SYSTEMIC RISK IN THE TURKISH FINANCIAL SYSTEM, "ESTIMATION AND RANKING OF CONDITIONAL CAPITAL SHORTFALL BY USING SRISK METHOD"

A THESIS SUBMITTED FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

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Eskisehir, 2020

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ABSTRACT

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The primary objective of this thesis is to measure systemic risk in the Turkish Financial System (TFS) by using SRISK methodology and identifying Systemically Important Financial Institutions (SIFI). We identify the total amount of capital that the Turkish government would have to provide to bail out the financial system in case of a crisis. We use a sample data that covers the period from January 01, 2002 to December 31, 2018. This sample includes a total of 50,186 observations. We obtain daily logarithmic returns for Banks, index and market capitalization from BLOMBERG. Book value of debt and book value of assets are from balance sheets of banks. GJR-GARCH volatility model and standard DCC correlation model were used to achieve the objectives of the thesis. The findings of the thesis highlight two main results. First, TFS has a systemic risk by 155.47 billion TRY in December 2018. This is the total amount of capital that the Turkish government would have to provide to bail out the financial system in case of a crisis. Second, Halk bank (22.72 %), Vakif bank (18.70 %), İş (18.19 %), Yapı Kredi bank (17.06 %) contributed to a total of 76.67% of the systemic risks in Turkey at the end of 2018. Accordingly, these four banks identified as SIFI in Turkey during 2018. The main recommendation of the thesis is to establish a specialized systemic risk center in Turkey.

Keywords: Turkish Financial System, Systemic Risk, SRISK, DCC-GARCH, Financial Crisis.

ÖZET

TÜRK FİNANSAL SİSTEMİNDE SİSTEMİK RİSK, "KOŞULLU SERMAYE YETERSİZLİĞİNİN SRISK YÖNETİMİYLE TAHMİNİ VE SIRALANMASI"

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Anadolu Üniversitesi, Sosyal Bilimler Enstitüsü, Ocak 2020

Danışman: Prof. Dr. Metin ÇOŞKUN

Bu tezin temel amacı, Türkiye finansal sistemindeki (TFS) sistemik riski SRISK metodolojisi kullanarak ve Sistemik Olarak Önemli Finansal Kurumları (SIFI's) tanımlayarak ölçmektir. Ayrıca, bir kriz durumunda finansal sistemi kurtarmak için Türk hükümetinin sağlayacağı toplam sermaye miktarını belirlemek tezin ulaşmak istediği diğer önemli bir amaçtır. Tezde bankaların ve endeksin günlük logaritmik getirileri, bankaların bilançoları, defter değerleri ve piyasa değerleri kullanılmıştır. 1 Ocak 2002-31 Aralık 2018 tarihleri arasındaki dönemi kapsayan toplam 50.186 gözlemi kapsamaktadır. Veriler Bloomberg'den temin edilmiştir. Tezin amaçlarına ulaşmak için GJR-GARCH oynaklık modeli ve standart DCC korelasyon modeli kullanılmıştır. Tezin bulguları iki ana sonucu vurgulamaktadır. Birincisi, TFS'nin Aralık 2018 tarihi itibariyle sistemik riskinin başka bir deyişle kriz durumunda finansal sistemi kurtarmak için Türk hükümetinin sağlayacağı toplam sermaye tutarının 155,47 milyar TL olacağı sonucuna ulaşılmıştır. İkincisi, Halk Bankası (%22,72), Vakıflar Bankası (%18,70), İş Bankası (%18,19), Yapı Kredi Bankası (%17,06)'sının 2018 sonunda Türkiye'deki sistemik risklerin %76,67'sine katkıda bulunduğudur. Bu dört banka 2018 yılında Türkiye'de SIFI olarak tanımlanmıştır. Tezin ana önerisi, Türkiye'de uzmanlaşmış bir sistemik risk merkezi oluşturmaktır.

Anahtar Kelimeler: Türk Finansal Sistemi, Sistemik Risk, SRISK, DCC-GARCH, Mali Kriz.

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Thank you all..

15/01/2020

STATEMENT OF COMPLIANCE WITH ETHICAL PRINCIPLES AND RULES

I hereby truthfully declare that this thesis is an original work prepared by me; that I have behaved in accordance with the scientific, ethical principles and rules throughout the stages of preparation, data collection, analysis, and presentation of my work; that I have cited the sources of all the data and information that could be obtained within the scope of this study, and included these sources in the references section; and that this study has been scanned for plagiarism with "scientific plagiarism detection program" used by Anadolu University, and that "it does not have any plagiarism" whatsoever. I also declare that, if a case contrary to my declaration is detected in my work at any time, I hereby express my consent to all the ethical and legal consequences that are involved.

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SYMBOLS AND ABBREVIATIONS

AKBNK	Akbank TAS
ALBRK	Albaraka Türk Participation Bank A.Ş.
BIST	Borsa Istanbul main index
BRSA(BDDK)	Banking Regulation and Supervision Agency
CoVaR	Conditional Value-at-Risk
ΔCoVaR	Delta Conditional Value-at-Risk
CBRT	The Central Bank of the Republic of Turkey
CMB	Capital Markets Board of Turkey
DCC	Dynamic Conditional Correlation
DENIZ	Deniz Bank A. Ş
ECB	European central bank
ES	Expected Shortfall
ESRB	European Systemic Risk Board
FCIB	Financial Crimes Investigation Board
FFR	Free Float Rate
GARAN	Garanti Bank
GDP	Gross Domestic Products
G10	Group of Ten
G20	Group of Twenty
ICBCT	ICBC Turkey
ISCTR	Turkiye Iş Bank
IMF	International Monetary Fund
KLNMA	Turkiye Kalkinma Bank A.Ş.
LRMES	Long Run Marginal Expected Shortfall
LTD	Lower Tail Dependence
MES	Marginal Expected Shortfall
MTF	Minister of Treasury and Finance
Market Cap	Market Capitalization

QML	Quasi Maximum Likelihood
QNBFB	QNB Finansbank
SDIF	Savings Deposit Insurance Fund
SES	Systemic Expected Shortfall
SIFIs	Systemically Important Financial Institutions
SKBNK	Şekerbank T.A.Ş.
SRC	Systemic Risk Center
SRDTS	Systemic Risk Data Tracking System
SRISK	The measurement of systemic risk
TCMA	Turkish Capital Market Association
TFS	Turkish financial system
TRY	Turkish Lira
TSKB	Turkiye Sinai Kalkinma Bank AS.
VAKBN	Vakif Bank
VaR	Value at Risk
YKBNK	Yapi ve Kredi Bank

CHAPTER ONE

1. INTRODUCTION

1.1. Background

A financial crisis can be defined as the capital shortfall of the financial system. The sequence of financial turmoil in the past decades around the world alerted regulators, policymakers, and researchers to identify the main reasons for the financial crisis. Besides, the recent global financial crisis of 2008 has highlighted the importance of systemic risk, which is known as a macro-level risk. Systemic risk refers to the probability that an event in a significant financial institution could create sharp instability or collapse to an entire economy. Enhancing the stability of the financial system requires identifying the Systemically Important Financial Institutions (SIFIs), which can take practical procedures to prevent a new financial crisis (Brownlees and Engle, 2017).

The Financial Stability Board defines the SIFIs as "*financial institutions whose distress or disorderly failure because of their size, complexity, and systemic interconnectedness would cause significant disruption to the broader financial system and economic activity*" (Financial Stability Board, 2010). In the face of this significant risk to the financial system, regulators and policymakers have called for additional regulatory requirements for SIFIs. Undoubtedly, achieving effective and efficient regulation of systemic risk requires identifying SIFIs. Additionally, another lesson learned from the last global financial crisis; It determines to which extent the governments can bail out the SIFIs when a new financial crisis occurs, and their capacity to cover capital shortfalls of SIFIs (Acharya et al. 2012).

From the last decades and on, many works in the literature contributed to the development of a range of theoretical and empirical models, most of them proposed after the global financial crisis as a result of the role of systemic risk in the crisis. In practice and depending on the data sources used in calculate systemic risk, two main approaches have been introduced in in the literature to measure the contribution of a financial institution to systemic risk in the whole financial system. The first one is based on information which the financial institution provides to regulators. The second method is based solely on public market data, which supposed to reflect all the information about

listed companies. Four methodologies of systemic risk measurements are developed in the financial literature. These methodologies are named as follows:

- The expected systemic loss (Systemic Expected Shortfall: SES) proposed by Acharya et al. (2010).
- Delta Conditional Value-at-Risk (ΔCoVaR) proposed by Adrian and Brunnermeier (2011).
- Expected marginal loss (Marginal Expected Shortfall: MES) proposed by Acharya et al. (2012).
- Measurement of systemic risk (SRISK) proposed by Acharya, Engle, and Richardson (2012) and Brownlees and Engle (2017).

Emerging markets, including Turkey, continued to attract massive Capital Inflows. Turkey, like several other emerging economies, depends heavily on capital inflows from foreign investors, and these funds are in the form of short-term capital inflows often characterized as hot money. The Turkish economy showed a high growth rate before the Turkish lira crisis of 2018, surpassing expectations. For example, the Turkish Statistical Institute announced Turkey's economy grew by 11 percent in the third quarter of 2017, after the decline in 2016 due to the coup attempt, the absence of political stability and geopolitical factors.

The volatility of equity for Turkish banks is high. Furthermore, Derbali and Hallara, (2015) concluded that the banking systems in Turkey are the highest volatility of equity in the Euro Zone. One of the most critical challenges facing the Turkish economy is to keep the stability of the financial system and reduce the volatility rate.

The purpose of this study is to determine the SIFIs in the Turkish financial system. We employ SRISK methodology to measure systemic risk by analyzing daily data for the period between January 1, 2002 and December 31, 2018, comprising daily market data of BIST Banks Index (XBANK).

The sector categories are based on a classification of Borsa Istanbul. This study, to the best of our knowledge, serves as the first study that adopts SRISK methodology to measure systemic risk and determine SIFIs in Turkey. This research is different from the research conducted by Binici et al. (2013), who used the correlations between bank stock returns (Comovement) to measure systemic risk in the Turkish banking system. Also, this

research uses recent data comparing with Talaslı (2013), who used Systemic Expected Shortfall (SES) to analysis systemic risk of Turkish financial institutions using data from 2000-2001 Turkish financial crisis. In addition, Derbali and Hallara (2016) used different approach based on Marginal Expected Shortfall (MES) to estimate and rank the systemic risk of European financial institutions.

Another unique feature of our study is that it determines the total amount of capital that the Turkish government would have to keep bailing out the financial system in case of a crisis. The Turkish government will enhance the stability and confidence in the financial system, and this will contribute to the growth of the Turkish economy. Furthermore, this will help Turkey in achieving its economic goal for 2023, where Turkey plans to be among the world's ten biggest economies.

1.2. Statement of Problem

Systemic risk is the main accused in the global financial crisis of 2007-2008. Firms considered a systemic risk are called SIFIs. Thus, an event at the level of one SIFIs will lead to a collapse in the whole financial system in any economy. Likewise, in the last global financial crisis, the size and combination of Lehman Brothers was a significant source of systemic risk to the US economy. So, when the firm is collapsed, problems were created throughout the financial system and the economy. After the last crisis, the policymakers, regulators, and researchers have intensified their efforts to develop more accurate methods to measure systemic risk and identify SIFIs. Consequently, the identification of SIFIs has helped regulators to identify weaknesses in the financial system, which helps take adequate corrective actions to face future financial crisis and thus maintaining the stability of the financial system. Turkey has a dynamic economy, and it needs to invigorate its growth. Over the last decade, the Turkish financial markets went through condense trade liberalization, and had have attracted worldwide capital inflows.

1.3. The objective of the study

This dissertation intends to achieve the following objectives:

i. Estimating systemic risk in the Turkish financial system.
ii. Identifying SIFIs in Turkey.
iii. Identifying the total amount of capital that the Turkish government would have to provide to bail out the financial system in case of a crisis.

1.4. Research Questions

This research addresses the following questions:

i. Does the Turkish financial system have systemic risk?
ii. What are the SIFIs in the Turkish financial system?
iii. What is the total amount of capital that the Turkish government would have to provide to bail out the financial system in case of a crisis?

1.5. Justification

The findings of this study may enable the investors, policymakers as well as regulators to measure systemic risk in Turkey and identify the SIFIs by applying SRISK as one of the best models, which measures systemic risk as mentioned in the literature. Indeed, the results may help stakeholders to know the systemic risk in Turkey. Furthermore, this study would enable the Turkish government to identify the total amount of required capital to bail out the financial system in case of a crisis. Besides, this study is the first empirical study measuring systemic risk in the Turkish financial system by applying the SRISK methodology and identify SIFIs.

1.6. Scope and Limitation

This study seeks to measure systemic risk and identify the SIFIs in Turkey by applying SRISK methodology. SRISK proposed to measure the conditional capital shortfalls of financial firms and non-financial firms. However, financial firms expected to be more leverage and volatile than non-financial firms. Moreover, the conditional capital shortfall for financial firms affects the whole economy (Brownlees and Engle, 2017).

The banking sector dominates the Turkish financial industry, around 90 per cent of all financial system (IMF, 2017). So, this study will focus on the banks by using daily data for the period between January 2, 2002, and December 31, 2018. Moreover, SRISK methodology does not take into consideration off-balance sheet information. Also, the systemic risk of non-listed institutions cannot be measured by SRISK methodology.

CHAPTER TWO

2. THEORETICAL BACKGROUND AND EMPIRICAL LITERATURE

2.1. Theoretical Literature

2.1.1. Introduction

Many studies in the literature connected between systemic risk and the global financial crisis 2007-2009, but by surveying the history of systemic risk, we found that the term of systemic risk exists before the last financial crisis. Furthermore, there are many studies, official summits, reports, private initiatives and academic papers that have addressed systemic risk before the last financial crisis.

Before the last financial crisis, 2007-2009 systemic risk term refers to the study of financial instability occurs at the level of the firm due to a systemic event. In addition, an essential lesson was learned from the 2007-2009 crisis that systemic risk considered as the main suspect of the financial crisis. Besides, any new financial crisis will affect the real economy and the global financial system. Thus, the systemic risk exists before the last financial crisis, and the conventional approach to deal with systemic risk has been macroprudential like a firm level. Furthermore, that might not be enough for dealing with shocks that affect the system as a whole. So, the importance of measuring systemic risk raised in the last decade and that attractive the researchers and regulators to improve empirical models to measure systemic risk (Potka, 2017).

In this chapter, we are reviewing the theoretical literature in section 1, the definition of systemic risk, the differences between systematic, unsystematic and systemic risk, sources of systemic risk, measurements of systemic risk, Turkish financial system (TFS) in section 2, and empirical literature in section 3.

2.1.2. Definition of Systemic Risk

The attempts to define systemic risk have started to appear in the mid-90s of the 20^{th} century. Thus, there are many attempts to definition systemic risk; for example, Kaufman (1995), describes the systemic risk as to the risk of occurrence of a chain reaction of bankruptcies. Another contribution for definition systemic risk improved by

De Bandt and Hartmann (2000), systemic risk can be defined as the risk of experiencing systemic events in the strong sense, taking into consideration the definition of systemic events as financial instability which influence spread among financial system as a whole.

In a report of Group of Ten (G10) (2001) proposed the following definition, systemic financial risk is the risk that an event will trigger a loss of economic value or confidence in, and attendant increases in uncertainty about a substantial portion of the financial system that is serious enough to quite probably have significant adverse effects on the real economy.

The European central bank (ECB, 2004) defines it as the probability that the default of one financial institution will make other financial institutions default. Also, this risk interdependence would harm liquidity, credit, stability and the confidence of the markets. A noteworthy the (ECB, 2010) redefined systemic risk again as the risk of experiencing a systemic event. Systemic events can be understood broadly as financial instabilities spreading to the extent that the financial intermediation process is impaired and economic growth and welfare suffer materially.

Acharya et al. (2009) find that systemic risk can be defined as capital market collapse or generalized bankruptcies, which may cause a financial crisis in banks. Also, Derbali and Hallara (2016) defined systemic risk as the risk of financial collapse with long term losses in the overall financial system.

Bisias et al. (2012) concluded that there are many different aspects of systemic risk like, imbalance (Caballero, 2009), collapse of public confidence in the system (Billio, Getmansky, Lo, and Pelizzon, 2012), correlated exposures of financial system (Acharya, Pedersen, Philippon, and Richardson, 2010), negative spillovers to the real economy (Group of Ten, 2001), information hazard (Mishkin, 2007), feedback behavior (Kapadia, Drehmann, Elliott, and Sterne, 2009), assets bubbles (Rosengren, 2010), contagion (Moussa, 2011), negative externalities (Financial Stability Board, 2009). So, it is tough to find a uniform and approved the definition of systemic risk.

According to Sadoghi (2017), systemic risk is the risk of default of a large fraction of the financial system as a whole due to the spread of financial exposures throughout the system. Also, Pokta (2017) defined systemic risk as to the risk that adverse financial conditions of one financial institution spread to others through contagion effects and

consequently have adverse effects on the real economy. Finally, Investopedia (2019), defined it as the possibility that an event at the company level could trigger severe instability or collapse an entire industry or economy.

As a conclusion, there are six-points in this section as follows:

1- The term systemic risk appears in the mid-90s of the 20th century, and there are many contributions to defined systemic risk, but the contribution increased sharply after the global financial crisis in 2007-2009.
2- The global financial crisis 2007-2009 highlighted the importance of measuring and managing systemic risk. Furthermore, persuade the researchers and regulators to intensify efforts to more understanding of systemic risk in the theoretical and empirical level.
3- Due to the different aspects of systemic risk and the lack of consensus in the literature, there are various methods and measurements have been developed in the literature about systemic risk.
4- Despite the wealth of scientific contribution for more understanding of systemic risk, especially after the 2007-2009 crisis, we notice that hitherto there is no consensus on the definition of systemic risk.
5- We can define systemic risk as "the risk of collapse of a financial system due to a systemic event occurred in the essential financial institution or more, and transmission that throughout the system."
6- A systemic event can be defined as a financial instability (Financial distress) in the essential financial institution.

2.1.3. Unsystematic, Systematic and Systemic Risk

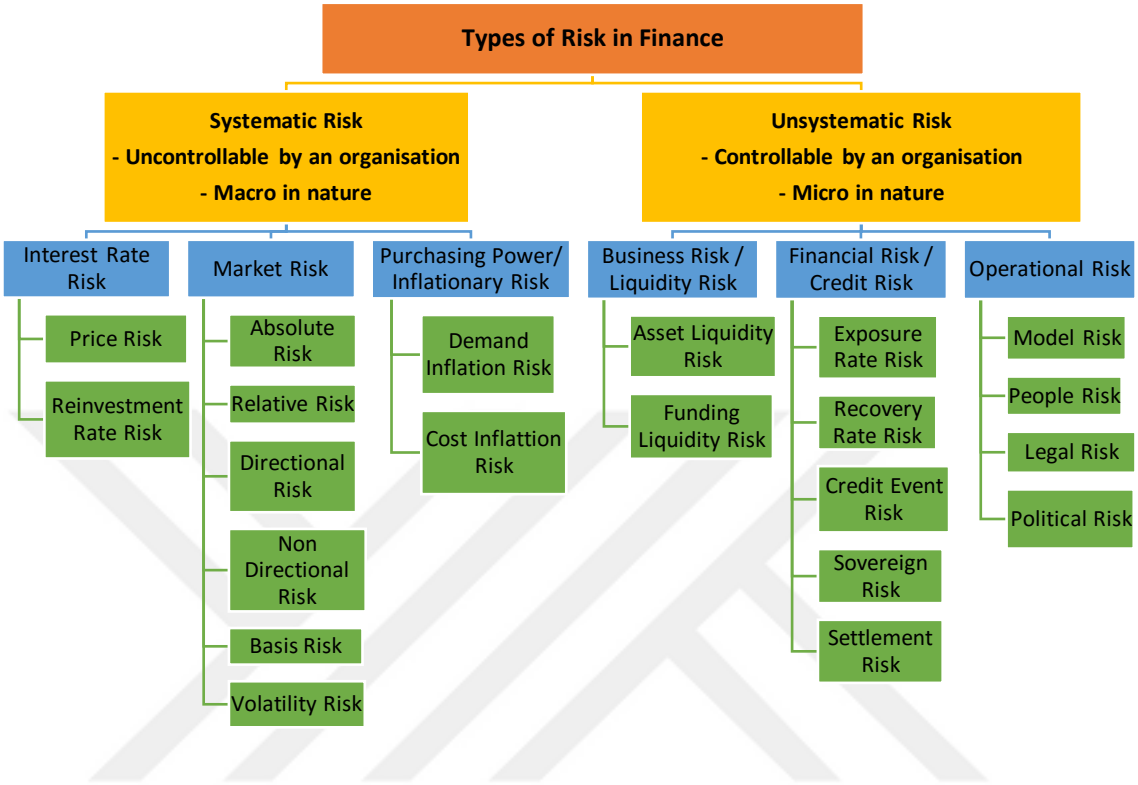
Unsystematic risk can be defined as the uncertainty associated with a particular investment or industry. So, any risk associated with an asset or investment is an unsystematic risk. Unsystematic risk can be drastically reduced by diversification, so a portfolio with various assets has almost no unsystematic risk. Unsystematic risk is controllable by a company or industry and micro in nature. Also, it is known as residual risk, diversifiable risk, specific risk, and non- systematic risk as seen in figure 2.1.

Systematic risk can be defined as the uncertainty inherent to the aggregate market that cannot be solved by diversification. Furthermore, it can be raised from the fluctuation of returns caused by the macroeconomic factors that affect all risky assets. Systemic risk cannot be avoided by diversification; thus, when the investor selects a diversified portfolio cannot reduce the systematic risk, because of this type of risk affects all assets in the market. Systematic risk is uncontrollable by a company or industry and macro in nature, also known as market risk, undiversifiable risk as seen in figure 2.1.

Systemic risk is defined above the risk of collapse a financial system due to a systemic event occurred in the essential financial institution or more, and transmission that throughout the system.

We can conclude that systemic risk is more severe and comprehensive on the financial system than systematic risk, and it ingrained with the macroeconomic shocks that affect all financial systems. Systemic risk is often a complete, exogenous shock to the system and maybe necessitating government intervention like the 2008 financial crisis.

Figure 2.1. *Types of Risk in Finance*



Source. *Akrani,2012 https://kalyan-city.blogspot.com/2012/01/types-of-risk-systematic-and.html*

2.1.4. Sources of Systemic Risk

According to Benoit et al. (2015), and Pokta (2017), there are three main categories of mechanisms behind systemic risk, 1- Systemic Risk-Taking, 2- Contagion effects, 3- Amplification mechanisms as seen in figure 2.2

1- Systemic Risk-taking

Systemic risk-taking occurs when many financial institutions investing in the same risky assets and taking significant exposures to the risk. Banks tend to share their risks to other financial institutions by investing in the same assets due to two reasons. First, the banks tend to move together, especially in case of crisis and that imposes negative externalities to other banks. Second, when one bank survives alone, the government will not be compelled to bail out the bank, but when the crisis threated financial system by collapse many banks, the government will be compelled to bail out the financial system (Benoit et al., 2015).

2- Contagion Effects

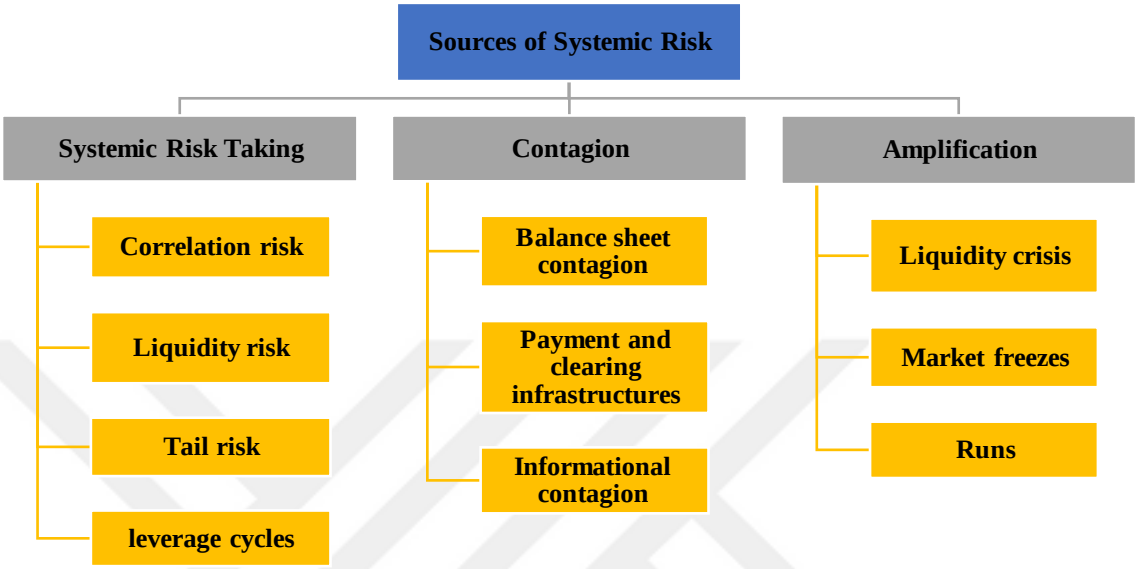
In finance, Contagion can be defined as the spread of financial distress from a financial institution to other institutions or from market to other markets that are associated with the first one. Moreover, it can occur both nationally and internationally; the contagion effects become more prominent phenomena due to the correlated between the financial market and the global economy. According to Benoit et al. (2015), there are three forms of reciprocal links that affect the stability of the system: 1- balance-sheet contagion, 2- payment, 3- clearing infrastructures and informational contagion.

3- Amplification Mechanisms

Amplification mechanisms occur when small events or shocks can turn into a systemic event, while a significant event has no impact on the institution. Amplification also is known as financial Accelerator (SRC, 2019). Pokta (2017) defined amplification as the possibility of a relatively small shock having a substantial effect on the payoffs of the institutions.

Benoit et al. (2015), introduce three mechanisms to explain amplification as follows: 1- liquidity shocks, 2- Market freezes, 3- Banks run.

Figure 2.2. *Sources of Systemic Risk*



Source. *Pokta, 2017.*

2.1.5. Measurements of Systemic Risk

2.1.5.1. Systemic Expected Shortfall (SES)

By reviewing the standard risk measures used inside financial institutions, there are two primary risk measures, the first is value-at-risk (VaR), and the second is expected shortfall (ES). Acharya et al. (2010), focus on ES rather than VaR for two reasons. First, when the risk is below 1% or 5%, VaR does not capture it. Second according to Artzner et al. (1999), VaR is not a comprehensible measure of risk, due to VaR of the sum of two portfolios can be higher than the sum of their individual VaRs, which cannot happen with ES. So, Acharya et al. (2010), "bridge the gap" by the proposed theoretical and empirical method known as systemic expected shortfall (SES). SES can be defined as the expected capital shortfall of a financial institution when the whole financial system is undercapitalization due to a future systemic event (Acharya et al. 2010).

2.1.5.2. Marginal Expected Shortfall (MES)

MES can be defined as the excepted equity loss of a firm when the overall financial market decline below a certain amount over a given period.

Idier, Lamé, and Mésonnier (2014) concluded that the MES could be generally used as standard indicators of financial firm fragility or systemic exposure, at the same time, they argued the ability to use MES as supervision purposes. The results appear that the pure balance sheet ratios were better than MES to expect the financial firm equity losses conditional on a systemic event. Thus, it is early to apply MES for supervision purposes.

In contrast, Derbali and Hallara, (2015) concluded that the MES could be used for supervision purposes and they call for more cooperation between regulators and academicians to improve proper measure and control systemic risk in the financial system.

2.1.5.3. Delta Conditional Value-at-Risk (ΔCoVaR)

In contrast to Acharya et al., (2010), Adrian and Brunnermeier (2011) focus on VaR rather than ES to develop a proper measurement for systemic risk. They proposed a measure of systemic risk known as Delta Conditional Value-at-Risk (ΔCoVaR), "defined as the change in the value at risk (VaR) of the financial system conditional on an institution being under distress relative to its median state." When a financial institution suffers from systemic events, the contingent spread in the financial system. ΔCoVaR is a systemic risk measurement that measures the level of interconnectedness between an institution and the financial system as a whole. ΔCoVaR is a forward-looking measure of systemic risk. This new systemic risk measure is designed by applying ΔCoVaR on the distressed financial institution characteristics like leverage, size, and maturity mismatch. In conclusion, this forward-looking measure can be used in a time series application of the macroprudential policy. Adrian and Brunnermeier (2011) find that there is a weak relation between VaR and ΔCoVaR in the cross-section, but there is a strong relationship between the VaR and ΔCoVaR in the time-series for the same institution.

Girardi and Ergün (2013) build on and generalize a recently proposed systemic risk measure by Adrian and Brunnermeier (2011): Conditional Value-at-Risk (CoVaR). They redefine financial distress as "the return of the institution is at most its VaR as opposed to being precisely at its VaR as proposed by the original study". By this development, we can determine more severe distress events and expand the power of measure in the capture of financial crisis. Additionally, Mainik and Schaanning (2012) concluded that, compared to Adrian and Brunnermeier's risk measure, CoVaR, as defined in their work, seems to be more proper to measure systemic risk and for regulation purposes.

The alertness about systemic risk has raised after the recent financial crisis and among investors and regulators. Value at Risk (VaR) considers as one of the most widely used risk measures whether by the investors and regulators, but the (VaR) has been criticized as focuses on measure the risk inside financial institutions and don't consider the interconnectedness between them. Furthermore, its unable to measure the systemic risk contribution of a financial institution to its financial system, so there was a need to develop a better measure of systemic risk that able to measure the contribution of financial institutions to the systemic risks of the financial system as a whole and identify and ranking (SIFIs).

2.1.5.4. Systemic Risk Measure (SRISK)

The literature highlighted the need for better model to measure systemic risk. Brownlees and Engle (2012) propose a systemic risk measure called SRISK that "measures the expected capital shortfall of a financial institution conditional on a prolonged and severe market decline." SRISK is related to SES introduced by Acharya et al., (2010), and it consider as an improved measure of systemic risk. SES calculates systemic risk by measuring expected capital shortfall of a financial institution when a systemic event occurs. In contrast, SRISK take into consideration the risk arising from the size of the firm, its degree of leverage and the expected loss in its equity stock conditional on the market failure, which we call Long Run Marginal Expected Shortfall (LRMES). SRISK can be computed using balance sheet information and a proper LRMES estimator. The SRISK methodology is used to create rankings of SIFIs: financial

institutions with the highest SRISK are the most important contributors to the capital shortfall of the financial system in times of distress. The overall systemic risk of a financial system is equal to the sum of SRISK for all financial institutions in this system. Additionally, it can be conceived as the aggregate amount of capital that the government would have to offer to rescue the financial system in case of crisis. Many studies used SRISK methodology to measure the systemic risk and determine SIFIs in different countries such as the US (Brownlees and Engle, 2017), China (Derbali, 2017), Canada (Coleman et al. 2017), and Denmark (Grinderslev and Kristiansen, 2016).

2.1.6. Turkish Financial System

2.1.6.1. Regulatory Structure of The Financial System

The financial system in Turkey is characterized by a fragmented organizational structure as seen in figure 2.3, in which supervision and control of the different segment of the financial system is carried out through the self- regulatory of the segment, like the presence of organization in every financial segment that regulates the work of companies and institutions within the financial segment, to which membership in this organization is required for market members (TCMA, 2018).

The banking system seized the large financial segment in Turkey, and it dominated 90 per cent of the financial system (IMF, 2017). Banking Regulation and Supervision Agency (BRSA) oversees the banking system and the regulation of all banking activities in the system. The banking system consists of commercial banks, participation banks, state-owned banks, foreign banks, audit firms, rating agencies, financial holding companies, leasing, factoring, and consumer finance companies. Banks Association of Turkey is the self-regulatory body for commercial banks, development and investment banks. Participation Banks Association of Turkey is the self-regulatory organization for participation banks under which operate interest-free (Islamic) banking principles. The Association of Financial Institutions is the self-regulatory organization for financial leasing, factoring and financing companies (BRSA, 2019).

Capital Markets Board of Turkey (CMB) "*supervises the capital markets. Moreover, all brokerage firms, banks that are authorized for capital market operations,*

asset management companies and investment trusts, should become members of the Turkish Capital Markets Association (TCMA), which represents the self-regulatory body of the capital markets. The primary role of TCMA is to set professional rules and monitor the members to ensure a transparent and stable capital market."

The Central Bank of the Republic of Turkey (CBRT), is primarily responsible for steering the monetary and fiscal policies in Turkey. The Bank's primary objective is price stability, financial stability, foreign exchange rate regime, the privilege of printing and issuing banknotes and payment systems. The CBRT is also charged with supporting the government's growth and employment policies which is not inconsistent with its essential functions, primarily price stability (CBRT, 2018).

MTF is the regulatory and supervisory authority for the insurance sector and the private pension system. The Insurance Association of Turkey is the self-regulatory organization for insurance, reinsurance, and pension companies. Also, the Financial Crimes Investigation Board (FCIB), "*under the Ministry of Treasury and Finance aims to prevent and combat money laundering and financing of terrorism to enhance market integrity*" (Turkish capital markets association, 2018).

2.1.6.2. Financial Stability and Systemic Risk in Turkey

The nature of the Turkish financial system imposes several authorities are responsible for financial stability and implement macroprudential policies for the monitoring and management of systemic risks. These authorities and their duties, mandates, and responsibilities regarding financial stability are given below (CBRT, 2018):

Table 2.1. *Relevant Authority and Area of Responsibility in TFS*

No.	Relevant Authority	Area of Responsibility
1.	The CBRT	Implementation of monetary policy and exchange rate regime to achieve price stability and financial stability, and management and supervision of payment and settlement systems
2.	Banking Regulation and Supervision Agency (BRSA)	Regulation and supervision of activities of all banks, financial holding companies, leasing companies, factoring companies, and financing companies

3.	Minister of Treasury and Finance (MTF)	Public finance, fiscal policy, and regulation and supervision of insurance companies
4.	Capital Markets Board (CMB)	Regulation and supervision of capital markets and intermediary institutions
5.	Savings Deposit Insurance Fund (SDIF)	Protection of the rights and interests of deposit holders, and resolution of banks

Source: *CBRT (2019)*

A range of cooperation and information sharing protocols between the MTF, BRSA, CMB, SDIF, and CBRT enhance the cooperation, coordination, and information sharing among these authorities. This cooperation contributes to achieving and maintaining financial stability, and to monitoring and managing systemic risks. In addition to these authorities, other relevant organizations such as the Financial Stability Committee and the Financial Sector Commission also develop policies oriented towards reducing systemic and macro risks for Turkey.

Financial Stability Committee

In line with the developments on the international platform and the needs triggered by the global financial crisis, the Financial Stability Committee (the Committee) was established under the chair of the MTF. The members of the Committee are Minister of Treasury and Finance, Governor of the CBRT, Chairmen of BRSA, CMB, and SDIF. The key responsibilities of the Committee are to monitor and prevent systemic risks and ensure coordination in systemic risk management (https://en.hmb.gov.tr/, 2019).

The main tasks of the Committee as follows:

- Detect and monitor systemic risks which could spill over to the whole financial system, and identify necessary measures and policy proposals to mitigate these risks,
- Warn the concerned parties about systemic risks, and follow the implementations related to these warnings and policy proposals,
- Assess systemic risk management plans prepared by related institutions,
- Ensure coordination in systemic risk management,
- Collect all sorts of data and information related to its mandate from public institutions, and ensure coordination of policies and implementations among institutions,
- Make decisions on other issues that fall within the scope of its mandate under the legislation.

Other ministers and public officials can also be invited to the Committee meetings by the Minister depending on the scope and nature of the issues to be discussed. Moreover, the Minister, in his/her capacity as the chair of the Committee, briefs the President of the Republic on the results of the Committee meetings and the decisions made by the Committee. On the other hand, working subgroups conduct detailed research and studies on issues related to financial stability. The secretariat of the Committee is carried out by the Minister of Treasury and Finance. The establishment of the Committee is an essential step for Turkey in terms of rendering a corporate structure in the coordination among institutions and creating an active communication channel. Moreover, the Financial Stability Committee plays a significant role in the design of macroprudential policies.

Financial Sector Commission

The Financial Sector Commission is composed of representatives of the BRSA, CBRT, Ministry of Treasury and Finance, CMB, SDIF, Competition Authority, Ministry of Development, Borsa Istanbul, Banks Association of Turkey, and Participation Banks Association of Turkey.

With this broad membership, the Commission undertakes the following tasks:

- Ensuring exchange of information, cooperation and coordination among institutions to maintain trust and stability in financial markets,
- Proposing joint policies,
- Expressing views on the matters related to the future of the financial sector.

The Financial Sector Commission convenes at least twice a year and briefs the Minister of Treasury and Finance on the results of its meetings. The secretariat of the Commission is carried out by the BRSA.

2.1.6.3. Systemic Risk Data Tracking System

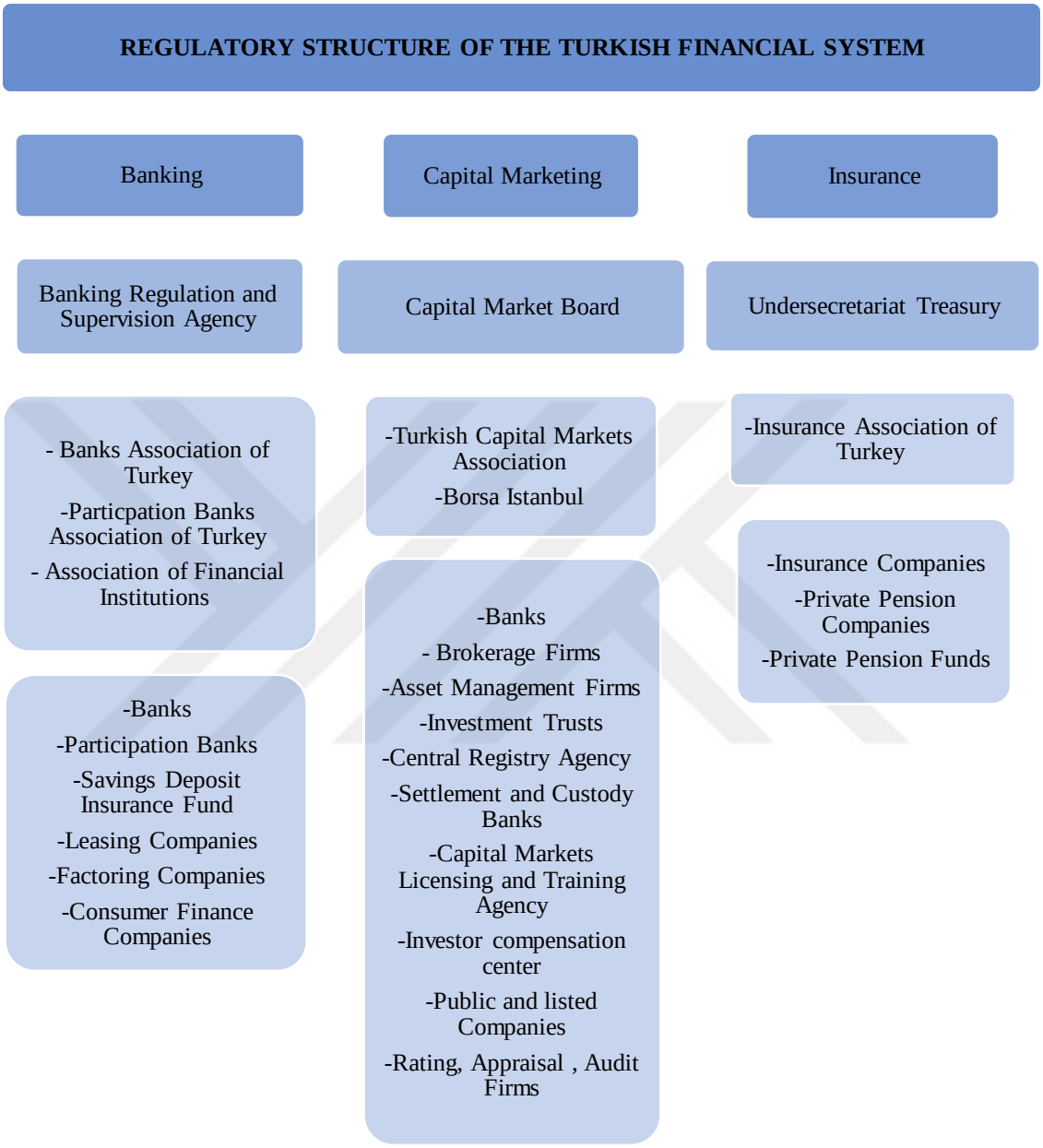
Governments around the world are trying to maintain the stability of their financial system to increase investor confidence and achieve targeted growth rates. one of the most important of these steps is to control systemic risks and prevent a new financial crisis. in Turkey, the regulatory authorities continue to enact legislations and create specialized committees to maintain the stability of the financial system such as

MTF establish the Financial Stability Committee. Also, the establishment of a system for tracking systemic risk data in coordination with the Stability and Financial Development Committee at CBRT.

Systemic Risk Data Tracking System (SRDTS), is a database created to pursue companies that have debts in foreign currencies that exceed a certain limit to monitor the operations of the company to influence the foreign exchange position of the (CBRT) by calculating every quarter. companies that have debts in foreign currencies more than $ 15 million are placed under supervision in the system furthermore the data is verified by independent audit committees.

We can consider the establishment of this system as a good step, but the system does not cover all aspects of systemic risk, and the system is satisfied only with the systemic risks resulting from foreign debt, regardless of the size of the debt in the local currency, the size of the firm and the level of risk in the firm.

Figure 2.3. *Regulatory Structure of The Turkish Financial System*



Source. *Turkish Capital Markets Association (TCMA) Handbook of Turkish capital markets 2018.*

2.1.6.4. Turkish Economy Overview

The Turkish economy is suffering from instability in the last few years as a result of the loss of confidence in the Turkish lira by investors both domestically and internationally. Where the Turkish economy began to recover after the failed coup attempt in mid-2016 by achieving high growth rates and controlling inflation and reduce

the unemployment rate. However, the Turkish economy has fallen into recession due to the large depreciate in the Turkish lira against foreign currencies in mid-2018, where the Turkish lira lost 20% of its value in the second half of 2018. Thus, its reflected on the economic growth, where the Turkish economy grew by 2.4% in the last quarter of 2018, and inflation rates reached a record high of 25% at the end of 2018. It has prompted the CBRT to take monetary and fiscal policies to reduce high inflation rates and also maintain prices stable and to retain the value of the Turkish lira.

According to IMF Executive Board Report (2017), Turkey's rapid economic growth is driven by economic incentives from the government and favorable political conditions in the region. Thus, this growth has caused to economic overheating, by internal and external imbalances, high inflation and a broader current account deficit. The report also highlighted many of the challenges facing the Turkish economy at present, such as significant external financing needs, limited foreign exchange reserves, changes in investor sentiment towards emerging markets, and persistent domestic and geopolitical risks. Despite the resilience of the Turkish economy, macroeconomic reforms must be undertaken to contain inflation, increase reserves and underpin the Lira. Moreover, comprehensive structural reforms will be necessary to boost Turkey’s growth prospects.

Despite the decline in public debt, but increasing risk requires the adoption of fiscal policies to achieve a surplus for the government during the coming period, increase foreign exchange reserves and reduce current account deficit. Furthermore, encouraging continued efforts to strengthen bank supervision and to make the macroprudential regime more robust (IMF, 2018).

We notice that the Turkish economy has developed significantly during the last two decades, especially after the financial crisis that hit the Turkish banking sector in 2000. In addition, the Turkish economy has achieved record growth rates during the last period, and this growth is noticed in all sectors and on the organizational level. The Turkish financial system has a strong and strict regulatory system. It has developed in line with international financial developments. The Financial Stability Committee and the Financial Sector Commission were established. These committees are newly established and need to be strengthened and developed to cope with increasing risks.

The stability of the financial system is crucial for Turkey, and this is achieved through the management and measurement of systemic risk. So, we recommend the establishment of a specialized systemic risk center in the Turkish financial system under the authority of CBRT. Many developed countries have established specialized institutions to manage systemic risks and prevent new financial crisis (such as Volatility Institute - NYU Stern in the United States, European Systemic Risk Board (ESRB) and the Systemic Risk Center SRC in London).

2.2. Empirical Literature

2.2.1. Introduction

This section of the study presents a review of the relevant literature concerning systemic risk and its proposed methods of measurement. It includes theoretical and empirical studies to explain relevant aspects of the study. By reviewing the literature we find many aspects have been proposed and debated in the literature such as, the comparison between the methods that suggested to measure the systemic risk (SES, MES, CATFIN, ΔCoVaR, VaR, SRISK), the factories that contribution of systemic risk (leverage, size, and equity beta), the validity of these methods to estimate systemic risk of an financial system, and which category of financial institutions consider the main contribution to the systemic risk (depository institutions, brokers, insurance, and non-depository institutions). For more understanding, we review the literature of systemic risk in this section.

Over the past few decades, the financial innovations proposed new patterns of financial institutions like hedge funds, mutual funds, investment funds, and broker/dealers, etc. and the financial system has become more complex. Thus, the regulators need to keep pace with this financial innovation to maintain the stability of the financial system. This complexity is an unavoidable consequence of competition, and technological improvement, inevitable consequences, including greater interconnectedness, accompany it. According to the empirical results of Billio, Getmansky, Lo and Pelizzon, (2012), the depository institutions appear to be even more prominent sources of interconnectedness than other financial institutions, which is consistent with the theoretical evidence from the recent financial crisis. The lack of

liquidity of depository institutions assets, coupled with the fact that depository institutions are not designed to withstand rapid and substantial losses (unlike hedge funds), make these institutions a natural repository for systemic risk.

International financial institutions provided many contributions to systemic risk measures. Financial Stability Board states that the systemic risk score should reflect the size, leverage, liquidity, interconnectedness, complexity, and substitutability. Expected capital shortfall method captures in a single measure many of the characteristics considered essential for systemic risks such as size, leverage, and interconnectedness. In contrast, Acharya, Engle, and Richardson (2012), whereas, Weiß, Bostandzic, and Neumann, (2014), concluded that systemic risk, in particular, is predominantly driven by characteristics of regulatory regimes. Also, in contrast to Billio, Getmansky, Lo and Pelizzon (2012), they state that little empirical evidence supporting the frequently stated arguments in the literature that bank size, leverage, non-interest income and the quality of a bank's credit portfolio are persistent determinants of systemic risk across financial crisis.

2.2.2 Previous Literature of Systemic Risk Measures

By reviewing the standard risk measures used inside financial institutions, there are two primary risk measures, the first is value-at-risk (*VaR*), and the second is expected shortfall (ES). Acharya et al. (2010) "bridge the gap" by the proposed theoretical and empirical method known as systemic expected shortfall (SES).

Acharya, Engle, and Richardson (2012) and Brownlees and Engle (2017) state that when the financial system as a whole is undercapitalization, the contribution of each financial institution to systemic risk can be measured by calculating it is a systemic expected shortfall (SES). Besides, we can rank all financial institutions in the system and identify the worst contributions of financial firms in case of crisis. The value of SES variation depending on the leverage ratio and expected marginal shortfall (MES) of a financial firm, Brownlees, and Engle (2017), demonstrate empirically the ability of components of SES to predict emerging systemic risk during the financial crisis of 2007–2009.

According to Idier, Lamé and Mésonnier (2014) the MES can be generally used as standard indicators of financial firm fragility or systemic exposure, at the same time, they

argued the ability of using MES as supervision purposes and unfortunately, the results appear that the pure balance sheet ratios were better able than MES to expect the financial firm equity losses conditional on a systemic event. Thus, it is early to apply MES for supervision purposes. Derbali and Hallara (2015) used MES as a measure of systemic risk in the financial systems in the euro area. The results appear that there is a systemic risk in the European financial system mostly after the global financial crisis in 2007 and following European sovereign debt crisis in 2010. Furthermore, they ranked the financial institutions in the European financial system by using Marginal Expected Shortfall (MES). Also, the financial institutions have a high-level contribution of systemic risk for their system. Thus, they concluded that the MES could be used for supervision purposes, and they call for more cooperation between regulators and academies to improve proper measure and control systemic risk in the financial system.

In contrast to Acharya et al., (2010), Adrian and Brunnermeier (2011) focus on VaR rather than ES to develop a proper measurement for systemic risk. They proposed a measure of systemic risk known as Delta Conditional Value-at-Risk (ΔCoVaR), "Defined as the change in the value at risk (VaR) of the financial system conditional on an institution being under distress relative to its median state." When a financial institution suffers from systemic events, the contingent spread in the financial system. ΔCoVaR is a systemic risk measurement that measures the level of interconnectedness between an institution and the financial system as a whole. ΔCoVaR is a forward-looking measure of systemic risk. This new systemic risk measure designed by applying ΔCoVaR on the distressed financial institution characteristics like leverage, size, and maturity mismatch.

In conclusion, this forward-looking measure can be used in a time series application of the macroprudential policy. Adrian and Brunnermeier (2011) find that for the same institution there is a weak relation between VaR and ΔCoVaR in the cross-section, but there is a strong relationship between the VaR and ΔCoVaR in the time-series.

Doubtfully Value at Risk (VaR) consider as one of the most widely used risk measures whether by the investors and regulators, but the (VaR) has been criticized as focuses on measure the risk inside financial institutions and do not take into account the interconnectedness between them. Furthermore, its unable to measure the systemic risk contribution of a financial institution to its financial system, so there was a need to find better measures of systemic risk, moreover, to be able to measure the contribution of

financial institutions to the systemic risks of the financial system as a whole, thus identify and ranking (SIFIs).

Girardi and Ergün (2013) build on and generalize a recently proposed systemic risk measure by Adrian and Brunnermeier (2011): Conditional Value-at-Risk (CoVaR). They redefine financial distress as "the return of the institution is at most at its VaR as opposed to being precisely at its VaR as proposed by the original study. By this development, we can determine more severe distress events also, expand the power of measure in the capture of financial crisis. Additionally, Mainik and Schaanning (2012) concluded that, compared to Adrian and Brunnermeier's risk measure, CoVaR, as defined in our work, seems to be more proper to measure systemic risk and for regulation purposes. Girardi and Ergün's (2013) results appear that depository institutions were the most significant contributors to systemic risk, followed by broker-dealers, insurance companies, and non-depository institutions, respectively.

Additionally, this result approved with Billio et al. (2012) who concluded that banks are more contributor to systemic risk than other financial sectors. Besides, they investigate the relation between institutions' characteristics and systemic risk contributions; their results suggest that VaR and they ΔCoVaR are weakly related in the time-series as well as in the cross-section. That is not in line with Adrian and Brunnermeier (2011) who find that for the same institution there is a weak relation between VaR and ΔCoVaR in the cross-section, but there is a relationship between the VaR and ΔCoVaR in the time-series. Besides, similar to Adrian and Brunnermeier (2011) and Acharya et al. (2010), find leverage, size, and equity beta to be necessary for explaining institutions' contributions to systemic risk.

Allen, Bali, and Tang (2012) proposed a measure of aggregate systemic risk, designated CATFIN, by predicting macroeconomic declines six months into the future using out-of-sample tests. This study concluded that dependable with bank "specialness," the CATFIN of both large and small banks predict future economic downturns, while another defined measure for both nonfinancial firms and financial firms has no limited predictive ability. Furthermore, significant systemic risk in the banking system affect the economic downturns through aggregate lending activity.

Substantial increases in systemic risk can characterize most financial crisis. Simultaneously, the empirical evidence state that there is no relationship between the probability of an extreme crash of the financial system due to financial crisis (Weiß et al., 2014).

Acharya, Engle, and Pierret (2014) compared the capital shortfall measured and regulatory stress tests. Their comparisons reveal the following impressive results. Stress test models translate an adverse macroeconomic scenario into asset losses on the balance sheet of banks. Stress tests would be more effective if capital requirements were measured differently from the capital adequacy ratio approach. Capital adequacy is not enough as regulatory risk weights do not reflect the change of risks. So, they recommend that regulatory stress tests complement their assessment of bank and system risks by using leverage-based and market-based measures of risk.

Brownlees, Chabot, Ghysels, and Kurz, (2016) Used a novel and unique data set covering eight historical financial crisis, and they find CoVaR and SRISK contain information that would allow regulators to identify SIFIs. VaR appears to be an adequate tool for systemic risk monitoring instead of CoVaR. In many of our analyses, SRISK appears to have a slight advantage over CoVaR. Nevertheless, CoVaR and SRISK provide somewhat similar rankings of the most systemic institutions, and their rankings are correlated with rankings based on size or beta. SRISK is also a prediction of the capital shortage a bank would experience conditional on a systemic event, and SRISK predicts capital shortages during the Great Depression

The alternative measurement approaches produce very different estimates of systemic risk.

Furthermore, the different systemic risk metrics may lead to contradicting assessments about the riskiness of different types of financial institutions. Kleinow, Moreira, Strobl, and Vähämaa (2017) present an empirical comparison of four commonly used systemic risk measures. The systemic risk metrics examined are the (i) marginal expected shortfall (MES), (ii) codependence risk (Co Risk), (iii) delta conditional value at risk (ΔCoVaR), and (iv) lower tail dependence (LTD). The four market-based measurement approaches produce very different estimates of systemic risk. The estimates produced the different risk metrics vary considerably within and between the three

segments of the financial industry as well as between larger and smaller institutions. Although it is challenging to draw universal conclusions, non-depository institutions seem to be the least systemically risky segment according to the four measures.

Furthermore, they find that the four alternative systemic risk measures behave inconsistently with each other over time and may lead to different assessments about the riskiness of different types of financial institutions. Out of the four measurement approaches, the marginal expected shortfall appears intuitively most appealing as it accurately outlines the timeline of the global financial crisis by producing consistently high estimates of systemic risk for the three industry segments and the two size categories amidst the financial turmoil in 2008–2009. Overall, findings suggest that the information provided by different systemic risk measures is quite heterogeneous, and therefore systemic risk assessments based on a single risk metric should be approached with caution.

Giglio, Kelly, and Pruitt (2015) proposed a practical principle to evaluate an extensive collection of systemic risk measures suggested in the literature, and they argue that the proper systemic risk measures should be consistent with the real economic outcomes, furthermore, should be able to predict the future financial shocks in the system. Thus, this proper systemic risk measure expected to be a useful tool for regulation and policy decisions. They find that only a few individual candidates measures be able to capture shocks in the macroeconomic downside risk, but none of them does so robustly across specifications. However, when appropriately aggregated, these measures have a robust predictive power for future shocks in the economy.

Based on the above, various systemic risk measures have been proposed in the last decade, and we can notice that several studies made comparisons between these measures to assess them. Benoit, Colletaz, Hurlin, and Pérignony (2013) have studied several popular systemic risk measures (MES, SES, SRISK, and CoVaR). Central banks and banking regulatory agencies currently use that. Findings indicate that these measures fall short in capturing the multifaceted nature of systemic risk. We have shown, both theoretically and empirically, that most of the variability of these three systemic measures can be captured by one market risk measure or firm characteristics. The quest for a proper systemic risk measure is still ongoing, but we have reasons to remain optimistic as more data become available, with better quality, higher frequency, and broader scope (see G20

Data Gaps Initiative and Cerutti, Claessens and McGuire, 2012). Given the very nature of systemic risk, future risk measures should combine various sources of information, including balance-sheet data and proprietary data on positions (e.g., common risk exposures Greenwood, Landier and Thesmar, 2015) and market data (e.g., CDS à la Giglio, 2012).

2.2.3 Previous Literature of (SRISK)

The literature highlighted the need for better tools to measure systemic risk. Brownlees and Engle (2017) propose a systemic risk measure called SRISK that "measures the expected capital shortfall of a financial institution conditional on a prolonged and severe market decline. Moreover, Theoretical and practical contributions to the development of accurate measures of systemic risk by regulators and academics worldwide, they still cause a considerable challenge to supervisory and regulatory bodies and perhaps the behavior of financial institutions creates systemic risks for the economy as a whole. Pokta (2017) present an empirical evaluation of one particular method of estimating systemic risk with the SRISK measure and point out its shortcomings. His main finding is that while the SRISK measure may be useful for the measurement of systemic risk, its usefulness is limited by the sensitivity to underlying modelling choices, and a more thorough empirical understanding of SRISK is necessary before it can be considered as a tool for systemic risk regulation.

Derbali (2017) assessed the systemic risk of Chinese financial institutions and to determine their contributions to the Chinese financial system. Derbali (2017) used the SRISK as a measure of systemic risk to present a ranking of Chinese financial institutions based on their level of systemic risk. They employ the SRISK as a measure of systemic risk. This measure is used to determine financial institutions' activity default and its potential to become systemic in the whole financial system. The SRISK measure indicates not only individual financial institutions' vulnerability but also the default dependency structure between financial institutions and the Chinese financial market returns. Also, these measures can be moderately useful for identifying systematically critical financial institutions. Besides, the empirical findings indicate that the systemic risk of Chinese financial institutions is significant. The contribution of each financial institution to the

risk of the whole financial system in China is very significant. We show that the dynamic conditional correlation between financial institutions and the market return is the main factor of the systemic risk in China. The results of systemic risk decomposition show that the institution which has a higher level of debt contributes positively and extremely to systemic risk. The limitation of systemic risk needs the application of adequate regulations and reforms in the Chinese financial systems.

Coleman, LaPlante, and Rubtsov (2017) analyzed and discussed possible modifications to the systemic risk measure (SRISK). So, they examined the impact and the choice of the prudential capital ratio parameter for banks and insurance companies. When the SRISK methodology is applied to insurance companies, the segregated fund's adjustment significantly decreases SRISK values. Careful examination of SRISK dynamics for Canadian banks suggests that instead of an expected capital shortfall, it would be more suitable to interpret SRISK values as the propensity of financial institutions to have massive losses during a financial crisis. As anticipated, local crisis are more impactful and result in higher estimates of systemic risk for both banks and insurance companies. Overall, the application of the SRISK methodology to the Canadian banking sector reveals that starting from December 2015, the systemic risk has been increasing. For the analyzed insurance companies, only Manulife is found to be systemically risky under this measure.

Grinderslev and Kristiansen (2016) have implemented SRISK in a Danish context. SRISK is a market-based stress test that only relies on public data available in real-time. SRISK incorporates information not necessarily captured by regulatory stress tests. The usage of a different set of information in combination with SRISK being quick and inexpensive to update, imply that we consider it as an excellent complement to the regulatory stress test already implemented in Denmark’s National bank. Although they have followed Brownlees and Engle (2015) quite closely concerning the modelling and implementation, SRISK was able to predict the government-funded capital injections to Danish credit institutions in 2009 with a relatively high degree of accuracy. Also, they find that SRISK indicated a decreasing degree of capitalization from the late spring of 2007 for the four major banks Danske Bank, Jyske Bank, Sydbank and Nordea. On this basis, they concluded that SRISK could have been a useful tool for detecting risks in the Danish banking sector before and during the financial crisis. Moreover, studies by other

authors find that SRISK has been a good predictor of capital shortfalls during several financial crisis, suggesting SRISK could be a relevant measure to monitor going forward as well.

The SRISK indicator undoubtedly has advantages Tavolaro and Visnovsky (2014): it uses public data; it is based on a transparent methodology that encompasses a refined economic analysis using the latest time-series econometric techniques and the results are publicly reported. Moreover, it addresses a very relevant topic. Academic contributions to systemic risk analysis enhance very stimulating debates about financial supervision and macro-prudential policies. When considering the possible use of the SRISK indicator as a supervisory tool, some limitations appear. They appear to us so salient that hardly any supervisory action can directly rely on the SRISK figures or ranking. It is not to say that the SRISK is not informative and should not be monitored. At a conceptual level, our fundamental concern is the information content. The SRISK reveals itself as mirroring market participants' expectations which may differ significantly from economic fundamentals. At a practical level, on top of its restricted application to listed institutions only, the main limitations of the SRISK are that it provides little information on the economic or financial mechanism at play and on which are the primary sources of risk. Therefore, no preventive actions can be taken based on the indicator. Note that several limitations presented in this note are also shared with other systemic risk indicators, notably the ΔCoVaR. Other strands of the literature dedicated to providing supervisory tools to handle systemic risk are quite promising, but they need first to be carefully analyzed, and Systemic assessed risk is a manifold concept embracing several dimensions of risk (frequent exposure, contagion, liquidity feature…) at different levels (financial, real economy and cross-border effects…). We consider that only a broad set of indicators can assess systemic risk, and thus provide comprehensive and adequate information to supervisory policy.

2.2.4 Previous Literature of Systemic Risk in the Turkish Financial System

According to Talaslı (2013), Turkish financial sector has been dominated by the banking sector, which has been extensively regulated and closely supervised by the regulatory system constituted following the 2000-2001 banking sector crisis. However,

the recent global financial crisis reveals that risk assessment of a bank should not be limited with an isolated evaluation of a bank's balance sheet or portfolio composition. In this context, they used SES measure proposed by Acharya et al. (2010). SES can be updated every day and consequently can help regulators or investors to track potential riskiness of the related stock. In order to test the applicability of SES to Turkish financial institutions, a multivariate regression model with a leverage ratio and MES of each financial firm as independent variables are fitted to institutions' stock value losses that are observed through crisis periods. Application is not restricted to the recent global financial crisis; the data related to the 2000-2001 banking sector crisis is also used. Although the high market capitalization requirement of Acharya et al. (2010) cannot be satisfied due to data shortage, regression results indicate that the SES model including both MES and leverage ratio has superior explanatory power over its rivals; ES, volatility, and stock market beta.

Binici, Köksal, and Orman (2013) used a correlation of bank equity returns to evaluate how systemic risk has evolved in the Turkish banking system over 1990-2011. They used daily stock price data of 17 banks listed in the Istanbul Stock Exchange (ISE), which includes commercial banks, participation banks, and investment banks, and accounts for approximately 76 per cent of all banking system assets. They investigate the evolution of systemic risk in the Turkish banking sector over the past two decades using the Comovement of banks' stock returns as a systemic risk indicator. Also, we explore possible determinants of systemic risk, the knowledge of which can be a useful input into effective macroprudential policymaking. Results show that the correlations between bank stock returns almost doubled in the 2000s in comparison to the 1990s. The correlations decreased somewhat after 2002 and increased again after the 2007-2009 financial crisis. The main determinants of systemic risk appear to be the market share of bank pairs, the number of nonperforming loans, herding behavior of banks, and volatilities of macro variables including the exchange rate, U.S. T-bills, EMBI+, VIX, and MSCI emerging markets index. An increase in the co-movement of stock returns might be indicative of systemic risk; however, it does not necessarily measure systemic risk or each institution's contribution to such risk.

Table 2.2. *Summary of Literature Review*

#	Author and Title	Data and Country and Variables	Methods	Main Findings
1.	Pokta (2017), Assessment of Systemic Risk Measures	C: the USA and Global Institutions D: Monthly data from December 2001 to January 2017 V: the Stock return of banks, Market Return, equity market value, Debt book value, prudential capital Ratio, and leverage ratio.	Systemic Risk Measure (SRISK)	SRISK measure may be useful for the measurement of systemic risk, its usefulness is limited by the sensitivity to underlying modelling choices, and a more thorough empirical understanding of SRISK is necessary before it can be considered as a tool for systemic risk regulation.
2.	Acharya et al. (2017), Measuring Systemic Risk	C: USA D: Crisis of 2007–2009 V: Size, Leverage, and Interconnectedness	Systemic Capital Shortfall (SES)	Systemic risk measures seem to be able to forecast the financial institutions with the worst contributions in financial crisis.
3.	Brownlees and Engle (2017), SRISK: a conditional capital shortfall measure of systemic risk	C: USA D: Daily data from January 3, 2000, to December 31, 2012. V: the Stock return of banks, Market Return, equity market value, Debt book value, prudential capital Ratio, and leverage ratio.	Systemic Risk Measure (SRISK)	The SRISK methodology offers valuable perceptions for monitoring the financial system and, retrospectively, it provides several early signs of the crisis.
4.	Coleman, et al. (2017), Analysis of the **SRISK** Measure and Its Application to the Canadian Banking and Insurance Industries	C: Canada D: Daily data from January 3, 2000, to June 30, 2016, for Canadian banks and Insurance Firms V: the Stock return of banks, Market Return, equity market value, Debt book value, prudential capital Ratio, and leverage ratio.	Systemic Risk Measure (SRISK)	The SRISK methodology is applied to insurance companies; the segregated fund's adjustment significantly decreases SRISK values.
5.	Derbali A. (2017), Systemic Risk in the Chinese Financial System: Measuring and Ranking	C: China D: daily return of seventy Chinese financial institutions and daily Chinese market return from January 2, 2008, to June 30, 2015. V: the Stock return of banks, Market Return, equity market value, Debt book value, prudential	(SRISK)	Chinese financial institutions have a significant contribution to the risk of the financial system in China. The results show that there is a positive relationship between the level of leverage of the firm and its Contribution to the systemic risk of the Chinese financial system.

		capital Ratio, and leverage ratio.		
6.	Kleinow et al. (2017), Measuring systemic risk: A comparison of alternative market-based approaches	C: USA D: Daily stock return data from CRSP over the period 2005 – 2014. V: Firms Stock Return, Market Return.	(MES) (CoRisk) (CoVaR (LTD)	the four market-based measurement methods provide inconsistent estimates of systemic risk. Besides, different market-based measurement provides very different estimations between the three segments of the financial industry as well as between larger and smaller institutions.
7.	Brownlees, et al. (2017), Back to the Future: Back testing Systemic Risk Measures during the Great Depression and Historical Bank Runs.	C: USA. D: weekly data of NYCH balance sheet statements. V: the Compound return of bank, Market Return, equity market value, Debt book value, prudential capital Ratio, and leverage ratio.	CoVaR (SRISK)	We find CoVaR and SRISK to be remarkably useful in warning regulators of SIFIs.
8.	Grinderslev and Kristiansen (2016), Systemic Risk in Danish banks. Implementing SRISK in A Danish Context.	C: Denmark D: Daily data from 3 January 1999 to 26 November 2015. V: the Stock return of banks, Market Return, equity market value, Debt book value, prudential capital Ratio, and leverage ratio.	Systemic Risk Measure (SRISK)	SRISK could have been a valuable measurement for identifying risks in the Danish banking system before and during the global financial crisis.
9.	Derbali A., and Hallara S. (2015), Systemic risk of European financial institutions: Estimation and ranking by the Marginal Expected Shortfall	C: European Union D: Daily data from January 1, 2006, to December 31, 2012. V: the Stock return of banks, Market Return, equity market value, Debt book value, prudential capital Ratio, and leverage ratio.	Marginal Expected Shortfall (MES)	There are systemic events in the European banking systems mainly after the accident of the financial crisis of 2007 and following the bursting of the sovereign debt crisis in 2010. We notice that European banks have a high level of contribution of systemic risk to the systemic risk of European financial systems.
10.	Giglio, et al. (2015), Systemic risk and the macroeconomy: An empirical evaluation	C: USA, UK, and Europe D: Daily data for USA, UK, and Europe. V: Multiple Variables.	(MES), (SRISK), CoVaR Delta CoVaR	We find that there are some individual measures capture moves in macroeconomic downside risk, but none of them does so robustly across specifications. When appropriately aggregated, these measures contain a robust predictive power for the

				distribution of macroeconomic shocks.
11.	Acharya et al. (2014), Testing macroprudential stress tests: The risk of regulatory risk weights	C: U.S. and EU bank D: supervisory data V: historical market prices, market capitalization, and leverage	Stress Tests and V-Lab Stress Test	outcomes show that stress tests would be more practical if capital requirements were measured inversely from the current static risk-weighted method.
12.	Idier et al. (2014). How useful is the Marginal Expected Shortfall for the measurement of systemic exposure? A practical assessment	C: France D: Daily panel data of 68 large US bank holding corporations over the period 1996–2010. V: Banks Stock Return, Market Return.	(MES)	results approve that the MES can be generally rationalized in terms of standard indicators of bank fragility or systemic exposure, like a high degree of reliance on wholesale funding, a high investment in corporate loans or low profitability.
13.	Tavolaro S. and Visnovsky F., (2014), What is the information content of the SRISK measure as a supervisory tool?	C: France D: - V: -	Systemic Risk Measure (SRISK)	We consider that only a broad set of indicators can assess systemic risk, and thus provide comprehensive and adequate information to supervisory policy.
14.	Weiß et al. (2014). What factors drive systemic risk during international financial crisis?	C: Germany D: Financial accounting data are retrieved from the Thomson Reuters World scope database. From an initial sample of 2519 banks, V: Banks Stock Return, Market Return.	(MES) (LTD)	Our examination of moderate and extreme systemic risk demonstrations that significant increases in moderate systemic risk characterize most financial crisis.
15.	Benoit et al. (2013), A Theoretical and Empirical Comparison of Systemic Risk Measures.	C: US Financial institutions D: Daily data from January 3, 2000 - December 31, 2010. V: the Stock return of banks, equity market value, Debt book value, and leverage ratio.	MES, SES, Delta CoVaR (SRISK)	Different systemic risk measures classify different SIFIs, and that (2) firm rankings based on systemic risk estimates reflect rankings gotten by sorting firms on market risk or liabilities.
16.	Binici et al. (2013), Stock Return Comovement and Systemic Risk in the Turkish Banking System	C: Turkey D: Daily stock price data of the 17 banks listed on the Istanbul Stock Exchange (ISE). V: Banks Stock Return, Market Return.	DCC-GARCH model	Critical factors of systemic risk seem to be the market share of the bank, the amount of non-performing loans, herding behaviour of banks, and volatilities of macro variables including the exchange rate.
17.	Girardi G. and Ergün A. Tolga (2013), Systemic risk	C: USA	CoVaR	The result shows that the bank were the main contributors to systemic risk, followed by

	measurement: Multivariate GARCH estimation of CoVaR	D: there are 1930 observations (daily data) for each institution. V: Firms Stock Return, Market Return.		broker-dealers, insurance firms, and non-depository firms. Leverage, size, and equity beta to be substantial in explaining institutions' contributions to systemic risk.
18.	Talaslı İ. (2013), Systemic risk analysis of Turkish financial institutions with a systemic expected shortfall	C: Turkey D: Daily data through 2000–2001 banking sector crisis and 2007–2009 global financial crisis. V: Banks Stock Return, Market Return.	(SES)	SES model with both MES and leverage ratio has a more considerable descriptive power over its competitors; expected shortfall, volatility, and stock market beta.
19.	Acharya et al. (2012), Capital Shortfall: A New Approach to Ranking and Regulating Systemic Risks	C: USA D: Crisis of 2007–2009. V: Size, Leverage, and Interconnectedness	(MES) (SRISK)	-
20.	Allen et al. (2012), Does Systemic Risk in the Financial Sector Predict Future Economic Downturns?	C: U.S., European, and Asian D: Daily bank data. V: GPD, stock return, and SGED	CATFIN, (VaR) (ES)	High levels of systemic risk in the banking system influence the macroeconomy through aggregate lending activity. Provisional asset pricing model shows that CATFIN is priced for financial and non-financial institutions.
21.	Billio et al. (2012), Econometric measures of connectedness and systemic risk in the finance and insurance sectors	D: USA D: U.S monthly returns data. V: the stock return of the institution	(PCA) (GCN).	The banking and insurance subdivisions can be smooth, more significant sources of connectedness than other parts.
22.	Engle, R. (2002), Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models	C: USA. D: - V: -	GARCH (DCC)	The comparison of DCC with simple multivariate GARCH and several other estimators shows that the DCC is often the most accurate.

Source: *Elaborated by the author.*

2.2.5 Conclusion

Several points can be observed by reviewing the literature.

First, previous studies confirmed the importance of measuring and managing systemic risk, especially after the 2008 global financial crisis.

Second, there are many aspects of systemic risk, and this is reflected in the diversity of proposed measures of systemic risk to reflect the aspect to which the subject was addressed.

Third, in general, there are two main models to measure risks within financial institutions, value at risk (VaR) and the expected capital shortfall (ES). Therefore, most of the proposed measures for systemic risk are derived from the above models.

Fourth, many models have been developed to measure systemic risks during the past decade. Additionally, many articles have compared these models to choose the best ones.

Fifth, most studies have concluded that the SRISK is the best model for measuring the systemic risk of financial systems and has a predictive capacity to identify SIFIs.

Sixth, SRISK has many advantages like the use the public and published data, transparent and uncomplicated methodology, the results are publicly reported and predictive ability.

Seventh, there are few limitations in the application of the SRISK model, on top of its restricted application to listed institutions only. The data entered in the model is limited to the balance sheet and general data. Consequently, the crucial data outside the balance sheet is not included in the model.

Eighth, previous studies concluded that SRISK has a high predictive capacity and it considers the best measurement developed so far. However, regulators cannot rely on their results considerably. Despite it can be applied in parallel with stress tests in financial institutions.

CHAPTER THREE

3. METHODOLOGY

3.1. Introduction

Systemic risk is one of the most elusive concepts in finance. In practice, a reasonable risk measure for systemic risk should capture many deferent facets that describe the importance of a given financial institution in the financial system (Brownlees and Engle, 2017).

Many empirical models have been developed to measure systemic risk, and these contributions significantly increased after the last global financial crisis in 2007-2009. According to literatures, such as Acharya, Pedersen, Philippon, and Richardson, (2017), Brownlees and Engle (2012), Acharya, Engle, Richardson, (2012), Tavolaro and Visnovsky (2014), Grinderslev and Kristiansen (2016), Brownlees and Engle (2017), Derbali (2017), and Coleman, LaPlante, and Rubtsov (2017), Pokta (2017), systemic risk measure (SRISK) is the most proper methodology to measure systemic risk of the financial system.

This section of the study presents the empirical models employed in the study to achieve the study goals, which are, measure the systemic risk in the TFS and to estimate and ranking of Conditional Capital Shortfall by Using SRISK Methodology, Thus, determine the Systemically Important Financial Institutions (SIFIs) in the TFS. Also, identifying the total amount of capital that the Turkish government would have to provide to bail out the financial system in case of a crisis.

This section describes the data and the sources of our data in the study and explains the intuitions behind using them. Also, it explains the appropriate data adjustments that are used to bring data in a consistent and economically meaningful format.

Moreover, this section describes the formal framework of the systemic risk measure (SRISK) methodology. The SRISK methodology provides a measurement to estimate systemic risk for a financial firm in case of crisis depending on the capital shortfall, which the firm is expected to experience conditional on a prolonged market decline. The SRISK methodology is like stress tests that are frequently practical to financial institutions.

Nevertheless, the main difference between SRISK and stress tests is that the SRISK methodology uses publicly available information only (market and balance sheet data), and that makes the SRISK methodology is comparatively inexpensive and broadly appropriate (Brownlees and Engle, 2017).

3.2. Sample Design

The banking system is representing more than 90 per cent of the Turkish financial system by assets. Thus, banks are vital and very important to financial stability in Turkey. Besides, nonbank financial institutions are small, like emerging market levels (IMF, 2017). So, the study takes evidence from Banks index categorized according to Borsa Istanbul classification, namely: BIST Banks (XBANK) to measure systemic risk in the Turkish financial system.

3.3. Data Sources and Data Collection

The data of this thesis consist of daily data to measure systemic risk in the Turkish financial system for the period of January 01, 2002 to December 31, 2018 which make a total of 50,186 observations and is unbalanced in that not all financial institutions have been trading continuously during the sample period. We obtain daily logarithmic returns for Banks, daily logarithmic returns for index and market capitalization from BLOMBERG. Book value of debt and book value of assets are from balance sheets of banks. Considering the following observations about the data:

- The sample started in 2002 due to the availability of the data like the BIST Banks Index return.
- The banks' balance sheets before 2005 are in old Turkish lira (Eski Türk lira) and the data in a million Turkish liras.
- The Book Value of assets and equity has been updated quarterly for banks.
- In this study, we have a total of 50,186 observations and it unbalanced in that not all banks have been trading continuously during the sample period.

3.4. Systemic Risk Measurement

The need for developing a theoretical and empirical methodology for a systemic risk measure significantly increased after the global financial crisis 2007-2009.

Furthermore, academicians and regulators around the world still study to estimate the systemic risk more precisely and identify the SIFIs in a financial system trying to prevent a new financial crisis or/and to reduce the cost of a financial crisis (Acharya et al.,2010).

3.5. Conditional Capital Shortfall

Acharya et al. (2010), started their approach by reviewing the standard risk measures used inside financial firms and discuss how these measures can be extended to apply for the whole financial system. Two standard measures of firm-level risk are value-at-risk (*VaR*) and expected shortfall (ES). Acharya et al. (2010) focus on *ES* rather than *VaR* for two reasons. First, when the decline is below 1% or 5%, *VaR* does not capture it. Second and according to Artzner et al. (1999), *VaR* is not a comprehensible measure of risk due to the *VaR* of the sum of two portfolios can be higher than the sum of their individual *VaRs*, which cannot happen with *ES*.

Acharya, Pedersen, Philippon, and Richardson (2017), proposed theoretical and empirical method that to align incentives, the regulator optimally imposes a tax on each bank that is related to the sum of its expected default losses and its expected contribution to a systemic crisis, which they denote the systemic expected shortfall (SES). Systemic expected shortfall (SES), can be defined as the expected capital shortfall of a financial institution when the whole financial system is undercapitalization due to a future systemic event. Otherwise, the higher SES for a bank means that when a future financial crisis occurs, the bank will incur more expected loss. Depending on the measurability of SES, Acharya et al., (2017), provides theoretical justification to measure Marginal Expected Shortfall (MES) for a financial firm, MES can be defined as the excepted equity loss of a firm when the overall financial market decline below a certain amount over a given period.

For making correct decisions regarding risk management and capital structure, we need to measure the systemic risk contribution of the individual institutions to the overall financial system. Let us divide the financial system return R into the sum of each bank's return r_i, that is, $R = \sum_i y_i r_i$, where y_i is the weight of bank i in the total financial system or banking system. From the definition of *ES*, we see that (Acharya et al., 2017):

$$ES_\alpha = -\sum_i y_i E[r_i | R \leq -VaR_\alpha]. \qquad (1)$$

From this expression, we see the sensitivity of overall risk to exposure y_i to each bank i:

$$\frac{\partial ES_\alpha}{\partial y_i} = -E[r_i | R \leq -VaR_\alpha] = MES_\alpha^i, \qquad (2)$$

Where MES^i is the bank i's a marginal expected shortfall. The (MES) measures how bank i's risk-taking adds to the financial system overall risk. In other words, MES can be measured by estimating bank i's expected equity losses when the financial system as a whole is doing poorly. These standard risk-management practices can be useful for thinking about systemic risk. A financial system is constituted by a number of banks. Besides, we can, therefore, consider the expected shortfall of the overall banking system by letting R be the return of the aggregate banking sector or the overall economy. Then each bank's contribution to this risk can be measured by its *MES*.

Based on Acharya et al. (2010,2017) framework, Brownlees and Engle (2011, 2017) introduced a measure called SRISK defined as "the expected capital shortfall of a financial entity conditional on a prolonged market decline." SRISK is equal to the capital shortfall of a firm during crisis computed using leverage and MES. There are many contributions to SRISK methodology. First, it provides a suitable ranking for (SIFIs) in a financial system: In times of crisis, firms with the highest SRISK are the most significant contributors to the capital shortfall of the financial system. Second, the overall systemic risk in the whole financial system is equal to the sum of SRISK across all firms. Thus, it can be thought of as the total amount of capital (reserves) that the government would have to provide to bail out the financial system in case of a future systemic event (financial crisis). Third, SRISK calculated by using the balance sheet data and appropriate LRMES estimator. In general, SRISK considered one of the most appropriate supervision tools for the regulators to measure systemic risk and make preventive procedures to prevent a new financial crisis (Brownlees and Engle, 2017).

The SRISK methodology concentrates on the investigative financial system made up of many financial firms. So, we need to compute capital shortfall of listed banks in the Turkish financial system by introducing variable known the capital shortfall which the

firm needs to hold it as the capital reserves due to regulation and prudential capital (Brownlees and Engle, 2017).

The Marginal Expected Shortfall (MES) is the contribution of a firm *i* to systemic risk of the whole financial system, as measured by the Expected Shortfall (ES) (Acharya et al.,2010). Thus, measure the undercapitalization (capital shortfall) of firm *i* on day *t* as:

$$\mathrm{CS}_{i\,t} = k\mathrm{A}_{\mathrm{i\,t}} - \mathrm{W}_{\mathrm{i\,t}} = k\,(\mathrm{D}_{\mathrm{i\,t}} + \mathrm{W}_{\mathrm{i\,t}}) - \mathrm{W}_{\mathrm{i\,t}}, \qquad (3)$$

where $\mathrm{W}_{i\,t}$ is the market value of equity, $\mathrm{D}_{i\,t}$ is the book value of debt, $\mathrm{A}_{i\,t}$ is the value of quasi-assets (the market value of equity plus the book value of debt), and *k* is the prudential capital ratio (12% in Turkey) as of 2018. Thus, when the capital shortfall is definite, the institution experiences distress, and when the capital shortfall is negative, the institution has a capital excess. Furthermore, the institution has not a significant systemic risk (Brownlees and Engle, 2017).

Depending on equation (3), equation (4) must be achieved to get the breakeven point for the allowed value of debt which will make the capital shortfall equal zero in case of a given market value of equity and prudential capital ratio. Thus, this breakeven point value should not be exceeded to keep the value of $\mathrm{CS}_{i\,t}$ as negative, which indicates that the financial firm has not a systemic risk.

$$\mathrm{D}_{i\,t} = \frac{\mathrm{W}_{i\,t}\,(1-k)}{k}, \qquad (4)$$

To measure systemic risk by SRISK methodology we need to predict the conditional undercapitalization of a financial institution in the situation of a systemic event. Brownlees and Engle (2017) define the systemic events as *"a market decline below a threshold C over a time horizon h."*

This study will use the SRISK to measure the systemic risk of individually Turkish financial institutions. Then, the firm with the highest SRISK is expected to be more contributors to the systemic risk of the financial system. The SRISK can be measured as follows:

$$\mathrm{SRISK}_{i,t} = \mathrm{E}_t\,(\mathrm{CS}_{i,t+h} \mid \mathrm{R}_{m,t+1:\,t+h} < \mathrm{C}),$$

$$= k\,\mathrm{E}_t\left(\mathrm{D}_{i,t+h}\,\middle|\mathrm{R}_{m,t+1:\,t+h} < \mathrm{C}\right) - (1-k)\mathrm{E}_t\left(\mathrm{W}_{\mathrm{i,t+h}}\middle|\mathrm{R}_{m,t+1:\,t+h} < \mathrm{C}\right) \qquad (5)$$

Note that in the case of crisis debt cannot be renegotiated, and attractive new cash flow would be more difficult, so in the case of a new crisis, $\mathrm{E}_t\left(\mathrm{D}_{i\,t+h}\,\middle|\,\mathrm{R}_{m\,t+1:\,t+h} < \mathrm{C}\right) = \mathrm{D}_{i\,t}$. Using this assumption, it follows that

$$\mathrm{SRISK}_{i\,t} = k\mathrm{D}_{i\,t} - (1-k)\mathrm{W}_{i\,t}(1-\mathrm{LRMES}_{i\,t}),$$

$$= \mathrm{W}_{i\,t}\left[k\,LVG_{i\,t} + (1-k)\,\mathrm{LRMES}_{i\,t} - 1\right], \qquad (6)$$

where LRMES denotes Long Run Marginal Expected Shortfall, depending on equation (6), equation (7) must be achieved to get the breakeven point for the allowed value of dept which will make the capital shortfall equal zero in case of a given market value of equity and prudential capital ratio. Thus, this breakeven point value should not be exceeded to keep the value of $\mathrm{SRISK}_{i\,t}$ as negative, which indicates that the financial firm has not a systemic risk.

$$\mathrm{D}_{i\,t} = \frac{(1-k)\mathrm{W}_{i\,t}\left(1-\mathrm{LRMES}_{i\,t}\right)}{k}, \qquad (7)$$

where $\mathrm{LVG}_{i\,t}$ denotes the quasi-leverage ratio $(\mathrm{D}_{i\,t} + \mathrm{W}_{i\,t})/\mathrm{W}_{i\,t}$ and $\mathrm{LRMES}_{i\,t}$ is The Long Run Marginal Expected Shortfall and according to Brownlees and Engle, (2017) it can be got by estimating the loss an equity investor would expect if equity markets fall by at least 10 percent in one month.

The expectation of the firm equity multi-period arithmetic return conditional on the systemic event is:

$$\mathrm{LRMES}_{i\,t} = -\mathrm{E}_t(R_{i\,t+1:t+h}|R_{m\,t+1:t+h} < C), \qquad (8)$$

Where $R_{i\,t+1:t+h}$, is the multi-period arithmetic firm equity return between period $t + 1$ and $t + h$. According to equation (6) the variations of the value of the "*SRISK for the financial firms is due to differences in the size of the firms, its degree of leverage, and its expected equity losses conditional on a prolonged market decline. SRISK is higher for*

firms that are larger, more leveraged and with higher sensitivity to market declines. Note that, for simplicity, the dependence on the prudential ratio k, the threshold C and the time horizon h, are implicit in the SRISK model" (Brownlees and Engle, 2017).

Moreover, Brownlees and Engle, (2017) provide a prediction for the level of capital shortfall a financial firm would experience in the future systemic event by the SRISK measure of equation (6). It is also interesting to define the 1 - α capital shortfall prediction interval conditional on the systemic event as:

$$\left(\mathrm{CS}_{i,t+h|t}^{\alpha/2}, \mathrm{CS}_{i,t+h|t}^{1-\alpha/2}\right) \quad , \qquad (9)$$

Where

$$CS_{i,t+h|t}^{q} = W_{i,t}\left[k\, LVG_{i,t} - (1-k)F_{i,t+1:t+h|t}^{-1}(q) - 1\right],$$

With $F_{i\,t+1:t+h|t}(\mathcal{X})$denoting the distribution function of the firm multi-period return conditional on the systemic event.

To achieve our objective regarding the total amount of capital that the regulations would have to provide to bail out the financial system in case of a crisis, we use the $\mathrm{SRISK}_{i,\,t}$ measure across all listed banks (XBANK) to construct a system-wide measure of financial distress. The total amount of systemic risk in the financial system is measured as:

$$\mathrm{SRISK}_t = \sum_{i=1}^{N} \mathrm{SRISK}_{i\,t}, \qquad (10)$$

Notice that in case of a crisis, it is difficult to mobilized capital surplus by mergers or loans. Therefore, when we calculate aggregate SRISK, they ignore the contribution of negative capital shortfalls (that is capital surpluses).

In equation (11), the percentage of the SRISK for the financial firm in the time *t* comes from taking the value of the SRISK for the same institution divided by the total SRISK for the financial system. Thus, they express the percentage SRISK measure as follows:

$$\mathrm{SRISK\%}_{i,t} = \frac{\mathrm{SRISK}_{i\,t}}{\mathrm{SRISK}_t} \text{ if } \mathrm{SRISK}_{i,t} > 0, \qquad (11)$$

Besides, to more benefit from the results of the study in assessing the percentage of systemic risks for Turkish banks at the individual level, we calculated the systemic risks of banks as a percentage of the book value of the bank's assets as shown in equation (12). Thus, at the individual level, it provides information to the bank's directors about managing any expected future financial crisis. Also, to assess SRISK of Turkish banks resulting from financial leverage, we calculated the systemic risks of banks as a percentage of the market cap, which gives information to stakeholders about the bank's ability to pay the debt in case of crisis as shown in equation (13). Finally, to assess SRISK of Turkish banks at the level of TFS, we calculated the systemic risks for banks as a percentage of Turkey's total GDP, which provides information to stakeholders about the expected damage that could result from any expected future financial crisis as shown in equation (14) and equation (15).

In order to assess the results of SRISK at the bank level, we have determined the value of systemic risk as a percentage of the book value of the bank's assets according to equation (12) and the higher ratio, means higher SRISK of the bank

$$SRISK\ \%_A = \frac{\mathrm{SRISK}_i}{\mathrm{A}_i} \qquad (12)$$

with SRISK denoting SRISK of the bank *i* and A denoting total assets of the bank *i.*

Furthermore, to assess the results of SRISK at the TFS level, in equation (13) we presented SRISK of the bank as a percentage of market cap of the same bank and the higher ratio, means higher SRISK of the bank:

$$SRISK\ \%_w = \frac{\mathrm{SRISK}_i}{\mathrm{W}_i} \qquad (13)$$

with SRISK denoting SRISK of the bank *i* and W denoting total assets of the bank *i.*

Finally, to assess the results of SRISK at the international level, in equation (14) and (15) we presented SRISK of bank as a percentage of GDP of Turkey and the higher ratio, means higher SRISK of the bank:

$$SRISK\ \%_{GDP} = \frac{\mathrm{SRISK}_i}{GDP_T} \qquad (14)$$

with SRISK denoting SRISK of the bank *i* and GDP_T denoting GDP of Turkey.

In equation (15), the percentage of SRISK for TFS in the time *t* comes from taking the value of the SRISK for the same institution divided by the total GDP of Turkey. Thus, they express the percentage SRISK measure as follows:

$$SRISK\ \%_{GDP} = \frac{\mathrm{SRISK}_t}{GDP_T} \qquad (15)$$

with SRISK_t denoting SRISK of TFS and GDP_T denoting GDP of Turkey.

3.6. Long Run Marginal Expected Shortfall (LRMES)

The computation of SRISK requires specifying a model for the market and firms returns that can be used to obtain estimators of the LRMES. Several different specifications and estimation techniques can be used to obtain this prediction. Therefore, we constructed LRMES predictions using a GJR-GARCH volatility model and the standard Dynamic Conditional Correlation (DCC) model (Glosten, Jagananthan, and Runkle, 1993; Rabemananjara and Zakoïan, 1993; Engle, 2002, 2009). The GARCH-DCC methodology is well-known in financial analysis in time series as this class of models can capture well the stylized facts of the data.

Let the logarithmic returns of the firm and the market represent respectively as $r_{i\,t} = \log(1+R_{i\,t})$ and $r_{m\,t} = \log(1+R_{m\,t})$. We assume that conditional on the information set F_{t-1} available at time $t-1$. The returning pair has an (unspecified) distribution *D* with zero mean and time-varying covariance,

$$\begin{bmatrix} r_{i\,t} \\ \\ r_{m\,t} \end{bmatrix} | F_{t-1} \sim D \left(0, \begin{bmatrix} \sigma_{i\,t}^2 & \rho_{i\,t}\sigma_{i\,t}\sigma_{m\,t} \\ \\ \rho_{i\,t}\sigma_{i\,t}\sigma_{m\,t} & \sigma_{m\,t}^2 \end{bmatrix} \right) \qquad (16)$$

This approach requires specifying equations for the evolution of the time-varying volatilities and correlation. We conduct the GJR-GARCH volatility model and the standard DCC correlation model. The GJR-GARCH model equations for the volatility dynamics are as the following:

$$\sigma_{i\,t}^2 = \omega_{v\,i} + \alpha_{v\,i} r_{i\,t-1}^2 + \gamma_{v\,i} r_{i\,t-1}^2 I_{i\,t-1}^- + \beta_{v\,i}\, \sigma_{i\,t-1}^2 , \qquad (17)$$

$$\sigma_{m\,t}^2 = \omega_{v\,m} + \alpha_{v\,m}\, r_{m\,t-1}^2 + \gamma_{v\,m}\, r_{m\,t-1}^2 I_{m\,t-1}^- + \beta_{v\,m}\, \sigma_{m\,t-1}^2 , \qquad (18)$$

with $I^{-}_{i\,t} = 1$ if $\{r_{i\,t} < 0\}\ and\ I^{-}_{m\,t} = 1\ if\{r_{m\,t} < 0\}$.

The DCC specification model correlation through the volatility adjusted returns $\epsilon_{i\,t} = r_{i\,t}/\sigma_{i\,t}\ and\ \epsilon_{m\,t} = r_{m\,t}\,/\,\sigma_{m\,t}$

$$\mathrm{Cor}\begin{pmatrix}\epsilon_{i\,t}\\ \\ \epsilon_{m\,t}\end{pmatrix} = R_t = \begin{bmatrix}1 & \rho_{i\,t}\\ \\ \rho_{i\,t} & 1\end{bmatrix} = diag\,(Q_{i\,t})^{-1/2}\,Q_{i\,t}\,diag\,(Q_{i\,t})^{-1/2}\,, \qquad (19)$$

Where $Q_{i\,t}$ is the so-called pseudo correlation matrix. The DCC model then specifies the dynamics of the pseudo-correlation matrix $Q_{i\,t}$ as

$$Q_{i\,t} = (1 - \alpha_{c\,i} - \beta_{c\,i})S_i + \alpha_{c\,i}\begin{bmatrix}\epsilon_{i\,t-1}\\ \\ \epsilon_{m\,t-1}\end{bmatrix}\begin{bmatrix}\epsilon_{i\,t-1}\\ \\ \epsilon_{m\,t-1}\end{bmatrix} + \beta_{c\,i}Q_{i\,t-1}\,, \qquad (20)$$

Where S_i is the unconditional correlation matrix of the firm and market-adjusted returns. The model is typically estimated by a two-step QML estimation procedure. More concentrated details on this modelling approach and estimation are provided in Engle (2009). In what follows we refer to this specification as GARCH-DCC for short.

LRMES is -in general- not available in closed form for this class of dynamic models so it can be customized according to the situation. However, it is straightforward to implement a simulation-based procedure to obtain exact LRMES predictions. The procedure consists of simulating a random sample of size *S* of *h* - period firm and market arithmetic return conditional on the information set available on day *t as follows:*

$$\begin{bmatrix}R^{s}_{i\,t+1:t+h}\\ \\ R^{s}_{m\,t+1:t+h}\end{bmatrix} \mid F_t\,,\ \ s = 1, \dots, S\,. \qquad (21)$$

These returns are computed by simulating a set of logarithmic returns of length *h* conditional on the information set on day *t*, computing the cumulative logarithmic return and then converting this into the arithmetic *h*-period return. The LRMES for day *t* is then calculated using the Monte Carlo average as recommended by (Brownlees and Engle, 2017). Therefore, the simulated arithmetic *h*-period returns should be as follows,

$$\mathrm{LRMES}_{i\,t}^{dyn} = -\frac{\sum_{s=1}^{S} R_{i\,t+1:t+h}^{s} I\{R_{m\,t+1:t+h}^{s} < C\}}{\sum_{s=1}^{S} I\{R_{m\,t+1:t+h}^{s} < C\}}\,. \qquad (22)$$

An appealing feature of the simulation-based procedure is that it also allows us to compute the capital shortfall prediction intervals of equation (8) using the quantiles of the simulated returns. With taking into consideration that in the algorithm, the innovations are simulated by resampling the standardized residuals of the GARCH-DCC rather than relying on parametric assumptions.

CHAPTER FOUR

4. EMPIRICAL RESULTS AND ANALYSIS

4.1. Empirical Results

Initially, an important thing to clarify is that if the value of SRISK is negative, it means that the bank has no systemic risk and if the value of the SRISK is positive, then the bank has a systemic risk and the higher positive value of SRISK, the bank has a greater systemic risk.

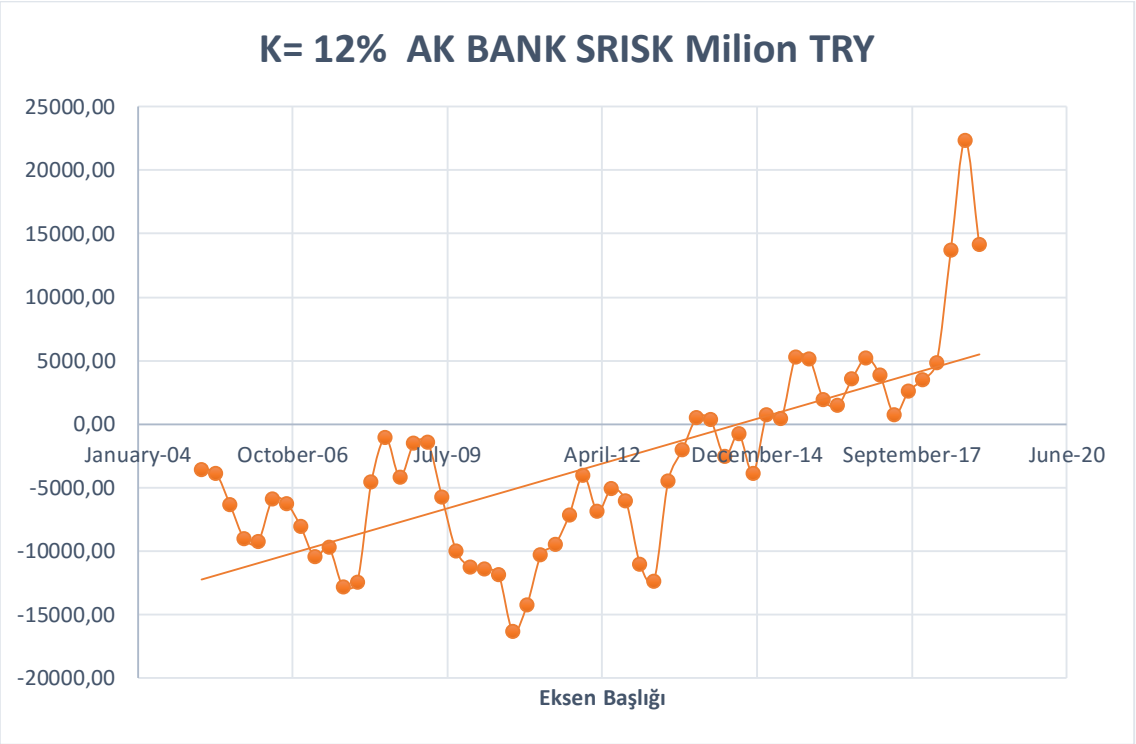
4.1.1. AKBNK Results

Akbank is a private bank in Turkey and has Free Float Rate (FFR) by 56.78 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 1 in the appendix, we can remark that the value of SRISK for Akbank from March-2005 to September-2013 is negative. Thus, Akbank has not systemic risk in this period, but we can notice that the value of SRISK increased during financial crisis in 2008 and this emphasizes the ability of SRISK model to measure systemic risk. In December-13, the value of SRISK is positive for the first time in the table by 467 Million TL of systemic risk, but in the last three quarters in 2014, the bank has no systemic risk. Nevertheless, from the first quarter of 2015 until the end of the study, the bank has increasing systemic risk, which the highest value has recorded in September-18 by 22,359 Million TL. Moreover, this can be attributed to the Turkish Lira crisis, which peaked in August 2018, when the Turkish Lira lost 30% of its value.

[INSERT TABLE A 1 ABOUT HERE]

Figure 4.1 display systemic risk quarterly results trends of Akbank during the period from March-2005 to December-2018. The value of the systemic risk of the bank started to be positive from the third quarter of 2013 and increased from the first quarter of 2015 until 2018, and the curve is heading upwards.

Figure 4.1. *AKBNK SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 1 in the appendix.*

In general, Akbank is considered as one of the largest and most prominent banks in Turkey, and the systemic risk value of Akbank is become be significant at the beginning of 2015, and the value increases significantly in recent years. So, the regulators alert to take preventive actions to maintain the stability of the banking system.

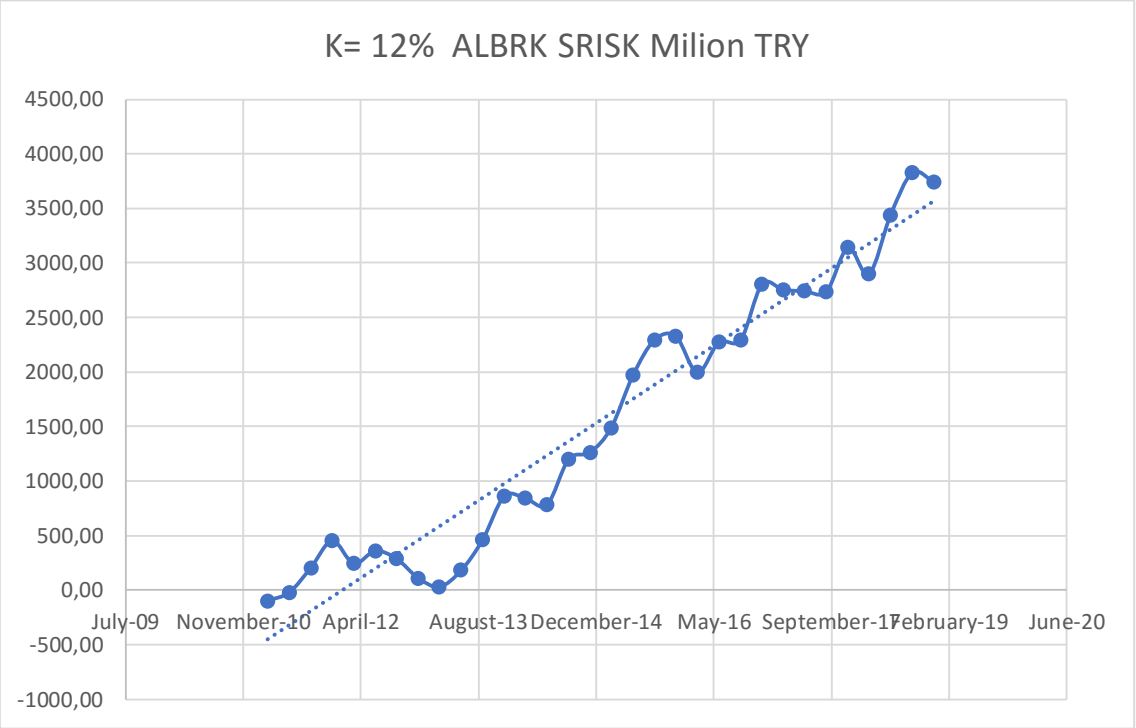
4.1.2. ALBRK Results

[INSERT TABLE A 2 ABOUT HERE]

Albaraka bank is a foreign bank and has Free Float Rate (FFR) by 31.57 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 2 in the appendix, we can remark that the value of SRISK in the first tow quarter of 2011 of the bank was negative, and that means the bank has not systemic risk. However, form September-2011 to

December-2018 the value of SRISK is positive, so the bank has systemic risk in this period. The highest value of systemic risk for the bank was recorded in the September-2018 by 3,827 Million TL. The systemic risk of Albaraka bank is significant when compared with total assets or market cap of the bank.

Figure 4.2. *ALBRK SRISK Million TRYFF*



Source. *Elaborated by the author by the data from table A 2 in the appendix.*

Figure 4.2 display systemic risk quarterly results trends of Albaraka bank during the period from January-2011 to December-2018. We can notice that the systemic risk of the bank debuts their increasing from September-2011 to December-2018 and the value of systemic risk increasing readily, so the curve is heading upwards clearly.

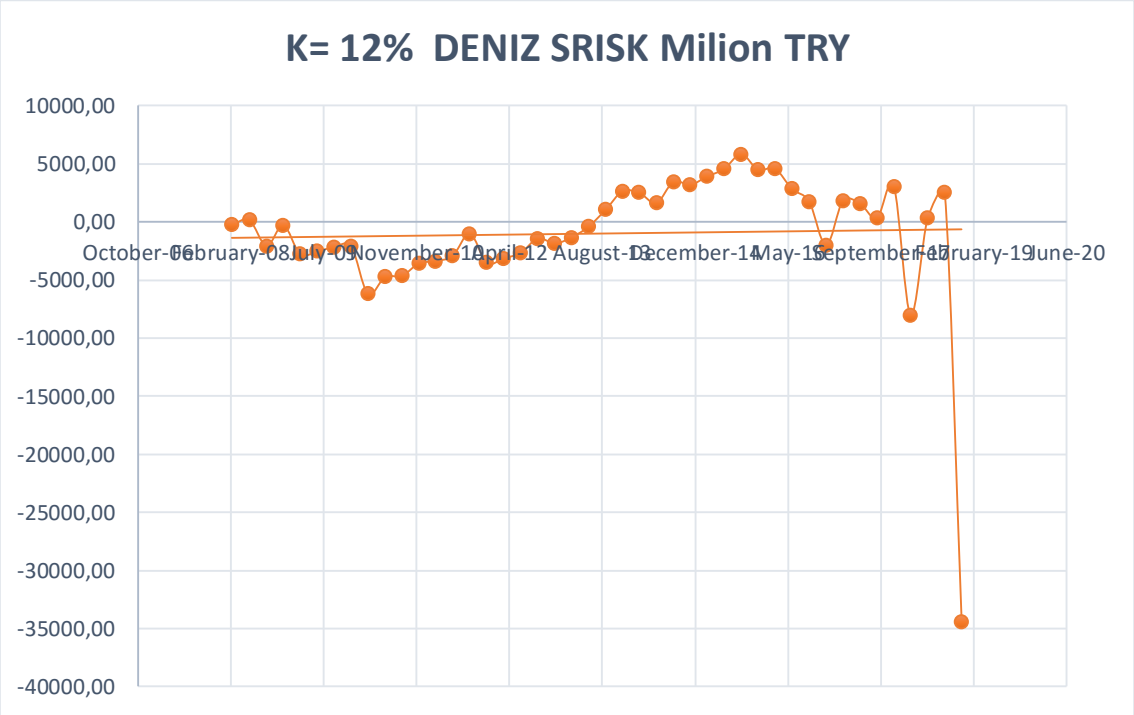
The bank and regulators need to take corrective actions to maintain the confidence of the bank and reduce the systemic risk in the coming period.

4.1.3. DENIZ Results

[INSERT TABLE A 3 ABOUT HERE]

Deniz bank is a foreign bank and has Free Float Rate (FFR) by 0.04 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 3 in the appendix, we can state that the systemic risk of the bank debuts on June-2008 and we can explain this as a result of the global financial crisis in 2008. The value of SRISK of the bank from September-08 to June-13 was negative; thus, the bank has no systemic risk and the value of SRISK of the bank from September-13 to December-18 except December-16, March-18 and December-18 were positive. The highest value of systemic risk for the bank was recorded in the September-2015 by 5,819 Million TRY. The SRISK of the bank was decisive in the 3th quarter of 2018 and that as a result of the Turkish lira crisis but we can clearly notice that the value of SRISK of the bank decreased sharply to be -34 billion TRY in December-2018, when we research on the data about the reason of that, we find that the market value of the bank started to increase rapidly from 15 billion on November-2018 to approximately 63 billion at the end of 2018.

Figure 4.3. *DENIZ SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 3 in the appendix.*

Figure 4.3 shows systemic risk quarterly results trend of Deniz bank during the period from January-2008 to December-2018. We can notice that the systemic risk of the Bank first emerged in the wake of the global financial crisis of 2008, especially in the second quarter of 2008. Moreover, the Bank did not record any systemic risks from September-2008 to June-13. The bank started to record systemic risk from September-2013 to September-2018, excluding December-2016 and March-2018.

In general, the figure can be read as follows: There is fluctuation in the systemic risk of the bank during the study period, but it is noted that the bank's trend is going up. It is requiring monitoring and controlling the systemic risks of the bank in the future and working to reduce the systemic risk of the bank through regulatory the lending and raising the bank's capital.

4.1.4. GARAN Results

[INSERT TABLE A 4 ABOUT HERE]

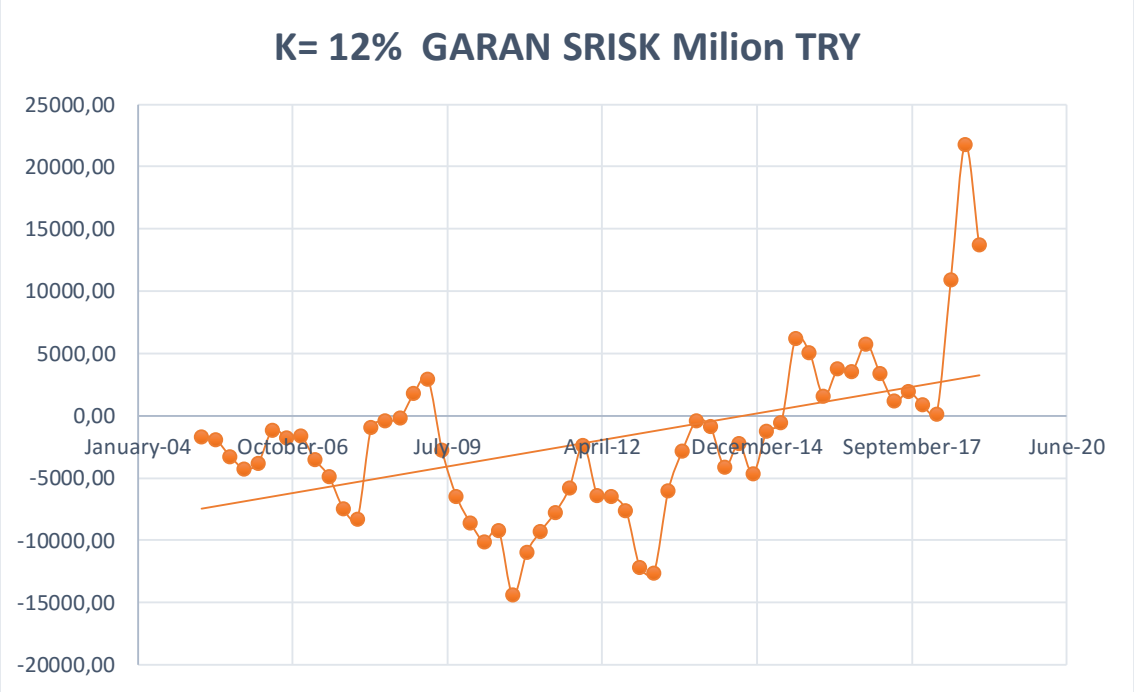
Garanti bank is a foreign bank and has Free Float Rate (FFR) by 58.45 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 4 in the appendix, we can remark that from the table, systemic risk of the bank debuts on December-2008 and March-2009, So we can read that as a result of the global financial crisis in 2008. The results show that the bank did not suffer from systemic risk from June-2009 to June-2015. Furthermore, results show that the Garanti bank suffered from systemic risks between September-2015 to December-2018 and recorded the highest systemic risk value in September-2018 by 21,7 billion TRY.

Figure 4.4 displays systemic risk quarterly results trend of Garanti bank during the period from January-2005 to December-2018. The figure shows that Garanti bank did not contribute to the systemic risk of the Turkish financial system from March-2005 to June-2015 except December-2008 and March-2009 and thus can be enlightened as a result of the global financial crisis in that period and this also reaffirms the ability of the model to measuring systemic risk.

Overall, the fluctuation in the Bank's contribution to systemic risk can be observed. However, in 2018, the bank's SRISK value increased rapidly to reach a record level in the third quarter of 2018 by more than 21 billion TRY. It clearly shows the significant impact of the 2018 Turkish lira crisis, which peaked during August-18.

Garanti bank is considered as the biggest bank in Turkey in terms of market cap and has a significant weight in the financial system. Therefore, the bank is classified as one of the most SIFIs in the Turkish financial system. The results clearly show the importance of measuring systemic risk and identifying SIFIs in Turkey to protect the financial system from new financial crisis.

Figure 4.4. *GARAN SRISK Million TRY*



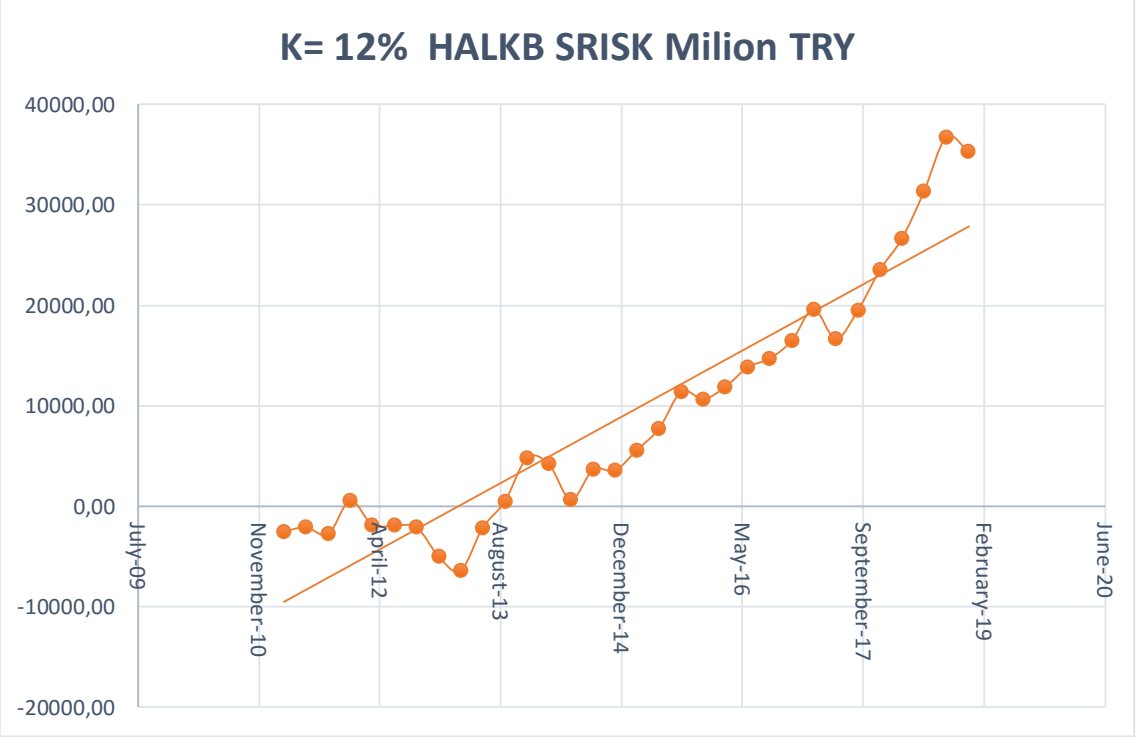
Source. *Elaborated by the author by the data from table A 4 in the appendix.*

4.1.5. HALKB Results

[INSERT TABLE A 5 ABOUT HERE]

Halk bank is a public bank and has Free Float Rate (FFR) by 48.93 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 5 in the appendix, we can remark that the bank has not recorded any systemic risk from March-2011 to June-2013. It can also see that the Bank started to suffer from systemic risk from September-2013 and then the systemic risk of the bank began significantly increasing from quarter to quarter pending the Bank recorded the highest systemic risk in September-2018 by 36,753 million TRY. Besides, it is the highest level of systemic risk recorded by a bank during the study period. Moreover, the bank contributes 22.72 percent of the systemic risk in the Turkish financial system at the end of 2018.

Figure 4.5. *HALKB SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 5 in the appendix.*

Figure 4.5 displays systemic risk quarterly results trend of Halk bank during the period from January-2011 to December-2018. From the figure, we can remark that Halk bank started to record systemic risk on September-2013. Then, the Bank's systemic risk started to increase exponentially until the end of 2018.

Overall, the systemic risk of the bank is the highest in the study, and we can rank Halk bank as the most SIFIs in Turkey. So, the results of the study send a clear negative

message about Halk bank, in addition to that the regulators need to conduct further checks and monitoring the work of the bank and take the corrective procedures to maintain the bank and the financial system as a whole.

4.1.6. ICBCT Results

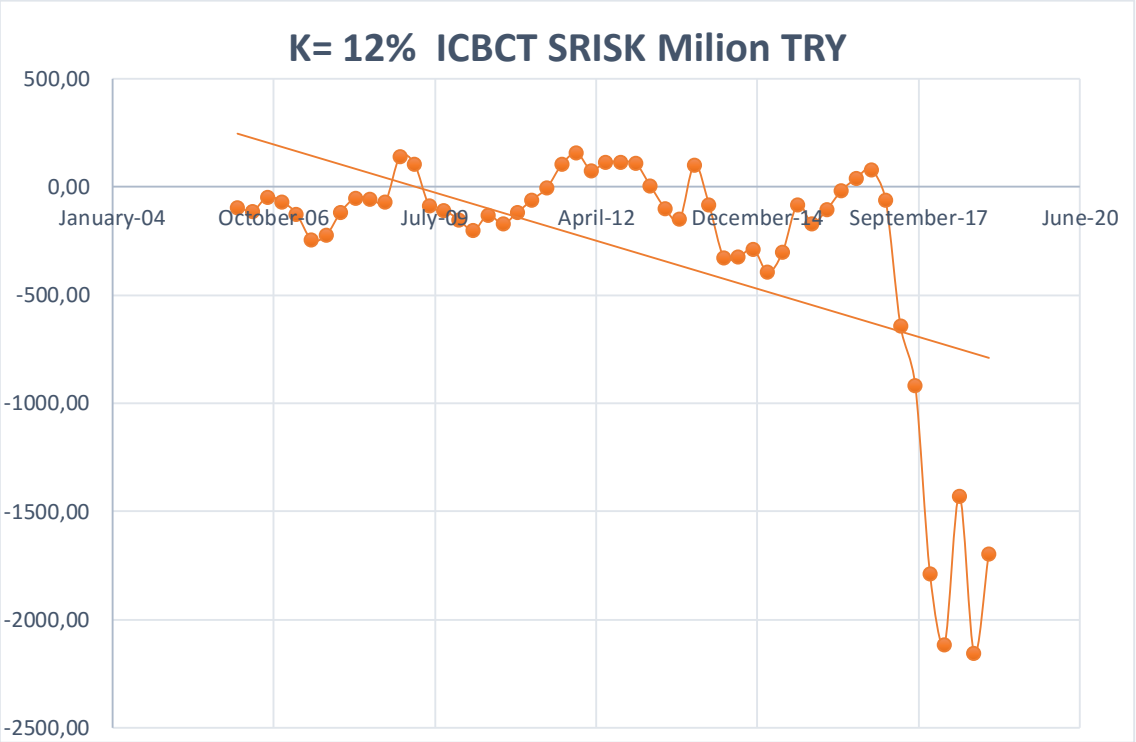
[INSERT TABLE A 6 ABOUT HERE]

ICBCT bank is a foreign bank and has Free Float Rate (FFR) by 25.02 percent (https://www.sabah.com.tr/apara/hisse-senetleri). The bank was founded in 1986 as Tekstil bank A.Ş. In 2014, Industrial and Commercial Bank of China ICBC acquired 75.5% of the stock. Acquisition completed in April 2015, then the name of the bank changed to "ICBC Turkey".

From table A 6 in the appendix, presents that the bank has not recorded any systemic risk from March-06 to December-08. It can also be seen that the Bank suffered from systemic risk on December-2008 and March-2009. Then the systemic risk of the bank began to fluctuate until the end of 2018. The Bank recorded the highest systemic risk in December-11 by 157 million TRY.

In figure 4.6, we display systemic risk quarterly results trend of ICBC bank during the period from January-2006 to December-2018. The figure shows that the bank did not suffer from significant systemic risks during the study period. It is also noted that the bank has no systemic risk from March-2017 to December-2018 and the value of SRISK began to decrease significantly during 2018.

Figure 4.6. *ICBCT SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 6 in the appendix.*

4.1.7. ISCTR Bank Results

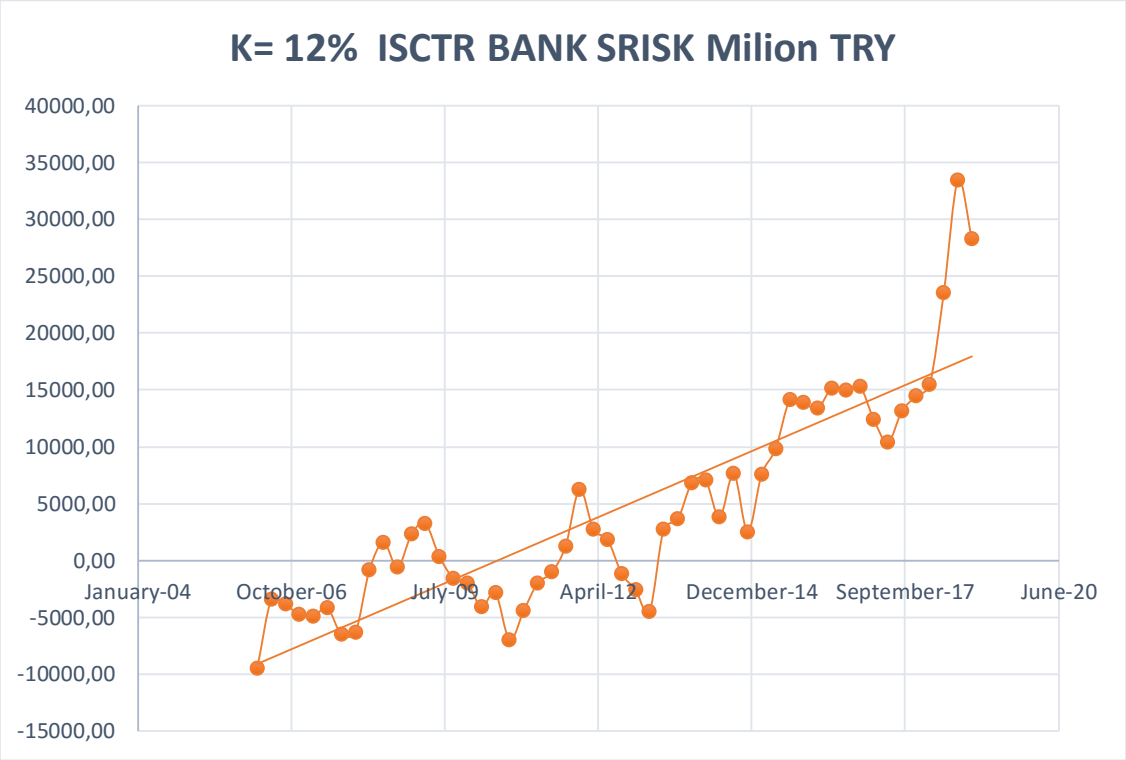
[INSERT TABLE A 7 ABOUT HERE]

Iş bank is a private bank and has Free Float Rate (FFR) by 34.42 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 7 in the appendix, we can remark that the bank has not recorded any systemic risk from March-2006 to March-2008. However, the bank recorded systemic risk for the first time on June-2008 to June-2009 except for September-2008. However, after the global financial crisis in 2008, the Bank was able to significantly reduce systemic risk until March-2013 then the systemic risk of the bank started to increase dramatically, and the bank recorded the highest systemic risk in September-2018 by 33,4 billion TRY.

The results show a significant negative impact of the Turkish lira crisis during the 2018, which doubled the systemic risk of the bank. Furthermore, SRISK value of the bank

at December-2018 represent 6.79 per cent of the total assets of the bank. Also, it represents about 137% of the market value of the bank.

Figure 4.7. *ISCTR SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 7 in the appendix.*

Figure 4.7 shows systemic risk quarterly results of İş bank during the period from January-2006 to December-2018. From the figure we can notice that is the Bank's systemic risk fluctuated from March-2006 to March-2013, then from June-2013, the Bank's systemic risk started to increase significantly, so the curve of Bank's systemic risk is heading upwards clearly.

The systemic risk of the bank is high, and we can rank İş bank as one of the most SIFIs in Turkey. Besides, the bank contributed to the systemic risk of the Turkish financial system by 17.18 percent by the end of 2018. So, the bank's management and regulators in Turkey should conduct a further assessment to identify the reasons for increasing the Bank's systemic risk in recent years and take effective procedures against triggering a systemic crisis

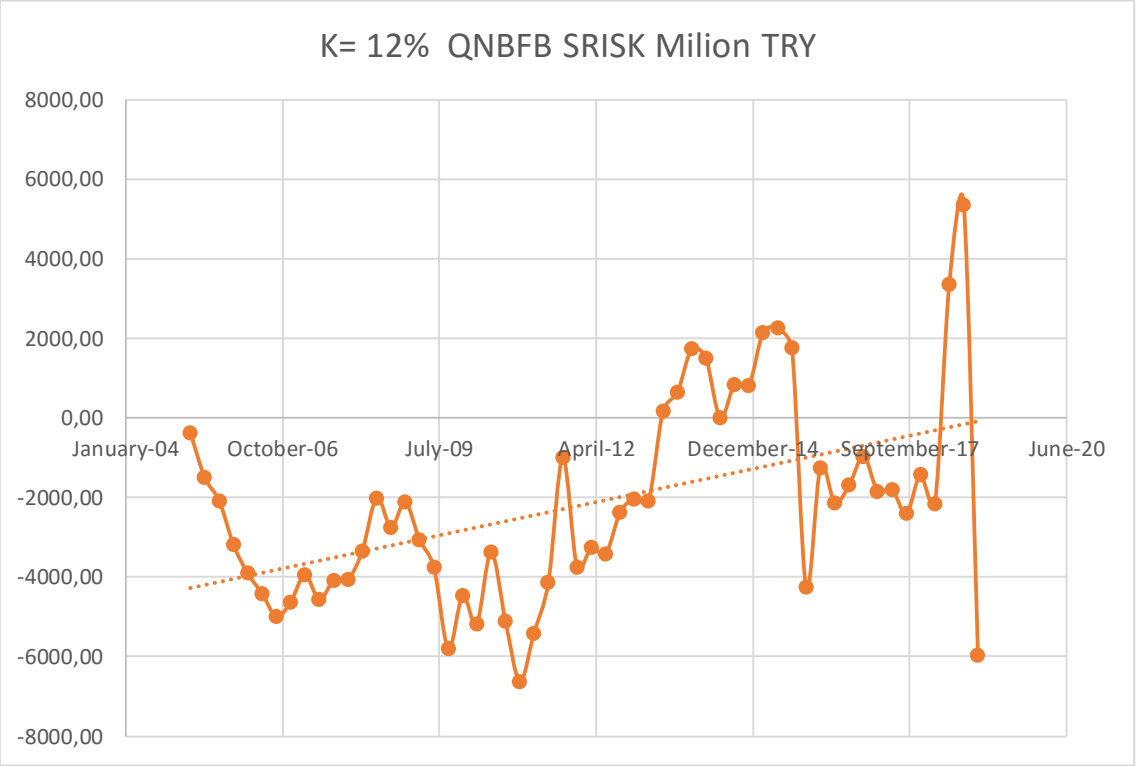
4.1.8. QNBFB Results

QNB Finansbank is a private bank and has Free Float Rate (FFR) by 46.76 percent (https://www.sabah.com.tr/apara/hisse-senetleri). Finansbank is acquired by Qatar National Bank (QNB Group), the biggest bank in Qatar and a leading financial institution in the Middle East and Africa region. The Bank's name was changed to QNB Finansbank in October 2016.

[INSERT TABLE A 8 ABOUT HERE]

From table A 8 in the appendix, we can remark that the bank has not recorded any systemic risk from March-2005 to March-2013. However, the bank recorded systemic risk from June-2013 to September-2015, and the bank recorded the highest systemic risk in September-2018 by 5,358 million TRY. The examination of the data, we can note that the acquisition of the Bank by Qatar National Bank has led to an increase in the market cap of the bank significantly. Therefore, after the announcement of this acquisition, the value of SRISK became negative, which mean that the bank has not a systemic risk from December-2015 to December-2018. Except for June-2018 and September-2018.

Figure 4.8. *QNBFB SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 8 in the appendix.*

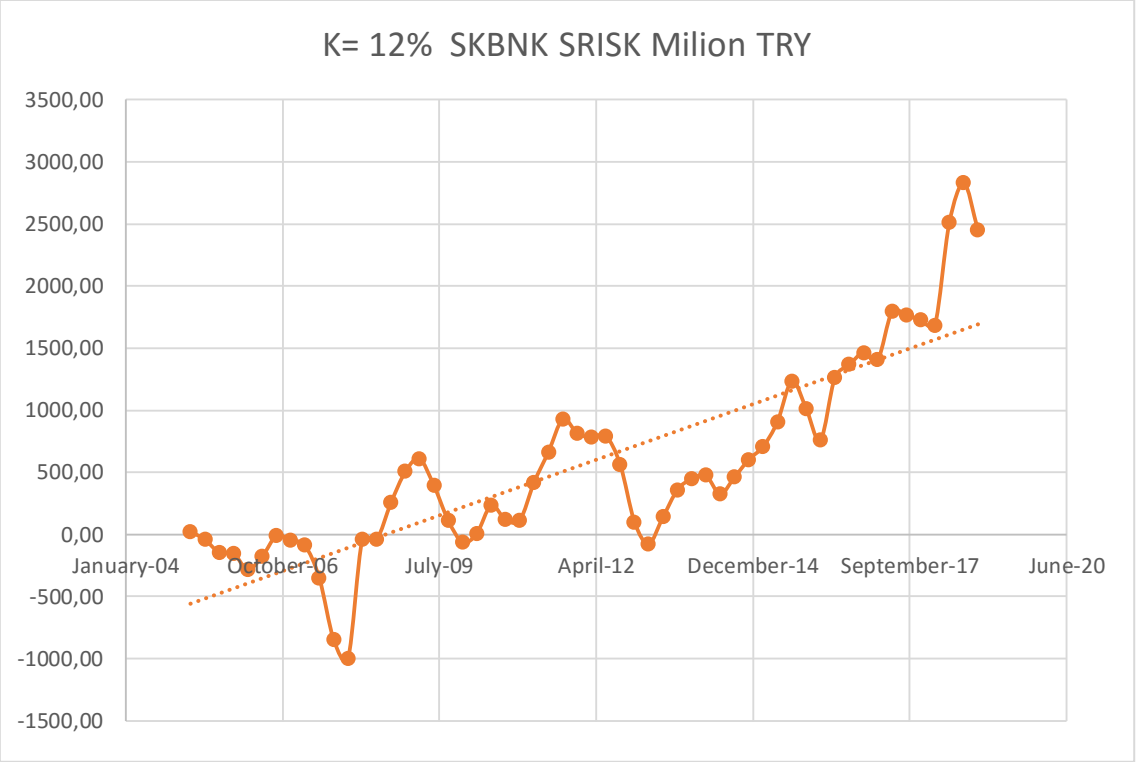
Figure 4.8 displays systemic risk quarterly results of QNB Finansbank during the period from March-2005 to December-2018. We can say that the Bank's systemic risk remained relatively insignificant in the period from 2005 to 2017. However, the Bank recorded high systemic risks in the second and third quarter of 2018 before these risks disappeared by the end of the fourth quarter of the same year. When examining the bank's data, we found that the market value of the bank increased by more than 60% during the last month of 2018.

4.1.9. SKBNK Results

[INSERT TABLE A 9 ABOUT HERE]

Sekerbank is a private bank and has Free Float Rate (FFR) by 99.91 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 9 in the appendix, we can remark that the bank's systemic risk fluctuated between March-2005 and March-2013. Moreover, the value of the SRISK of the bank was positive and increased during the global financial crisis in 2008. The systemic risk of the bank started to increase sharply from June-2013 to ends of the sample, and the bank recorded the highest systemic risk in September-2018 by 2,831 million TRY.

Figure 4.9. *SKBNK SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 9 in the appendix.*

Figure 4.9 presents systemic risk quarterly results of Şeker bank during the period from March-2005 to December-2018. The figure gives a clear picture of the direction of the systemic risk of Seker bank in general, and especially at the beginning of 2013, where the systemic risk curve is moving upwards. Consequently, this indicates the Bank's contribution to the systemic risks of the Turkish financial system and the need to take appropriate procedures to reduce the systemic risks of the Bank during the coming period.

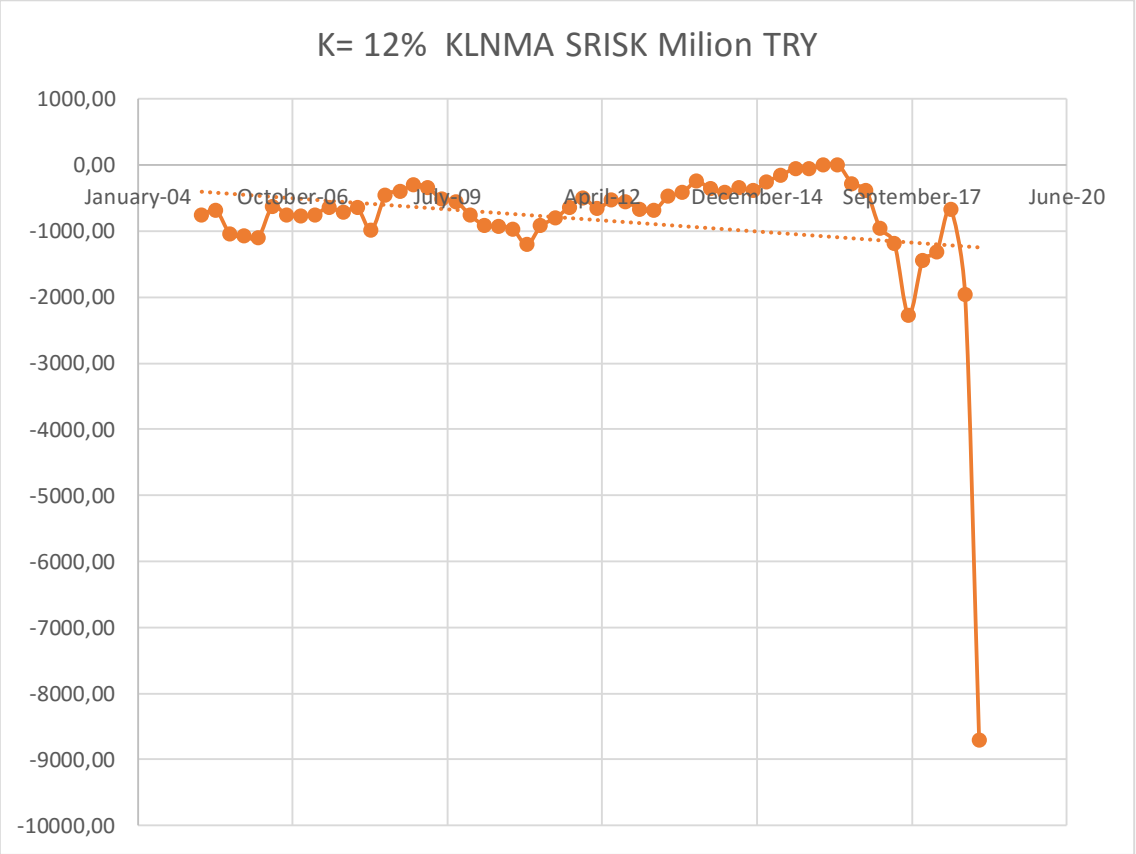
4.1.10. KLNMA Results

[INSERT TABLE A 10 ABOUT HERE]

From table A 10 in the appendix, the bank considered as one of the public banks in the sample and has Free Float Rate (FFR) by 0.92 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From the results table, we can notice that the bank did not record any significant systemic risks during the study period, even during the global financial crisis of 208 and the Turkish lira crisis in 2018.

In figure 4.10, we display systemic risk quarterly results trend of Turkey Development Bank (KLNMA) during the period from March-2006 to December-2018. The figure shows that the bank did not suffer from significant systemic risks during the study period. It is also noted that the value of SRISK began to decrease significantly during 2017 and 2018.

Figure 4.10. *KLNMA SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 10 in the appendix.*

4.1.11. TSKB Results

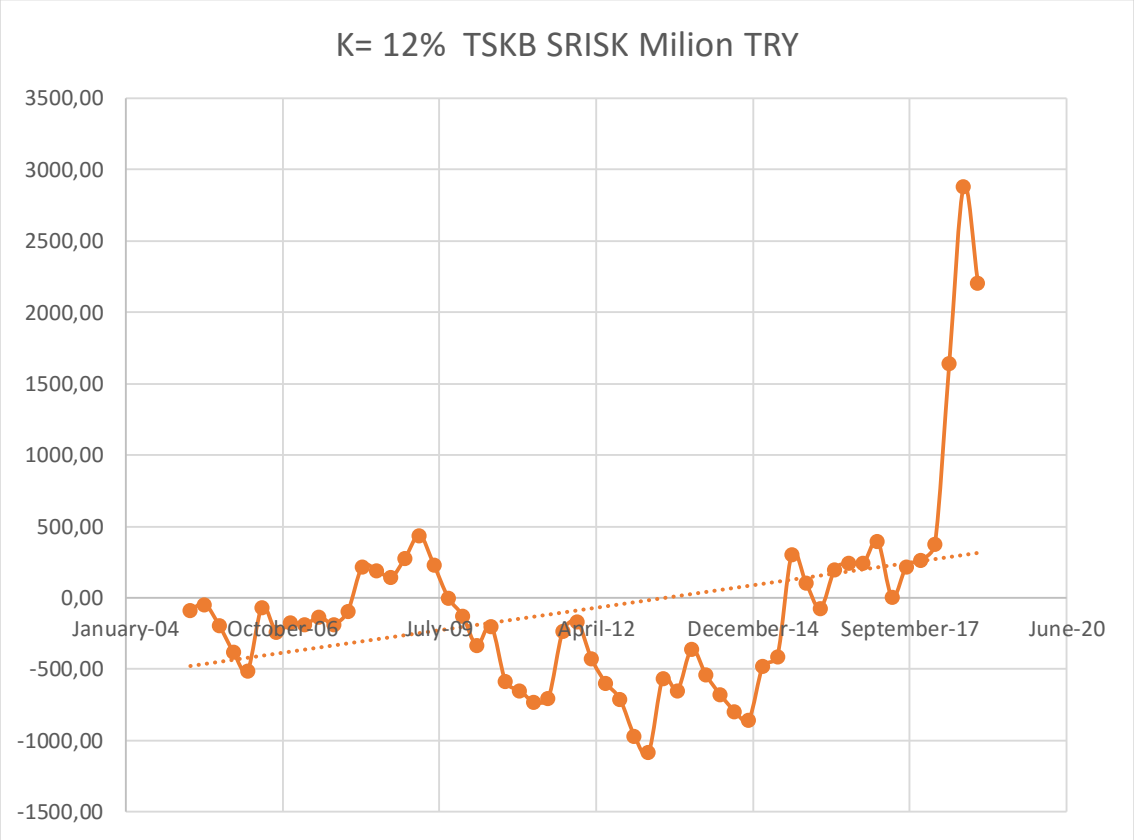
[INSERT TABLE A 11 ABOUT HERE]

TSKB is a public bank and has Free Float Rate (FFR) by 54.14 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 5 in the appendix, we can notice that the Bank's systemic risks fluctuated during the period from 2005 to 2017 with

the assurance that the Bank recorded systemic risks during the global financial crisis 2008, but the value of these risks is insignificant.

In 2018, the Bank recorded significant systemic risk, especially in the third quarter, which recorded 2,882 Million TRY.

Figure 4.11. *TSKB SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 11 in the appendix.*

Figure 4.11 display systemic risk quarterly results trends of TSKB bank during the period from March-2005 to December-2018. The above figure shows that the bank did not suffer from significant systemic risks until 2017, but during 2018, and due to the crisis of the devaluation of the Turkish lira against foreign currencies, we can be seen the significant impact of the lira crisis on the systemic risk of the bank. Where the bank recorded significant systemic risks during the crisis so that it can be said, there is a direct correlation between the devaluation of the currency and the systemic risks of the financial system.

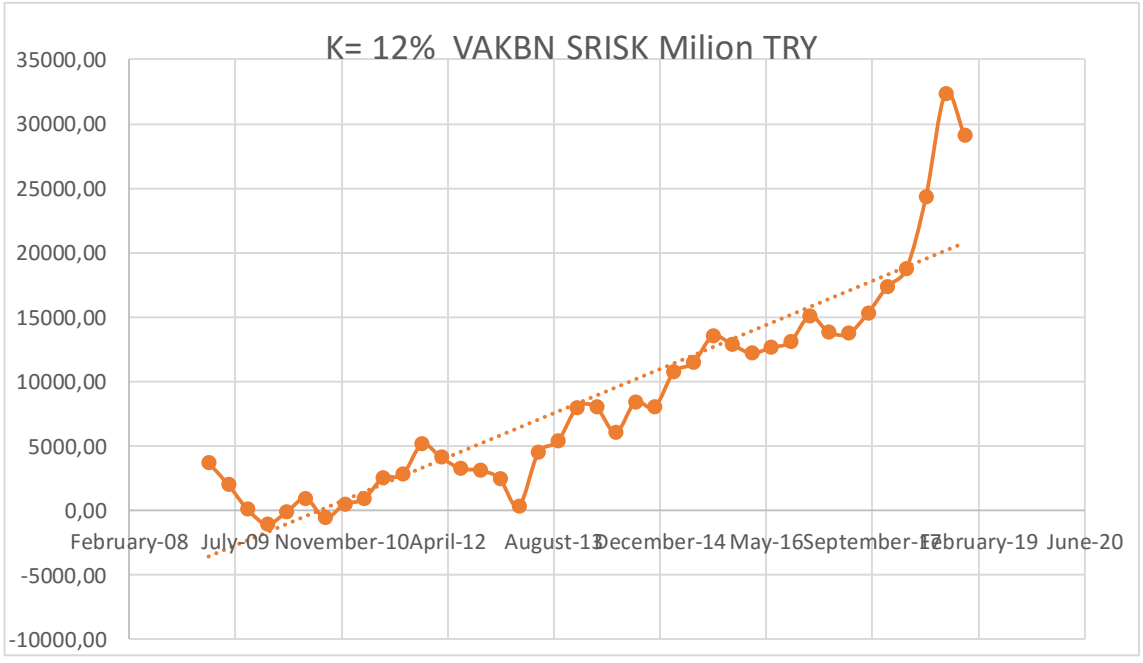
4.1.12. VAKBN Results

[INSERT TABLE A 12 ABOUT HERE]

Vakıfbank is a public bank and has Free Float Rate (FFR) by 25.22 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 12 in the appendix, we can remark that the bank recorded systemic risk during the study period except for December-2009, March-2010 and September-2010. Additionally, the value of the systemic risk of the bank was increasing from year to year, and the bank recorded the highest systemic risk in September-2018 by 32,341 million TRY.

The results show a significant negative impact of the Turkish lira crisis during the past year, which doubled the systemic risk of the bank. Moreover, we can identify Vakif Bank as one of the most SIFI's in Turkey. The bank contributes 18.70 percent of the TFS's systemic risk. SRISK value of the bank represent 8.77 percent of the total assets of the bank at December-18; also, it represents about 298.11 percent of the market value of the bank in the same period.

Figure 4.12. *VAKBN SRISK Million TRY*



Source. *Elaborated by the author by the data from table A 12 in the appendix.*

Figure 4.12 display quarterly results of systemic risk for Vakif Bank during the period from March-2009 to December-2018. From the figure, we can observe that Vakif bank record systemic risk for the first time on December-2009. Then, the Bank's systemic risk started to increase significantly until the end of the study period, the value of the systemic risk of the bank increased readily, so the curve is heading upwards clearly.

Overall, the bank is considered as one of the state banks in the Turkish financial system. According to the results, the bank could also be classified as one of the SIFI's in Turkey. We, therefore, believe that regulators in Turkey need to conduct further examinations of the Bank's systemic risks and causes through a specialized center of systemic risk to analyze and report systemic risks for financial institutions in order to increase the stability of the financial system and prevent financial crisis.

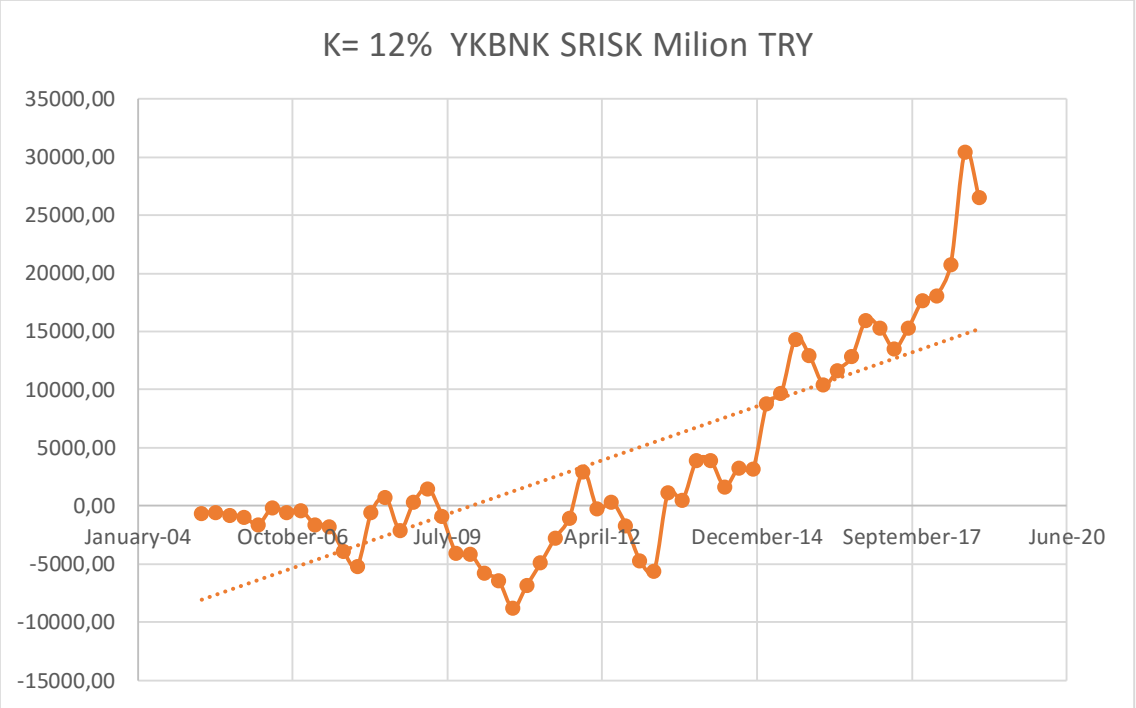
4.1.13. YKBNK Bank Results

[INSERT TABLE A 13 ABOUT HERE]

YapıKredi bank is a private bank and has Free Float Rate (FFR) by 23.78 percent (https://www.sabah.com.tr/apara/hisse-senetleri). From table A 13 in the appendix, we can state that the bank recorded systemic risk for the first time in the aftermath of the 2008 global financial crisis, specifically on June-08. However, the bank's systemic risk reminds insignificant until March-2015. Besides, from March-2015 to December-2018, the value of the systemic risk of the bank was increasing from year to year, and the bank recorded the highest systemic risk in September-18 by 30,482 million TRY.

The results show a significant negative impact of the Turkish lira crisis during 2018. Thus, we can identify YapKredi Bank as one of the most SIFI's in Turkey. The bank contributes of 17.06 percent of the TFS's systemic risk in December-2018. SRISK value of the bank represents 7.62 per cent of the total assets of the bank at December-2018. Besides, it represents about 196.23 per cent of the market cap of the bank in the same period.

Figure 4.13. *YKBNK SRISK Million TRY*

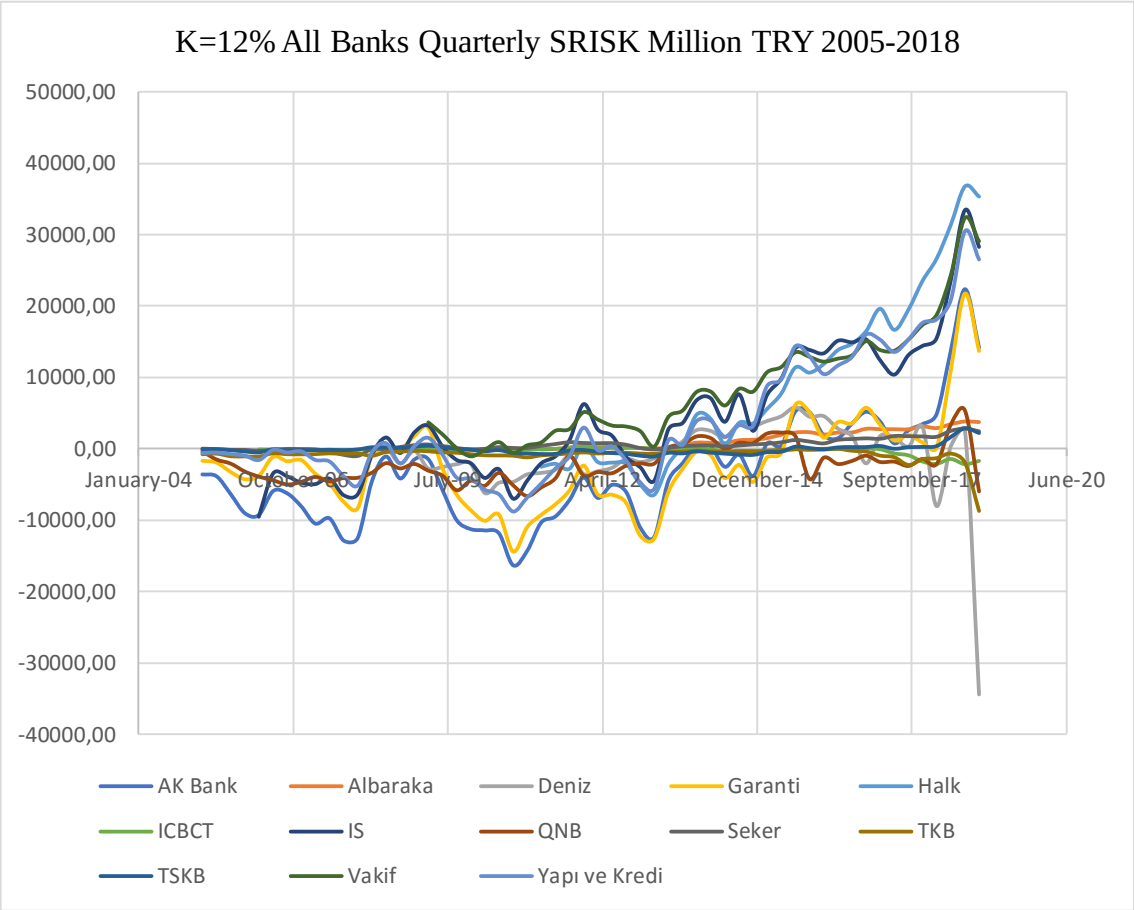


Source. *Elaborated by the author by the data from table A 13 in the appendix.*

Figure 4.13 displays quarterly results of systemic risk for YapKredi Bank during the period from March-2005 to December-2018. From the figure, we can observe that the systemic risk of YapKredi banks started to be significant in March-2015. Then, the Bank's systemic risk started to increase significantly until the end of the study period, the value of the systemic risk of the bank increased readily, so the curve is heading upwards clearly.

Overall, the bank is considered as one of the private banks in the Turkish financial system. According to the results, the bank could also be classified as one of the SIFI's in Turkey. The figure clearly shows that the direction of the bank's systemic risk curve is moving upwards dramatically. Therefore, we believe that the bank and regulators in Turkey need to continuously measure systemic risks while taking the necessary actions to reduce the systemic risk of the bank during the coming period to maintain the system stability and increase investor confidence in Turkey's financial system.

Figure 4.14. *All Banks Quarterly SRISK Million TRY 2005-2018*



Source. *Elaborated by the author by the data from table A 14 in the appendix.*

Figure 4.14 displays quarterly results of systemic risk for all bank during the period from January-2005 to December-2018. From the figure, we can observe that the banks did not record any systemic risk between 2005 and last quarter of 2008. Additionally, the banks started to record systemic risk during global financial crisis. Systemic risk of the banks started to be significant from 2014.

We can classify the banks into three groups, the first records significant systemic risks and includes (Halkbank, Vakıfbank, İşbank and Yapıkredi bank) often public banks. The second records systemic risks and includes (Garanti bank and Akbank) often private banks. The third has not records systemic risks or the systemic risk of the bank not significant and includes other banks often foreign banks.

4.1.14. Turkish Financial System (TFS) Results

[INSERT TABLE A 14 ABOUT HERE]

The data of this study consist of daily data to measure systemic risk of the Turkish financial system for the period of January 01, 2002 to December 31, 2018 which make a total of 50,186 observations and is unbalanced in that not all financial institutions have been trading continuously during the sample period as displayed in the table.

From table A 14 in the appendix, we can notice that TFS has not recorded any systemic risk in December-2005, December-2006, and December-2007, but the systemic risk of TFS appeared in 2008 following the global financial crisis by 5358.56 Million TRY. However, it is faded back in 2009 but appeared again in 2010 with value 606.24 Million TRY, but it is not significant.

From December-2010 to December-2018, the value of the systemic risk of TFS was increasing from year to year, and TFS recorded the highest systemic risk in December-2018 by 155.47 billion TRY. The significant increase in the value of SRISK for the financial system as a whole can be seen in 2018, and it can be explained by the crisis of the Turkish lira depreciation against foreign currencies. By analyzing the model and reading the financial system data, we can determine the reason for the significant increase in systemic risk after the lira crisis in two main reasons:

First, a significant increase in the value of debt to the financial system resulting from the depreciation of the local currency, as foreign debt is denominated in foreign currencies. Consequently, the decline in the local currency has led to increased leverage of banks and as a result, increased leverage of the financial system as a whole. Second, the significant decline in the share price of banks led to a sharp decline in the market cap of banks during the crisis period.

Figure 4.15. *TFS SRISK Million TRY*

Source. *Elaborated by the author by the data from table A 14 in the appendix.*

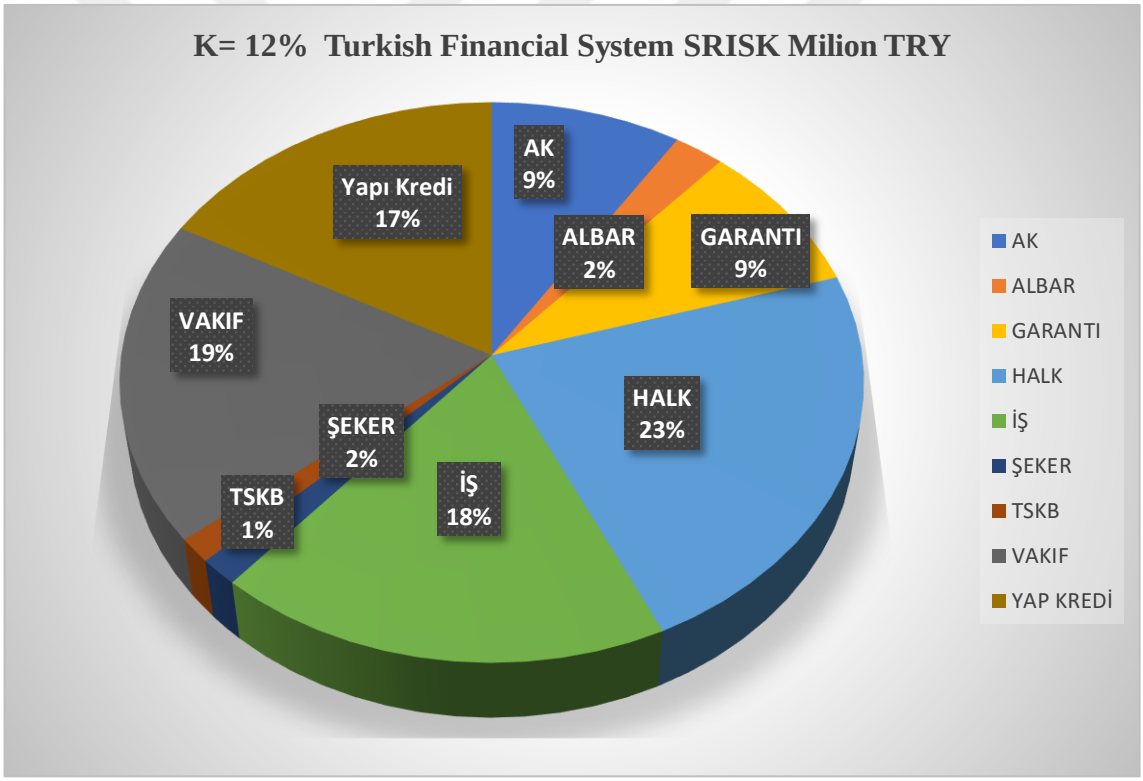
Figure 4.15 shows the annual results of systemic risk for TFS during the period from December-05 to December-18. The figure gives a clear message of the direction of the systemic risk of TFS as well, the systemic risk of the system began to be significant by December-13, where the systemic risk curve is moving upwards.

In addition, we can observe the growth of the systemic risk (SRISK) in the TFS through the period from December-13 to December-18, The above figure shows the rapid and significant growth of systemic risks in the TFS, especially in the last year after the Turkish lira crisis, the value of systemic risks in Turkey doubled to reach a record by the end of 2018.

Based on the above results, regulators in Turkey need to continue to assess the systemic risks in Turkey in the short and long term to determine the reasons behind the high systemic risks of some financial institutions identified in this study and that threaten the financial system as a whole. So, we believe that regulators in Turkey need to take the necessary actions to reduce the systemic risk of the TFS during the coming period to maintain the system stability and increase investor confidence in Turkey's economy.

We can state that a significant increase in the systemic risk of TFS during the prior period, especially that the systemic risks doubled after the crisis of the Turkish lira in 2018 and reached alarming levels. Regulators and the Ministry of Finance and Treasury in Turkey should take the necessary procedures to prevent the increase of these risks in the short term and reduce the value of systemic risks of SIFI's in Turkey in the long term. Besides, this can be accomplished by conducting further examinations and analyses and identifying the main reasons for the high systemic risk at the banks identified in this study. Also, at the end of this study, we will write some recommendations that will help to control the systemic risks of the TFS and thus increase the stability of the system and the confidence of investors in it.

Figure 4.16. *TFS SRISK bank's contribution in December-18*



Source. *Elaborated by the author by the data from table A 15 in the appendix.*

Figure 4.16 shows the percentage of each bank's contribution to the systemic risks of TFS in the fourth quarter of 2018. From the figure, we can observe that Halk Bank is the most contributor to systemic risk in the TFS by 23 percent by the end of 2018. Vakif Bank is ranked second in terms of contributing to the systemic risks of the TFS by 19 percent, Is Bank is ranked third by 18 percent, and Yapı Kredi Bank is ranked fourth by 17 percent. Additionally, we can notice that the previous four banks contribute a total of

77 percent of the systemic risk of TFS, which is very high. Thus, we can classify these four banks as SIFIs in Turkey.

[INSERT TABLE A 15 ABOUT HERE]

Table A 15 in the appendix ranks Turkish banks in terms of percentage contribution to the systemic risks of the Turkish financial system in the last quarter between 2005-2018. Initially, a critical thing to be clarified is that when the value of SRISK is negative, it means that no systemic risk in the financial system. Thus, the previous table presents the results of the systemic risks of Turkish banks in Turkey starting in 2008. Also, the results explained by the fact that the SRISK value of TFS before that date was negative in the sense that the financial system before 2008 had no systemic risk.

The results showed that the Turkish financial system recorded systemic risk for the first time following the 2008 global financial crisis. In addition, the results show the ranking of banks in terms of contributing to systemic risk, according to the previous table, İş Bank ranked first with a contribution rate of 42.77 per cent, Garanti Bank by 33.36 percent, Seker Bank 9.44 percent, Yapı Kredi Bank 6.55 percent, TSKB 5.25 percent, ICBCT 2.64 percent.

In 2010 two banks have systemic risk, Vakif Bank by 80.90 percent and Seker Bank 19.10 percent. In 2011 we can rank İş, Vakif, and Yapı Kredi as SIFIs by a contribution 38.27, 31.37, and 18.16 percent to the systemic risk of TFS, respectively. In 2012, we can state that Vakif Bank is only the SIFIs in turkey, that contribute by 88.58 per cent from the total systemic risk.

In 2013, there are ten banks out of 13, that contributed of systemic risk in the TFS, but we can rank five banks of them as SIFIs, Vakif Bank 26.84 percent, İş Bank 22.90 percent, Halk Bank 16.11 percent, Yapı Kredi Bank 13.12 percent and Deniz Bank 8.85 percent. In 2014, Vakif bank continued to be the most SIFIs in Turkey for the third consecutive year by a contribution of 34.60 per cent of systemic risk in TFS. Halk Bank came second by 15.41 per cent, Deniz bank came third by 13.78 per cent, and İş bank came fourth by 10.86.

In 2015, 10 banks contributed to systemic risk of TFS, but we can observe that four of them can be considered as SIFSs in Turkey which contributed in a total of 73.48 per cent of systemic risk in TFS as follow, İş bank 20.22 percent, Yap Kredi bank 18.88 percent, Vakif bank 18.80 and Halk Bank 15.58 percent. In 2016 the results did not change in the ranking of SIFSs in Turkey, but it occurred on banks contribution per cent of systemic risk in TFS as following, Halk bank 21.01 per cent, Yap Kredi bank 20.41 per cent, İş bank 19.54 per cent and Vakif bank 19.22 per cent.

In 2017, Halk bank continued to be the most SIFIs in Turkey, which contributed individually by 27.54 per cent from TFS's systemic risk. Moreover, it is considered as the most significant contribution from Halk bank to the systemic risk of TFS in the study period. Yapı Kredi bank continues to be second by contributed 20.65 per cent of the total systemic risk in TFS. Moreover, we can rank Yapı Kredi bank as one of SIFIs in Turkey. Also, Vakif bank contributed by 20.32 per cent of the total systemic risk in TFS, and it has deemed one of SIFIs in Turkey. In fourth place came İş bank which contribution by 16.87 per cent of the total systemic risk in TFS and it has deemed one of SIFIs in Turkey. According to the previous results, we can see that ten banks out of 13 contributed to the systemic risks of the Turkish financial system during 2017, but the previous four banks (Halk, Yap Kredi, Vakif, İş) contributed to a total of 85.38 per cent of the systemic risks in Turkey during 2017. Accordingly, they are SIFI's in Turkey during 2017.

The results did not change significantly in 2018 at the level of SIFI's. Halk bank continued to rank first in the contribution of systemic risk in TFS by 22.72 percent. Vakif bank came second by 18.70 percent, and İş bank came third by 18.19 percent. Yap Kredi Bank slipped to the fourth locality by 17.06 percent. Furthermore, we can observe that Akbank and Garanti bank came in fifth and sixth respectively as they contributed by 9.12 per cent and 8.82 percent respectively. However, we can state that it is the contribution to systemic risk in TFS remained insignificant. Thus, the previous four banks (Halk, Vakif, İş, Yap Kredi) contributed to a total of 76.67 percent of the systemic risks in Turkey at the end of 2018. Accordingly, they are SIFI's in Turkey during 2018.

Finally, we can note that Seker bank appears as SIFI's for 11 time, Vakif bank appear as SIFI's for 9 time, Is bank, Yapı Kredi bank and Albaraka bank appear as SIFI's for 8 time, Halk bank appear as SIFI's for 7 time, Garanti bank, TSKB, and Akbank

appear as SIFI for 5 time, Deniz bank and ICBCT bank appear as SIFI for 4 time, and QNB Finansbank appears as SIFI for 2 time.

Accordingly, we can be seen from the previous analysis that during the last five years of 2014-2018, the rating of SIFI's in Turkey has not changed. Nevertheless, there has been a change in the contribution percentage of each bank individually and thus an insignificant change in the ranking of banks from year to year. Therefore, we can declare that the following four banks (Halk, Vakif, İş, Yap Kredi) are considered as SIFI's in Turkey at the end of 2018. Hence, and based on the results in table 4.16, we can discern that we have achieved one of the most important objectives of the study is the identification of SIFI's in Turkey during the study period.

4.2. Impact of the Lira Crisis in 2018 on the Systemic Risks of the Turkish Financial System:

[INSERT TABLE A 16 ABOUT HERE]

From table A 16 in the appendix, we display systemic risk of banks in the TFS at September-18 and the Bank's contribution as a per cent to systemic risk to the TFS.

The Turkish lira suffered a significant depreciation crisis in 2018 when the value of the Turkish currency depreciation significantly against foreign currencies. The peak of this decline occurred in August last year, also the Turkish lira lost about 40% of its value during 2018. Experts attribute the depreciation to political and economic reasons most importantly the dispute between Turkey and the United States on several political issues, besides that one economic reason is the US imposing additional tariffs on Turkish iron and aluminum imports.

The CBRT applied several procedures that contributed to the stability of the value of the Turkish lira, the most important action is that raising interest rates and injecting billions of foreign currencies into the market to meet the growing demand for the Turkish lira.

Initially, it can be recalled that in study period, the highest recorded value of SRISK of TFS was recorded in the month following the Turkish lira crisis, which reached

about 194,572 Million TRY. We can remark that the value of SRISK doubled during the crisis, and this reflects the significant negative influence of the lira crisis on the value of systemic risk for the Turkish financial system.

Additionally, Halk bank recorded the most considerable SRISK value by 36.75 billion TRY and contributed to SRISK of the TFS by 18.89 percent, when comparing the value of SRISK with value of SRISK of the same bank in 2017, we note a significant increase in the value of systemic risk of the bank. İş bank came second, which recoded SRISK value by 33.4 billion TRY and contributed to SRISK of the TFS by 18.89 percent. Vakif bank came third, which recorded SRISK value by 32,341 Million TRY and contributed to SRISK of the TFS by 16.62 percent. Yapı Kredi came fourth, which recoded SRISK value by 30.48 billion TRY and contributed to SRISK of the TFS by 15.67 percent. Akbank contributed to SRISK of the TFS by 11.49 percent, and it came fifth, which recorded the value of SRISK by 22.4 billion. Garanti Bank contributed to SRISK of the TFS by 11.18 percent, and it came sixth, and it recorded the value of SRISK by 22,3 billion. Other banks logged systemic risk through the crisis, and as its results appear in table A 16, it is not significant.

[INSERT TABLE A 17 ABOUT HERE]

From table A 17 in the appendix, we can observe that Halk bank came first, with systemic risk accounted for 9.34 % of the Bank's total assets. Albaraka Bank came second, with systemic risk accounted for 8.87 % of the Bank's total assets. It should be noted that Albaraka bank does not have the second-largest systemic risk, but when calculated the Bank's systemic risk as a percentage of its assets came in second place.

Vakif bank have a systemic risk by 8.77 % from its assets, and it appeared third in the table, Seker Bank has a systemic risk by 7.82 % of its assets and came fourth, Yapı Kredi Bank appeared fifth by 7.62 % of its assets. Iş bank came sixth by 6.79 % of its assets, TSKB has a systemic risk by 5.76 % of its assets, and it came seventh, Akbank has a systemic risk by 4.33 % of its assets, and it came eighth, Garanti Bank came ninth by 3.81 % of its assets.

Based on the above results, we believe that the regulatory authorities in Turkey need to conduct additional checks and identify the reasons of the systemic risks in the

TFS, especially in SIFI's, which we identified in this study to control systemic risks and maintain system stability.

[INSERT TABLE A 18 ABOUT HERE]

From table A 18 in the appendix, we can notice that Halk Bank recorded the highest percentage of systemic risk compared to the market cap of the bank, which SRISK of the bank is about four times the market capitalization of the bank. Albaraka Bank recorded a high systemic risk compared to the market cap, which SRISK of the bank is about 3.5 times the market cap of the bank. Vakif Bank came third, and SRISK of the bank is about three times the market cap of the bank. Yap Kredi Bank and Seker Bank recorded SRISK to about twice of their market cap. Iş Bank recorded SRISK equivalent 1.3 times of its market cap, and other banks recorded SRISK less than 100 per cent of their market cap as in the table. TFS has SRISK equivalent to about 1.3 times of TFS market cap.

[INSERT TABLE A 19 ABOUT HERE]

Table, A 19 in the appendix, presents the contribution of SRISK on GDP (SRISK/ GDP) of each Bank and TFS on December-18. We can find that Halk Bank (0.95 percent), Vakif Bank (0.79 percent), Iş bank (0.76 percent), Yap Kredi (0.72 percent), Akbank (0.38 percent), Garanti bank (0.37 percent), Albaraka bank (0.10 percent), Seker bank (0.07 percent), TSKB (0.06 percent) have, respectively, the highest ratio of systemic risk to GDP (SRISK/GDP) on December 31, 2018. Additionally, the aggregate systemic risk of TFS represents 4.20 per cent of Turkey GDP.

4.3. SRISK Rankings Sensitivity Analysis

Table 4.1. *SRISK MILLION TRY SENSITIVITY ANALYSIS*

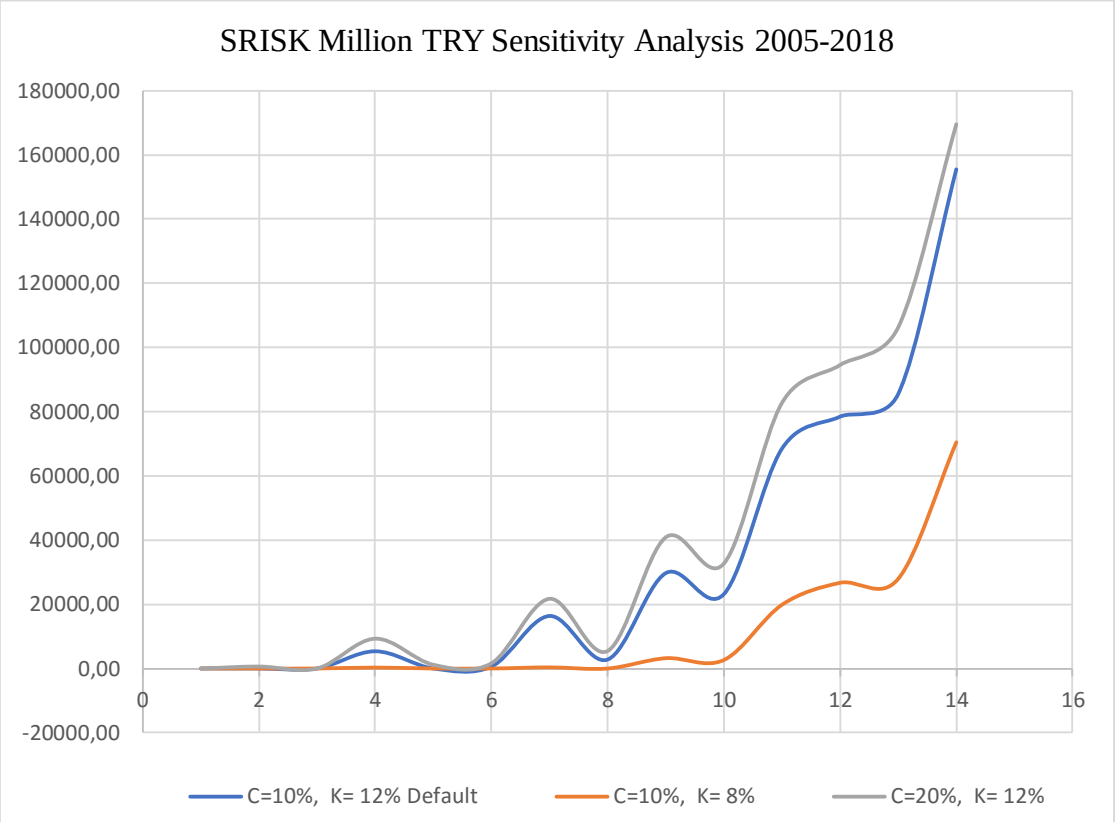
Banks	K = 12%, C = -10% Default	K = 8%, C = -10%	K = 12%, C = -20%
2005-Q4	0.00	0.00	0.00
2006-Q4	0.00	0.00	611.28
2007-Q4	0.00	0.00	0.00
2008-Q4	5358.56	287.69	9284.96
2009-Q4	0.00	0.00	1162.70
2010-Q4	606.24	0.00	1629.90
2011-Q4	16358.87	350.03	21708.82
2012-Q4	2794.47	0.00	5453.11
2013-Q4	29711.31	3210.67	40872.24
2014-Q4	23161.55	2646.25	32693.83
2015-Q4	68481.33	19850.98	82730.49
2016-Q4	78447.03	26692.80	94534.39
2017-Q4	85491.78	27917.59	106249.87
2018-Q4	155471.08	70450.17	169507.67

Source. *Elaborated by the author*.

The table reports the default SRISK measure with SRISK indices computed using alternative choices of the SRISK parameters at the end of the last quarter of each year starting from 2005 until 2018. The set of alternative SRISK parameters are k = 12%, C = −10, h = 22., k = 8%, C = −10%, h = 22 and k = 12%, C = −20%, h = 22.

We assess the sensitivity of the SRISK rankings. We consider decreasing the prudential capital ratio k to 8%, decreasing the systemic event threshold C to -20%, using the LRMES estimator. Thus, we can notice that when we decreased K from 12% to 8%, SRISK will be halved, from 155.47 billion TRY to 70.45 billion TRY. Additionally, when we decreased C from -10% to -20%, SRISK increased from 155.47 billion TRY to 169.50 billion TRY. Overall, it is straightforward to see from the results of table 4.1 that SRISK increases when k increases, or C decreases and these results are consistent with Brownlees and Engle (2017).

Figure 4.17. *SRISK Million TRY Sensitivity Analysis 2005-2018*



Source. *Elaborated by the author by the data from table 4.1.*

Figure 4.17 shows the default SRISK measure with SRISK indices computed using alternative choices of the SRISK parameters at the end of the last quarter of each year starting from 2005 until 2018.

We can observe that the value of SRISK is not changed significantly when we decrease C from -10% to -20%, and this appears from the compatibility of the blue and grey lines in the figure. However, when we decrease K from 12% to 8%, the value of SRISK decrease to halved and this appears from the mismatch of the blue and orange lines in the figure. So, we can conclude that the process of determining the value of K is the responsibility of the regulatory authorities in each country in proportion to several economic factors such as capital adequacy ratio.

CHAPTER FIVE

5. CONCLUSION AND POLICY RECOMMENDATIONS

5.1. Introduction

The term systemic risk exists before the 2008 global financial crisis. However, the global financial crisis in 2008 has played a significant role in attracting attention to the importance of measuring and managing systemic risk. Hence, the period following the crisis have seen significant contributions in the scientific and practical field to propose models for measuring systemic risks in financial institutions and systems.

In this dissertation, we presented the main proposed methods for measuring systemic risk in chapter 2. Also, we examined the systemic risk in the TFS by using SRISK method. Accordingly, we answered the central questions of the study by estimate systemic risk in the Turkish financial system, identify SIFIs in Turkey and identify the total amount of capital that the Turkish government would have to provide to bail out the financial system in case of a crisis. In this chapter, we will cover a summary of the empirical results and possible policy recommendations.

5.2. Conclusions

The main aim of this thesis is to estimate systemic risk in the TFS and identifies SIFI's in Turkey by using the SRISK method. SRISK method proposed by Brownlees and Engle (2017), it can be defined as "measures the expected capital shortfall of a financial institution conditional on a prolonged and severe market decline," and it can be computed using balance sheet information and a proper LRMES estimator. We now summarize the conclusions of our analysis as follows:

1. Systemic risk can be defined as "the risk of collapse of a financial system due to a systemic event occurred in the essential financial institution or more, and transmission that throughout the system."
2. A systemic event can be defined as a financial instability (Financial distress) in the essential financial institution.

3. Banks in Turkey recorded a positive value for SRISK for the first time in the aftermath of the global financial crisis, where the model succeeded in measuring systemic risk. During the period of the study, the highest value of SRISK for TFS recorded in the month following the Turkish lira crisis in 2018, in which the SRISK reached about 194.57 billion TRY on September-2018, where the model succeeded in measuring systemic risk.
4. We can state that one of the most important conclusions is that the results confirmed the ability of the SRISK method to measure systemic risks and identify SIFI's in financial systems and this is consistent with Brownlees and Engle (2017), Derbali (2017), and Coleman, LaPlante, and Rubtsov (2017).
5. The systemic risk of TFS appeared for the first time at December-2008 following the global financial crisis by 5358.56 Million TRY. Besides, TFS recorded high value of SRISK in December-2018 by 155,471 Million TRY. So, we can identify the total amount of capital that the Turkish government would have to provide to bail out the financial system in case of a crisis by 155,471 Million TRY as it appears in December-2018.
6. From our empirical results, we can conclude that Halk bank (22.72%), Vakif bank (18.70%), Is bank (18.19%), Yap Kredi bank (17.06%) respectively contributed to a total of (76.67%) of the systemic risks in Turkey at December-2018. Accordingly, we can identify these banks (Halk, Vakif, Is, and Yap Kredi) as SIFI’s in Turkey.
7. Halk bank came first, with systemic risk accounted for 9.34 % of the Bank's total assets. Albaraka Bank came second, with systemic risk accounted for 8.87 % of the Bank's total assets. It should be noted that Albaraka bank does not have the second-largest systemic risk, but when calculated the Bank's systemic risk as a percentage of its assets came in second place. Vakif bank have a systemic risk by 8.77 % from its assets, and it appeared third in the table, Seker Bank has a systemic risk by 7.82 % of its assets and came fourth, Yapı Kredi Bank appeared fifth by 7.62 % of its assets. Iş bank came sixth by 6.79 % of its assets, TSKB has a systemic risk by 5.76 % of its assets, and it came seventh, Akbank has a systemic risk by 4.33 % of its assets, and it came eighth, Garanti Bank came ninth by 3.81 % of its assets.
8. Halk Bank recorded the highest percentage of systemic risk compared to the market cap of the bank, which SRISK of the bank is about four times the market capitalization of the bank. Albaraka Bank recorded a high systemic risk compared to the market

cap, which SRISK of the bank is about 3.5 times the market cap of the bank. Vakif Bank came third, and SRISK of the bank is about three times the market cap of the bank. Yap Kredi Bank and Seker Bank recorded SRISK to about twice of their market cap. Iş Bank recorded SRISK equivalent 1.3 times of its market cap, and other banks recorded SRISK less than 100 per cent of their market cap.

9. Halk Bank (0.95 percent), Vakif Bank (0.79 percent), Iş bank (0.76 percent), Yap Kredi (0.72 percent), Akbank (0.38 percent), Garanti bank (0.37 percent), Albaraka bank (0.10 percent), Seker bank (0.07 percent), TSKB (0.06 percent) have, respectively, the highest ratio of systemic risk to GDP (SRISK/GDP) on December 31, 2018. Additionally, the aggregate systemic risk of TFS represents 4.20 per cent of Turkey GDP.
10. Seker bank appears as SIFI's for 11 time, Vakif bank appear as SIFI's for 9 time, Is bank, Yapı Kredi bank and Albaraka bank appear as SIFI's for 8 time, Halk bank appear as SIFI's for 7 time, Garanti bank, TSKB, and Akbank appear as SIFI for 5 time, Deniz bank and ICBCT bank appear as SIFI for 4 time, and QNB Finansbank appears as SIFI for 2 time.
11. We can classify the banks into three groups, the first records significant systemic risks and includes (Halkbank, Vakıfbank, İşbank and Yapıkredi bank) often public banks. The second records systemic risks and includes (Garanti bank and Akbank) often private banks. The third has not records systemic risks or the systemic risk of the bank not significant and includes other banks often foreign banks.
12. When we decreased K from 12% to 8%, SRISK will be halved, from 155.47 billion TRY to 70.45 billion TRY. Additionally, when we decreased C from -10% to -20%, SRISK increased from 155.47 billion TRY to 169.50 billion TRY. Overall, it is straightforward to see from the results of table 4.1 that SRISK increases when k increases, or C decreases and these results are consistent with Brownlees and Engle (2017).
13. When we decrease K from 12% to 8%, the value of SRISK decrease to halved and this appears from the mismatch of the blue and orange lines in the figure. So, we can conclude that the process of determining the value of K is the responsibility of the regulatory authorities in each country in proportion to several economic factors such as capital adequacy ratio.

5.3 Recommendations

We believe that the application of the recommendations of this dissertation will contribute to achieving the required stability of the Turkish financial system and reducing the sensitivity of the financial system to political and economic shocks. Based on the empirical findings; the study made the following recommendations.

1. The study identified SIFI's in Turkey and its risk ratio until the end of 2018. Thus, the study recommends calculating systemic risk in TFS every month and regularly identify SIFI's in Turkey.
2. Controlling of the systemic risks of the periodically identified SIFI's by increasing the supervision of the SIFI's in Turkey and making the necessary interventions to maintain the stability of the Turkish financial system and improves investors' confidence by, increasing the reserves of SIFI's, decreasing the leverage ratio of SIFI's, decreasing the lending, and increasing the capital of SIFI's.
3. Many developed countries have established specialized centers to manage systemic risks to prevent any financial crisis such as (Volatility Institute - NYU Stern in the United States), (the European Systemic Risk Board-ESRB), and (Systemic Risk Centre-SRC in London). So, we recommend establishing a specialized systemic risk center in Turkey under the authority of CBRT.
4. We recommend conducting further examinations of SIFI's in Turkey that identified by the study and determines the reasons for the notable levels of systemic risks in these institutions. Accordingly, developing a reform program with careful follow-up to reduce the systemic risks of these institutions.
5. Establish a scientific research department to identify the causes of systemic risks in financial systems and how to manage it. Likewise, we proposed a formula to calculate the breakeven point for the allowed value of the dept, which will make the capital shortfall equal zero in case of a given market cap and prudential capital ratio. Thus, this breakeven point value should not be exceeded to keep the value of CS ($_{i\,t}$) negative, which indicates that the financial firm has not a systemic risk.

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APPENDIX

Table A 1: *AKBNK SRISK Quartile SRISK Results in Million TRY from 2005 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-05	-3586.59	0.15	27.	March-12	-6884.85	0.14
2.	June-05	-3857.29	0.16	28.	June-12	-5050.50	0.16
3.	September-05	-6377.64	0.19	29.	September-12	-6066.72	0.13
4.	December-05	-9019.86	0.16	30.	December-12	-11029.37	0.13
5.	March-06	-9265.92	0.17	31.	March-13	-12358.09	0.14
6.	June-06	-5928.70	0.19	32.	June-13	-4478.12	0.20
7.	September-06	-6247.70	0.19	33.	September-13	-2015.79	0.19
8.	December-06	-8072.20	0.15	34.	December-13	466.96	0.19
9.	March-07	-10473.44	0.14	35.	March-14	356.85	0.18
10.	June-07	-9739.15	0.14	36.	June-14	-2524.04	0.16
11.	September-07	-12856.52	0.20	37.	September-14	-797.77	0.15
12.	December-07	-12477.16	0.16	38.	December-14	-3858.46	0.16
13.	March-08	-4583.50	0.16	39.	March-15	749.08	0.16
14.	June-08	-1072.25	0.17	40.	June-15	420.55	0.16
15.	September-08	-4161.13	0.26	41.	September-15	5262.72	0.16
16.	December-08	-1501.85	0.17	42.	December-15	5135.74	0.16
17.	March-09	-1454.60	0.20	43.	March-16	1909.47	0.16
18.	June-09	-5776.00	0.20	44.	June-16	1472.27	0.15
19.	September-09	-10005.91	0.15	45.	September-16	3562.83	0.17
20.	December-09	-11254.97	0.16	46.	December-16	5186.51	0.14
21.	March-10	-11429.10	0.16	47.	March-17	3831.25	0.13
22.	June-10	-11835.43	0.16	48.	June-17	758.25	0.14
23.	September-10	-16321.46	0.14	49.	September-17	2587.29	0.16
24.	December-10	-14277.60	0.15	50.	December-17	3473.76	0.15
25.	March-11	-10334.65	0.17	51.	March-18	4828.817	0.14
26.	June-11	-9481.07	0.16	52.	June-18	13680.71	0.16
27.	September-11	-7149.87	0.19	53.	September-18	22359.24	0.20
28.	December-11	-4023.65	0.15	54.	December-18	14173.62	0.18

Source. *The author elaborates it.*

The table present systemic risk quarterly results of Akbank during the period from March-2005 to December-2018.

Table A 2: *ALBRK SRISK Quartile Results in Million TRY from 2011 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-11	-97.40	0.08	15.	March-15	1489.53	0.07
2.	June-11	-20.20	0.08	16.	June-15	1967.77	0.09
3.	September-11	205.75	0.08	17.	September-15	2293.63	0.07
4.	December-11	453.41	0.08	18.	December-15	2327.08	0.08
5.	March-12	243.70	0.10	19.	March-16	1993.93	0.08
6.	June-12	359.30	0.09	20.	June-16	2273.78	0.07
7.	September-12	285.73	0.11	21.	September-16	2291.43	0.08
8.	December-12	109.22	0.09	22.	December-16	2803.61	0.08
9.	March-13	31.61	0.09	23.	March-17	2753.96	0.07
10.	June-13	181.41	0.07	24.	June-17	2741.31	0.08
11.	September-13	464.69	0.08	25.	September-17	2737.42	0.07
12.	December-13	860.62	0.16	26.	December-17	3138.97	0.26
13.	March-14	842.30	0.08	27.	March-18	2897.52	0.06
14.	June-14	783.54	0.06	28.	June-18	3440.76	0.07
15.	September-14	1200.07	0.07	29.	September-18	3827.08	0.06
16.	December-14	1263.50	0.07	30.	December-18	3743.02	0.07

Source. *The author elaborates it.*

The table present systemic risk quarterly results of Albaraka bank during the period from March-2011 to December-2018.

Table A 3: *DENIZ SRISK Quartile Results in Million TRY from 2008 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-08	-259.08	0.06	21.	September-13	1037.94	0.10
2.	June-08	149.81	0.04	22.	December-13	2630.25	0.20
3.	September-08	-2072.39	0.12	23.	March-14	2505.36	0.07
4.	December-08	-291.86	0.09	24.	June-14	1620.08	0.06
5.	March-09	-2774.58	0.10	25.	September-14	3446.66	0.07
6.	June-09	-2543.47	0.04	26.	December-14	3190.53	0.07
7.	September-09	-2165.64	0.06	27.	March-15	3894.06	0.03
8.	December-09	-2104.28	0.05	28.	June-15	4559.64	0.06
9.	March-10	-6187.91	0.04	29.	September-15	5818.88	-0.10
10.	June-10	-4751.44	0.08	30.	December-15	4489.23	0.04
11.	September-10	-4639.74	0.06	31.	March-16	4579.14	0.02
12.	December-10	-3575.25	0.07	32.	June-16	2822.58	0.03
13.	March-11	-3376.64	0.06	33.	September-16	1744.74	0.07
14.	June-11	-2923.57	0.06	34.	December-16	-2039.81	0.06
15.	September-11	-1012.33	0.09	35.	March-17	1776.26	0.14
16.	December-11	-3523.82	0.05	36.	June-17	1582.43	0.04
17.	March-12	-3141.56	0.05	37.	September-17	308.35	0.06
18.	June-12	-2665.73	0.07	38.	December-17	3024.08	0.07
19.	September-12	-1430.14	0.07	39.	March-18	-8025.15	0.01
20.	December-12	-1852.75	0.08	40.	June-18	340.11	0.03
21.	March-13	-1354.38	0.06	41.	September-18	2552.37	0.06
22.	June-13	-413.68	0.07	42.	December-18	-34405.42	0.12

Source. *The author elaborates it.*

The table present systemic risk quarterly results of Deniz bank during the period from March-2008 to December-2018.

Table A 4: *GARAN SRISK Quartile Results in Million TRY from 2005 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-05	-1666.00	0.172	27.	March-12	-6392.64	0.158
2.	June-05	-1941.81	0.174	28.	June-12	-6434.54	0.144
3.	September-05	-3255.44	0.099	29.	September-12	-7590.06	0.144
4.	December-05	-4255.71	0.098	30.	December-12	-12175.48	0.157
5.	March-06	-3790.15	0.139	31.	March-13	-12592.60	0.160
6.	June-06	-1131.43	0.139	32.	June-13	-6051.03	0.205
7.	September-06	-1735.88	0.166	33.	September-13	-2804.11	0.221
8.	December-06	-1586.74	0.184	34.	December-13	-410.31	0.171
9.	March-07	-3490.44	0.193	35.	March-14	-889.24	0.176
10.	June-07	-4876.30	0.186	36.	June-14	-4101.60	0.164
11.	September-07	-7427.21	0.193	37.	September-14	-2252.18	0.154
12.	December-07	-8320.96	0.196	38.	December-14	-4652.63	0.201
13.	March-08	-914.60	0.214	39.	March-15	-1208.11	0.182
14.	June-08	-429.66	0.193	40.	June-15	-571.44	0.173
15.	September-08	-190.77	0.238	41.	September-15	6185.59	0.165
16.	December-08	1787.52	0.194	42.	December-15	5092.66	0.175
17.	March-09	2960.10	0.176	43.	March-16	1558.53	0.134
18.	June-09	-2762.69	0.182	44.	June-16	3747.91	0.155
19.	September-09	-6438.16	0.176	45.	September-16	3562.09	0.161
20.	December-09	-8596.43	0.163	46.	December-16	5762.03	0.145
21.	March-10	-10088.56	0.200	47.	March-17	3365.60	0.135
22.	June-10	-9221.36	0.169	48.	June-17	1161.33	0.134
23.	September-10	-14401.65	0.158	49.	September-17	1932.60	0.143
24.	December-10	-10952.87	0.175	50.	December-17	870.10	0.162
25.	March-11	-9259.18	0.167	51.	March-18	117.25	0.157
26.	June-11	-7781.37	0.169	52.	June-18	10907.71	0.171
27.	September-11	-5808.35	0.194	53.	September-18	21753.35	0.229
28.	December-11	-2351.99	0.182	54.	December-18	13707.80	0.190

Source. *The author elaborates it.*

The table present systemic risk quarterly results of Garanti bank during the period from March-2005 to December-2018.

Table A 5: *HALKB SRISK Quartile Results in Million TRY from 2011 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-11	-2516.04	0.17	31.	March-15	5585.39	0.17
2.	June-11	-2103.52	0.14	32.	June-15	7735.29	0.18
3.	September-11	-2786.43	0.14	33.	September-15	11403.06	0.17
4.	December-11	569.15	0.14	34.	December-15	10671.05	0.17
5.	March-12	-1859.94	0.14	35.	March-16	11866.00	0.21
6.	June-12	-1935.31	0.18	36.	June-16	13818.29	0.18
7.	September-12	-2115.07	0.15	37.	September-16	14713.51	0.19
8.	December-12	-4989.32	0.14	38.	December-16	16479.36	0.15
9.	March-13	-6446.25	0.15	39.	March-17	19617.26	0.35
10.	June-13	-2149.95	0.19	40.	June-17	16663.69	0.15
11.	September-13	481.54	0.18	41.	September-17	19514.62	0.16
12.	December-13	4787.53	0.23	42.	December-17	23541.94	0.15
13.	March-14	4212.17	0.21	43.	March-18	26613.58	0.12
14.	June-14	668.31	0.16	44.	June-18	31341.56	0.13
15.	September-14	3638.78	0.17	45.	September-18	36752.79	0.14
16.	December-14	3568.37	0.14	46.	December-18	35327.27	0.15

Source. *The author elaborates it.*

The table present systemic risk quarterly results of Halk bank during the period from March-2011 to December-2018.

Table A 6: *ICBCT SRISK Quartile Results in Million TRY from 2006 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-06	-93.49	0.1183	25.	September-12	114.16	0.0809
2.	June-06	-111.61	0.1685	26.	December-12	108.98	0.1994
3.	September-06	-46.62	0.1399	27.	March-13	7.42	0.3417
4.	December-06	-67.92	0.0972	28.	June-13	-97.21	0.1476
5.	March-07	-124.97	0.1529	29.	September-13	-149.39	0.0492
6.	June-07	-243.19	0.0775	30.	December-13	103.82	0.2760
7.	September-07	-222.83	0.1418	31.	March-14	-79.73	0.0689
8.	December-07	-114.90	0.1310	32.	June-14	-325.90	0.0565
9.	March-08	-50.55	0.2593	33.	September-14	-323.71	0.0576
10.	June-08	-55.39	0.1227	34.	December-14	-285.99	0.0639
11.	September-08	-68.81	0.1842	35.	March-15	-393.79	0.0478
12.	December-08	141.23	0.1048	36.	June-15	-301.14	0.0385
13.	March-09	106.12	0.1113	37.	September-15	-80.73	0.0586
14.	June-09	-86.83	0.1144	38.	December-15	-168.78	0.0704
15.	September-09	-107.55	0.1077	39.	March-16	-104.89	0.0701
16.	December-09	-151.14	0.1038	40.	June-16	-15.98	0.0732
17.	March-10	-201.44	0.0839	41.	September-16	40.15	0.0682
18.	June-10	-129.41	0.1281	42.	December-16	82.10	0.0733
19.	September-10	-171.02	0.0988	43.	March-17	-60.53	0.0503
20.	December-10	-116.65	0.0842	44.	June-17	-641.78	0.2496
21.	March-11	-59.22	0.0989	45.	September-17	-918.22	0.1648
22.	June-11	-4.00	0.1142	46.	December-17	-1787.14	0.0721
23.	September-11	104.35	0.1311	47.	March-18	-2113.52	0.08
24.	December-11	156.93	0.1261	48.	June-18	-1425.86	0.13
25.	March-12	77.69	0.0952	49.	September-18	-2152.61	0.07
26.	June-12	115.03	0.0892	50.	December-18	-1692.52	0.08

Source. *The author elaborates it.*

The table displays systemic risk quarterly results of ICBC bank during the period from March-2006 to December-2018.

Table A 7: *ISCTR SRISK Quartile Results in Million TRY from 2006 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-06	-9526.78	0.17	25.	September-12	-1159.04	0.17
2.	June-06	-3462.30	0.20	26.	December-12	-2584.84	0.15
3.	September-06	-3867.20	0.20	27.	March-13	-4478.69	0.15
4.	December-06	-4760.55	0.20	28.	June-13	2728.30	0.21
5.	March-07	-4947.61	0.19	29.	September-13	3612.15	0.15
6.	June-07	-4178.80	0.18	30.	December-13	6805.36	0.15
7.	September-07	-6506.55	0.19	31.	March-14	7083.71	0.17
8.	December-07	-6359.01	0.18	32.	June-14	3781.51	0.14
9.	March-08	-880.96	0.18	33.	September-14	7646.87	0.16
10.	June-08	1581.33	0.19	34.	December-14	2514.23	0.16
11.	September-08	-588.34	0.20	35.	March-15	7531.35	0.17
12.	December-08	2291.70	0.17	36.	June-15	9832.81	0.16
13.	March-09	3248.47	0.19	37.	September-15	14117.52	0.15
14.	June-09	335.00	0.16	38.	December-15	13844.07	0.16
15.	September-09	-1570.86	0.18	39.	March-16	13372.65	0.15
16.	December-09	-2018.44	0.18	40.	June-16	15139.49	0.15
17.	March-10	-4085.03	0.16	41.	September-16	14918.89	0.15
18.	June-10	-2857.76	0.19	42.	December-16	15329.91	0.14
19.	September-10	-6987.28	0.18	43.	March-17	12416.98	0.12
20.	December-10	-4451.96	0.17	44.	June-17	10384.81	0.13
21.	March-11	-2039.47	0.16	45.	September-17	13138.00	0.13
22.	June-11	-1054.93	0.16	46.	December-17	14426.33	0.14
23.	September-11	1256.86	0.17	47.	March-18	15468.13	0.16
24.	December-11	6260.72	0.17	48.	June-18	23566.07	0.17
25.	March-12	2711.01	0.17	49.	September-18	33434.10	0.19
26.	June-12	1831.24	0.18	50.	December-18	28275.32	0.13

Source. *The author elaborates it.*

The table displays systemic risk quarterly results of İş bank during the period from March-2006 to December-2018.

Table A 8: *QNBFB SRISK Quartile Results in Million TRY from 2005 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-05	-375.70	0.17	27.	March-12	-3254.49	0.05
2.	June-05	-1503.60	0.15	28.	June-12	-3421.20	0.05
3.	September-05	-2084.94	0.14	29.	September-12	-2372.88	0.04
4.	December-05	-3188.59	0.10	30.	December-12	-2037.55	0.05
5.	March-06	-3901.29	0.17	31.	March-13	-2082.42	0.04
6.	June-06	-4414.55	0.02	32.	June-13	161.90	0.13
7.	September-06	-4996.81	-0.02	33.	September-13	633.76	0.09
8.	December-06	-4629.14	0.00	34.	December-13	1734.23	0.15
9.	March-07	-3948.60	0.10	35.	March-14	1505.18	0.07
10.	June-07	-4564.25	0.02	36.	June-14	4.68	0.06
11.	September-07	-4089.74	0.05	37.	September-14	840.51	0.04
12.	December-07	-4056.81	0.03	38.	December-14	805.89	0.07
13.	March-08	-3354.28	0.04	39.	March-15	2138.78	0.07
14.	June-08	-2010.07	0.05	40.	June-15	2262.84	0.13
15.	September-08	-2745.87	0.16	41.	September-15	1752.29	0.15
16.	December-08	-2125.40	0.11	42.	December-15	-4249.26	0.10
17.	March-09	-3066.48	0.06	43.	March-16	-1249.47	0.05
18.	June-09	-3759.52	0.06	44.	June-16	-2130.85	0.04
19.	September-09	-5807.76	0.15	45.	September-16	-1693.66	0.06
20.	December-09	-4469.88	0.10	46.	December-16	-965.01	0.10
21.	March-10	-5178.21	0.05	47.	March-17	-1845.88	0.04
22.	June-10	-3374.55	0.09	48.	June-17	-1802.68	0.04
23.	September-10	-5119.93	0.10	49.	September-17	-2404.21	0.07
24.	December-10	-6622.46	0.05	50.	December-17	-1413.99	0.07
25.	March-11	-5415.81	0.07	51.	March-18	-2153.29	0.04
26.	June-11	-4140.74	0.03	52.	June-18	3364.38	0.07
27.	September-11	-998.99	0.10	53.	September-18	5358.10	0.05
28.	December-11	-3755.24	0.07	54.	December-18	-5966.92	0.13

Source. *The author elaborates it.*

The table displays systemic risk quarterly results of QNB Finansbank during the period from March-2005 to December-2018.

Table A 9: *SKBNK SRISK Quartile Results in Million TRY from 2005 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-05	24.25	0.14	27.	March-12	780.91	0.12
2.	June-05	-41.11	0.11	28.	June-12	793.02	0.11
3.	September-05	-145.14	0.07	29.	September-12	563.61	0.11
4.	December-05	-152.49	0.11	30.	December-12	100.93	0.10
5.	March-06	-282.29	0.12	31.	March-13	-75.78	0.17
6.	June-06	-179.52	0.09	32.	June-13	140.27	0.09
7.	September-06	-10.35	0.30	33.	September-13	359.33	0.07
8.	December-06	-46.34	0.09	34.	December-13	448.86	0.15
9.	March-07	-88.38	0.12	35.	March-14	475.13	0.05
10.	June-07	-350.99	0.15	36.	June-14	326.62	0.08
11.	September-07	-849.64	0.17	37.	September-14	463.20	0.05
12.	December-07	-1000.56	0.11	38.	December-14	604.51	0.06
13.	March-08	-41.25	0.15	39.	March-15	707.71	0.07
14.	June-08	-39.68	0.03	40.	June-15	907.52	0.12
15.	September-08	258.03	0.14	41.	September-15	1235.61	0.06
16.	December-08	505.82	0.11	42.	December-15	1015.90	0.06
17.	March-09	608.67	0.15	43.	March-16	758.71	-0.04
18.	June-09	393.48	0.13	44.	June-16	1262.08	0.10
19.	September-09	110.54	0.13	45.	September-16	1367.12	0.09
20.	December-09	-61.79	0.13	46.	December-16	1464.67	0.09
21.	March-10	7.32	0.12	47.	March-17	1405.08	0.06
22.	June-10	233.42	0.12	48.	June-17	1795.08	0.09
23.	September-10	118.00	0.11	49.	September-17	1763.47	0.12
24.	December-10	115.81	0.08	50.	December-17	1726.76	0.08
25.	March-11	417.01	0.11	51.	March-18	1683.99	0.03
26.	June-11	664.31	0.12	52.	June-18	2509.43	0.14
27.	September-11	927.21	0.15	53.	September-18	2831.08	0.11
28.	December-11	816.58	0.07	54.	December-18	2449.97	0.09

Source. *The author elaborates it.*

The table shows systemic risk quarterly results of Şeker bank during the period from March-2005 to December-2018.

Table A 10: *KLNMA SRISK Quartile Results in Million TRY from 2005 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-05	-761.98	0.09	27.	March-12	-654.02	0.08
2.	June-05	-682.58	0.12	28.	June-12	-524.93	0.11
3.	September-05	-1042.18	0.15	29.	September-12	-551.63	0.07
4.	December-05	-1065.77	0.10	30.	December-12	-662.69	0.06
5.	March-06	-1100.34	0.09	31.	March-13	-686.10	0.09
6.	June-06	-623.25	0.13	32.	June-13	-475.08	0.06
7.	September-06	-760.66	0.13	33.	September-13	-413.70	0.08
8.	December-06	-769.36	0.10	34.	December-13	-246.57	0.26
9.	March-07	-748.44	0.12	35.	March-14	-357.89	0.07
10.	June-07	-638.01	0.11	36.	June-14	-415.25	0.07
11.	September-07	-717.02	0.09	37.	September-14	-338.71	0.07
12.	December-07	-643.53	0.09	38.	December-14	-375.81	0.05
13.	March-08	-978.35	0.06	39.	March-15	-248.28	0.06
14.	June-08	-455.00	0.20	40.	June-15	-147.50	0.05
15.	September-08	-403.56	0.12	41.	September-15	-49.47	0.04
16.	December-08	-291.50	0.09	42.	December-15	-55.92	0.06
17.	March-09	-343.39	0.08	43.	March-16	0.26	0.13
18.	June-09	-516.27	0.14	44.	June-16	9.04	0.04
19.	September-09	-549.97	0.10	45.	September-16	-275.68	0.05
20.	December-09	-760.96	0.14	46.	December-16	-383.29	0.09
21.	March-10	-908.96	0.08	47.	March-17	-957.37	0.06
22.	June-10	-930.86	0.11	48.	June-17	-1180.57	0.04
23.	September-10	-968.15	0.09	49.	September-17	-2270.38	-0.07
24.	December-10	-1205.45	0.08	50.	December-17	-1443.53	0.03
25.	March-11	-919.60	0.09	51.	March-18	-1313.79	0.04
26.	June-11	-804.66	0.09	52.	June-18	-664.72	0.08
27.	September-11	-635.26	0.08	53.	September-18	-1956.82	0.27
28.	December-11	-501.04	0.07	54.	December-18	-8706.93	0.15

Source. *The author elaborates it.*

The table displays systemic risk quarterly results of Turkey Development Bank during the period from March-2006 to December-2018.

Table A 11: *TSKB SRISK Quartile Results in Million TRY from 2005 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-05	-83.16	0.13	27.	March-12	-424.58	0.12
2.	June-05	-44.61	0.12	28.	June-12	-595.02	0.11
3.	September-05	-194.09	0.22	29.	September-12	-712.24	0.12
4.	December-05	-380.14	0.12	30.	December-12	-967.28	0.10
5.	March-06	-508.97	0.17	31.	March-13	-1083.52	0.11
6.	June-06	-64.67	0.17	32.	June-13	-560.14	0.22
7.	September-06	-239.29	0.11	33.	September-13	-648.80	0.07
8.	December-06	-170.78	0.14	34.	December-13	-359.49	0.20
9.	March-07	-188.33	0.13	35.	March-14	-538.45	0.10
10.	June-07	-132.32	0.13	36.	June-14	-677.64	0.08
11.	September-07	-183.48	0.14	37.	September-14	-792.43	0.09
12.	December-07	-89.45	0.14	38.	December-14	-851.83	0.08
13.	March-08	219.67	0.14	39.	March-15	-473.96	0.13
14.	June-08	195.66	0.12	40.	June-15	-407.81	0.09
15.	September-08	144.84	0.14	41.	September-15	307.62	0.12
16.	December-08	281.53	0.08	42.	December-15	103.02	0.11
17.	March-09	439.63	0.15	43.	March-16	-72.64	0.11
18.	June-09	231.13	0.13	44.	June-16	199.41	0.13
19.	September-09	0.43	0.13	45.	September-16	244.54	0.10
20.	December-09	-124.11	0.14	46.	December-16	244.84	0.10
21.	March-10	-332.47	0.12	47.	March-17	396.81	0.08
22.	June-10	-196.11	0.14	48.	June-17	5.35	0.10
23.	September-10	-585.74	0.14	49.	September-17	221.22	0.10
24.	December-10	-648.31	0.10	50.	December-17	264.48	0.09
25.	March-11	-730.05	0.05	51.	March-18	375.65	0.09
26.	June-11	-703.28	0.14	52.	June-18	1645.93	0.12
27.	September-11	-233.32	0.16	53.	September-18	2882.38	0.11
28.	December-11	-162.67	0.12	54.	December-18	2207.24	0.09

Source. *The author elaborates it.*

The table presents systemic risk quarterly results of TSKB during the period from March-2005 to December-2018.

Table A 12: *VAKBN SRISK Quartile Results in Million TRY from 2009 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-09	3707.06	0.16	19.	March-14	8018.90	0.20
2.	June-09	2023.67	0.16	20.	June-14	6057.51	0.18
3.	September-09	89.91	0.15	21.	September-14	8404.66	0.18
4.	December-09	-1054.53	0.15	22.	December-14	8013.68	0.14
5.	March-10	-161.83	0.15	23.	March-15	10719.68	0.18
6.	June-10	933.44	0.17	24.	June-15	11452.58	0.19
7.	September-10	-578.83	0.15	25.	September-15	13523.64	0.14
8.	December-10	490.42	0.14	26.	December-15	12871.79	0.16
9.	March-11	886.18	0.15	27.	March-16	12214.86	0.18
10.	June-11	2523.32	0.16	28.	June-16	12629.89	0.15
11.	September-11	2771.56	0.17	29.	September-16	13095.83	0.17
12.	December-11	5131.58	0.17	30.	December-16	15080.39	0.15
13.	March-12	4104.71	0.18	31.	March-17	13836.62	0.13
14.	June-12	3258.68	0.14	32.	June-17	13735.32	0.15
15.	September-12	3116.76	0.14	33.	September-17	15305.72	0.16
16.	December-12	2475.34	0.15	34.	December-17	17372.21	0.17
17.	March-13	312.59	0.14	35.	March-18	18735.99	0.15
18.	June-13	4482.06	0.22	36.	June-18	24300.70	0.14
19.	September-13	5362.57	0.17	37.	September-18	32341.16	0.18
20.	December-13	7974.25	0.19	38.	December-18	29066.19	0.15

Source. *The author elaborates it.*

The table displays systemic risk quarterly results of Vakif Bank during the period from March-2009 to December-2018.

Table A 13: *YKBNK SRISK Quartile Results in Million TRY from 2005 – 2018*

No.	Dates	SRISK	LRMES	No.	Dates	SRISK	LRMES
1.	March-05	-585.36	0.17	27.	March-12	-217.66	0.17
2.	June-05	-520.87	0.12	28.	June-12	340.26	0.16
3.	September-05	-749.80	0.12	29.	September-12	-1654.28	0.14
4.	December-05	-960.33	0.13	30.	December-12	-4706.10	0.13
5.	March-06	-1580.01	0.11	31.	March-13	-5615.41	0.14
6.	June-06	-158.21	0.17	32.	June-13	1206.26	0.24
7.	September-06	-511.59	0.16	33.	September-13	541.42	0.16
8.	December-06	-363.13	0.14	34.	December-13	3899.43	0.16
9.	March-07	-1564.05	0.18	35.	March-14	3953.71	0.18
10.	June-07	-1773.00	0.13	36.	June-14	1693.68	0.14
11.	September-07	-3853.67	0.15	37.	September-14	3291.43	0.14
12.	December-07	-5154.90	0.15	38.	December-14	3200.84	0.13
13.	March-08	-533.08	0.17	39.	March-15	8792.96	0.15
14.	June-08	775.85	0.18	40.	June-15	9713.61	0.16
15.	September-08	-2041.35	0.18	41.	September-15	14386.43	0.16
16.	December-08	350.77	0.19	42.	December-15	12930.79	0.15
17.	March-09	1537.93	0.17	43.	March-16	10468.27	0.15
18.	June-09	-830.17	0.14	44.	June-16	11672.63	0.15
19.	September-09	-4053.18	0.13	45.	September-16	12881.55	0.16
20.	December-09	-4149.24	0.13	46.	December-16	16013.62	0.15
21.	March-10	-5727.49	0.14	47.	March-17	15287.12	0.12
22.	June-10	-6378.90	0.14	48.	June-17	13559.90	0.14
23.	September-10	-8787.38	0.14	49.	September-17	15322.06	0.16
24.	December-10	-6818.53	0.15	50.	December-17	17653.15	0.13
25.	March-11	-4882.53	0.15	51.	March-18	18119.13	0.14
26.	June-11	-2764.03	0.15	52.	June-18	20803.03	0.17
27.	September-11	-1029.91	0.21	53.	September-18	30481.90	0.18
28.	December-11	2970.50	0.16	54.	December-18	26520.65	0.11

Source. *The author elaborates it.*

The table displays quarterly results of systemic risk for Yapı Kredi Bank during the period from March-2005 to December-2018.

Table A 14: *Turkish Financial System (TFS) SRISK Quartile Results from 2008 – 2018*

Table A 14: Turkish Financial System SRISK Million TRY in the sample period

Dates	Dec-08	Dec-09	Dec-10	Dec-11	Dec-12	Dec-13	Dec-14	Dec-15	Dec-16	Dec-17	Dec-18	2018 %
AK	-1501.8	-11254.97	-14277.60	-4023.65	-11029.37	466.96	-3858.46	5135.74	5186.51	3473.76	14173.62	9.12%
ALBAR	-	-	-	453.41	109.22	860.62	1263.50	2327.08	2803.61	3138.97	3743.02	2.41%
DENIZ	-291.86	-2104.28	-3575.25	-3523.82	-1852.75	2630.25	3190.53	4489.23	-2039.8	3024.08	-34405.4	0.00%
GARANTI	1787.52	-8596.43	-10952.87	-2351.99	-12175.48	-410.31	-4652.63	5092.66	5762.03	870.10	13707.80	8.82%
HALK	-	-	-	569.15	-4989.32	4787.53	3568.37	10671.05	16479.36	23541.94	35327.27	22.72%
ICBCT	141.23	-151.14	-116.65	156.93	108.98	103.82	-285.99	-168.78	82.10	-1787.14	-1692.52	0.00%
İŞ	2291.70	-2018.44	-4451.96	6260.72	-2584.84	6805.36	2514.23	13844.07	15329.91	14426.33	28275.32	18.19%
QNB	-2125.4	-4469.88	-6622.46	-3755.24	-2037.55	1734.23	805.89	-4249.26	-965.01	-1413.99	-5966.92	0.00%
ŞEKER	505.82	-61.79	115.81	816.58	100.93	448.86	604.51	1015.90	1464.67	1726.76	2449.97	1.58%
TKB	-291.50	-760.96	-1205.45	-501.04	-662.69	-246.57	-375.81	-55.92	-383.29	-1443.53	-8706.93	0.00%
TSKB	281.53	-124.11	-648.31	-162.67	-967.28	-359.49	-851.83	103.02	244.84	264.48	2207.24	1.42%
VAKIF	-	-1054.53	490.42	5131.58	2475.34	7974.25	8013.68	12871.79	15080.39	17372.21	29066.19	18.70%
YAP KREDİ	350.77	-4149.24	-6818.53	2970.50	-4706.10	3899.43	3200.84	12930.79	16013.62	17653.15	26520.65	17.06%
SRISK	5358.56	0.00	606.24	16358.87	2794.47	29711.31	23161.55	68481.33	78447.03	85491.78	155471.08	100%

Source. *Elaborated by the author*. The table shows quarterly results of systemic risk for the Turkish Financial System (TFS) during the period from December -08 to December-18.

Table A 15: *TFS SRISK% Rankings 2005-2018*

Q4 2008			Q4 2010	
No.	**Bank**	**SRISK %**	**Bank**	**SRISK %**
1.	ISCTR	42.77	VAKBN	80.90
2.	GARAN	33.36	SKBNK	19.10
3.	SKBNK	9.44		
4.	YKBNK	6.55		
5.	TSKB	5.25		
6.	ICBCT	2.64		
	Total	100%	Total	100%
	Q4 2011		**Q4 2012**	
No.	**Bank**	**SRISK %**	**Bank**	**SRISK %**
1.	ISCTR	38.27	VAKBN	88.58
2.	VAKBN	31.37	ALBRK	3.91
3.	YKBNK	18.16	ICBCT	3.90
4.	SKBNK	4.99	SKBNK	3.61
5.	HALKB	3.48		
6.	ALBRK	2.77		
	Total	100%	Total	100%
	Q4 2013		**Q4 2014**	
No.	**Bank**	**SRISK %**	**Bank**	**SRISK %**
1.	VAKBN	26.84	VAKBN	34.60
2.	ISCTR	22.90	HALKB	15.41
3.	HALKB	16.11	YKBNK	13.82
4.	YKBNK	13.12	DENIZ	13.78
5.	DENIZ	8.85	ISCTR	10.86
6.	QNBFB	5.84	ALBRK	5.46
7.	ALBRK	2.90	QNBFB	3.48
8.	AKBNK	1.57	SKBNK	2.61
9.	SKBNK	1.51		
10.	ICBCT	0.35		

	Total	100%	Total	100%
	Q4 2015		**Q4 2016**	
No.	**Bank**	**SRISK %**	**Bank**	**SRISK %**
1.	ISCTR	20.22	HALKB	21.01
2.	YKBNK	18.88	YKBNK	20.41
3.	VAKBN	18.80	ISCTR	19.54
4.	HALKB	15.58	VAKBN	19.22
5.	AKBNK	7.50	GARAN	7.35
6.	GARAN	7.44	AKBNK	6.61
7.	DENIZ	6.56	ALBRK	3.57
8.	ALBRK	3.40	SKBNK	1.87
9.	SKBNK	1.48	TSKB	0.31
10.	TSKB	0.15	ICBCT	0.10
	Total	100%	Total	100%

Q4 2017		
No.	**Bank**	**SRISK %**
1.	HALKB	27.54
2.	YKBNK	20.65
3.	VAKBN	20.32
4.	ISCTR	16.87
5.	AKBNK	4.06
6.	ALBRK	3.67
7.	DENIZ	3.54
8.	SKBNK	2.02
9.	GARAN	1.02
10.	TSKB	0.31
	Total	100%

Q4 2018		
No.	**Bank**	**SRISK %**
1.	HALKB	22.72
2.	VAKBN	18.70
3.	ISCTR	18.19

4.	YKBNK	17.06
5.	AKBNK	9.12
6.	GARAN	8.82
7.	ALBRK	2.41
8.	SKBNK	1.58
9.	TSKB	1.42
	Total	100%

Source. *The author elaborates it.*

The table reports SRISK% rankings of the Turkish Financial System (TFS) Banks in the fourth quarter of each year starting from 2005 until 2018.

Table A 16: *Banks SRISK Million TRY and %, Sep-2018 at the height of the Turkish lira crisis*

No.	Bank	SRISK Million TRY	SRISK %
1.	HALKB	36,753	18.89
2.	ISCTR	33,434	17.18
3.	VAKBN	32,341	16.62
4.	YKBNK	30,482	15.67
5.	AKBNK	22,359	11.49
6.	GARAN	21,753	11.18
7.	QNBFB	5,358	2.75
8.	ALBRK	3,827	1.97
9.	TSKB	2,882	1.48
10.	SKBNK	2,831	1.46
11.	DENIZ	2,552	1.31
	TFS Total	194,572	100

Source. *The author elaborates it.*

The results in table 4.17 indicate the effect of Turkish lira crisis last year at the value of the systemic risk of the TFS at the height of the Turkish lira crisis.

Table A 17: *Banks SRISK% as Total of Assets Dec-2018*

No.	Bank	SRISK Million TRY	Total Assets Million TRY	SRISK % of Total Assets
1.	HALKB	35,327	378,422	9.34%
2.	ALBRK	3,743	42,222	8.87%
3.	VAKBN	29,066	331,356	8.77%
4.	SKBNK	2,450	31,321	7.82%
5.	YKBNK	26,521	348,044	7.62%
6.	ISCTR	28,275	416,388	6.79%
7.	TSKB	2,207	38,298	5.76%
8.	AKBNK	14,174	327,642	4.33%
9.	GARAN	13,708	359,477	3.81%
10.	TFS	155,471	2,273,170	6.84%

Source. *The author elaborates it.*

The table presents the contribution of SRISK on total assets (SRISK/Total assets) of each Bank and TFS on December-18.

Table A 18: *Banks SRISK as % of Market Cap Dec-2018*

No.	Bank	SRISK Million TRY	Market Cap Million TRY	SRISK % of Market Cap
1.	HALKB	35,327	8,775	402.59%
2.	ALBRK	3,743	1,098	340.89%
3.	VAKBN	29,066	9,750	298.11%
4.	YKBNK	26,521	13,515	196.23%
5.	SKBNK	2,450	1,274	192.34%
6.	ISCTR	28,275	20,520	137.80%
7.	TSKB	2,207	2,268	97.32%
8.	AKBNK	14,174	27,440	51.65%
9.	GARAN	13,708	45,024	30.45%
10.	TFS	155,471	129,664	119.90%

Source. *The author elaborates it.*

The table presents the contribution of SRISK on Market Cap (SRISK/Market Cap) of each Bank and TFS on December-18.

Table A 19: *SRISK of Banks as a percentage of Turkey's GDP 2018:*

No.	Bank	SRISK Million TRY	GDP Million TRY	SRISK % of GDP
1.	HALKB	35,327	3,700,000	0.95%
2.	VAKBN	29,066	3,700,000	0.79%
3.	ISCTR	28,275	3,700,000	0.76%
4.	YKBNK	26,521	3,700,000	0.72%
5.	AKBNK	14,174	3,700,000	0.38%
6.	GARAN	13,708	3,700,000	0.37%
7.	ALBRK	3,743	3,700,000	0.10%
8.	SKBNK	2,450	3,700,000	0.07%
9.	TSKB	2,207	3,700,000	0.06%
10.	TFS	155,471	3,700,000	4.20%

Source. *The author elaborates it.*

The table presents the contribution of SRISK on Turkey's GDP (SRISK/GDP) of each Bank and TFS on December-18.

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