of herding behavior for 12 leading cryptocurrencies by using state space model. Moreover, considering the news published during herding behavior, it was suggested that much news did not make a statistical significance on herding behavior.

In a study conducted by Stavroyiannis and Babalos (2019) in order to understand the differences on samples and the differences between models, the time-varying parameter representing the dynamic model, and the CSAD method were used similarly for the static model. In this study, although herding behavior was found with the static equation, no meaningful result could be suggested in dynamic modeling. When the asymmetric feature of herding behavior was considered, they suggested that dynamic analysis provided more accurate results.

In a study conducted by Kumar (2020) in order to better understand the characteristics of cryptocurrency markets, the top 100 cryptocurrencies were considered with static CSAD method and dynamic rolling window analysis. In addition to this, the conditions of the cryptocurrency market during the highly volatile periods were also considered, as well as the basic herding equation. Considering the volatility of the market, herding behavior was observed during periods of high volatility, while anti-herding behavior was observed on non-volatile days.

Ballis and Drakos (2020: 4) captured presence of herding behavior in a sample of top 6 cryptocurrencies with CSAD modeling. Especially the periods in which the market with positive returns show a faster pace compared to the periods with negative returns. Especially the periods in which the market with positive returns showed a faster pace compared to the periods with negative returns.

In another aspect, to understand the interrelation between cryptocurrencies, Jalal et al. (2020) discussed whether there is a herding behavior in the cryptocurrency

market. As seen in other previous studies, it was observed that herding behavior was more intense during periods of high volatility. In addition, it was suggested that the interrelation of the 6 major cryptocurrencies only occurred in the period of low turbulence.

Another study conducted by Raimundo Júnior et al. (2020: 5-13), using the Royalton's Cryptocurrency Index (CRIX), which includes the most prominent 80 cryptocurrencies. They suggested that the crypto market was significantly affected by market stress, thus causing a herding behavior. Moreover, they observed that this situation is significantly intense in highly volatile periods, regardless of market return and volatility index, apart from market conditions.

Mandaci and Cagli (2022) studied whether herding behavior appeared in both pre and during Covid-19 pandemic period in cryptocurrencies. They used the model of Patterson and Sharma (2006) to detect presence of herding. The study suggested a strong presence of herding behavior especially during Covid-19 pandemic period.

To understand whether Bitcoin, which is still developing as a trend in 2022, has an infectious role in this market, various studies were discussed in this section. In general, understanding whether the price changes in cryptocurrencies are in line with the efficient market theory or are affected by Bitcoin will provide a better understanding of herding behavior for these markets. Vidal-Tomás et al. (2019) used 65 cryptocurrencies to address the contagion effect of Bitcoin. In this study, in which CSAD and CSSD methods were used, the effect of the top 5 cryptocurrencies in the sample on other cryptocurrencies in the sample was discussed. Besides the excessive price volatility was not caused by herding behavior, Bitcoin did not have an infectious effect on other cryptocurrencies. However, considering the top 5 cryptocurrencies, it caused herding behavior on other cryptocurrencies in the sample.

Silva et al. (2019), used the CRIX and suggested that investors were more affected by negative effects than positive effects. Although CSAD method did not reflect results regarding herding behavior, the state space model and CSSD were able to capture the herding behavior. In addition, it was emphasized that Bitcoin had a contagious effect on other cryptocurrencies other than the stable coin. Similarly, in order to understand the impact of Bitcoin on other currencies, it was discussed in the concept of transfer currency.

According to Kaiser and Stöckl (2020: 4), when all cryptocurrencies were considered, Bitcoin could be seen as transfer currency transactions. Therefore, it was stated that when investors buy a virtual currency, they firstly make transactions with Bitcoin and then make transactions with other virtual currencies.

As in financial markets, it is necessary to understand the influence of external factors in order to understand market dynamics in cryptocurrencies. In a study conducted by Senarathne et al. (2020: 31), oil and gold indices appear to affect herding behavior in cryptocurrencies. Especially when observing herding behavior on the criptocurrency30 index (CCi30), they suggested that the effect of the mentioned commodities causes herding tendency with non-fundamental information. On the other hand, another exogenous factor, the US stock risk premium did not affect any significant herding behavior on cryptocurrencies.

To better understand the influence of external factors, Philippas et al. (2020) conducted a study that covers the impact of US exchange rate volatility, treasury volatility index and policy uncertainty indices on top 100 cryptocurrencies. They found that the indicators in the cryptocurrency markets were completely affected by external factors mentioned. Moreover, the increases in searches on Google and Twitter for Bitcoin also led to herding behavior.

Another research conducted by Gurdgiev and O'Loughlin (2020: 5), with volatility index, namely the fear index, and the US equity uncertainty index, and with the market capitalization of the top 10 cryptocurrencies. By using daily data and, applying panel data models they found that cryptocurrency markets exhibited herding behavior during bull and bear periods. Moreover, while the forum sentiment had an effect in both periods, it was observed that the uncertainty effect caused herding behavior only during the bull period. In general, investors exhibited a more probable herding behavior in the bear period compared to the bull periods.

# CHAPTER THREE
# EMPIRICAL ANALYSIS

This part of the thesis consists of the aim of the study and the information about the data used in the study. Then we give information on the methodology used. Lastly, we give our empirical results and discuss our findings.

## 3.1. AIM OF THE THESIS

The concept of money, which has been changing since the history of mankind, can now be realized in electronic environments with the developments in technological infrastructures. The idea of cryptocurrency, which is digitally active, has started to take its place in the markets like other commodities. On the other hand, in order to observe movements in the markets, studying the herding behavior, which is one of the concepts of behavioral finance, will be important to understand the decision-making mechanisms of investors. As mentioned in the literature section, this behavior will be an important indicator for the course of markets.

The aim of this thesis is to examine true herding behavior in the cryptocurrency markets. Considering the effects of Covid-19 on economic indicators, herding behavior was analyzed on cryptocurrencies both before and during Covid-19. From this point of view, in order to understand the situation between the periods, it is important for data reliability that the cryptocurrencies are defined on the official cryptocurrency exchange market. Therefore, cryptocurrencies with high market capitalization that have been active on the Binance cryptocurrency exchange since September 11, 2018, were analyzed. At the same time, compared to literature that stated Chapter 2, the Covid pandemic period and the use of the CCi30 index, which is defined as market portfolio, will fill the gap in the literature by differing in terms of data variable.

## 3.2. DATA

In this thesis, our data consists of the cryptocurrencies namely, Binance Coin, Bitcoin, Cardano, Ethereum, Litecoin, Neo, Tron, Stellar, Ripple and VeChain that are traded on Binance cryptocurrency exchange. The selection of cryptocurrencies is based on the market capitalization and the availability of data. Total market capitalization of the cryptocurrencies in our sample is 66.8%. In addition, the CCi30 index is used as a proxy for the market. This index is defined as a dynamic index of the top 30 cryptocurrencies by market capitalization, excluding stablecoins.

We use daily closing prices which are obtained from the Binance application programming interface. The data covers the period from September 11, 2018, to September 11, 2021, for a total period of 36 months. We divide our sample period into two sub-periods such as Before Covid-19 (September 11, 2018- March 11, 2020) and During Covid-19 (March 11, 2020-September 11, 2022). Our data consist of 1095 observations.

## 3.3. METHODOLOGY

The cross-sectional absolute deviation (CSAD) proposed by Chang et al. (2000) is used as a measure of herding behavior. CSAD measure suggests that when securities have similar returns, it may be because of investors that are behaving in a herd-like manner rather than making independent decisions based on their individual knowledge and beliefs. This method is based on the idea that if the returns of a group of securities which are considered as cryptocurrencies in this thesis, are not dispersed around their average, it may indicate that market participants are ignoring their diverse beliefs and instead following similar trading patterns based on a perceived "market consensus."

CSAD is calculated as:

$$CSAD_t = \frac{\sum_{i=1}^{N} |R_{i,t} - R_{m,t}|}{N}$$

where $R_{i,t}$ referred as the returns of cryptocurrency "$i$" in the period of "$t$", N is stated as the number of cryptocurrencies and $R_{m,t}$ is the market portfolio. According to Chang et al. (2000), when there is no herding behavior, CSAD and the returns of the market will have been positive and linear. On the other hand, if there is a herding behavior the relationship will not be linear. With that, it is stated that CSAD and the square market return must be negatively related which is considered as evidence of herding. With that statement, these returns were regressed as:

$$CSAD_t = \alpha + \beta_1 . |R_{m,t}| + \beta_2 . R_{m,t}^2 + e_t$$

To find a herding behavior in cryptocurrency market, it is expected that $\beta_2$ must be negative and statistically significant. When all the information is considered, the hypotheses in the thesis are as follows:

- $H_0$: There is not any herding behavior in cryptocurrency market.
- $H_{1a}$: There is a herding behavior in cryptocurrency market.

In addition, since herding mostly exists as a result of uncertainties, we expect that herding may exist particularly during the Covid-19 pandemic. So that we divide our sample period into two as before and during Covid-19 pandemic and examine these sub-periods separately.

- $H_{1b}$: There is a herding behavior in cryptocurrency market before Covid-19 pandemic period.
- $H_{1c}$: There is a herding behavior in cryptocurrency market during Covid-19 pandemic period.

## 3.4. EMPIRICAL RESULTS

This part consists of the descriptive statistics, unit root tests and regression results.

### 3.4.1. Descriptive Statistics

Table 5 depicts the summary statistics of the variables.

**Table 5:** Descriptive Statistics

| | CSAD | $\lvert R_{m,t} \rvert$ | $R_{m,t}^2$ |
|---|---|---|---|
| **Whole Sample** | | | |
| **Mean** | 0.021443 | 0.029585 | 0.001917 |
| **Median** | 0.017961 | 0.019521 | 0.000381 |
| **Maximum** | 0.119974 | 0.383984 | 0.147444 |
| **Minimum** | 0.002692 | 0.000000 | 0.000000 |
| **Std. Dev.** | 0.014055 | 0.032287 | 0.006353 |
| **Skewness** | 2.437495 | 3.193491 | 14.20961 |
| **Kurtosis** | 11.75475 | 23.09713 | 285.4070 |
| **Jarque-Bera** | 4581.262*** | 20288.89*** | 3675612*** |
| **Before Covid-19 Pandemic** | | | |
| **Mean** | 0.018017 | 0.026037 | 0.001468 |
| **Median** | 0.015982 | 0.015662 | 0.000245 |
| **Maximum** | 0.071228 | 0.185685 | 0.034479 |
| **Minimum** | 0.002692 | 8.10E-06 | 6.55E-11 |
| **Std. Dev.** | 0.009600 | 0.028139 | 0.003392 |
| **Skewness** | 1.932340 | 2.100091 | 4.559043 |
| **Kurtosis** | 9.117349 | 8.170531 | 30.32299 |
| **Jarque-Bera** | 1191.138*** | 1009.552*** | 18875.34*** |
| **During Covid-19 Pandemic** | | | |
| **Mean** | 0.024851 | 0.033113 | 0.002363 |
| **Median** | 0.020159 | 0.023981 | 0.000575 |
| **Maximum** | 0.119974 | 0.383984 | 0.147444 |
| **Minimum** | 0.004898 | 0.000000 | 0.000000 |
| **Std. Dev.** | 0.016715 | 0.035618 | 0.008290 |
| **Skewness** | 2.120253 | 3.609300 | 12.32551 |
| **Kurtosis** | 8.988103 | 26.87975 | 193.1932 |
| **Jarque-Bera** | 1231.573*** | 14236.27*** | 841367.9*** |

Note: *** denotes significance at 1% level.

As seen in Table 5, the mean and the standard deviation of CSAD for during Covid-19 sub-period are higher than those of the other periods. Similarly, both the mean and standard deviation of the absolute market return are greater during Covid-19 period than those of the other periods. The skewness and kurtosis statistics suggest that the indices are right-skewed and leptokurtic. About the Jarque-Bera tests, we reject the null hypothesis of normality, for all regression variables at the 1% level indicating that they are highly nonnormal.

### 3.4.2. Unit Root Tests

First, in order to test the accuracy of the results and the reliability of the model with the sample, Augmented Dickey and Fuller (ADF) Unit Root test is applied. The purpose of this test is to determine whether there is a time-dependent change in the time series values. In non-stationary cases, it is argued that the regression model cannot be expressed by a simple model. Therefore, it is examined whether the data is stationary or not. Our results are presented in Table 6.

**Table 6:** Augmented Dickey and Fuller Unit Root Tests

| | **Trend** | | **Trend and Intercept** | |
|---|---|---|---|---|
| | **Coefficient** | **t-Statistic** | **Coefficient** | **t-Statistic** |
| $\boldsymbol{CSAD_t}$ | -0.624631*** | -15.68187 | -0.625242*** | -15.68032 |
| $\boldsymbol{\lvert R_{m,t} \rvert}$ | -0.904198*** | -21.16485 | -0.904867*** | -21.16255 |
| $\boldsymbol{R_{m,t}^2}$ | -0.965971*** | -22.52235 | -0.967472*** | -22.53787 |

Note: *** denotes significance at 1% level.

The results indicate that the time series is likely to be stationary, with a high level of confidence. This means that the statistical properties of the time series, such as the mean and variance, are likely to be constant over time, and the time series does not exhibit trends, seasonality, or other patterns that change over time. This is an important assumption in time series analysis, and it may be necessary to transform non-stationary time series data before applying these techniques. In summary, unit root tests indicate that the data is stationary.

### 3.4.3. Estimation of Herding Behavior with CSAD

Table 7, 8 and 9 show the estimation results for herding behavior by using CSAD proposed by Chang et al. (2000) for the whole, before Covid-19 and during Covid-19 periods respectively. All estimations are done using the ordinary least squares (OLS).

**Table 7:** CSAD Regression Results (Whole Period)

| $\boldsymbol{CSAD_t = \alpha + \beta_1 . \lvert R_{m,t} \rvert + \beta_2 . R_{m,t}^2 + e_t}$ | | | |
|---|---|---|---|
| **Coefficient** | **Value** | **t-statistic** | **Prob.** |
| $\alpha$ | 0.015092*** | 28.52052 | 0.0000 |
| $\lvert R_{m,t} \rvert$ | 0.243927*** | 10.05754 | 0.0000 |
| $R_{m,t}^2$ | -0.451190*** | -5.748303 | 0.0000 |
| Adjusted R-squared | 0.165612 | Akaike Inf. Criterion | -5.870014 |
| Residual sum squared | 0.179989 | Durbin-Watson Stat. | 1.053681 |
| Log likelihood | 3216.832 | Wald F-Statistic | 71.69919 |

Note: *** denotes significance at 1% level.

As seen in Table 7, the value of coefficient $|R_{m,t}|$ is positive and statistically significant, meaning that the $CSAD_t$ of returns on cryptocurrencies is an increasing function of the absolute value of market returns ($|R_{m,t}|$). In addition, the value of $R_{m,t}^2$ coefficient is negative and significant at 1% level indicating the existence of herding behavior.

As a result, we can say that there is evidence of herding behavior for the whole period. Therefore, the null hypothesis "“$H_0$: There is not any herding behavior in cryptocurrency market.” is rejected.

**Table 8:** CSAD Regression Results (Before Covid-19 Sub-Period)

| $CSAD_t = \alpha + \beta_1.\lvert R_{m,t}\rvert + \beta_2.R_{m,t}^2 + e_t$ | | | |
|---|---|---|---|
| **Coefficient** | **Value** | **t-statistic** | **Prob.** |
| $\alpha$ | 0.013948 *** | 22.07036 | 0.0000 |
| $\lvert R_{m,t}\rvert$ | 0.158017 *** | 3.419646 | 0.0007 |
| $R_{m,t}^2$ | -0.030868 | -0.073501 | 0.9414 |
| Adjusted R-squared | 0.202419 | Akaike Inf. Criterion | -6.674882 |
| Residual sum squared | 0.039910 | Durbin-Watson Stat. | 1.450497 |
| Log likelihood | 1825.243 | Wald F-Statistic | 43.86803 |

Note: *** denotes significance at 1% level.

Then, the herding behavior before the Covid-19 pandemic was analyzed. As can be seen from Table 8, similar to the results for the whole period, the value of coefficient $|R_{m,t}|$ is positive and statistically significant, meaning that the $CSAD_t$ of returns on cryptocurrencies is an increasing function of the absolute value of market returns ($|R_{m,t}|$). However, despite the value of $R_{m,t}^2$ coefficient is negative, it is not statistically significant indicating anti-herding behavior for the period before Covid-19. As a result, the null hypothesis is accepted for the period before pandemic. And "$H_{1b}$: There is a herding behavior in cryptocurrency market before Covid-19 pandemic period." is rejected.

**Table 9:** CSAD Regression Results (During Covid-19 Sub-Period)

| $CSAD_t = \alpha + \beta_1.\lvert R_{m,t}\rvert + \beta_2.R_{m,t}^2 + e_t$ | | | |
|---|---|---|---|
| **Coefficient** | **Value** | **t-statistic** | **Prob.** |
| $\alpha$ | 0.017153*** | 17.84782 | 0.0000 |
| $\lvert R_{m,t}\rvert$ | 0.271497*** | 6.962393 | 0.0000 |
| $R_{m,t}^2$ | -0.546695*** | -5.021830 | 0.0000 |
| Adjusted R-squared | 0.142701 | Akaike Criterion | -5.493588 |
| Residual sum squared | 0.130773 | Durbin-Watson Stat. | 0.984772 |
| Log likelihood | 1510.990 | Wald F-Statistic | 41.60215 |

Note: *** denotes significance at 1% level.

Table 9 presents the regression results for Covid-19 period. As it can be seen, the value of coefficient $|R_{m,t}|$ is positive and statistically significant, meaning that the $CSAD_t$ of returns on cryptocurrencies is an increasing function of the absolute value of market returns ($|R_{m,t}|$). And the value of $R_{m,t}^2$ coefficient is negative and significant at 1% level indicating the existence of herding behavior. As a result, it can be suggested the market shows herding behavior particularly during the Covid-19 period consisting of many unforeseen events. So therefore, we reject the null hypothesis. "$H_{1c}$: There is a herding behavior in cryptocurrency market during Covid-19 pandemic period." is accepted.

According to the findings in general, between September 11, 2018, and September 11, 2021, a case of herding behavior was captured with the CSAD method. When the sample is divided into two sub-periods, the analysis on the model shows that herding behavior on cryptocurrencies was observed only in the 18-month period which is starting from the declaration of Covid-19 as a pandemic on March 11, 2020, to September 11, 2021.

## CONCLUSION

Developments in technological infrastructures have affected the concept of money throughout history. The precious metals that used in the trading process have become the papers printed by governments in return. Moreover, with the effects of digitalization, the use of money is now realized through digital environments. Especially with the rapid developments in technological environment, the concept of cryptocurrency, a new system, has started to take its place in world. Although transactions without the need for a third party are advantageous in terms of both cost and time for cryptocurrencies, the misuse of anonymity is the biggest disadvantage.

Changes in the economic indicators in markets are not only based on endogenous factors. Especially when looking at history, the effects of wars and diseases on money can be seen as great factors. As of 2022, the impact of the Covid-19 pandemic, which is still ongoing, poses a great danger to both the health of individuals and economic indicators. Disruptions in production lines due to isolation policies have significantly affected growth rates and inflation in countries.

The impact of the concept of money on individuals differs from traditional finance theories. Especially with the introduction of the concept of behavioral finance, the behavior of individuals in decision-making stages has begun to be examined in different dimensions. Irrational behaviors exhibited by individuals lead to different biases in different situations. In particular, the effect of "Herding Behavior", which is seen as one of the social effects, has been the subject of this thesis.

Studies in the literature have examined herding behavior in both financial markets and cryptocurrency markets. In particular, herding behavior in financial markets has been examined by authors such as Chang et al. (2000), Vieria and Pereira (2015), Bhaduri and Mahapatra (2013), Chen at al. (2003), Munkh-Ulzii et al. (2018), Luu and Luong (2020), Elkhaldi and Abelfatteh (2014), and it has been argued that investors behave irrationally thus that issue leads herding behavior.

Herding behavior towards cryptocurrencies has also been a topic in the literature, although not as much as financial markets. The studies have examined the herding behavior in cryptocurrencies according to their majority characteristics (Calderón, 2018; Bouri et al., 2018; Leclair, 2018; Stavroyiannis and Babalos, 2019;

Kumar, 2020), the status of Bitcoin (Vidal-Tomás et al, 2019; Silva et al., 2019; Kaiser and Stöckl, 2020) and external factors (Senarathne et al., 2020; Philippas et al., 2020; Gurdgiev and O'Loughlin, 2020).

This study uses daily data of 10 cryptocurrencies, which represents 66.8% of the cryptocurrency market capitalization as of October 1, 2022. The data period covers a 36-month period from September 11, 2018, to September 11, 2021. In particular, before Covid-19 pandemic period and the during Covid-19 pandemic period, are also examined as two separate sub-periods. The CSAD method proposed by Chang et al. (2000) is used to estimate herding.

Our results indicate the presence of true herding behavior for the whole period and the pandemic period. However, we do not observe any herding behavior before pandemic. The findings support our expectations that herding exists mostly during the uncertainty here representing by Covid-19 pandemic. The tendency of herding behavior in the market is seen as the tendency of individuals to follow other investors rather than making independent decisions based on their own analysis. In the presence of herding behavior, irrational price movements are likely to be observed in the cryptocurrency market. In this herding behavior, different anomalies can be observed for investors and the market. In particular, when investors simultaneously move in the same direction in the cryptocurrency market, high volatility can be observed, which can lead to bubble pricing. This can therefore have a significant impact on market stability. One of the effects of herding behavior in the cryptocurrency market is that it can lead to a decrease in the diversification of investors' portfolios. In addition, when individuals follow market pricing rather than their own decisions, potential investment decisions may be missed, and poor investment decisions may be made. Therefore, in extreme conditions such as Covid-19, investing in cryptocurrency markets according to the market trend may have negative consequences for investors.

The findings of the study are parallel to the findings of Bouri et al. (2018), Calderón et al. (2018), Ballis and Drakos (2020), Jalal et al. (2020), Raimundo Júnior et al. (2020), Mandaci and Cagli (2022) suggesting herding behavior in cryptocurrency markets. On the other hand, our results differ from the results of the studies of Silva et al. (2019) and Senarathne et al. (2020) which did not observe any herding behavior after the application of the same methodology.

The model used in the research and the time period considered can be seen as a limitation of the study. Especially in the models presented by Hwang and Salmon (2004), Patterson and Sharma (2006), Christie and Huang (1995), the presence of herding behavior may be concluded by a different case. In addition, the fact that the period used in the study covers a 36-month period and variables such as the cryptocurrencies that used in the study can also be seen as one of the limitations.

Future research can be achieved by examining other behavioral economics concepts for the cryptocurrency market. In particular, the effects of behavioral biases which have been extensively researched in financial markets, can be observed in cryptocurrency markets. Moreover, the use of different models mentioned in limitation will provide a better understanding of cryptocurrency markets.

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