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BANKRUPTCY ANALYSIS FOR 17 COMPANIES IN TURKISH STOCK MARKET FOR THE YEARS 2018 AND 2019

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Bankruptcy Analysis for 17 Companies in Turkish Market for the year 2018 and 2019

Türkiye Borsasındaki 17 Şirketin 2018 ve 2019 Yılı İflas Analizi

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4) CAPM uygulamaları
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Anahtar kelimeler(İngilizce)

1) Merton Model
2) Black-Cox Model
3) The Credit Risk Estimation
4) CAPM Applications
5) Credit Derivatives

Table of Contents

List of Figures

List of Tables

Abstract

In this study, it is aimed to explain the concept of credit risk in the framework of Basel II and to investigate credit risk of the banks and the real sector in Turkey. To do that, celebrated Merton model is employed for the period 2017-2018 and 17 companies listed in BIST are considered.

The findings shed lights on the deteoriorated financial outlook of the Turkish companies. In particular, Turkish banks has very high default probability compared to other big companies listed in BIST. It is thought that this finding provides preliminary warning for the emergent precautionary measures needed to be taken by the policy makers.

Özet

Bu çalışmada, Basel II çerçevesinde kredi riski kavramını açıklamak ve Türkiye'deki bankaların ve reel sektörün kredi riskini araştırmak amaçlanmaktadır. Bunu yapmak için, ünlü Merton modeli 2017-2018 dönemi için kullanılmıştır ve BIST'te listelenen 17 şirket dikkate alınmıştır.

Elde edilen bulgular, Türk şirketlerinin bozuk fınansal görünümüne ışık tutmaktadır. Özellikle, Türk bankaları BIST'te listelenen diğer büyük şirketlerle karşılaştırıldığında çok yüksek temerrüt olasılığına sahiptir. Bu çalışmanın bulguları, politika yapıcılar tarafından alınması gereken acil tedbirlere ilişkin bir uyarı olara yorumlanabileceği düşünülmektedir.

INTRODUCTION

Banks have a key role in the healthy functioning and development of the country's economy. A sound banking promotes a country’s economy and makes it go in the right direction. As the history of economic crises is confirm, most of crises have originated bank-related issue.

Because of the fact that banks are credit institutions, a significant portion of the risks arise from loans. The banks, by taking into account the nature of the financial intermediation, the basic activities of financial intermediation, have the funds used by the banks to demand funds from the financial markets and thus provide the services that reduce the uncertainty by taking over the credit risks that others do not want to undertake. Due to the fact that the lending process constitutes the main activity of the banks, they are always faced with credit risk throughout their operations, and this shows that credit risk is not only a source of existence for banks, but also the reason of extinction if it cannot be determined and managed well. In this respect, banks have faced many serious difficulties for many years due to their credit risk. As credit risk is not managed well enough, problem loans are increasing in banks and this situation causes them to remain in a difficult position by disrupting the asset quality of banks.

Generally, inadequate credit standards, weak credit portfolio risk management or the deterioration in the credit quality of bank customers and other changes in conditions such as good conditions, whether or not measured, such as problems in banks lead to an increase in non-performing loans. For this reason, banks that are of great importance to the national economy in many respects can manage their activities in a healthy manner and to minimize the risks that may arise due to credit risk. It is of great importance to be prepared. The need for this process, which can be expressed as credit risk management, is increasing day by day due to the new generation modern methods developed for this purpose.

One of the most important risks of commercial banks is credit risk. It is impossible for banks to undertake banking activities without undertaking the risk of credit and managing credit risk. For the effective management of risks in commercial banking; risks should be defined, risks should be measured, necessary applications should be started and follow-up stages should be carried out.

Different models are used in analyzing and measuring the credit risk. These models can be studied in a very broad framework from relatively qualitative to highly quantitative ones. Many of these models, which do not exclude each other, are used in the pricing of commercial banks' loans or in determining the loan amount.

There have been significant developments over the last two decades in the models of credit risk measurement. Changes in the economic system have made credit risk management important. Commercial banks are able to take into account the risks of the credits they use and monitor all credit portfolios. Although many credit risk measurement models use different methods, all models attempt to calculate the probability of loans that have defaulted or changed quality.

After a brief introduction in the first part, in the second part, risk management in banking sector is discussed. In the third part, credit risk estimation technique is introduced in detail. In the fourth and fifth chapter, structural model as well as reduced model are introduced. Literature review is provided in the sixth chapter. In the seventh chapter, data used in the study are introduced and CAPM and Merton model application is conducted. In the final chapter concludes.

2. RISK MANAGEMENT IN BANKS

In terms of financial institutions, generally speaking, risk is the possibility of encountering unwanted situations. Within the framework of finance theory, risk is defined as the difference between the return of the financial transactions and the present value of the cash flows related to these transactions. Risk refers technically to the distribution of probability values for returns on average value. Anything that affects the probability distribution in this sense will affect the investment risk both positively and negatively. Mathematically, the risk is a function of the variance of the distribution of expected returns. In the context of all these definitions, the risk can be explained as the positive or negative difference between the expected value and the realized value in the financial literature (IMKB, 1999).

The concept of risk and uncertainty is used interchangeably.Iit is the interconnection of these two concepts. Uncertainty, ignorance and the surprises of the future, and the risk include danger and vulnerability. In this context, a distinctive definition can be made. The risk is the probability of loss to a known or expected hazard clearance. If the presence and extent of the hazard is not fully known, the risk of uncertainty carries uncertainty if the vulnerability and vulnerability are not fully known.

While financial uncertainty is the distribution of the possible results to be achieved, the risk occurrence is the difference between the most likely outcome (expected) and the actual (actualized) result, and the greater the distribution, the greater the uncertainty. In other words, uncertainty is the inability to predict or detect probability values for the expected results. Therefore, there is no possibility to make a numerical analysis about the possible results. 5 The uncertainty, which is used as a synonym in financial terms in general, has a more general meaning than risk. In fact, financial markets are not feared risk, but uncertainty. This is due

to the fact that financial market risks can be measured and managed and it is not possible to say the same for uncertainty (Weston and Brigham, 1975).

2.1. Types and Classification of Risk in Banking

Types of risk in finance can be exhibited as in Figure-1. However, for the sake of generalization, only credit, market, and exchange rate risks are discussed in this study.

Figure 1: Types of Risks

Source: Kalyan (2012)

2.2. Credit Risk

Credit risk does not comply with the terms of the loan agreement, the possibility of failing to fulfill the obligations, interest and principal payments constitute the credit risk. Almost every credit transaction carries the possibility of non-repayment, delay, default (Akguc, 2007, 8).

Credit risk is the probability that a bank's loan client or a party to it cannot meet its obligations in accordance with the terms of the agreement. Credit risk is not only a risk arising from the credit accounts of banks, but also the loan accounts in which the loan loans are monitored; The Bank's securities portfolio consists of deposits with reverse balance, accounts held by other financial institutions, letters of guarantee and other guarantees, commitments and derivative contracts.

Without the credit risk, it is impossible to engage in banking activities; The only banking transaction that can theoretically be done without credit risk or with a credit risk close to the border is the lending of the collected resources to the national currency, the state treasury or the central bank. The risk that a transaction cannot fulfill the obligation of the counterparty before it is due, is the credit risk arising from the market risk; this risk arises when the loss in market prices moves in the opposite direction to the original contract price. The credit risk arising from the market risk is the risk that one of the parties fails to meet the terms of the contract before the due date and the other party has to perform the same transaction at new market prices in order to meet their financial liabilities. In this case, the loss occurs when the market prices are above the price in the first contract (Laurent and Schmit, 2007).

The purpose of credit risk measurement is to manage the loans with a portfolio approach, to make the pricing in a way to include risks and to create a guarantee against unexpected losses. Basic components of portfolio credit risk models are:

- Default (expected loss, unexpected loss),
- Recovery,
- Rating-migration,
- Risk-adjusted performance measurement and
- Risk-based capital.

Default: The default refers to the situation in which the bank considers that the debtor's debts to the bank group will not be fully paid without resorting to pledge money, or if the debtor has delayed more than 90 days to fulfill any of his obligations.

Expected Loss: It is an expected loss in a portfolio subject to credit risk (Rich ve Tange, 2003)

$$EL=PDxLGDxDA \quad (1)$$

where:

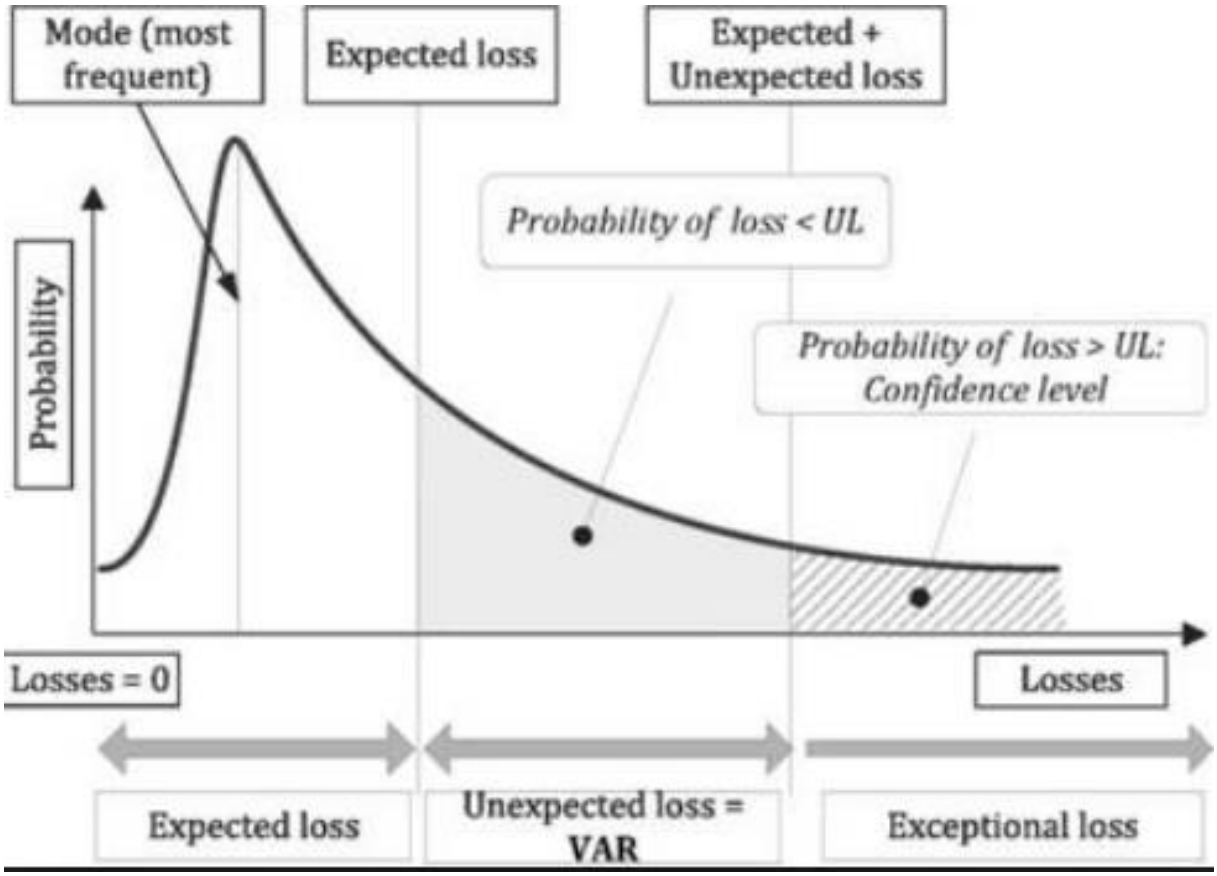
PD is probability of default,

LGD is loss given default, and

DA is the default amount

Unexpected Loss: Unexpected loss is a loss that may occur due to the distribution around the average of uncertainty and the expected loss value that can occur beyond the expected losses (Navarrete, 2007).

Figure 2: Expected and Unexpected Loss



Source: Dan (2015)

Recovery: The rate of recovery or recovery is the amount that the bank can collect or recover if the loan is not paid by the debtor (Altman, Resti and Sironi, 2003).

Rating migration: Each rating grade shift occurs as a result of independent competitive risks under the conditions of estimating the proportional risks of explanatory variables that may be observed. The probability transition models based on the traffic transition matrices are defined as rating migration models (Kavcioglu, 2011).

Risk-adjusted performance measurement: Traditionally, there are two ratios used in banking performance measurement. The first one is the Net Profit / Total

Assets ratio, called the return on assets (ROA), and the second is the Net Profit / Equity ratio. Different versions have been developed over time to make these rates sensitive to risk (Altıntaş, 2018):

- Return on risk-adjusted assets: The risk is calculated using the risk factor and adjusted to the adjusted asset. For example, Net Profit / Risk Weighted Assets.
- Risk-adjusted return on assets: The return is corrected with a risk factor. For example, (Loan Portfolio Return - Expected Loss) / Credits Portfolio.
- Return on risk-adjusted capital: It is the ratio of return to capital is adjusted by risk factor. For instance, Net Income / Economic Capital.
- Risk-adjusted return on capital: where the fulfillment of shareholders' equity is a risk factor. For example, (Net Profit-Capital Cost) / Capital.
- Risk-adjusted return on risk adjusted capital: In this method, both the return and capital risk factors are corrected. Loan Portfolio Return-Expected Loss / Economic Capital is one example

Risk-based capital: It is related to the fact that banks do not have enough capital to cover their losses as a result of market risks (Bessis, 2010). It is recommended by the Basel Committees that banks hold at least 12.5 times more equity than the total risk they hold (Basel Committee on Banking Supervision, 2006). In this sense, this risk can also be classified as a general risk, except for market risk.

2.3. Basel-II

The new Basel Capital Accord (Basel-II) provides the norm for measuring and assessing the capital adequacy of banks recently introduced in many countries. The Basel Banking Audit Committee, which consists of central banks and bank regulators of developed countries operating in Basel, Switzerland, has not been binding on the whole world, but the the world has been accepted and implemented in the banking sector.

The establishment of the Basel Committee rests on the fluctuation of the oil crisis in international markets leading to the excessive increase in oil prices. After this crisis, the quality of auditing and inspection in the banking sector has gained importance and questioned. In 1988, the Basel Committee published the Basel I Capital Adequacy Accord, which aims only to take a standard in capital adequacy calculation methods that take account of credit risk and apply in different countries.

This regulation was inadequate in terms of changing conditions, developing banking sector and increased risk types and new capital standards were needed. Therefore, it was seen that the market risks of the financial structures of banks have a significant effect and in the course of the developments in the sector, Basel I has been in the process of changing and developing since 1996.

The most basic criticism for Basel I is the fact that banks ignored other risks they face as a result of focusing on credit risk. Differing from the differences of banks due to the different features, all types of banks foreseen uniform applications. Another criticism to be managed by Basel I is; As a result of the developments in the markets of securitization and derivative products, the roles and positions undertaken by the banks in these markets and their increased risks could not be adequately evaluated. In general terms, it can be said that the Basel I Accord is not sufficient against the increasing risk and needs in the banking sector. Then, in addition to credit and market risks, operational risks were also included in the scope of the agreement.

The first draft text was published in 1999 and updated with ongoing studies since its publication in June 2004, which was published as ’Basel II New Capital Accord’ and entered into force in 2007.

Basel II criteria in general terms (Yüksel, 2011):

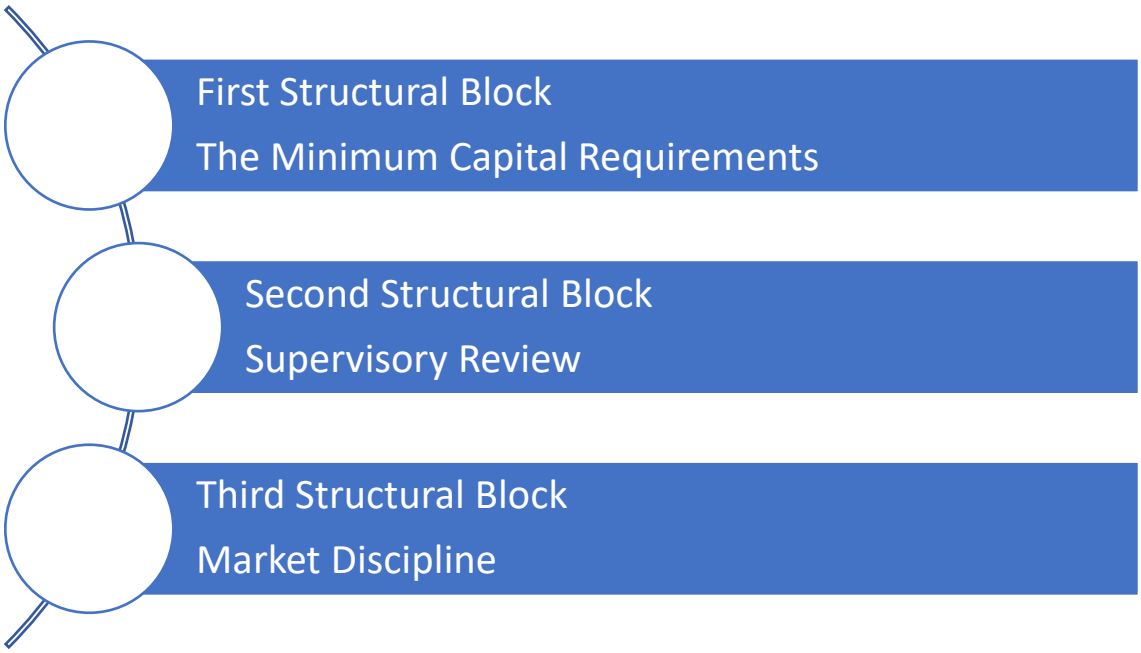
- Ensuring that banks are exposed to the minimum capital adequacy by providing them with a better analysis and measurement of the risks they may face,
- Understand the importance of national supervisors and strengthen their practices,
- Ensuring transparency by determining public disclosure requirements,
- The aim was to ensure market discipline.

Basel II regulation consists of three structural blocks:

- The first structural block allows quantitative assessment and sets out minimum capital requirements that are more sensitive to risk.
- The second structural block covers the process of examining the supervisory authority with qualitative assessment.
- The third structural block relates to the provision of market discipline through public disclosure.

As is shown in Figure-3, Basel has three structural block and in this part of the study, these three structural block are discussed.

Figure 3: Basel Structural Block



2.3.1. First Structural Building Block

In BASEL II, as in BASEL I, the minimum capital adequacy ratio is 8%. Although the credit risk is further elaborated in this consensus, the concept of operational risk was added for the first time. There is no change in market risk. In addition, the contribution capital should not exceed 100% of the capital.

$$\text{Minimum Capital Requirements} = \frac{\text{Total Capital}}{\text{Credit Risk} + \text{Market Risk} + \text{Operational Risk}} = 8\%$$

2.3.2. Second Structural Building Block

Within the scope of the Basel II Accord, risks such as interest rate risk, business and strategic risks in banking calculations that are not included in the first structural block are included in the second structural block. In addition, external structural factors for banks are included in the second structural block. Issues such as public auditing of all these risks, basic principles such as transparency and accountability, and risk management guidance are within the scope of the second

structural block. The Committee has adopted four basic principles in addition to the Basic Principles of Effective Banking Supervision that it has developed as a guide for supervisors (Takan and Boyacıoğlu,2011).

These four principles are:

- Capital Adequacy Assessment System
- Evaluation Process of Audit Authority
- Sanctions of the Supervisory Authority
- Early Intervention Capability of the Supervisor

2.3.3. Third Structural Block

The provision of market discipline, which is the third structural block, is possible if the banks operating in the banking sector explain their knowledge about capital and risk levels in detail. The bank's disclosure of information helps both the bank's counterparties to make healthier decisions with the bank and to ensure that banks are disciplined in order to prevent them from taking excessive levels of risk by the principle of transparency. In the third structural block, the reports should be disclosed to the public in different periods according to the nature of the reports. For instance (Stephanou and Mendoza: 2005):

- Banks operating on an international basis, quarterly, on capital and total capital adequacy ratios and components,
- Information that is made for informational purposes,
- Information about the Bank's risk management and reporting systems is conducted annually.

Table 1: The Difference Between Basel I and Basel II Accord

	Basel I Accord	Basel II Accord
Banks	Standard Applications to all Banks	• Applying effective techniques for risk

		management, • Credit and operational risk approaches, • Increased importance of data quality
Regulatory Authorities	• Better information need • Different authorities for different financial institutions	• Increased strength in motivation and punishment, • More and timely access to information
Rating Agencies	Due to limited number of agencies, there is a oligopolistic structure	• Growth opportunity created by the rating requests of the participants in the money and capital market, • Many new organizations entering the sector
Capital Markets	Tendency towards credit derivatives and securitization	• Securitization and the growth of derivatives markets, • Growth of debt market
Customers	High external source requirement	• Need for credit rating to obtain source • The profitability is transparent

Source: (Altay, 2015:141)

3. THE CREDIT RISK ESTIMATION

Considering the credit risk management parameters and capital requirements stipulated by Basel II, it is a well-known fact that banks should establish a credit risk management policy within their own structure in accordance with current regulations.

The credit risk measurement of Basel II, which is now considered as a reference in the credit risk management and adopted by the economies of developed countries, is based on the following two basic approaches as mentioned before;

• Standard approaches

• Internal rating approaches.

Standard approaches include credit risk weights, treasury and central banks, financial institutions and other corporate credit customers of countries with rating ratings, credit ratings from customers with no ratings, and risk weights for certain assets as similar to Basel I. Internal rating approaches require banks to make their credit risk assessments through rating systems that are going to form their own standards but are detailed in Basel II. The internal rating approach is based on the calculation of expected loss and unexpected loss amounts related to the loan portfolio. The capital requirement is for unexpected losses. Expected losses must be deducted from the capital (Altıntaş, 2006).

3.1. Internal Models in Credit Risk Modelling

Allowing the use of internal models to estimate market risk, BIS does not exhibit the same attitude for internal credit risk models. Below this negative approach, there are some important hesitations about the methodological dimension of internal credit risk measurements (Kafetzaki-Boulamatsis, 2001).

The most important requirement for the adoption of credit risk models as applicable by the regulatory authorities is that a significant improvement in the

internal risk management processes has been achieved. However, the fact that models can be used to determine minimum capital requirements can be achieved by solving methodological risks and uncertainties such as lack of data and validity of the model.

The biggest obstacle to identifying the factors and variables that influence the changes in credit quality is the lack of past performance data for the relevant loans. Moreover, the fact that the time horizon is taken as the basis for the measurement of risk makes the problem experienced in this subject more pronounced. For this reason, model parameters can often be analyzed in the light of simplistic assumptions and information from various sources. It is inevitable that the effects of the preferences on this subject is tested with the help of sensitivity analyzes.

In order for regulatory authorities to decide on the availability of models, these internal models are required to adequately reflect the risks they undertake due to the credit portfolios of banks. Accordingly, the expected loss probabilities used in credit risk measurement and economic capital estimates are expected to contain a reasonable level of certainty. However, it is not possible to talk about a common practice similar to the retrospective validity tests used for market risk estimation models. Therefore, it is recommended that supervisory units rely on internal and external validation procedures or on the basis of the standards they will establish based on qualitative and quantitative criteria when developing a conviction about how good the modeling processes are. It is recommended that the model results be tested against other banks and / or similar portfolios. Supervisors may need to bring in some sanctions to prevent abuses, as well as incentives to support the use of internal models (Hirtle, 2001).

Before proceeding to the structural and reduced credit risk model, it is worthwhile discussing the theoretical structure of the credit risk modelling.

3.2. Economic Capital Allocation for Credit Risk

The economic capital of the two banks whose credit portfolios are similar might be different for each other. The reason for this is the consideration of the probability density function (PDF) of the targeted PDs and loan losses when calculating the capital amount. In this context, an analytical framework is needed to estimate the amount of capital required for credit risk exposure, which can be related to the bank's targeted PD (Jones and Mingo, 1998).

The expected loss corresponds to the average loss expected by the bank due to the loan portfolio within the prescribed period. Banks explain the risk of any loan portfolio with the concept of unexpected loss, which is defined as the loss amount that occurs above the expected loss. The area of the distribution curve beyond the target default ratio is considered to be the significance or significance level of the analysis. The shape determined or predicted for the curve will determine the strength of the positive relationship between LGD and PD. The strength of this relationship will affect the amount of losses to be associated with the credit portfolio (Chabaane et al., 2007).

The minimum capital requirement of a bank based on credit risk is considered as a function of possible losses due to the credit risk to which it is exposed. Based on the idea that banks are prepared and cautious for the losses that occur in parallel with the expectations, it is stated that the main determinant parameter on the minimum capital amount required is the unexpected losses expressing the deviation from the expected losses (Nickell et al., 2005).

In other words, the amount of economic capital required may be considered as the amount of additional capital needed to achieve the target default rate after the expected losses are met. In particular, a credit risk model should guide all policies, procedures and practices used to determine the default probability function of the current loan portfolio. should not be forgotten.

In the process of calculating the economic capital and provisions by using internal credit risk models, micro- and macro-based approaches can be used. In the micro-based approach, while creating a separate risk model for each loan group or type, the credit portfolio is generally considered as a whole in macro-based applications. The most important reason for choosing risk measurements on the basis of portfolio is the opinion that the binary analysis based on bad - good credit classification is in some cases insufficient. Moreover, the revised frequency of economic capital allocation decisions varies on a bank basis (Wilson, 1998).

3.3. Estimating the Credit Loss

Credit loss for a portfolio is defined as the difference between the current value of the portfolio and the value that is reached after a certain period of time. The estimation of the default probability function of the credit portfolio requires the determination of the probability distribution of the current value of the portfolio and the value to be reached at the end of the planned period. It is imperative that a suitable definition of credit loss is made before the current and future value estimates are made. At this point, banks may prefer any of two different conceptual approaches: Default Mode Paradigm and Market Value Based Approach (Mark to Market Paradigm).

There are also two alternative approaches to the decision to be taken when dealing with the credit risk. The first of these approaches is the method known as the liquidation period and where each credit instrument is matched with its specific maturity. There are assumptions that each instrument are held to maturity and there is a limited number of markets in which the instrument can be traded. In the other approach, the same time horizon is applied for all asset classes. For the common time period to be applied, one or more rarely five-year periods may be preferred. It is foreseen that new capital formation is ensured within the period taken, measures to reduce losses, new information is generated, default rate data can be obtained, budgets and reports are prepared and credit renewal transactions are realized.

Credit Losses are discussed by two different approaches:

- Default Mode Paradigm
- Market Value Based Approach

3.3.1. Default Mode Paradigm

In this approach, the loss of credit occurs if the user of the loan exhibits non-repayment behavior within the prescribed period. The credit loss to be incurred in the event that the loan user enters into the payment facility is as much as the difference between the total amount of the loan extended until the time of default and the present value of the amounts that can be collected in the future (Altıntaş, 2007).

In the approach, the current and future value concepts, which are expressed in relation to the credit instrument, are explained based on the dual situation in accordance with the definition of default (default or not). While the current value of a credit receivable is defined as the amount that is exposed to credit risk, the uncertain future value of the receivable is closely related to whether the credit debtor falls within the prescribed period. In this context, the future value of a loan is considered to be equal to the gross amount of the loan amount to be included in the bank records in the period to be taken into consideration in case the loan debtor does not enter into payment incurred. On the other hand, in case of insolvency, the future value of the loan will be reached as a result of multiplication of the loan amount (1-LGD). The lower loss rate indicates more collectability. As can be seen, the current value of the credit instrument at the time of estimation of the loss probability function is known, while the future value is uncertain.

In credit risk models based on default, a clear assumption or assumption should be made of the combined probability distribution of each credit item. Distribution estimates should be based on the main risk components (PD, LGD and EAD). In

order to make a distribution estimation related to the loss probabilities discussed as a whole, it is necessary to establish EAD, PD and LGD distribution profiles of all credit components constituting the portfolio exposed to credit risk.

In order to make the distribution predictions of the basic risk components, it is necessary to perform the loss analysis based on the mean - standard deviation approach. The standard deviation values are considered as the unexpected loss value of the portfolio. In some of the systems that serve to allocate economic capital to manage credit risk, preliminary assumptions can be made regarding the shape of the distribution of the probability of loss probability. The process is shortened by considering that the distribution is similar to the standard distribution functions such as beta, normal or F distribution. In cases where there is no distribution assumption, the use of nonparametric estimation techniques, such as simulation, becomes necessary.

Practitioners call the research method based on the mean - standard deviation approach as the Unexpected Loss Approach. In this approach, the determination of economic capital is made by multiplying the standard deviation value calculated for the credit losses related to the portfolio with a certain coefficient. In order to calculate the expected and unexpected credit losses, the expected credit loss amount of each credit instrument in the portfolio is determined. All calculations for portfolio values are carried out in a manner similar to that described in Markowitz's Modern Portfolio Theory.

$$\mu = \sum EAD_i * PD_i * LGD_i \quad (2)$$

Standard deviation of the portfolio is

$$\sigma = \sum \sigma_i \rho_i \quad (3)$$

In the above equation; σi shows the loss standard deviation of the portfolio component, and ρi shows the correlation of the credit losses of the portfolio component with the credit losses calculated for the overall portfolio. The

correlation coefficient (ρi) reveals the portfolio effect created by the credit component together with other components. The high correlation of the credit component with the portfolio values will also make the expected standard deviation of the portfolio higher. Therefore, it is recommended that banks should not add to the portfolio of credit components, which have negative correlation or low positive correlation, and should not destroy the diversification effect by concentrating on a few credit components (Wilson, 1998).

Estimating standard deviation of the each credit loss is given by:

$$\sigma_i = EAD_i * (PD_i(1- PD_i) * LGD_i^2 + PD_i VOL_i^2)^{1/2} \quad (4)$$

VOL represents the LGD's standard deviation.

As can be seen, the PD value attributed to the customer is a critical input parameter for analysis. In almost all credit risk modeling systems, including the default-based approach, while realistic PD estimates are made for customers, internal credit rating activities carried out by the bank's credit assessment personnel stand out. The probability of default for any customer will be decisive for all credit transactions with that customer.

The process for determining the customer's credibility level and hence the PD is at least one of the following components (Hull, 2012):

a) Traditional and subjective classification scales in which the characteristics of the customer as well as the credit are tried to identified
b) Commercial credit scoring models prepared by a specialist institution
c) Internal credit risk estimation models

Banks are more likely to use internal credit risk models. However, it is also observed that the internal credit rating categories determined especially for corporate loans are made compatible with the results published by expert rating companies such as S&P and Moody's. The likelihood of a customer moving to a

category other than the current credit category can be determined using the Credit Transition Matrix. Tables can also be prepared for summary categories, which are calculated in terms of average default probabilities. To be interpret, moving from credit rating of AAA to AA from T to T+1 is nearly 7%.

Tablo 2: Rating Transition Matrix

		***T*+1**							
		AAA	**AA**	**A**	**BBB**	**BB**	**B**	**CCC**	**D**
T	**AAA**	**92.29**	6.96	0.54	0.14	0.06	0.00	0.00	0.000
	AA	0.64	**90.75**	7.81	0.61	0.07	0.09	0.02	0.010
	A	0.05	2.09	**91.38**	5.77	0.45	0.17	0.03	0.051
	BBB	0.03	0.20	4.23	**89.33**	4.74	0.86	0.23	0.376
	BB	0.03	0.08	0.39	5.68	**83.10**	8.12	1.14	1.464
	B	0.00	0.08	0.26	0.36	5.44	**82.33**	4.87	6.663
	CCC	0.10	0.00	0.29	0.57	1.52	10.84	**52.66**	34.030
	D	0.00	0.00	0.00	0.00	0.00	0.00	0.00	**100**

Source: Schuermann (2007:2)

3.3.2. Market Value Based Approach

Unlike the default-based approach, in this approach, it is assumed that the loan loss may occur as a result of any decrease in the credit quality of the asset except for the default event. The credit rating on the loan portfolio is based on changes in market value and any difference between the values at the beginning and end of the period is considered as credit loss. It is thought that some events other than default may affect the financial position of the bank by creating a change in the value of the credit asset. Therefore, transitions from higher credit ratings to lower grades are perceived as potential loss causes. Monte Carlo Simulation techniques are used in the calculation of probability values in transition matrices.

3.3.2.1. Discounted Cash Flow Approach

In this approach, the present value of a credit receivable which has not yet become a default is considered to be the present value of the cash flows expected to be realized in the future depending on the contract. The timeframe to be used in the reduction of the cash flows of a credit receivable with a certain internal credit rating is similar to that of a bond with the same credit rating in the market. While the current value of the loan is known, the future value will be determined according to the degree of risk that occurs at the end of the period and the distribution of payments over the period. Therefore, the value of a credit receivable may change as a result of changes in the customer credibility and maturity structure over time (Saunders and Allen, 2012).

One of the levels at which the transition between credits may occur is the worst scenario in which the default is experienced. Therefore, it is meaningless to find credit value by reducing contractual cash flows. Therefore, in calculating the future value of the loan, it is more accurate to deduct the amount of loss to be calculated from the total reduced value calculated.

3.3.2.2. Risk-Neutral Approach

In order to overcome the disadvantages of the Discounted Cash Flow Approach, this valuation approach is presented to present a structural model of the firm value and bankruptcy. A default event can be mentioned if the total asset value of the company is below the amount required to pay the total debts. Instead of contractual payments, conditional reductions are preferred. The reason for this is that the contractual payment may be collected by the issuer of the loan in the event that the party receiving the loan fails to pay. In case of the occurrence of the default event, the bank is able to collect only 1 - LGD of the loan amount. LGD amount is refunded. Such a credit relationship is similar to the fact that the lending party has derivative contracts on the customer's right to buy. The sum of

the present value of the default derivative contracts is considered as the future value of the loan extended. The discount rate to be used in the reduction of cash flows caused by derivative contracts should be risk free interest rate (Delianedis and Geske, 2003).

The risk-neutral pricing criterion can be seen as a correction for the possibility of defaulting the creditors to bring together systematic and non-systematic (borrower-specific) risk factors. The level of adjustment to be made depends on the expected return and the asset value change of the loan party. At this point, CAPM compatible asset return and risk models are developed. The target price criterion is obtained by adding the average rate of return of the market portfolio to the risk-free rate of return (risk premium) obtained by multiplying the return on assets by a coefficient representing the sensitivity to the market yield.

3.3.2.3. Independent Credit Ratings

While determining the minimum capital requirement of banks that have chosen to apply the method, an evaluation is made on the ratings given by independent external audit companies on the risk weights they will apply to their assets.

In its simplest definition, the rating is a tool that measures the timely and complete fulfillment of the willingness and ability of the debtor to pay the principal and interest obligations. In other words, it is the measurement process for determining the credit history of an economic unit and its repayment capacity (Küçükkocaoğlu, 2018).

The definition of credit rating made by the CMB in our country is as follows. Credit rating is an independent, impartial and fair evaluation and classification of capital markets instruments representing the risk status and payability of enterprises or the indebtedness of their capital, interest and similar liabilities by rating agencies as independent, impartial and fair.

The concept of credit grading is an instrument that was introduced in the 19th century in order to provide the official development of the relations between those who demanded debt in the United States and those who funded them. The credit rating enabled the development of the domestic markets and the rapid growth of capital markets in the international arena. It is seen that the rating process is made to securities, commercial companies, financial institutions and banks. Moody Investment Services Company, founded by John Moody, is the first rating company in the world. Moddy was followed in 1916 by Poor bus Publishing Company. In 1922, the Standard Statistics Company was established and then this company was merged with the Poor birleşs Publishing Company and named Standard & Poor şirkets. The third company that started its operations in 1924 in this field is Fitch Publishing Company of New York (Babuscu and Hazar, 2008).

3.4. Types of Credit Ratings

Types of the credit ratings can be classified based on their maturity and types.

3.4.1. Maturity

It is a long-term opinion on the institutional quality of the issuer based on the basic economic and financial characteristics of the sector. While reaching this opinion, the economic conjuncture sensitivity and various risks are taken into consideration such as competition, legal regulations, technological developments, demand changes and management quality.

Liquidity and capital resources on all liabilities up to a year is taken into consideration considering the ability to reach the source.

3.4.2. Types

The rating in international currency rating is evaluated by the ability of the institution to pay foreign currency liabilities by creating foreign currency. All country risks are taken into account.

International local currency rating evaluates the ability of the institution to pay local currency liabilities by creating local currency according to international criteria.

National local currency rating assesses the ability of the institution to pay local currency by creating local currency according to national criteria. Country risks are not taken into account.

3.4.3 Rating Agencies and Their Ratings

The three most important and established companies in the rating industry are Moody ands İnvestors Service, Standart and Poor Moods Corporation and FitchIBCA. After giving brief information about these companies, long and short term rating symbols of companies will be given. Since the rating symbols used in the study are the rating symbols of the Standard And Poors And company used by the BIS and the supervisory authorities, the meaning of the rating symbols of this company is examined in detail. The ratings of Standard and Poors and Moodys and Fitch can be seen in Table 2.

Table 3: Comparison of the Agencies' Ratings

Ungefähre Umschreibung (englisch)	Moody's		S&P		Fitch	
	Long Term	Short Term	Long Term	Short Term	Long Term	Short Term
Investment Grade: Highest (Triple A)	Aaa	P-1 (Prime-1)	AAA	A-1+	AAA	F1+
Investment Grade: Very high	Aa1		AA+		AA+	
	Aa2		AA		AA	
	Aa3		AA-		AA-	
Investment Grade: High	A1		A+	A-1	A+	F1/F1+
	A2	P-2/P-1	A		A	F1
	A3	P-2/P-1	A-	A-2	A-	F2/F1
Investment Grade: Good	Baa1	P-2 (Prime-2)	BBB+		BBB+	F2
	Baa2	P-3/P-2	BBB	A-3	BBB	F3/F2
	Baa3	P-3 (Prime-3)	BBB-		BBB-	F3
Speculative Grade: Speculative	Ba1	Not Prime	BB+	B	BB+	B
	Ba2		BB		BB	
	Ba3		BB-		BB-	
Speculative Grade: Highly speculative	B1		B+		B+	
	B2		B		B	
	B3		B-		B-	
Speculative Grade: Very high risks	Caa1		CCC+	C	CCC	C
	Caa2		CCC			
	Caa3		CCC-			
Speculative Grade: Very near to default	Ca		CC		CC	
			C		C	
In default	C		SD/D	D	RD/D	RD/D

Source: Moneyland (2018)

Moody's Investors Service, founded in 1900, first graded over 1,500 bonds of 250 large American Railway companies in 1909 using ratings symbols from Aaa to C. In 1913, the company expanded its field of activity and also rated indigenous companies and public institutions. Moodytırs was acquired by Dun & Bradstreet in 1962. In the 1970s, the Bank entered the European bond market and in 1972, for the first time in the 1980s, they ranked their asset-based securities, mortgage-backed securities and insurance companies for the first time. In 2000, the company was separated from Dun&Bradstreet and continued to operate in a completely independent manner (Moody's, 2009).

FitchIBCA is another important rating company. The owner of the company is FIMALAC, a French company. Fitch Publishing Company, originally a publishing company, was acquired in 1989 by the group of independent investors.

Fitch merged with a British company, IBCA, in 1997, and later acquired Duff & Phelps in 2000.

Other than these, Canada-based Canadian Bond Rating Service, founded in 1972, founded in 1974, USA-based Thompson Bank Watch, founded in 1975, Japanese Bond Rating Institute of Japanese origin, established in 1977, Canadian Dominion Bond Rating Service and Japanese companies established in 1985 Japanese Credit Rating Agency and Nippon Invertor Service are the major rating companies worldwide.

3.4.3.1. Ratings of Standard and Poor's

The foundations of the Standard and Poor company were laid in 1860, first to provide financial data for Europeans to respond to their interests in the developing infrastructure sector in the United States. In 1916, the company started to rank the company's debt with public debt. Currently, McGraw-Hill Inc. Company's subsidiary (S&P, 2009).

Definitions of Long-Term Credit Ratings:

- AAA Rating: The highest rating given. Represents an extraordinary qualification in the payment of the debt and the principal.
- AA Rating: It refers to a great power in repayment of principal and interest. This category differs slightly with a top class (Langhor and Langhor, 2010).
- A Rating: Although it is strong in the payment of principal and interest, it is more sensitive to the continuous effects of changes in external conditions and economic situation compared to a higher rating.
- BBB Rating: In this category, the repayment of the principal and interest of the debt is sufficient, but this qualification may weaken due to changes in circumstances.

The categories after this category are more speculative in the payment of the principal and interest of the debt of BB, B, CCC, CC and C. BB represents the lowest and C represents the highest speculation class.

- BB Rating: The risk of non-repayment of debts in this group is lower compared to other speculative-rated securities. However, adverse changes in the business or financial and economic conditions may weaken the power to repay the principal and interest on time.
- B Rating: The probability of repayment of the principal and interest of the debt is high. However, as a result of economic and financial developments, the entity may have difficulty repaying debt.
- CCC Rating: In this category where the risk of non-payment is very high, there is a possibility of repayment of the principal and interest of the debt due under appropriate conditions. On the other hand, the reimbursement in the unfavorable conditions is greatly challenging (Langhor and Langhor, 2010).
- CC Rating: In this category, which is more speculative than a higher group, a negative change in economic conditions can cause serious problems in repayment of debt.
- C Rating: In the category of non-repayment of debt, only one category is superior and the borrower in this group has gone bankrupt. However, they still continue to repay the loan. This note represents the highest of speculative degrees.
- D Rating: In this group, the principal and interest of the due debt will not be reimbursed or the debt will not be paid even though the due date is not paid.

[+/-] The (+) and (-) signs are used to confirm the relative position of the grades from AA to CCC in the main categories. (+) an upper, (-) refers to a subclass category.

- N.R. (Not Rated) - Not rated.
- P (Probability) - Indicates that the rating is not accurate.
- Pi (Public Information) - Rating indicates that the issuer is based solely on public financial data.

Definitions of Short-Term Credit Ratings:

The short-term rating includes loans with a maturity of less than 12 months and focused on the liquidity required to perform financial commitments on time (Boyacioglu, 2002):

- A-1: It is the highest category of credit quality. It shows that the capacity to pay financial liabilities on time is very strong. Collateralized debts are also added to the (+) sign127.
- A-2: The capacity to pay its obligations on time is sufficient. However, the collateral level of debts is lower than the category A-1.
- A-3: While the repayment capacity of the debt is sufficient, it is more likely to be affected by adverse developments in conditions compared to a higher level.
- B: It is speculative that the repayment of the debts due.
- C: It is quite doubtful that the debt can be repaid.
- D: Debts are not likely to repay.

3.5. Credit Risk Mitigation Techniques

Banks use various techniques to reduce their exposure to credit risks. Credit risk mitigation techniques must meet the minimum standards for legal certainty in order to be used in capital adequacy calculation (BRSA, 2006).

Credit reduction techniques generally include the following issues (BSRA, 2009).

- Secured Transactions
- In-balance Netting
- Strict Rules in Credit Agreements
- Warranties and Credit Derivatives.

3.5.1. Secured Transactions

A secured transaction means a transaction that banks are exposed to because of a used or potential loan and that the credit risk or potential credit risk is fully or partially secured by a counterparty, or by a third party's guarantee on behalf of the counterparty.

In Basel II Standard Method, risk reduction techniques are taken into consideration by using one of two different methods. These are Simple and Comprehensive Methods.

In a simple method, the risks are divided into two as collateralized and unsecured parts, while the collateralized parts are multiplied by the risk weights of the collaterals, while the unsecured parts are multiplied by the risk weight the borrower is subject to. In the comprehensive method, the risks and collaterals received against this risk are increased or decreased depending on the changeability of both amounts over time and the difference between the two amounts obtained is multiplied by the counterparty's risk weight. In this framework, the risks related to the counterparty are increased through appropriate deductions, the guarantees received are reduced through appropriate deductions and then the difference between the increased risk and the reduced collateral amount is multiplied by the counterparty's risk weight. In the comprehensive method, an additional deduction will also be applied if the risk and collateral is in separate currencies. The cuts to be applied can be applied at the rates recommended by the Committee, or they can be estimated by banks using

historical data or to obtain risk measurement models of the bank. Banks can implement any of these approaches in the banking portfolio and only comprehensive approach in the trading portfolio. Partial guarantees are accepted in both approaches. The mismatches between the credit and the maturity of the collateral are only allowed in the comprehensive approach (Yuksel, 2005).

3.5.2. In-balance Netting

In-balance netting is the clarification of the receivables and payables to be arisen from the work contracts to be realized in the current or future contracts within the rules set forth by the two parties under an agreement.

Netting transactions result in some legal risks while reducing credit risk. Because netting is still not legally regulated in many countries and there are some irregularities that may arise if the netting ends, there may be conflicts due to lack of regulation. For this reason, netting operations are performed on the condition that some elements are found. These elements (Babuccu, 2008):

• The agreement covers each relevant legal situation and the reporting bank has the authority to finalize the clarification,

• The maturity of deposits is at least as high as the relevant credit;

• The reporting bank is monitoring and controlling the related accounts on a net basis.

3.5.3. Guarantees

Warranties must bear the right to a direct claim against the provider of protection, and the scope of protection must explicitly refer to specific credit risks or to a pool of credit risks. The protection should be irrevocable, except when the buyer cannot pay the accrued debt in accordance with the credit protection contract. The contract must not contain any substance that increases the actual cost of protection as a result of credit quality deterioration in the credit risk that allows the

protection provider to unilaterally cancel the credit protection or subject to hedging (JCR, 2009).

Acceptable Guarantor, Warranters and Guarantors are as follows.

- Treasury and central banks with a lower risk weight than the other party, local public institutions, banks and securities companies
- A- or higher rated organizations. This includes the credit protection provided by the parent company, associate and subsidiaries with lower risk weight than the borrower.

3.6. Credit Derivatives

Credit derivatives, the value of the credit risk from the asset or asset portfolio, and this asset or asset portfolio without transfer of the credit risk is transferred to the other party by transferring the contract are the contracts. There are two parties in credit derivatives (Yaslidag, 2007).

• The party selling the risk; sells the risk of the loan to the risk buyer for a premium.

• Risk taker; it buys this risk without instrumentation, that is, without credit. The risk buyer undertakes to bear the economic negative consequences of the transaction.

3.6.1. Types of credit derivatives

• Total Return Swap Contracts: A secondary financial contract where the total return on an asset is exchanged for another cash flow during the contract period.

• Credit Margin Derivatives: These are instruments that allow the risks arising from the changes in the credit margin to be separated from the market risk and interest rate risk and enable the investors to provide protection against the risks caused by the mobility in the margins by forming their investment strategies

according to the movements in the margins. The credit margin is the rate at which the investor can claim a credit risk of a particular asset, in addition to the risk-free rate of return or the return on another asset.

• Credit Risk Swaps (CDS): The purpose is to transfer credit risk between the parties and manage market risk in this way. Credit risk swap contracts reduce the risk of the investor by transferring the potential risk from one party to another without requiring the transfer of the related bond or other asset related to the debt between the parties. This agreement is similar to an insurance contract.

• Credit Default Swaps: This is the contract for the wage or premium against the seller of protection who wants to protect himself from the fact that the default default swap agreement overwrites the loan by the borrower.

In addition to these, securities linked to credit may make credit risk separate from other risks and subject to sale. Credit-linked securities, which are used to transfer credit risk with or without a derivative of a derivative, transfer the underlying asset or asset portfolio risks with synthetic securitization method. For example, credit-based bonds can be given.

4. STRUCTURAL MODELS

Along with the Basel II standards, credit risk (CR, credit risk) modeling has become an important component of risk management systems and continues to be one of the areas where financial institutions are highly emphasized. The purpose of the institutions in modeling the credit risk is to measure, combine and manage risk based on the geographical regions and product groups. The outputs of these models also play an important role in the risk management and performance measurement processes of banks, including performance-based provisioning, customer profitability analysis, and risk-based pricing.

Historically, there is a large number of studies dealing with the decision to default, or endogenous default models. Under structural models, a default event is thought to happen when firms's assets reach a sufficiently low level in relation with its liabilities. These models require some strong assumptions on the dynamics of the firm's debt/asset as well as its capital structured. The main pros of structural models are that they give an intuitive understanding.

4.1. Merton Model

Merton model is the initial point of the structural credit risk model. This model tries basically to address the question of how capable does the company to meet its obligation? To properly answer this question, Merton model evaluates credit risk of a company's debt.

Historically, the first-class applications of credit risk models are the structural approach. This model group includes assumptions about the value of the firm's assets. The liability structure of the firm determines the insolvency status together with the firm's asset value variability. The original Merton model, like the Black & Scholes model, recognizes that interest rates are constant.

Although Merton models are among the statistical models, these models calculate the default based on the asset price and not on the firm ratios. The default process

of a firm is determined by the value of the firm's assets and the risk of default. In other words, these models take into account the change in the asset value of firms; the default of the firms is realized when the value of the assets of the firms falls below the value of their debts (Tudela and Young, 2003).

Under this assumption, credit risk is driven by dynamism in asset prices. The model assesses the carrying amounts of the liabilities by adding a number of systemic elements to the possibility of exceeding the market values of the assets. In these models, the market value of firm assets is not considered as observable values; market value can be determined using the book value of liabilities calculated using stock prices, fluctuations in these prices and option characteristics in stocks (Anbar, 2005).

Merton's model of risky borrowing begins with a number of assumptions, which allow the modeler to see the equity as an option on the entity's assets. For the model to be valid, various assumptions, such as in the Black-Scholes option model, should be loaded into the model (Set, 2007:22):

- The only random variable in the model is the value of the company's assets.
- The Company's assets are completely liquid.
- Interest rates are fixed.
- There is only one period in the life of the company.
- The volatility of the company's assets is constant.
- The Company's assets follows a stochastic process consistent with lognormal distribution.

Merton has made some additional assumptions to make it easier for companies to assess their debts:

- The debt has only one payment (in the form of debt, plus interest income or discounted bonds).

- Management determines the amount of debt and does not change the amount of debt until the company closes at the end of the period.
- If the company's assets are less than their debts at the end of a single period, bankruptcy will take place.
- The value of the firm's liability plus the equity value of the firm is equal to the market value of the firm's assets.
- The value of the firm's debt is simply the difference between the value of the company's assets and the equity value.

In order to model credit risk, the Merton model assumes total value of asset follows geometric Brownian Motion:

$$dA_t = rA_t d_t + \sigma A_t dW_t$$

where r is the expected rate of return, σ is the volatility of asset, and W_t is the Brownian Motion. For the sake of simplicity, Merton model further assumes that market is frictionless in which liquidation value equals to firm value.

In this model, company's face value of debt, coupon paying bond, is represented by D, the value of the firm is the total value of equity denoted by E, and the maturity of this debt is T. Basic and fundamental accounting identity is:

$$E_T = \max(A_T - D, 0)$$

If the total value of asset exceeds the total value of debt, total value of debt is paid and what re- mains from the total asset is distributed among shareholders. If value of debt is greater than the total value then it amounts to default. In the default case, bondholders have right to receive liquidation value.

As the Merton model assumes that company's assets are traded in a complete market, risk free rate, r, can be used in lieu of expected return. This allows us to employ the Black-Scholes by which one can model the value of equity in the form of European Call option.

$$E = A\varphi(d_1) - De^{-r(T-t)}\varphi(d_2) \quad (5)$$

where

$$d_1 = \frac{\ln\left(\frac{A}{D}\right) + (r + \sigma^2/2)(T-t)}{\sigma\sqrt{T-t}} \quad (6)$$

$$d_2 = d_1 - \sigma(T-t) \quad (7)$$

and θ is the cumulative normal distribution function with mean 0 and standard deviation 1.

Under this setup, credit default at maturity, T, with risk-neutral probability, P, is:

$$P(A_T < D) = \varphi(-d_2) \quad (8)$$

To value debt, D_t before maturity, it suffices to subtract European put option from a zero coupon

bond, D_t.

$$D_t = Ke^{-r(T-t)} - P_t \quad (9)$$

where P_t is the value of the put option and K is the strike price. As it is dealt with the risky bond as corporate debt, then credit spread, the yield difference between the bond issued by government and the one with lower credit rating, should be taken into account. Thus,

$$D_t = Ke^{-(r-s)(T-t)} \quad (10)$$

where s is the credit spread. Finally, the closed from solution of the credit spread can be derived as follows:

$$s = -1/(T-t)\ [\log\ (\varphi(d_2) + (A_t/K)\ e^{r(T-t)}\ (1 - \varphi(d_1))] \quad (11)$$

The simplicity of the Merton model rests with applying the Black and Scholes formula of pricing the European options to value firm's equity and debt. However, this comes at the cost of too simplistic assumptions about the asset value process, interest rate, and the capital structure (Laajimi, 2012).

Due to simplified assumptions of Merton Model, some other models are proposed. Black-Cox Model is one of them and is discussed in this study.

4.2. Black-Cox Model

The Merton model is classified as exogenous default model in that the default barrier in this model is equal to the nominal value of debt meaning that no default before maturity of the debt. This has raised critics on the Merton model. Black and Cox model (1976) addresses this shortcoming by introducing first passage model in which default can happen any time as long as asset value, At , reaches the default barrier from above.

Dynamics of the assets value is the same with the Merton model:

$$dA_t = \mu A_t dt + \sigma A_t dW_t \tag{12}$$

This model assumes a time-dependent default threshold. Let K be the default threshold and for

a given K, the optimal default time is given by:

$$\tau = \inf\{t \geq 0 : Vt \leq K\}$$

$$\tau = \inf\{\, t \geq 0 : Wt = \{ \frac{\ln \frac{A_t}{A_0} - r - \sigma^2 t}{\sigma} \} \tag{13}$$

Solving stochastic differential equation gives us the following as default probability:

$$d_1=\frac{\ln\left(\frac{K}{e^{r(T-t)}V_t}\right)+(\sigma^2/2)(T-t)}{\sigma\sqrt{T-t}} \quad (14)$$

$$d_2=d_1-\sigma(T-t) \quad (15)$$

In the literature, Leland (1994), Leland and Toft (1996), Brigo and Tarenghi (2004) along with other provide many extenstion to the Black and Cox model. However these are out of our scope. These two models the backbones of the structural models however they are not safe from critics.

Structural models that provide a useful research method for estimating and modeling credit risk provide a numerical point of view regarding key issues concerning credit risk pricing. A simple and direct criterion is provided for the probability estimates.

The most important feature of the structural models that are found to be negative is that they cause difficulties in the implementation of empirical tests for model validity. In the short term, the predictability level of the default event is low and the asset valuation process requires time. There is also an uncertainty about the correct pricing of corporate bonds. Estimates of price differences were significantly variable. On the other hand, it is considered that credit rating changes cannot be adequately reflected in the model results and the assumptions made regarding the capital structure of the company are considered to be overly simple. These negative characteristics may be the validity of the estimates to be realized through the structural models.

5. REDUCED-FORM CREDIT RISK MODEL

Reduced form models are called the reduced form because they reduce the complex mechanisms of defaulting to simple expressions that do not produce arbitrage pricing. The default rate in these models is the risk ratio.

In the early days of credit derivatives markets, traders were using the Merton model for pricing. It was soon noticed that the market default of credit default swaps was completely different from the Merton model. The Jarrow-Trunbull model is the first model to allow market prices to be matched and provide a rational economic basis for the development of market prices. In this model, the probability of default falls into a random variable dependent on arbitrary number of lognormally distributed risk factors and probability of defaulting on random interest rates (Jarrow et al., 1997).

In structural approach models, the probability of default is expected to decrease as the maturity approaches. However, this assumption reduces the power and consistency of the models. For this reason, reduced models have emerged as the phenomenon of default is seen as a random and unexpected situation. The models introduced by Jarrow and Turnbull (1992) are also known as Intensity-Based Models. This approach has been tried and tested by numerous researchers (Artzner and Delbaen, 1995, Duffie and Singleton, 1999, etc.) during the 90s. The basic assumptions of reduced models are (Jarrow and Stuart M.Turnbull, 1995):

- The information is scarce and can be observed by the market.
- The default time is uncertain.
- The market value of the bond depends solely on the spot interest rate.
- There are no early warning signals for the occurrence of the default event.
- Therefore, the event of default is not the result of an economic process

In creating the model, it is foreseen that the company's debts consist of a individual bond with no interest. Loan price differences are decomposed to

calculate PD and LGD values. Price differences are accepted as the cost of default and these two variables are multiplied by each other. Various methods have been developed in accordance with such sorting efforts. For example, the method developed by Das and Tufano (1996) defines PD with a specific density function, while LGD is associated with a risk-free interest rate. Duffie and Singleton (1998) suggested that LGD can be determined as a percentage of the pre-default credit balance.

In this model, credit default rate is given as:

$$PD_{t/t+1}=s(t)-s(t+1)/s(t) \quad (16)$$

PD is probability of default between t and t+1 and s(t) is the probability of non-default and s(t+1) is the probability of default at time t+1

Tablo 4: Credit Risk Migration

Years	AAA	AA	A	BBB	BB	B	CCC
1	1	1	0,99	0,96	0,95	0,93	0,89
2	1	0,99	0,98	0,95	0,94	0,90	0,86
3	0,99	0,98	0,97	0,94	0,92	0,89	0,84

Source: Standard and Poors (Cell values are hypothetical)

The cell values in these tables based on historical data show the probability of not defaulting the bonds with the corresponding original credit rating within the prescribed time (s). However, since the default events are defined as instantaneous and unexpected entities in the reduced models, the probability values must be updated for each period. Update process and instant probability density calculation are done in accordance with Poisson distribution:

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{s(t) - s(t+\Delta t)}{\Delta t s(t)} = -\frac{1}{s(t)} \lim_{\Delta t \to 0} \frac{s(t+\Delta t) - s(t)}{\Delta t} = \frac{s'(t)}{s(t)} \quad (17)$$

The probability of default (PD) and the value of firm debts, that is F(0, T), before the specified time horizon (maturity) is calculated as follows:

$$PD(\tau \leq T) = E\left(e^{-\int_0^T \lambda_S d_S}\right) \quad (18)$$

$$1 - PD = e^{-s(t)} \quad (19)$$

$$F(0,T) = E([1_{\{\tau \leq T\}} \delta_\tau + 1_{\{\tau > T\}}] e^{-\int_0^T r_S d_S} \quad (20)$$

where, T is maturity, r_s is the spot rate, and E is the expected value.

Table 5: Merton vs. Jarrow Model

Assumption	**Merton Model**	**Jarrow Model**
Interest Rate	Fixed	Random
Reason of Default	Firm Assets	Interest Rates and Macro factors
Capital Structure	Bond with no coupon payment	No restriction on capital structure
Number of Periods	1 period	Multi-period

Repayment in the event of Default	Specified by the model	Random repayment

One of the examples of reduced model trials is the work of Janosi, Jarrow and Yildirim. In this study, a reduced model proposal using stock returns is presented. With the help of price-earnings ratios, sudden tip changes in the rates of return were determined and accurate predictions were made regarding the probability of default (Janosi et al. 2003).

Reduced models are thought to be more successful in reflecting market data to forecasts. In addition, it has been observed that the methodological problems of the structural models are not valid in the reduced models. It is a useful approach for pricing risky debts or credit derivatives. KPMG's Financial Analysis System and Kamakura Risk Manager software are based on a reduced model approach (Saunders and Allen, 2002).

Because of the complexity of the models, empirical validity tests can be difficult. Explaining the differences in the maturity structure of firms' loan price differences is another problematic point.

6. LITERATURE REVIEW

Hammer, Alexander and Miguel (2003) examined observable risk factors in the framework of Basel II. Default relationships and default probabilities have contributed to risk factors. Logistic regression, multiple linear regression and dicriminant analysis were used. Statistical models for credit risk analysis, basic factor models and macroeconomic models of logistic regression analysis are more positive than linear regression analysis. These models were analyzed by analyzing empirical rating data between 1982 and 1999. The data set of the study consisted of the data set of 800 banks from 70 different countries evaluated by Fitch and the data were collected in 2001. As a result, it is seen that portfolio models significantly reduce uncertainties about the parameters required for Value-at-Risk measurement. The first experimental evidence for the risk factors underlying models and models is given by S&P data.

In this study, Handorf and Lili (2005) used the financial data of the individual banks from the first quarter of 1990 to the fourth quarter of 2000 to estimate the credit risk and credit quality of banks. 1331 individual banks were divided into 4 groups and benefited from 53240 observations in 3 months. In this study, the banks were divided according to the weight of their average total assets. In the group of large banks, between $ 500 million and $ 10 billion in the group of regional banks, and between $ 200 million and $ 500 million in the group of large banks, and $ 25 million in the group of small banks, the group of small banks was examined. As a result, banks have analyzed the expected credit risks well, and it has been understood that major banks are successful in managing credit risk.

In this study, Weber, Scholz and Michalik (2008), the integration of environmental risks other than credit risk management, rating, costing, pricing, monitoring and work in general was handled with a survey in the European banking sector. Environmental risks in the credit risk management process are important for risk management. A questionnaire was applied to 205 banks in eight European countries.

Only 50 of these 205 banks received responses. Half of the responding banks have signed the United Nations Environment Program and the other half are banks that have not signed. It was understood that 82% of the answers came from the German, Swiss and Polish banks and the majority of the member states of the European Union were banks. In the credit risk management process, only 9 out of 50 banks were protected against environmental problems. Considering the data, it was seen that environmental risks had a significant effect on credit risk management.

In the study of Ghost and Das (2007), the factors affecting the credit risk of developing banks, the credit policies of financial instruments and the data of 1994-2005 period of the state banks in India were investigated. Macroeconomic and microeconomic data are used to determine credit risk. Macro and Micro level GDP growth rate, banks' growth rate, real interest rate and real credit growth have been analyzed. With the increase of private banks and foreign banks, the active ratio of 5 banks belonging to Indian banks decreased from 0.46 in 1993-1994 period to 0.38 in 2004-05 period. In the study, the share of non-performing loans in total loans was high.

Suresh, Kumar and Gowda (2009) were tried to measure and manage the credit risk of banks in a certain framework, also analyzed the credit developments and the diversified portfolio relationship of private banks. For the measurement of credit risk, the data of the private banks for the periods 1995-1996 and 2006-2007 were used. One-way ANOVA test, correlation coefficient and regression analysis methods were used for the selected 15 private banks. The private banks index is divided into 4 regions: agricultural region, semi-urban region, urban region and metropolitan area. Each region is divided into 7 portfolios and calculated separately for each year. In all regions, industrial loans vary from 24% to 47% while in agricultural areas loans are approximately 36%, in rural areas from 14% to 21%, commercial loans from 12% to 14%, transportation loans from 1.5% to 3% 5, loans were the lowest with 0,86% and 1.36% in places other than

metropolitan areas. Banks have come to the conclusion that they need to diversify their portfolios if they want to achieve a better result in their loan portfolios.

Bodla and Verma (2009) conducted an analysis by commercial banks in India within the framework of credit risk management. The size and ownership effect of banks in credit risk management practices are examined. Commercial banks in India, public banks, private banks and foreign banks. In this study, banks are divided into two groups: small banks and large banks. In addition, a survey was conducted with senior managers of banks and risk management department. In this survey, firstly, it was aimed to determine whether there is a difference between big banks and small banks in credit risk applications, and secondly, whether there is any difference between public banks and private banks. In the credit risk management application, Altman ,s Z-Score Model, Merton Model, KMV Credit Monitor Model, Credit Metrics, Credit Risk +, McKinesy Credit Portfolio View are used. Banks in India have avoided derivative products to hedge against risk.

Njanike (2009) conduct ana analysis by randomly selecting 10 commercial banks. The 20 questions selected for each commercial bank were used for two data. The questionnaire and interview method were used in the analysis. The survey conducted 10 interviews with credit managers and senior executives of commercial banks. Thus, uncertainty about credit risk management has been clarified. The bad results of credit risk management caused the banks to fail.

Matoussi (2010) examined the risk of short-term loans of a commercial bank in Tunisia. Two different statistical methods were used in the classification of data: artificial neural networks and comparative linear regression analysis. Analysis was made in years 2003, 2004, 2005 and 2006 by years. The loans granted to industrial companies in Tunisia have been taken into account by a commercial bank. Multilayer neural network model was used to predict the results. Cash flow and collateral variables are the best data set. In 2006, the loss of the bank fell from 18.7 percent to 12 percent. In the study, variables such as financial ratio, firm and

industry debts were used in general. As a result, despite the lack of data in the study, it has been ensured that new agreements were made in Basel and encouraged the establishment of reliable databases.

Aman and Zaman (2010) investigated the performance, credit risk and the impact of privatization of private and foreign banks in the 1990-2005 period. Simple Error Correction Model (ECM) and Augmented Dickey Fuller Test were used. In the study, independent variables such as liquidity risk, capital adequacy and credit factors were examined. In addition, return on equity as a dependent variable was taken in the study. Credit risks and performances of public, private and foreign banks were compared. Banks' performance and credit risk were measured using regression analysis. Correlation analysis was used to find a strong and weak relationship between variables.

State banks, private banks and foreign banks' data for the period of 1990-2005 were used in the study. Since the privatization in the financial sector was first realized in 1992, the data for the private banks were used for the period of 1992-2005. As a result of the regression analysis of the foreign banks, the fact that the credit factor is positive is a sign that the analysis is significant. With credit management policy, more credit is offered to customers. It was recommended that this would be avoided through risk management, as giving more credit to customers would lead to high risk. It shows that Public Economic Banks have a negative impact on return on equity. In order to increase the profitability of the bank, it is concluded that the liquidity risk should be reduced. As a result of the regression analysis, it was observed that the credit factor was effective on return on equity (ROE) in private banks. Credit factor was positive.

Cristea, Vasilescu, Hamarat and Tufan (2010) examined the success and failure of banks. It separated according to their capital banks in Turkey and resulted in applications using financial ratios of these banks. Successful and unsuccessful failures of banks were analyzed by linear regression analysis and diseriminant analysis. The study was conducted for 2006 and analyzed for 26 banks including

18 domestic deposit banks and 8 foreign deposit banks. In the study, data such as capital adequacy ratios, asset ratios, liquidity ratios, profitability ratios, income expense structure, share of banking sector, share of branch and activity rates were taken from central bank site and banks' success and failure situations were estimated. The performance analysis of the banks was performed with these ratios. In the analysis, domestic failed banks were given a value of 0, and foreign successful banks were given a value of 1. As a result, foreign banks were classified as wrong. According to liquidity ratios, 76.2% of banks are classified correctly. Turkish banks' deposits with foreign commercial banks were found to be more successful than it is because of the lack of more branches of foreign banks in Turkey. Since there was a strong competition in the sector and the profits of the banks came from the cards and commissions in general, it was seen that the foreign banks which had no more customers and branches had less profit.

7. DATA AND METHODOLOGY

In this part, firstly CAPM is applied to obtain drift term to be used in Merton model.

7.1. CAPM Application

It is a model based on estimates of expected returns of risky assets. Although the model is developed for securities, it can also be used for fixed asset investments. The Financial Asset Pricing Model (FVFM) is based on two fundamental risks: systematic and non-systematic. FVFM was developed by William Sharpe, John Lintner and Jan Mossin, based on the modern portfolio theory developed by Harry Markowitz. The mathematical model of FVFM can be shown as follows:

$$E(R_i) = \alpha_i + \beta_i E(R_m)$$

where R_i is the expected excess return, α_i is the constat term, β_i is the slope term, and finally, R_m is the excess market return or market risk premium. Differently, CAPM can be shown as:

$$E(r_i) - r_f = \beta_i [E(r_m) - r_f]$$

In this case, r_i is the stock return, r_f is the riskless rate and r_m is the market return.

Risk premim is of considerable importance in CAPM. Theoretically, when risk is avoided, more risky assets offer higher returns. They also offer lower returns on lower risk assets. In this case, when the investor takes on a risk, he desires a higher return than risk-free investment. The difference between the two is therefore called the risk premium. Mathematically,

$$E(r_m) - r_f > 0$$

$E(r_m)$ represents the expected return on the risky asset and rf represents the risk-free return. The positive difference between these two points indicates the presence of excess yield and means the rewarding of the risk.

Beta shows how risky the asset is when it encounters market risk.

$$\text{Beta} = \text{Cov}\,(r_i, r_m) / \text{Var}\,(r_m)$$

Here r_i, i. The return of the stock, rm, refers to the return of the relevant index (or market).

The different values of Beta indicate that the different assets have different risk values and hence different returns.

• Beta = 1, in this case the relevant stock has the same risk as the stock market. Thus, if the stock market (BIST) rises by 1%, the related share increases by 1%. Likewise, if the stock market declines by 1%, the price of the related share decreases by 1%.

• Beta> 1, in this case, the risk level of the stock and volatility are higher than the stock market. Even though the direction of change of the stock price is the same as the market, the change in the stock is more. For example, when the stock market increases by 1%, the corresponding stock increases by more than 1%. When the market value decreases by 1%, the stock price decreases by more than 12%.

• Beta <0, in this case the stock is considered to be less volatile and less risky in this case than the stock market. For example, when the market value increases by 1% (decreases), the stock is increasing (decreasing) by less than 1%.

The main assumptions of CAPM are provided below:

1. There are infinite number of buyers and sellers in the market. Therefore, the individual price is not decisive and the decisions made by the individuals do not affect the market.

2. The investment period is the same for each investor and the asset is held for a single period.

3. All assets are marketable and divisible. It is possible to trade the asset as a part. It is also assumed that there is a risk-free asset. All investors can borrow as much as they want from the risk-free interest rate.

4. No transaction costs and no tax.

5. All investors try to maximize the benefits they expect from their wealth at the end of the period and avoid risk. If there are two investment options with the same expected return, investors will prefer the investment option with the smallest variance. Likewise, if there are two investment options with the same variance as the return, the option with the expected return will be preferred by the investors.

6. The probability distribution of returns determines the investment decisions of the investors. The probability of the return of investments and distribution of investment is measured on the basis of the expected return on investment and the variance of return.

Table 6: CAPM Application for Akbank

	(2)
Variables	akbank_ret
Beta_akbank	0.0772
	(0.0735)

Constant	-0.000372
	(0.000978)
Observations	503
R-squared	0.062

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7: CAPM Application for Aselsan

	(1)
Variables	aselsan_ret
Beta_aselsan	0.0745
	(0.0740)
Constant	0.00100
	(0.00111)
Observations	503
R-squared	0.054

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8: CAPM Application for Dogan Holding

	(1)
Variables	dogan_ret
Beta_godan	0.0792
	(0.0735)

Constant	0.000952
	(0.00135)
Observations	503
R-squared	0.055

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 9: CAPM Application for Garanti

	(1)
Variables	garanti_ret
Beta_garanti	0.0806
	(0.0734)
Constant	8.72e-05
	(0.00105)
Observations	503
R-squared	0.066

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 10: CAPM Application for Sabanci

	(1)
Variables	sab_ret

Beta_sabanci	0.0743
	(0.0737)
Constant	-0.000744
	(0.000754)
Observations	503
R-squared	0.062

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 11: CAPM Application for Koc Holding

	(1)
Variables	koc_ret
Beta_koc	0.0808
	(0.0733)
Constant	-1.92e-05
	(0.000774)
Observations	503
R-squared	0.073

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 12: CAPM Application for Petkim

	(1)
Variables	petkim_ret
Beta_petkim	0.0847

	(0.0732)
Constant	0.000789
	(0.00102)
Observations	503
R-squared	0.073

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 13: CAPM Application for Zorlu Holding

	(1)
Variables	zorlu_ret
Beta_zorlu	0.0794
	(0.0734)
Constant	-0.000297
	(0.00106)
Observations	503
R-squared	0.063

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 14: CAPM Application for TAV

	(1)
Variables	tav_ret

Beta_tav	0.0774
	(0.0737)
Constant	0.000891
	(0.00108)
Observations	503
R-squared	0.060

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 15: CAPM Application for Tekfen

	(1)
Variables	tekfen_ret
Beta_tekfen	0.0725
	(0.0742)
Constant	0.00250**
	(0.00105)
Observations	503
R-squared	0.053

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 16: CAPM Application for THY

	(1)
Variables	thy_ret

Beta_THY	0.0774
	(0.0739)
Constant	0.00213*
	(0.00118)
Observations	503
R-squared	0.057

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 17: CAPM Application for Tupras

	(1)
Variables	tupras_ret
Beta_tupras	0.0797
	(0.0735)
Constant	0.000901
	(0.000904)
Observations	503
R-squared	0.068

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 18: CAPM Application for Albaraka

Variables	(1) albaraka_ret
Beta_albaraka	0.0827
	(0.0732)
Constant	0.000301
	(0.00103)
Observations	503
R-squared	0.069

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 19: CAPM Application for Turk Telekom

Variables	(1) tt_ret
Beta_turktelekom	0.0740
	(0.0739)
Constant	-0.000737
	(0.000954)
Observations	503
R-squared	0.057

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 20: CAPM Application for Turkcell

Variables	(1) turkcell_ret
Beta_turkcell	0.0699
	(0.0742)
Constant	7.69e-05
	(0.000880)
Observations	503
R-squared	0.053

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 21: CAPM Application for Halkbank

Variables	(1) halk_ret
Beta_halkbank	0.0742
	(0.0738)
Constant	-0.000647
	(0.00118)
Observations	503
R-squared	0.053

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Tablo 22: CAPM Application for Vestel

Variables	(1) vestel_ret
Beta_vestel	0.0747
	(0.0738)
Constant	-0.000771
	(0.00122)
Observations	503
R-squared	0.052

Note: Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In this study, 17 companies listed in Borsa Istanbul are used to calculate the probability of default and distance to default by applying Merton model. In order to determine the probability of default:

- Firm‘s liability from balance sheet
- Firm‘s equity value simply by multiplying the outstanding share and price
- Asset volatility
- Time to maturity

In short, we are ready to apply merton model if we know equity value, debt level, drift term and asset volatility. Variables sources are provided below.

Table 23: Variable Sources

Variable	**Sources**
Equity value	Center for Research in Security Prices
Debt Level	Center for Research in Security Prices
Asset volatility	Yahoo Finance
Security Return	Yahoo Finance

Table-25 provides the data used for estimating probability of default in 2017 and 2018. Accordingly, equity value, liability, riske free rate, drift term, and asset volatility are used. For the sake of clarity, risk free rate is the yield of 1-month Turkish T-bill, drift is the intercept term obtained from CAPM provided above.

Table 24: Data Used for calibration in 2017

Company Tickers	**Equity Value (Million TL)**	**Liability (Million TL)**	**Risk Free Rate**	**Drift**	**Asset Volatility**
AKBNK.IS	33783,36	80741	0,136	-0,000372	0,2529907
TCELL.IS	33421,32	12536	0,136	0,0000769	0,2376255
ASELS.IS	19253,4366	534	0,136	0,001	0,4066856
KCHOL.IS	34319,67	36381	0,136	-0,000019	0,2261390
PETKM.IS	10595,46	2952	0,136	0,000789	0,2569049
THYAO.IS	21652,2	34259	0,136	0,00213	0,3430404
VESTL.IS	2539,4322	4518	0,136	-0,000771	0,4009692
DOHOL.IS	2276,73606	4031	0,136	0,000952	0,3900897
TUPRS.IS	30425,9085	15051	0,136	0,000901	0,2582718
ZOREN.IS	316	7818	0,136	-0,000297	0,3113718

GARAN.IS	45024	89386	0,136	0,0000872	0,2586210
TAVHL.IS	8159,2909	1119	0,136	0,000891	0,2883859
ALBRK.IS	1395	7330	0,136	0,000301	0,3730647
TKFEN.IS	6290	1180	0,136	0,0025	0,3409097
TTKOM.IS	22540	17429	0,136	-0,000737	0,2406353
SAHOL.IS	22696,5983	84200	0,136	-0,000744	0,2078852
HALKB.IS	13475	70813	0,136	-0,000647	0,3735192

Tablo 25: Data Used for calibration in 2018

Company Tickers	**Equity Value (Million TL)**	**Liability (Million TL)**	**Rate**	**Drift**	**Equity Volatility**
AKBNK.IS	23116,72	75781	0,22	-0,000372	0,40244075
TCELL.IS	25483,8091	20156	0,22	0,0000769	0,35904407
ASELS.IS	14518,8109	786	0,22	0,001	0,36453106
KCHOL.IS	26538,3163	50717	0,22	-0,000019	0,30235289
PETKM.IS	8382	7325	0,22	0,000789	0,43001769
THYAO.IS	22342,2014	55834	0,22	0,00213	0,46819102
VESTL.IS	1868,5122	7227	0,22	-0,000771	0,46529011
DOHOL.IS	2692,15014	2489	0,22	0,000952	0,53595718
TUPRS.IS	28873,3115	17950	0,22	0,000901	0,35951643
ZOREN.IS	248	11280	0,22	-0,000297	0,42132683
GARAN.IS	33503,2818	79175	0,22	0,0000872	0,44126633
TAVHL.IS	8195,619	1457	0,22	0,000891	0,44615558
ALBRK.IS	1152	8525	0,22	0,000301	0,33915257
TKFEN.IS	7880,99963	1118	0,22	0,0025	0,39007236
TTKOM.IS	2073,75	20801	0,22	-0,000737	0,4034687
SAHOL.IS	15376,7832	80121	0,22	-0,000744	0,30267856

HALKB.IS	8925	78895	0,22	-0,000647	0,43938887

At this point, it is worthwhile to introduce the companies considered in this study. These companies are:

- Akbank
- Turkcell
- Aselsan
- Koc Holding
- Petkim
- THY
- Vestel
- Dogan Holding
- Tupras
- Zorlu Holding
- Garanti
- TAV Holding
- Albaraka Turk
- Tekfen Holding
- Turk Telekom
- Sabanci Holding
- Halkbank

Akbank

Akbank was founded in Adana on January 30, 1948 as a privately owned commercial bank. The purpose of the establishment is to provide financing to cotton producers in the region. In 1954, Akbank increased its number of branches rapidly after the General Directorate's move to Istanbul, and in 1963, it began to automate all banking transactions.Akbank was opened to the public in 1990 and

started to be listed as American Depository Receipt (ADR) in international markets with secondary public offering in 1998.

Akbank's core activities include corporate and investment banking, commercial banking, SME banking, retail banking, payment systems, treasury transactions and banking and banking services including private banking and international banking services. In addition to its standard banking activities, the Bank operates as a subsidiary of Aksigorta A.Ş. and AvivaSA Emeklilik ve Hayat A.Ş. also carries out insurance agency activities (Akbank, 2019).

Turkcell

Turkcell is a resident, integrated communication and technology services company. It provides its customers with voice, data, TV services and value-added individual and corporate services via mobile and fixed networks.

Turkcell's mobile communication service began in February 1994. On April 27, 1998. Having signed a 25-year GSM license agreement with the Ministry of Transportation, Turkcell continued its development by increasing the variety, quality and number of customers based on the mobile voice and data communication services it offers to its customers. Turkcell, whose shares started to be traded on Borsa Istanbul (BIST) and New York Stock Exchange (NYSE) on July 11, 2000, is the only Turkish company listed on NYSE. Turkcell is also included in the Borsa Istanbul Sustainability Index (Turkcell, 2019).

Aselsan

Founded in 1975 to meet the communication needs of the Turkish Armed Forces with national facilities, ASELSAN is a joint-stock company affiliated to the Turkish Armed Forces Foundation (TSKGV). 74,20% of ASELSAN shares belong to TSKGV, while 25,70% are traded on Borsa Istanbul (BIST). Turkey's largest defense ASELSAN with electronics provider, particularly the Turkish Armed Forces, including domestic and international needs authorities,

communications and information technology, radar and electronic warfare, electro-optics, avionics, unmanned systems, land, sea and weapon systems, air It has a wide range of products to meet the needs of defense and missile systems, command control systems, transportation, security, traffic, automation and health technologies. Today, ASELSAN has become a brand that exports its original products and is one of the top 100 defense industry companies in the world (Defense News Top 100) (Aselsan, 2019).

Koc Holding

Koc Holding was founded in 1926 which had a special focus on construction facilities. With the addition of new product groups and varieties after 1960s, the production areas of Koç Group companies expanded considerably. Construction of two, three and four wheeled vehicles from agro-machinery to fabric, various office equipment to heating equipment, radio and television receivers, refrigerator, washing machine and vacuum cleaner, household appliances such as cooker, oven, glass wool, boiler, radiator and liquid oil gas. The company was working in a wide range of fields from sub-industry to food industry to chain stores, tourism, finance and insurance services. Turkey's first domestic car “Anadol” after the acceleration of domestic economic development Koç Group, Murat, Tempra, held in a Ford Taurus and Ford Escort. In 1979, “Asil Çelik” was the largest heavy industrial facility in the private sector. In the same year, “Karsan” started to produce Peugeot commercial vehicles. “United Oksijen” which produces all kinds of industrial, medical and gas production, was commissioned in Gebze, Istanbul. In 1986, Ford-Otosan started manufacturing diesel engines in İnönü. Koç Group entered the economic life with Koç-American Bank, which he founded in partnership with American Express Company for the same year. The bank was renamed Koçbank. Having entered the new century with a new vision that is globalized globally, the target of Koç Group is to increase the power of technology and brand, to maintain the leadership claim in all it does, to

concentrate on competitiveness, to increase overseas sales and to be one of the leading companies in the world by growing healthily each year (Koc, 2019).

Petkim

Petrochemical Industry is an industrial branch that produces plastic, rubber and fiber raw materials and other organic intermediate goods starting from petroleum refinery products and natural gas. Packaging electronic automotive construction provides input to many sectors such as textiles and agriculture. In other words, petrochemical sector is a locomotive sector providing input to other sectors. The petrochemical sector represents 25% of the total chemical production in Turkey, Petkim is one of Turkey's largest petrochemicals producer these days Chemical Industry in Turkey's largest player. PETKİM was privatized on 30.05.2008 and 51% of its shares were transferred to SOCAR & Turcas Petrokimya A.Ş. With the completion of privatization, work has been accelerated to increase the capacity with high profit margin and layer value creating products. Petkim is one of Turkey's largest industrial companies, 44 years of vast experience and aimed at sustainable growth with its dynamic structure (Petkim, 2019).

THY

THY, which was established on 20 May 1933, was attached to the Ministry of Public Works and remained under the Ministry of National Defense until 1935. In 1984, THY became a State Economic Enterprise with a capital of 60 billion TL. In 1985, with the addition of the A310 aircraft to the fleet, the Far East and Trans-Atlantic flights began about 40 years after the first international flight. Having reached a capital of TL 700 billion in 1990, THY was attached to the Public Participation Administration. Today, T.C. The capital structure of THY, which is affiliated to the Privatization Administration, has changed again with a new public offering in May 2006 and 53.57% of the shares have been traded on the BIST. The remaining 46.43% share still belongs to the Privatization Administration (TurkishAirlines, 2019).

Vestel

Vestel Group of Companies consists of 28 companies, 18 of which are abroad. World production concept in class, innovative and high quality products with a broad vision and not only in our country in the global market, which is also a strong company, guiding the market, Vestel, Turkey's symbol and pride in the export field technology to the world. Vestel technology and design capabilities based on the diversified range of products exported to 155 countries and is the export champion in the electronics sector in Turkey for 21 years. 16 employs over a thousand people, technology development capability and the share of the exports represent an important force for Turkey's economy, Vestel, the first 2 of the European TV market, one of the top 5 manufacturers of white goods market leader in the TV market in Turkey, white goods, the top three in market one of the manufacturer. Taking its place among the most modern and state-of-the-art technology manufacturers in Europe, Vestel carries out all its production in Vestel City, one of the largest factories in Europe, located in Manisa (Vestel, 2019).

Dogan Holding

Doğan Şirketler Grubu Holding A.Ş. took the first steps to the business world with the Honorary President Aydın Doğan registering with the Mecidiyeköy Tax Office in 1959 and establishing his first company in the automotive sector in 1961. Today, Doğan Group companies play a leading role with their innovative visions in the fields of energy, industry, automotive trade, financial services, media and tourism. Group companies, which are open to change with flexible management structures, adopting a quality and customer-oriented management approach, successfully synthesize this understanding with transparent communication and effective team work which are the constant parts of the corporate culture. The corporate and ethical values applied by the Doğan Group with all of its companies represent an example to other institutions in the business world. Aiming to achieve global success in its production activities and commercial activities, Doğan Group closely monitors developments in Turkey

and abroad in all sectors. The Group carries out its activities efficiently through its strategic cooperation with international groups in the wide geography where it operates (Dogan Holding, 2019).

Tupras

Tüpraş, founded in 1983, has a capacity to process 28.1 million tons of crude oil with its four refineries in Kocaeli, İzmir, Kırıkkale and Batman. Tupras, with the added value created by the total income and is the largest industrial company in Turkey. Tüpraş, the 7th largest refining company in Europe, is among the Mediterranean's highest complex refinery companies with an average of 9.5 Nelson complexity index. In 2018, Tüpraş decided to establish a Commercial Office in London in order to further strengthen its operational efficiency through international integration. has taken concrete strategic steps that will provide additional added value from supply and sales chain by incorporating leading players in the sector. In the area of renewable energy, it aims to reduce energy costs and reduce its carbon footprint by prioritizing meeting the energy needs of its refineries. In 2018, Tüpraş continued its digital transformation efforts. From the transformations that will change the business life to the Industry 4.0 concepts that affect the refinery processes, it has started to implement a wide range of projects. In 2018, Tüpraş opened a Data Analytics Center at METU and ITU Technopolis and aims to add value to its high level of data collected from its production and commercial activities through its machinery learning and artificial intelligence algorithms. On the other hand, the Company continued its feasibility studies and compliance with the International Maritime Organization (IMO) amendments to be put into effect in 2020 (Koc, 2019).

Zorlu Holding

Zorlu Holding was established in Denizli in the early 1950s. In the 2000s, Turkey's largest organizations among its name from the textile activities of Zorlu

Holding managed to real estate, are spread over a wide area from electronics to energy. As of 2006, Zorlu Holding operates in four main areas:

- Home textile, polyester yarn

-Electronic products, information technologies and consumer durables

-Energy production

-Real estate

1980 continues to grow with to much work in the home textile field and under the name of Zorlu Holding Textile Group Turkey's created the crown recognized as the brand leader in the home textile Zorlu Holding, Vestel Electronics has added to the organization in 1994. In 1996, the Holding stepped into the energy sector with Zorlu Energy and increased its number of companies. In 2006, he entered the real estate sector. Zorlu Holding, today, 52 companies and approximately 30,000 employees, the future of Turkey and Turkish people work for the quality of life (Tac, 2019).

Garanti Bank

Founded in 1946 in Ankara, Garanti Bank, with the upcoming consolidated assets as of June 30, 2018 to 385 billion Turkish Lira, is Turkey's second largest private bank. Operating in all business segments of the banking sector including corporate, commercial, SME, retail, private and investment banking, payment systems, Garanti has international subsidiaries in the Netherlands and Romania, as well as private pension and life insurance, leasing, factoring, investment and portfolio. An integrated financial services group with financial subsidiaries in management areas. As of June 30, 2018, there are 926 branches in Turkey, seven in Cyprus and one in Malta, eight branches abroad, one in London, Düsseldorf and one in Shanghai, and 15.8 million customers (Garanti, 2019).

TAV Holding

TAV's history began in 1997 with the tender of Istanbul Atatürk Airport International Terminal. TAV was established as a joint venture between Tepe and Akfen Groups. Istanbul Atatürk Airport was one of the first examples of projects realized with the Build-Operate-Transfer model in the world and was put into service in 2000. This project reflects the modern face of Turkey, TAV's success story was also the first concrete step.

With its know-how, highly qualified human resources and advanced technology, TAV has quickly become a global brand in both airport construction projects and in a brand new field such as airport operations. The Company was restructured in 2006 in line with the targets it adopted and organized its operation and construction activities as TAV Airports Holding (TAV Airports) and TAV Construction. Following this arrangement, TAV Airports was offered to the public in February 2007. In May 2012, Group ADP became the majority shareholder of TAV Airports. Group to add new ones to the successful operation every year and continues to

Albaraka Turk

Albaraka Turk Participation Bank founded in 1984 by leading Islamic banking in Turkey in 1985. Middle East's strong capital group Albaraka of the Banking Group (ABG), the Islamic Development Bank (IDB) and the Turkish economy that serve more than half a century as a participation bank established under the leadership of a local industrial group. As of 31.12.2018, in our partnership structure; The share of foreign partners is 65,99%, the share of domestic shareholders is 8,77% and the share of the public is 25,23%.

Tekfen Holding

Founded in 1956, Tekfen is an engineering consultancy company. The uncompromising commitment to global quality standards in business management

has ensured that the company has been constantly growing and stable for over sixty years. Today, Tekfen Holding A.Ş., a subsidiary of Tekfen Construction and Installation Co., Turkey, Middle East, North Africa, the Caucasus and Central Asia, East and has a reputable name as an international contractor with great success in Central Europe. Large-scale activities include heavy construction works to refineries and petrochemical plants; from satellite to large industrial processing facilities; from pipelines and marine structures to power plants, electricity and communication. Together with its strategic partnerships, Tekfen is able to deliver its services to a wide variety of customers worldwide (Tekfen, 2019).

Turk Telekom

Turk Telekom, which has 178 years of history, is Turkey's first integrated telecommunications operator. In 2015, Türk Telekomünikasyon A.Ş., TT Mobil İletişim Hizmetleri A.Ş. was established in order to meet the rapidly changing communication and technology needs of the customers in the most powerful and accurate way. and TTNET A.Ş. has adopted a mevzuat customer-oriented ederek and integrated structure by maintaining its legal personality in its current form and fully complying with the regulations and regulations they are subject to. Türk Telekom, which has a wide service network and a wide product range in the field of individual and corporate services, brought together mobile, internet, telephone and TV products and services under the single brand Türk Telekom as of January 2016.

55% of the Turk Telekom’s shares of LYY (Levent Configuration Management Inc.), 25% of its shares of T.C. The Ministry of Finance and Treasury and the last 5% of Fund assets belong to Turkey. The remaining 15% shares were offered to the public. Türk Telekom A.Ş. shares are traded on the Istanbul Stock Exchange (BIST) as of May 2008. Turkish Telecommunication Inc., mobile operator TT Mobile Communication Services Inc., broadband operator TTNET AS, convergence technologies company Argela Software and Information

Technologies Inc., IT solution provider Innova Bilişim Çözümleri A.Ş., The online training software company Sebit Training and Information Technologies Inc., the call center company AssisTT Guidance and Customer Services Inc., has 100 percent of the wholesale data and capacity service provider Türk Telekom International and its subsidiaries (Turktelekom, 2019).

Sabanci Holding

Haci Omer Sabanci Holding, one of Turkey's largest industrial and financial conglomerate is the parent company of the Sabanci Group companies representing. Sabancı Group consists of 65 companies, almost all of which are leaders of the sectors in which they operate. The main areas of interest of the Sabancı Group are Financial Services, Food and Retailing, Tire, Reinforcement Materials and Automotive, Chemicals and Foreign Trade, Cement, Textile, Energy, Paper and Packaging Materials, Tourism and Information Technologies. Sabancı Holding has subsidiaries in 13 companies listed on the Istanbul Stock Exchange. Sabancı Group companies operate in 12 foreign countries and market their products in Europe, Middle East, Asia, North Africa, North and South America. Its reputation and brand image, strong partnerships and Turkey thanks to the knowledge and experience of the Sabanci Group markets, and growth in its main business areas were opened to the world markets through joint ventures. Sabancı Holding's international partners include Bridgestone, Toyota, Bekaert, Heidelberg Cement, Carrefour, Dia, Hilton International, Mitsubishi Motor Co., International Paper and Philip Morris (Sabanci, 2019).

Halkbank

HalkBank was founded in 1933. The purpose of the establishment is to give cheap loans to tradesmen and industrialists who are small and of common size. Turkey's third largest State-Owned Banks (State Bank) include yurtiçeri is to take its place in a large number of branches and ATMs to engage with. HalkBank started its

operations in 1938 and is located in 159th place among the world's largest banks thanks to its asset size of TL 128,480,000,000.

In the second half of 2004, Pamukbank T.A.Ş. was transferred to T. Halk Bankası A.Ş., and the transfer was completed on 17.11.2004. Halkbank - Pamukbank integration has been carried out without any problems for many years in the banking sector (Halkbank, 2019).

7.2. Application of Merton Model

Credit risk measurement has always been important for banks and other financial institutions. Recently banks have been allocating more resources for this issue than they normally are. The reason for this is that the basis for Basel II proposals is to use the internal resources of the bank to calculate the probability of default of customers used to determine the regulatory credit risk capital.

A popular model for measuring credit risk is Merton's model. In 1974, Robert Merton proposed a model to calculate the credit risk of a company by defining its equity as a purchase option over its assets.

This model assumes that the company has a discounted debt due for a certain T date in the future. In this model, the value of the assets of the firm is assumed to be consistent with the lognormal distribution with a constant volatility. The company has two class assets: equity and debt. Equity does not earn participation income. Debt T is a pure discounted bond with the promise of D payment. If the asset value of the firm is greater than the promised D payment at time T, this amount shall be paid to the debtor and the remaining asset value shall be taken by the shareholders. If the asset value is less than the debt amount, the company falls into default. The borrower takes the payment up to the asset value and the shareholders can take nothing.

The Company's equity is a European purchase option defined on its assets. The maturity date of this option is T and the maturity price is the nominal value of the

maturity. The model can be used to estimate the company's risk-insensitive default or credit risk on debt.

The company's equity value, the value of its assets, and finally the liability are shown as E, A, and L, respectively. In the context of the Merton model, asset value can be calculated as follow:

$$A_T=E_T+L_T$$

After finding the asset value of the companies, the equity value of the companies at time zero can be calculated as:

$$E_0=A_0N(d_1)-Le^{-rT}N(d_2)$$

$$d_1=\ln(A_0e^{rT}/L)/\ \sigma_A\sqrt{T}$$

$$d_2=d_1-\ \sigma_A\sqrt{T}$$

where L is the current debt and the long-term debt, σ_A is the asset volatility, and T is the time to maturity. Now, it is time to estimate probability of default and distance to default:

$$\text{Distance to Default(DD)}=\ln(A_0/L)+(\ \mu-\ \sigma_A^2/2)*T$$

$$\text{Probability of Default (PD)}=N(-DD)$$

At this stage, the default probability and distance to default are estimated and assessed for each company considered in this study.

Table-27 presents the Akbank's PD and DD. Accordingly, findings show a distance to default measure is 4.64 standard deviations for Akbank indicating that Akbank is 4.64 standard deviation away from default. This result leads to a default probability of 0.000 ın 2017. However, in 2018, the Outlook of Akbank slides very badly in that DD decreases to 2.7793 and PD increases to 0.0027 which is very high and indicates very bad asset-liability balance.

Table 26: Akbank's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0027
Distance to Default	4.6414	2.7793
Asset Volatility	0.0746	0.0941

Table-28 gives the findings for Turkcell. It tells that probability of default increases in 2018 in paralell to the shrinking distance to default. In 2017, Turkcell's PD was 0.000 and it stays constant in 2018. So, despite the higher slumping distance to default, default probability of Turkcell is still very low.

Table 27: Turkcell's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0000
Distance to Default	7.4317	3.9768
Asset Volatility	0.1728	0.2005

Aselsan is known with its strong financial form and the results confirms this fact. Accordingly, in both years, Aselsan's PD stays constant at 0.0000 but the distance to default has decreased slightly from 8.9330 to 8.4154.

Table 28: Aselsan's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0000
Distance to Default	8.9330	8.4154
Asset Volatility	0.3957	0.3458

Table-30 presents the PD and DD results for Koc Holding. As observed in many companies, Koc Holdings probability of default stay constant 0.0000 between 2017 and 2018. Again, despite the increased distance to default, probability of default of Koc is very low and shows no sign of distress.

Table 29: Koc Holding's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0000
Distance to Default	5.9975	3.9999
Asset Volatility	0.1098	0.1039

Petkim's PD and DD indicate similarity to other companies. Findings exhibit a distance to default measure of 7.4869 standard deviations for Petkim indicating that Petkim is 7.4869 standard deviation away from default in 2017. In 2018, DD decreases to 3.2128 which makes Petkim closer to the default point. Hence, PD of Petkim raises to 0.0007.

Table 30: Petkim's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0007
Distance to Default	7.4869	3.2128
Asset Volatility	0.2009	0.2295

THY's DD was 3.6367 showing a sign of weakening financial situation in 2017. However, things got worse in 2018 because DD and PP become 2.4645 and 0.0069, respectively. This result shows that THY's distance to default has dropped significantly due to the deteoriated balance sheet.

Table 31: THY's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0001	0.0069
Distance to Default	3.6367	2.4645
Asset Volatility	0.1328	0.1338

Vestel's DD and PD were not good in 2017. DD was 3.0139 indicating a lower than 1 standard deviation away from default and PD was 0.0013 in 2017. However, Vestel's probability of default has continued to increase and become 0.0094 in 2018.

Table 32: Vestel's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0013	0.0094
Distance to Default	3.0139	2.3499
Asset Volatility	0.1443	0.0956

Table 33 indicates the result for Dogan Holding's DD and PP. Dogan Holding is an exception in terms of DD and PD because many of the companies in this study have increased PD and decreasing DD but Dogan Holding's performance was other way around.

Thus, DD and PD for Dogan Holding were 3.1165 and 0.0009, respectively. Then, in 2018, DD and PD became 2.4969 and 0.0063, respectively. Increasing asset and market equity value confirm this observation.

Table 33: Dogan Holdings's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0009	0.0063
Distance to Default	3.1165	2.4969
Asset Volatility	0.1408	0.2785

Table-34 provides information about Tupras's DD and PD in 2017 ans 2018. Again, DD of Tupras has raised from 6.3181 to 4.2181 between 2017 and 2018. This shows that Tupras was nearly 6 standard deviation away from default and its distance to default shrunk to 4.2181 in 2018. However, suprisingly, PD of Tupras were constant at 0.000 between 2017-2018.

Table 34: Tupras's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0000
Distance to Default	6.3181	4.2181
Asset Volatility	0.1728	0.2217

Zorlu Holding's DDs and PDs indicate that sliding outlook does not confine with the banking sector in Turkey. As a big R&D company, Zorlu Holding has a high PD in 2017 and DD shows, Zorlu was 3.2 standard deviation away from default in 2017. The outlook even get worse in 2018 and PD became 0.0091.

Table 35: Zorlu Holding's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0006	0.0091
Distance to Default	3.2450	2.3621
Asset Volatility	0.0121	0.0091

Garanti, as a one of the leading bank in Turkey, has a no default probability in 2017 but default probability in 2018 has increased to 0.0043 which is huge and poses threat to the sustainability of its operations.

Table 36: Garanti's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0043
Distance to Default	4.6665	2.6246
Asset Volatility	0.0866	0.1312

Table 37 reveals the DD and PD results for TAV holding between 2017 and 2018. TAV Holding's financial outlook seem to be strong. In both years, PD stays constant at 0.0000, even though distance to default has decreased from 2017 to 2018.

Table 37: TAV Holding's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0000
Distance to Default	8.2171	4.8044
Asset Volatility	0.2536	0.3788

Another bank in Turkey is Albaraka Turk and it also gives strong sign of weakening. Because, its DD shrunk from 2.8960 to 3.1266 and PDs has also dropped nearly from %0,19 to %0,09. This observation is another sign for weakening financial structure of Turkish banks.

Table 38: Albaraka Turk's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0019	0.0009
Distance to Default	2.8960	3.1266
Asset Volatility	0.0596	0.0404

Tekfen's PD and DD figures stay solid during 2017-2018. In both years, DD was relatively stable and PD were 0.000. Hence, this result shows that asset value of Tekfen outnumbers its liabilities.

Table 39: Tekfen's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0000
Distance to Default	6.2943	5.9413
Asset Volatility	0.2871	0.3416

Table-40 indicates the Turk Telekom's DD and PD figure between 2017-2018. Accordingly, DD of Turk Telekom was 6.0428 and PD was 0.0000 however the DD and corresponding PD was deteoriorated in 2018. PD of Turk Telekom climbed to %0,52 which is a sign of weakened balance sheet of the company.

Table 40: Turk Telekom's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0052
Distance to Default	6.0428	2.5597
Asset Volatility	0.1357	0.0366

Sabanci's, one the largest holding in Turkey, PD has plummet very sharply from 2017 to 2018. PD of Sabanci was 0.0000 in 2017 but it became 0.0002 and its distance to default was 3.5627 standard deviation.

Table 41: Sabanci's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0000	0.0002
Distance to Default	5.3683	3.5627
Asset Volatility	0.0441	0.0487

As observe in many banks, Halkbank's PD and DD got worse between 2017 and 2018. These indicators show huge thread on future operations of Halkbank because PD of Halkbank was 0.0020 in 2017 and 2.8 standard deviation away from default and it was even worse in 2018.

Table 42: Halkbank's Probability of Default and Distance to Default

	2017	2018
Probability of Default	0.0020	0.0091
Distance to Default	2.8765	2.3632
Asset Volatility	0.0597	0.0447

CONCLUSION

In terms of the actors in financial markets, risk is an extremely important concept. In general terms, the risk is the positive or negative deviation between the expected return and the expected return while the probability of loss is objectively identifiable. As a result, with the abolition of the obstacles in globalization and capital flows, international investors started to show more sensitivity to the determination of risk since the 1990s.

Credit risk has been long on the agenda of financial circles in that it is a tool related to claims that have a positive probability of default. Another aspect that makes the credit risk important is that not all investors can get expected return from their investment rather, in the case of default, they can lose their money invested. To this respect, in this study, credit risk modelling is studied.

Merton model is an analysis used to assess the credit risk of a company's liability. Thus, it is a model which make it possible to comprehend the capability of meeting of a company's financial obligation.

In this study, Merton model is applied for 17 companies listed in Borsa Istanbul for the period of 2017-2018. Results are striking in that probability of default is noticeable increasing from 2017 to 2018. In particular, companies operating in banking sector have very high probability of default which is a strong sign of deteoriatred asset-liability balance. In other words, assets may not be adequate to cover Turkish companies liability that poses huge threat to their future operations.

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